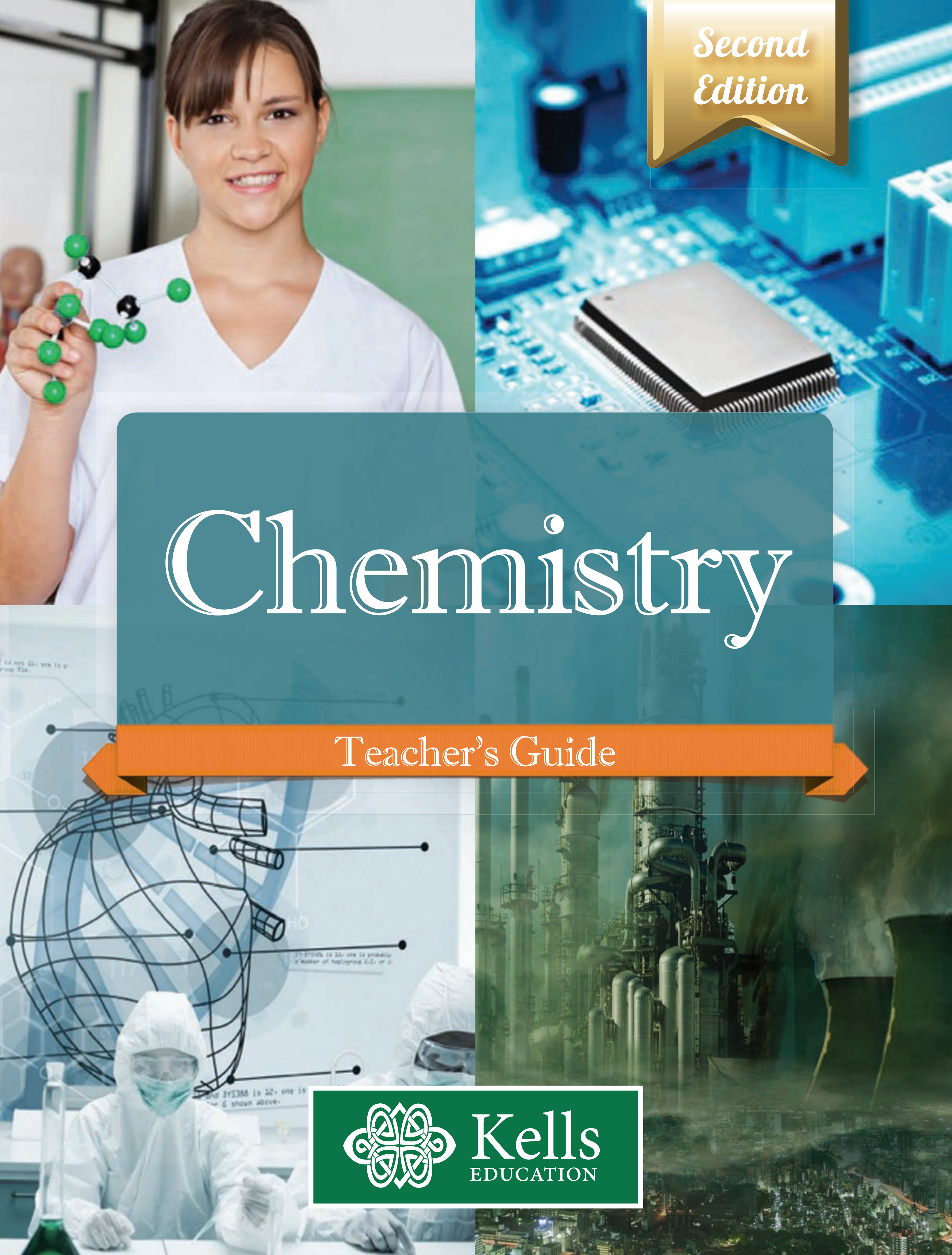

Second Edition

Chemistry

Teacher's Guide

Kells EDUCATION

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Chemistry Teacher's Guide

Kells EDUCATION

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Table of Contents

To the Teacher

Dear teacher,

The book aims to guide you in teaching students to discover chemistry. You will teach about matter and energy and the interaction between them. Students will understand that chemistry is everywhere in the world around us! It's in the food we eat, clothes we wear, water we drink, medicines, and the air we breathe.

As you know, chemistry is known as the "central science" because it is linked to all the other sciences. You will guide students in the lab experiments and projects that encourage them to use their knowledge while working in teams.

The glossary provides new vocabulary to help them in their studies and understanding. There are also tips, recommendations of videos, books and articles that will help them expand their knowledge beyond the classroom.

The skills you teach will help them make informed decisions about what they consume and their understanding of the environmental problems facing the world. So, get ready to lead the way in the fun exploration into Chemistry!

The author

Unit 1 begins with how chemistry and technology relate to humans, health and the environment. Later on, there is the topic of the physical properties of matter, qualitative, extensive and intensive. Then the topic of mixtures is introduced and the unit continues with separating mixes, pollution and concentration of mixtures. The unit ends by introducing The Law of Conservation of Mass.

Unit 2 covers properties of matter and their chemical classification. It starts with the classification of matter and moves on to the importance of recycling metals and then to an introduction of Mendeleev's work. The Periodic Table is introduced and finally, the end of the unit focuses on chemical bonds.

Unit 3 focuses on chemical reactions and begins with identifying chemical changes. It moves on to a focus on food and calories and then on to Lewis and Pauling's contributions to chemistry. Finally, there is the explanation, comparison and representation of measurement scales.

Unit 4 is about the creation of new materials. It starts off with the importance of acids and bases in everyday life and acidic foods and how they should be avoided. The unit ends with the importance of oxide reactions and reductions.

Unit 5 concludes briefly with a project plan based on chemistry and technology. There is also a self-evaluation.

How to use this book

Session Information: In this section, you will see the course pacing as week and session. Consider each session is fifty minutes long to cover a 40 week course and you also have the expected learning outcome.

Content Delivery: In this section, you will see recommendations to deliver information in class.

SESSION INFORMATION

Week: 3

Sessions: 14, 15

Expected learning outcome: Classify different matter based on their state of aggregation; identify their relationship with the physical conditions of the environment.

CONTENT DELIVERY

Start: Elicit definitions that were studied the previous session.

Development: Students should read the section *Qualitative Physical Properties,* which starts on page 15, the entire page 16 and ends on page 17 (The section *To Integrate* will be developed the following session). Ask comprehension-check questions. Give them plenty of examples so they clearly understand Later on, they should draw the qualitative physical properties of matter, according to the information on the page.

Closing: Students are to do the experiment described in the section *Reflect, Explain and Share* on page 17. It might be assigned for homework, considering they will need a device with Internet access.

Homework: Students should get a piece of cardboard and markers.

FIG. 1.18 All these apples are red, but are they equally red?

describe it. The other senses are no exception, despite the relative use of our senses; the description we make of objects is very valuable (Fig. 1.18).

There are certain properties of matter that we can perceive with our senses and are **indisputable**; the states of matter, or states of aggregation, are an example, because their differences are so clear that there is no doubt when you are in the presence of an object in a certain state of matter.

Qualitative properties of matter are those that are descriptive and cannot be measurable, they are related to the quality of things. For example: when temperature and / or pressure vary, materials change; they transform from solids to liquids or from liquids to gases when the temperature rises, a property is affected, but it is still the same matter in a different form, this phenomenon is called physical change (Fig. 1.19).

When we describe a substance as a solid, liquid or gas, what we are describing is their aggregation state, which is a physical property of matter. The most common aggregation states in nature are solid, liquid and gas. Each one of them has characteristics or properties which make them different from each other and therefore, easy to recognize.

FIG. 1.19 When an ice cube melts, a physical change occurs because water is not transformed into a different substance.

Reflect, Explain and Share

Look around your classroom and take note of as many objects as you can. Write a list in your notebook, classifying each of them according to its state. Compare your observations with the class to find out how many of you have the same results.

If an ice cube is heated, we can see it melts and we interpret that as an example of a physical phenomenon since water is not transformed into another substance during this process: solid or liquid is still water! Solids are characterized by a definite shape and volume, which can only change when a force is applied to them. Liquids, on the other hand, are **fluids** that have a definite volume but not a definite shape; they take the shape of the container they are in. Gases have no definite shape or volume and tend to occupy all the available space.

You've been in contact with solids, liquids and gases all the time, and you can easily differentiate them by just looking at them, though explaining their differences may be a bit more complicated; therefore, to explain their properties, the Kinetic Molecular Theory of Matter was formulated.

This theory explains the macroscopic characteristics of the different aggregation states, based on what happens at a **molecular level**. The particles that conform a solid are very close together (they experience strong attractive forces among each other) and they hardly move, they are kept in a definite place and only vibrate; as a result, a solid always has a constant shape (Fig. 1.20).

GLOSSARY

Indisputable. Something that is so obvious and true that there is no argument against it.

Fluid. Any substance that can flow through a tube.

Molecular level. It refers to what happens in the microscopic world of molecules and atoms.

Kinetic energy. Energy due to motion.

FIG. 1.20 Using your sense of touch you can recognize a solid because of the shape it has.

Particles in a liquid state have more **kinetic energy,** they move from one place to another and they are farther from each other than those in a solid state, therefore there is a greater mobility and the forces of attraction between the particles are not so strong. That is why liquids do not have a definite shape, but enough to keep a definite volume.

In a gas, particles have even more kinetic energy, so they move faster than those in a liquid and are widely separated; there is basically no attractive force between them. Gases expand and acquire the shape of the container they are in due to the movement of their molecules which don't grow in size but expand in volume. This means they occupy a lot of space.

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SKILLS DEVELOPMENT

Visual/Spatial skills: Building models.

Reading skills: Scanning, reading for detail.

EVALUATION OF CONTENT

Students should be able to provide with examples.

16

Skills Development: This is the list of strategies you will be using in the session.

Evaluation of Content: This is the description of how you should evaluate learning outcomes.

Projects Rubrics

Aspect	Beginner	In process	Expert
Theoretical framework	The introduction is weak or there are major inaccurate aspects.	The introduction does not fit with the rest of the project or there are minor inaccurate aspects.	The introduction provides with accurate and relevant information.
Project evidence	The project has inaccurate data. It is irrelevant or repetitive and it contains questionable evidence.	The project has minor errors or it is not very elaborated.	The project is clearly explained.
Project design and performance	The variables are not controlled. The study object is not focused. There's a lack of data.	Some variables are controlled. The study object is focused. The data has mistakes.	The variables are under control. The study object is clearly focused. There are few data mistakes.
Conclusion	There is not a conclusion or it is not sustained.	There is a conclusion, but it is weakly sustained.	The conclusion is well sustained.
References	The reference list contains one or two sources but the references are incomplete.	The reference list contains three sources with complete references.	The reference list contains four or more sources with complete references.
Language use	The project is not very clear. It lacks organization, coherency or appropriate grammar use.	The project is clear, with a few flaws on organization, coherency or appropriate grammar use.	The project is coherently described and clearly stated with few grammar and spelling mistakes.
Collaborative work	Not all the members of the team presented or participated.	Some of the members of the team presented or participated.	All the members of the team presented or participated.

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Chemistry
Unit **4 Assessment**

Date: ____________________

Name: ____________________

UNDERLINE THE CORRECT ANSWER

1. A substance, considered acid has a ______________ flavor.
   - **a)** Bitter.
   - **b)** Sweet.
   - **c)** Sour.
   - **d)** Bittersweet.
2. A substance with capacity to donate a proton when reacting with wa
   - **a)** A base.
   - **b)** A salt.
   - **c)** An acid.
   - **d)** A hydronium.
3. A substance considered a base has a ______________ flavor.
   - **a)** Bitter.
   - **b)** Sweet.
   - **c)** Sour.
   - **d)** Bittersweet.
4. The process through which a molecule separates in ions when it is in water is known as:
   - **a)** Electrification.
   - **b)** Ionization.
   - **c)** Dissociation.
   - **d)** Decomposition.
5. Sodium hydroxide (NaOH) is:
   - **a)** A base.
   - **b)** A salt.
   - **c)** An acid.
   - **d)** A hydroxil.
6. Arrhenius theory is quite adequate to explain behavior in water of:
   - **a)** Strong electrolites.
   - **b)** Light electrolites.

Chemistry
Unit **4 Assessment Answer Key**

Match the columns

1. c
2. c
3. a
4. c
5. a
6. b
7. a
8. d
9. c
10. d
11. b
12. b
13. c
14. c
15. a
16. b
17. c
18. c
19. c
20. a

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Summative Assessment: Unit evaluation instruments with answer key.

Rubrics: Rubrics to evaluate students' performance in science.

Attendance list and Evaluation format: These formats will help you keep track of the evaluation procedure specially designed for the content of this book.

Answers to the exercises

Important Note: If there are answers that are not here, it is because they depend on students' own perception or knowledge.

Unit 1
Page 15
To Integrate

Because chemistry studies knowledge we have of materials and substances specially its transformation into other substances. It is the science that generates knowledge and technology directly relating its application in everyday life, to produce and improve food, medicine, clothing, etc.

Page 19
Explain, Reflect and Share

What's the difference between mass and weight? That mass refers to the quantity of matter a body has measured in kilograms. Weight refers to the force on an object due to gravity and it is measured in Newtons.

What is gravity? It is the force with which the mass of a body attracts another.

How is the weight of an object calculated? The weight of an object is calculated by multiplying the mass by gravity. The resulting units are Newtons.

If a person goes to the moon, what changes is his weight because the size of the moon is different to that of the Earth, thus its gravity force is different and when the mass is multiplied by gravity, the person's weight will be different.

Page 25
Explain, Reflect and Share

The solution of sugar in water at 70& is more concentrated since the greater the percentage of mass in a solution is, the more concentrated it will be.

Page 27
Get Started!
Reflect

- No, they cannot be separated.
- Yes, there is more than one way.
- Because it will all depend on the characteristics of the substances.

Unit 2
Page 50
Reflect, Explain and Share

Element, symbol	Number of valence electrons	Number of electrons missing to reach the octet rule	Valence (capacity of creating a bond)
Hydrogen	1	1	1
Helium, He	2	0	0
Lithium, Li	1	7	1
Carbon, C	4	4	4
Oxygen, O	6	2	2
Neon, Ne	8	0	0
Sodium, Na	1	7	1
Sulfur, S	6	2	2
Chorine, Cl	7	1	1
Argon	8	0	0

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Chemistry
Attendance and Evaluation List

School: ______________ School year: ______________ Teacher: ______________

Student's name	Unit attendance																Sequences grades			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16				

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Answers to exercises: Exercises which do not depend on students' own answers have answer key.

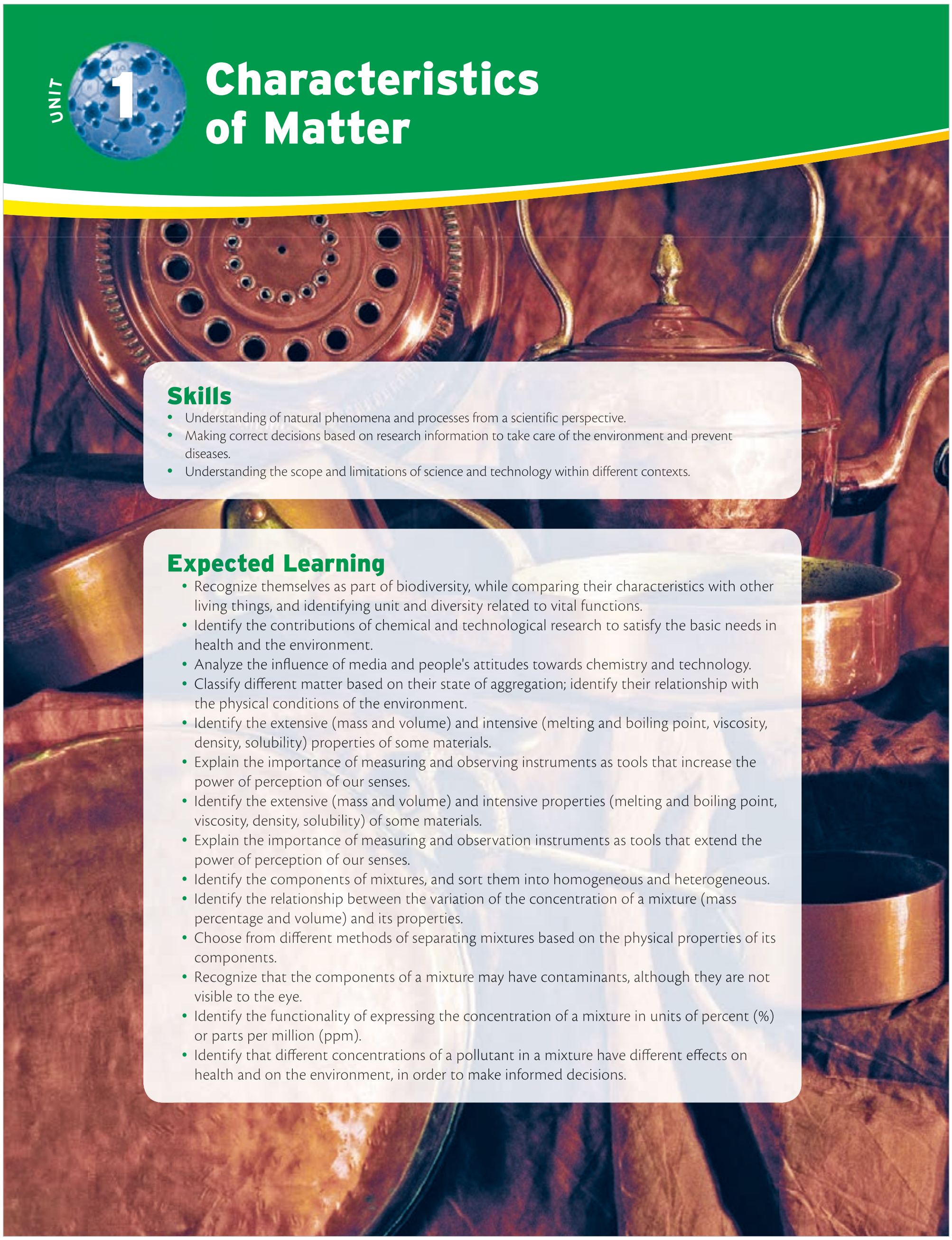
Kells

SESSION INFORMATION

Week: 1

Session: 1

Expected learning outcome: Identify unit content in order to write a study plan.



UNIT 1

Characteristics of Matter

Skills

- Understanding of natural phenomena and processes from a scientific perspective.
- Making correct decisions based on research information to take care of the environment and prevent diseases.
- Understanding the scope and limitations of science and technology within different contexts.

Expected Learning

- Recognize themselves as part of biodiversity, while comparing their characteristics with other living things, and identifying unit and diversity related to vital functions.
- Identify the contributions of chemical and technological research to satisfy the basic needs in health and the environment.
- Analyze the influence of media and people's attitudes towards chemistry and technology.
- Classify different matter based on their state of aggregation; identify their relationship with the physical conditions of the environment.
- Identify the extensive (mass and volume) and intensive (melting and boiling point, viscosity, density, solubility) properties of some materials.
- Explain the importance of measuring and observing instruments as tools that increase the power of perception of our senses.
- Identify the extensive (mass and volume) and intensive properties (melting and boiling point, viscosity, density, solubility) of some materials.
- Explain the importance of measuring and observation instruments as tools that extend the power of perception of our senses.
- Identify the components of mixtures, and sort them into homogeneous and heterogeneous.
- Identify the relationship between the variation of the concentration of a mixture (mass percentage and volume) and its properties.
- Choose from different methods of separating mixtures based on the physical properties of its components.
- Recognize that the components of a mixture may have contaminants, although they are not visible to the eye.
- Identify the functionality of expressing the concentration of a mixture in units of percent (%) or parts per million (ppm).
- Identify that different concentrations of a pollutant in a mixture have different effects on health and on the environment, in order to make informed decisions.

CONTENT DELIVERY

Start: The teacher should introduce himself, the subject, the class schedule, and the grading criteria.

Development: Students should read the objectives. Check how familiar they are with the topics in order to activate prior knowledge and identify how clear the information is for your students.

Closing: Students should identify topics in the unit they consider will be hard to understand in order to make a study plan.

SKILLS DEVELOPMENT

Reading skills: Scanning, skimming, sequencing, reading for detail.

Interpersonal skills: Introducing themselves.

Metacognitive skills: Identifying areas of opportunity.

EVALUATION OF CONTENT

Students should get their study plan checked by the teacher.

➔ Diagnostic Evaluation

Instructions:

1. Look at the pictures

2. Answer the questions.
   - Which images are related to chemistry?
   - Describe how each of the images you chose is related to chemistry.
   - Which images are not related to chemistry? Explain why.
   - Do you consider that increasing your knowledge of Chemistry and its technological applications help in your daily life? Explain why and how.
3. Share your answers.

Science and Technology in Today's World

How Chemistry and Technology Relate to the Human Being, Health and the Environment

Throughout our life, we use different but practical objects such as utensils for eating or glasses for drinking; we also use products such as laundry detergents, skin moisturizing creams or even canned foods. Also, you may have noticed that a piece of paper is transformed into ashes when it is burned, that when we mix and bake flour, eggs, baking powder, sugar and milk, we get a delicious cake or that if you leave a piece of iron outdoors, it **corrodes**.

Like all sciences, Chemistry aims at understanding and explaining the world around us, providing knowledge through findings, as well as studying matter and how it is transformed into other matter, such as for technology.

From prehistoric **metallurgical methods** that allowed the manufacture of bronze objects to space rockets for space exploration nowadays, chemical technology has played a decisive role in the human way of life. If you look around, you'll discover that there are many products that would be impossible to have without the chemical technology like: plastics, medicines, synthetic clothing and canned foods, among others. These products have a great impact on your daily life.

➔ Expected Learning

Identify the contributions of chemical and technological research to satisfy the basic needs in health and the environment.

Analyze the influence of media and people's attitudes towards chemistry and technology.

Glossary

Corrode. Wearing out a surface gradually by friction or by chemical reaction.

Metallurgical methods. Process used for obtaining and treating metals.

SESSION INFORMATION

Week: 1

Session: 2

Expected learning outcomes: Identify the contributions of chemical and technological research to satisfy the basic needs in health and the environment.

Analyze the influence of media and people's attitude towards chemistry and technology.

CONTENT DELIVERY

Start: Organize pairs. Students will answer the section *Diagnostic Evaluation.*

Delivery: Clarify that the evaluation is for you and them to see the starting point of the subject. Have them work in the activities and elicit answers in whole class. Students will read the rest of page 9 and 10. In case they have vocabulary questions, ask them to look up the words.

Closing: Organize teams of three or four people. Students will prepare the activity in the section *Get Started* on page 10 to present it the following two sessions. Help them as necessary so that students have a clear idea of what they have to do. Explain what you will evaluate in their presentation (Check the projects rubrics on page 157).

SKILLS DEVELOPMENT

Humanistic skills: Personalization.

Critical thinking skills: Analyzing, observing.

Logical/Mathematical skills: Discovering relations.

EVALUATION OF CONTENT

Eliciting answers to the diagnostic evaluation or asking them to write their answers down on a piece of paper.

SESSION INFORMATION

Week: 1

Sessions: 3, 4

Expected learning outcomes: Identify the contributions of chemical and technological research to satisfy the basic needs in health and the environment.

Analyze the influence of media and people's attitude towards chemistry and technology.

CONTENT DELIVERY

Start: Ask students to get together with their teammates and elicit if they had trouble doing their project. Give suggestions on how they can improve their teamwork.

Development: Teams should present their projects.

Closing: Students should self-evaluate their presentations. Help them identify what they should improve for their following presentations.

Homework: Students should get three pieces of clothing they like from their wardrobe.

Get started!

In which daily activities is chemical technology present?

1. In your notebook, make a list of activities that you do on any given day.
2. Identify some of the technological products that influence your activities from that list, for example, fuel.
3. Choose three of the products you identified. Research how these products are manufactured.
4. Make a poster illustrating the information you found. Do not forget to include references to the sources of information you consulted.
5. Present your poster to the class.

FIG. 1.1 Styrofoam materials take a long time to biodegrade; they accumulate and pollute the environment.

Going further

It is important to note that, while scientific knowledge has no ethical implications by itself nor can it be judged as positive or negative, it is a way of explaining the world. The application of its knowledge to generate technology has important ethical and moral implications.

What happens is that even though technology has improved the quality of life of individuals, it has also had some adverse consequences. Consider the case of polystyrene, known as Styrofoam, that spongy white material that is used for making disposable plates and cups: although its use allows for a more comfortable lifestyle, it takes a long time to biodegrade therefore pollutes the environment (Fig. 1.1).

Others are harmful and destroy the environment such as mustard gas, causing burns on the skin and affecting the respiratory system of soldiers during wars (Fig. 1.2).

All humans have a number of needs to live decently. Thanks to chemical and technological contributions, certain levels of welfare have been gradually achieved. If you observe and analyze the involvement of chemistry in the things you use every day, you'll find it has a profound impact on the food you eat, the fabrics you wear, the medicines that are prescribed to keep healthy and the plastic objects you use for several tasks (Fig. 1.3).

One of the basic needs of every human being is food, but in modern societies only a small part of the population is engaged in growing food, fishing and animal breeding to meet the world's food demand. To provide sufficient food for so many people, several technologies based on chemistry have been developed and implemented.

Biological knowledge about the nutritional needs of plants, along with chemical knowledge about how to produce these nutrients, have allowed the creation of a huge global industry dedicated to the production and marketing of artificial fertilizers, through which agricultural production has managed to increase (Fig. 1.4).

FIG. 1.2 The use of mustard gas to harm enemy soldiers in war is an example of how technology can be used to destroy.

FIG. 1.3 Many of the products you use are obtained through the application of chemical knowledge.

FIG. 1.4 Artificial fertilizers are added to many crops to provide plants with the nutrients they need to grow.

10

SKILLS DEVELOPMENT

Interpersonal skills: Teaching others, working as team members.

Critical thinking skills: Doing research.

Metacognitive skills: Self-monitoring, self-evaluating.

EVALUATION OF CONTENT

Check students' posters and presentation.

FIG. 1.5 In crops that cover large areas, insecticides are spread by crop dusters.

FIG. 1.6 Animals are vaccinated to keep them healthy.

Glossary

Insecticide. Technological product used to eliminate unwanted insects.

Herbicide. Technological product used to eliminate unwanted plants.

Preservative. A chemical substance that is added to processed foods to prevent decomposition.

Synthetic fibers. Artificially produced fibers that are commonly used in the textile industry.

Medicine. A substance used to prevent, cure or alleviate any disease, pain or discomfort.

One problem with modern farming is the proliferation of pests and diseases that can quickly devastate a region, causing a loss of the expected production. In order to prevent such disasters, the chemical industry has developed various **insecticides** and **herbicides** to keep crops free of pests (Fig. 1.5).

Now the challenge is to develop techniques and substances that allow crop fertilization and pest elimination without being so aggressive to the environment.

In addition to agricultural production, chemistry has also had a major impact on livestock production. Thanks to chemical knowledge, food to nourish and accelerate the growth of the animal have been developed, and medicines and vaccines have been created to ensure their health (Fig. 1.6).

On the other hand, chemistry has been actively involved in the development of industrialized foods. Processed foods, such as canned and packaged goods, usually have **preservatives** that make them last longer without rotting, as well as additives to improve their color, taste and nutritional value. With today's lifestyle, most people have some kinds of processed food at home (Fig. 1.7). Are there any industrialized foods in your home?

FIG. 1.7 Processed foods contain chemical preservatives to prevent food spoilage.

Reflect, Explain and Share

- Go to the website www.youtube.com ; search for homemade organic insecticide, and play the video. Follow the instructions to make your own organic insecticide. You can substitute neem seeds with a large handful of lemon grass or two teaspoons of citronella extract.
- Ask for permission to use this insecticide at home and use it for a week to test it. Did it work? Share the recipe you used with your family and people in your community, talk to them about the benefits of the insecticide not being toxic to plants, humans or animals.

It is not an easy task to feed the current population of our planet, and neither is it to cover the basic needs of clothing for so many people. Much chemical research has been dedicated to finding new materials that can be used to make fibers. Nylon, lycra (or spandex), polyester and rayon, are examples of **synthetic fibers** that are often used in the textile industry.

Today, synthetic fibers are more versatile than natural (Fig. 1.8). Polyester, for example, is used to produce sewing thread, manufacture artificial leather products (plastic leather). It is used to make fabrics suitable for light shirts and resistant parachutes. It all depends on the finishing process. (Fig. 1.9).

Medicines are an important product of technological advance and a great example of how chemistry has been used to improve and maintain our health.

Health has improved with drugs. Not only has the quality of life improved, but also life expectancy.

FIG. 1.8 Synthetic fibers are used to manufacture everything from shoes to jackets.

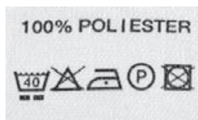


FIG. 1.9 Polyester is a synthetic fiber widely used in the textile industry.

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SESSION INFORMATION

Week: 1

Sessions: 5, 6

Expected learning outcomes: Identify the contributions of chemical and technological research to satisfy the basic needs in health and the environment.

Analyze the influence of media and people's attitude towards chemistry and technology.

CONTENT DELIVERY

Start: Students will read the glossary, which is in the extreme top right of the page. Elicit definitions.

Development: Students should read the first part of the page, which refers to insecticides. Ask comprehension-check questions. Elicit answers in whole class.

Closing: Ask students to take out the clothes they could get. They should examine the tag and find what kind of fabric it is. In teams of four or five, they should graph the results stating the different types of fabric they find. Students should do the activity in the section *Reflect, Explain and Share* on page 12. Elicit answers.

Homework: Students should make some kind of craft with a pet bottle. Insist that they do not buy more bottles; they should use one bottle from the trashcan instead.

SKILLS DEVELOPMENT

Reading skills: Scanning, reading for detail.

Humanistic skills: Personalizing.

Visual/Spatial skills: Graphing information.

EVALUATION OF CONTENT

Check students' graphs.

SESSION INFORMATION

Week: 2

Sessions: 7, 8

Expected learning outcomes: Identify the contributions of chemical and technological research to satisfy the basic needs in health and the environment.

Analyze the influence of media and people's attitude towards chemistry and technology.

CONTENT DELIVERY

Start: Students should present their crafts to start with the class. Ask where they got the idea from and if they have any idea how much pet is produced every year. Elicit answers.

Development: Students should read the page and the top of page 13. Ask students to mind map the information regarding pet production.

Closing: Check students mind maps on pet production, described on page 12 and top of page 13.

Homework: Students should take to the following class some environmentally friendly product and some regular product, an organic piece of food and a regular one. It is important that they buy the products themselves to compare prices.

Glossary

Health. State in which a living being performs all its functions normally.

Active ingredient. Is the substance in a pharmaceutical drug that has a therapeutic effect and is biologically active.

Greenhouse effect. Phenomenon by which certain gases in the atmosphere retain some of the Earth's heat.

Reflect, Explain and Share

If a car is moving at 120 km/hr from south to north, what is its speed and what is its velocity? Choose five favorite articles of clothing. Check the tags for the materials. Add the information to a table like the one below. Categorize the materials as natural or synthetic.

	Piece of Clothing	Composition	Natural or Synthetic?
1	T-shirt	95% cotton 5% spandex	Cotton: natural Spandex: Synthetic

- According to the information you obtained, what kind of fibers are the most commonly found in your favorite clothes, synthetic or natural? Share your information with your classmates and find out what type of fibers (synthetic or natural) are more used in the group. Reflect as a group on how your life would change if there were no synthetic fibers.

FIG. 1.10 There are many drugs that help us control and cure diseases.

As chemistry started to develop as a science, curiosity towards remedies and their therapeutic effect began. Scientists started studying and recognizing the **active ingredient** of the remedy. Once they know the ingredient, scientists determine if it can be synthesized in a lab to produce the medicine, how the active ingredient can be transformed and what benefits or toxic consequences it can bring. The large-scale synthesis of an active ingredient and its commercialization in the form of pills, injectable solutions and syrups, helps meet the demand for health and population welfare (Fig. 1.10).

In relation to the environment, technology has both a negative and a positive impact. Negative because, unfortunately, technological products are usually obtained from industrial processes that pollute, or even harm the environment. And positive because technology can sometimes reverse the damage done to the environment. Polyethylene terephthalate (PET) is a highly resistant synthetic plastic that is used to make containers and commercialize from soft drinks and water, to cosmetics, such as creams and shampoos. The use of PET in the manufacture of bottles became popular in the late twentieth century. If you analyze the packaging of the products around you, you will notice that PET is a very commonly used material (Fig. 1.11). Can you imagine how life would be without this material in our everyday life?

FIG. 1.11 PET is a widely used plastic used to commercialize a lot of products.

PET containers are produced in large industrial plants that are powered by electricity produced by burning fossil fuels (natural gas, oil and coal), which generate carbon dioxide (CO^2). This gas is excessively harmful because it encourages the **greenhouse effect** and global warming, in other words, an abnormal increase in global temperature. This, of course, is a negative impact of technology on the environment (Fig. 1.12).

PET takes a long time to biodegrade, it accumulates, causing a serious waste problem.

Fortunately, chemistry also helps to improve the quality of the environment, lessening the impact of using technological resources. In the case of PET, the impact is lessened by recycling and re-producing packaging containers, or making fabrics that can later be used for shirts, bags and many other items. (Fig. 1.13 and 1.14, page 13).

FIG. 1.12 The use of fossil fuels for producing PET containers generates large amounts of carbon dioxide (CO_2).

12

SKILLS DEVELOPMENT

Critical thinking skills: Mind mapping.

Humanistic skills: Personalizing.

Visual/Spatial skills: Building models.

EVALUATION OF CONTENT

Students should get their mind map checked by the teacher.

Regarding CO_2, technological methods have also been implemented. One of the most promising methods, the so-called "carbon capture and storage", consists of collecting CO_2 from exhaust stacks and deposits buried under forests and green areas. The expectation is that the carbon dioxide stored underground comes up slowly to the surface, so that it can be used by plants which, unlike humans, require CO_2 to perform photosynthesis. (Fig. 1.15).

FIG. 1.13 PET accumulates causing a serious problem to the environment.

FIG. 1.14 PET packaging containers can be **recycled** to make fabrics.

Influence of media and personal attitudes towards chemistry and technology

In chemistry, a substance that can be transformed into another is called **chemical**. Chemical substances are also called *chemical compounds*, *chemical products* or just *chemicals*. The point is that all the substances we know, from oxygen to water can be transformed into others. This means that all substances are chemicals. As you can conclude, when a commercial product is advertised as "chemical free" it may not indicate that it has no chemical substances, because all known substances are chemical compounds. So what does it mean? (Fig. 1.16),

Chemicals are divided into two categories: natural (obtained directly from nature) and synthetic (which can only be produced in a laboratory). Therefore, when a product says "contains no chemicals," it actually refers to any of the following descriptions:

- That it only contains naturally produced chemical substances (i.e., that can be directly obtained from nature).
- That it does not contain toxic chemicals (such as some pesticides or substances that have proven to be harmful).
- That it does not incorporate additives (chemicals that are added to a product to improve its appearance and durability, as flavorings, colorings and preservatives).

We also find **organic** or biological **products**, which means that these products were obtained by ensuring that plants and animals are not exposed to toxic chemicals, such as synthetic pesticides or additives (Fig. 1.17).

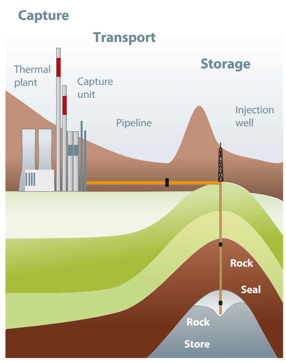


FIG. 1.15 CO_2 emanating from factories can be captured and stored in underground tanks.

FIG. 1.16 Some products claim to be *chemical free*.

FIG. 1.17 Organic products are free of synthetic substances and avoid the use of any kind of additives and compounds that may be toxic.

GLOSSARY

Chemical. Any substance that can be transformed into another. All substances we know, even water, are chemicals.

Recycle. Subjecting a material to a process so that it can be reused.

Organic product. A product that was obtained without the use of additives, synthetic chemicals or toxic substances.

13

SESSION INFORMATION

Week: 2

Sessions: 9, 10

Expected learning outcomes: Identify the contributions of chemical and technological research to satisfy the basic needs in health and the environment.

Analyze the influence of media and people's attitude towards chemistry and technology.

CONTENT DELIVERY

Start: Organize teams of three or four students. Ask students to take out the products and write a comparative chart; including the price, odor and any other characteristic they can contrast.

Development: Students will read the section *Influence of media and personal attitudes towards chemistry and technology.* Ask them to complete their comparative chart with the information they can find in the section.

Closing: Check students' comparative charts.

Homework: Organize teams of three or four members. Ask students to get the materials for the lab practice. The materials list is on page 14 in the section *Hands on Chemistry!*

SKILLS DEVELOPMENT

Critical thinking skills: Comparing and contrasting.

EVALUATION OF CONTENT

Students should get their comparative chart checked by the teacher.

SESSION INFORMATION

Week: 2

Sessions: 11, 12

Expected learning outcomes: Identify the contributions of chemical and technological research to satisfy the basic needs in health and the environment.

Analyze the influence of media and people's attitude towards chemistry and technology.

CONTENT DELIVERY

Start: Check that teams have all the materials they need for the lab practice.

Development: Students should make silly putty in the experiment.

Closing: Students should write the report, which is explained in the section *Hands on Chemistry! (Explain)* In the lowest part of the page as well as doing the activities described on page 15, in the section *To integrate,* which can either be done in class or be done for homework. For the section *To Integrate* you can check the answers on page 161.

There are hundreds of synthetic and natural chemicals that have important uses, for example, fabrics made of synthetic fibers, such as polyester, and natural fibers such as cotton. There are synthetic and natural medicines like aspirin and tea willow bark; natural foods, such as sugar, and synthetic, such as sucrose (sold under the name of artificial sweetener). Although there is a general feeling that natural products are better than synthetic because they have fewer adverse effects on health and the environment, it is important to take into account that many scientific advances are due to synthetic chemicals.

Hands on Chemistry!

SILLY PUTTY

Introduction

Synthetic fibers such as nylon and lycra, and many plastics, such as PET, are polymers that do not exist in nature and are industrially produced in large chemical reactors. In this experiment you will produce your own polymer: putty.

Putty is a polymer that is made with polyvinyl acetate (the main component of white glue) and sodium tetraborate or borax.

You will need:

- 2 100 ml beakers
- A watch glass or wax paper
- A spatula
- A balance
- A paper napkin
- 20 ml of white glue
- 20 ml of tap water
- 2 g of sodium tetra borate (also called sodium borate or borax, you can find it in drug stores or hardware stores).
- Five drops of food coloring in your favorite color (you will find it in the supermarket, it is used to color food).

Preventive measures:

- Do not ingest or inhale the borax.
- Do not eat the putty.
- The experiment requires adult supervision.

Procedure

Work with your class in teams of five or six people.

1. Place the watch glass or waxed paper on the balance and, with the spatula, weigh 2 g of borax.
2. Add 20 ml of tap water in one of the beakers (use the markings on the vessel to measure the required quantities). Then, add the borax to this glass of water. Stir with the spatula. When finished, remove the spatula and wipe it with a napkin.
3. Add 20 ml of liquid glue and five drops of food coloring into the other beaker. Use the spatula to mix the dye.
4. Pour the borax solution and water into the beaker containing the dye and liquid glue. Use the spatula to mix everything.
5. When the mixture becomes thick, take it out of the beaker and put it on the napkin to remove excessive liquid. Then, knead with your hands.
6. Ready? You have made putty! Try heating it a little by rubbing it in your hands; it is fun to see how far you can stretch it!

The putty can last a long time if you store it in a sealed plastic bag. When it dries, add a few drops of water on it and knead it with your hands.

Explain

Prepare a report explaining the procedures you followed in this experiment, use pictures to illustrate the procedure. This report should be part of your *Hands on Chemistry!* portfolio of evidence.

14

SKILLS DEVELOPMENT

Naturalistic skills: Doing an experiment.

Verbal/Linguistic skills: Writing a procedure.

Writing skills: Writing process.

EVALUATION OF CONTENT

Students should get their reports checked by the teacher.

INTEGRATIVE
Activity

To integrate

Work in groups to answer the questions:

- Why is it important to study chemistry? What is the difference between studying chemistry and technology? How does technological chemistry impact our everyday life? What ethical and moral implications does the use of technological products have, taking into account that they often cause deterioration in the environment?
- How has chemical knowledge lessened the negative effects caused by the use of technology? Look for some examples.

Based on your answers, ask the following question: Should we not use chemistry anymore? Write the conclusions of the discussion in your notebook.

Closing up!

Part of the study of nature is a responsibility of chemistry. We have used technology as a base for manufacturing many products, but many of them have damaged our environment. However, the responsibility of using the products does not only lie on chemistry or on the professionals who study it, but on consumers.

Identifying the Physical Properties of Matter

Qualitative Physical Properties

Expected Learning

Classify different matter based on their state of aggregation; identify their relationship with the physical conditions of the environment.

Our perception and description of the world depends on the stimuli we receive. Chemistry studies the type of **matter** that makes up the world around us, its components and elements; matter is life itself and the universe. Matter has different properties and characteristics that are involved in different processes. Matter is classified based on these processes.

Get started!

Describing the matter

1. Find a fruit or vegetable in the kitchen in your house. In your notebook, write down a detailed description of it; draw sketches, make reference to its use, but DON'T mention its name.
2. Share your description with a partner. Were they able to guess based on your description? If they do not identify it, write down the food that your classmates mentioned.
3. Is it difficult to identify an object with a simple description?

Glossary

Matter. Refers to the subsstances that conform an object.

Relative. Arguably. Could be questionable. Something not absolute.

Going further

Matter has several properties that, in some cases, we can describe by using our five senses. This appreciation, in many cases, is **relative** and depends on factors other than the properties themselves. We can perceive even more variations that do not depend on the object but on our sense of sight; the perception of color can vary from one person to another due to health status and to the quality of the image perceived by each person, according to his/her visual capacity. Smell is another sense that we can use to describe the characteristics of an object or material. The ability to smell and the memory everyone has regarding odors influences what we perceive and how we

SESSION INFORMATION

Week: 3

Session: 13

Expected learning outcome: Classify different matter based on their state of aggregation; identify their relationship with the physical conditions of the environment.

CONTENT DELIVERY

Start: Write on top of the board the words: Matter, Qualitative Physical Properties, Intensive properties and Extensive Properties. Along with your class, define each concept. Have students write down the definitions you give. (Check the definitions on pages 15 to 20).

Development: Organize pairs. Students are to do the introductory activity described in the section *Get started!* Have them work first in pairs and then mix pairs to perform all the activity.

Closing: Elicit answers.

SKILLS DEVELOPMENT

Critical thinking skills: Defining concepts.

Naturalistic skills: Observing details.

Verbal/Linguistic skills: Describing objects.

EVALUATION OF CONTENT

Check that students both write their description and share it with another partner.

SESSION INFORMATION

Week: 3

Sessions: 14, 15

Expected learning outcome: Classify different matter based on their state of aggregation; identify their relationship with the physical conditions of the environment.

CONTENT DELIVERY

Start: Elicit definitions that were studied the previous session.

Development: Students should read the section *Qualitative Physical Properties*, which starts on page 15, the entire page 16 and ends on page 17 (The section *To Integrate* will be developed the following session). Ask comprehension-check questions. Give them plenty of examples so they clearly understand Later on, they should draw the qualitative physical properties of matter, according to the information on the page.

Closing: Students are to do the experiment described in the section *Reflect, Explain and Share* on page 17. It might be assigned for homework, considering they will need a device with Internet access.

Homework: Students should get a piece of cardboard and markers.

FIG. 1.18 All these apples are red, but are they equally red?

describe it. The other senses are no exception, despite the relative use of our senses; the description we make of objects is very valuable (Fig. 1.18).

There are certain properties of matter that we can perceive with our senses and are **indisputable**; the states of matter, or states of aggregation, are an example, because their differences are so clear that there is no doubt when you are in the presence of an object in a certain state of matter.

Qualitative properties of matter are those that are descriptive and cannot be measurable, they are related to the quality of things. For example: when temperature and / or pressure vary, materials change; they transform from solids to liquids or from liquids to gases when the temperature rises, a property is affected, but it is still the same matter in a different form, this phenomenon is called physical change (Fig. 1.19).

When we describe a substance as a solid, liquid or gas, what we are describing is their aggregation state, which is a physical property of matter. The most common aggregation states in nature are solid, liquid and gas. Each one of them has characteristics or properties which make them different from each other and therefore, easy to recognize.

FIG. 1.19 When an ice cube melts, a physical change occurs because water is not transformed into a different substance.

Reflect, Explain and Share

Look around your classroom and take note of as many objects as you can. Write a list in your notebook, classifying each of them according to its state. Compare your observations with the class to find out how many of you have the same results.

If an ice cube is heated, we can see it melts and we interpret that as an example of a physical phenomenon since water is not transformed into another substance during this process: solid or liquid is still water! Solids are characterized by a definite shape and volume, which can only change when a force is applied to them. Liquids, on the other hand, are **fluids** that have a definite volume but not a definite shape; they take the shape of the container they are in. Gases have no definite shape or volume and tend to occupy all the available space.

You've been in contact with solids, liquids and gases all the time, and you can easily differentiate them by just looking at them, though explaining their differences may be a bit more complicated; therefore, to explain their properties, the Kinetic Molecular Theory of Matter was formulated.

This theory explains the macroscopic characteristics of the different aggregation states, based on what happens at a **molecular level**. The particles that conform a solid are very close together (they experience strong attractive forces among each other) and they hardly move, they are kept in a definite place and only vibrate; as a result, a solid always has a constant shape (Fig. 1.20).

Glossary

Indisputable. Something that is so obvious and true that there is no argument against it.

Fluid. Any substance that can flow through a tube.

Molecular level. It refers to what happens in the microscopic world of molecules and atoms.

Kinetic energy. Energy due to motion.

FIG. 1.20 Using your sense of touch you can recognize a solid because of the shape it has.

Particles in a liquid state have more **kinetic energy**, they move from one place to another and they are farther from each other than those in a solid state, therefore there is a greater mobility and the forces of attraction between the particles are not so strong. That is why liquids do not have a definite shape, but enough to keep a definite volume.

In a gas, particles have even more kinetic energy, so they move faster than those in a liquid and are widely separated; there is basically no attractive force between them. Gases expand and acquire the shape of the container they are in due to the movement of their molecules which don't grow in size but expand in volume. This means they occupy a lot of space.

SKILLS DEVELOPMENT

Visual/Spatial skills: Building models.

Reading skills: Scanning, reading for detail.

EVALUATION OF CONTENT

Students should be able to provide with examples.

Kells

➔ Reflect, Explain and Share

- Visit http://goo.gl/Nz6c and start the simulation (press the "on" button on the image displayed) to see how an increase in temperature causes a change in the kinetic energy of the particles resulting in the aggregation state.
- Copy the following table in your notebook to compare the aspects of a solid, a liquid and a gas:

Aggregation State	Temperature	Kinetic energy of the particles	Separation between particles	Attraction between particles
Solid				
Liquid				
Gaseous				

For a substance to change from solid to liquid or from liquid to gas, the kinetic energy of its particles must increase, There are two ways to cause this: by increasing the **temperature** or by decreasing the **pressure**. Raising the temperature of an object means heating it, causing the particles to increase their kinetic energy. The aggregation state of a substance depends on the environment in which it is located.

Changes in pressure also affect the state of aggregation of a substance: if the pressure is low, the particles have more freedom to move, so lowering the pressure of a liquid, for example, causes the substance to easily pass to the gaseous state. Opposed to this, increasing the pressure in a gaseous substance will move it into a liquid state. This phenomenon can be observed in the operation of a lighter (Fig. 1.21).

FIG. 1.21 The gas inside a lighter is under a pressure 12 times greater than atmospheric pressure.

Lighters contain a liquid mixture of **propane** and **butane**, two substances that are usually gases, but if they are packaged in a container increasing the pressure inside, we can see them as liquids.

Many natural phenomena that maintain life on our planet depend on the changes in the states of aggregation, such as the water cycle.

To integrate

Draw a mind map on a piece of cardboard describing the three main states of aggregation of matter. Illustrate it and organize an exhibition. Give a title, such as: "Observing the World through the States of Aggregation".

Closing up!

The world we know is full of different substances, many can be identified and sorted through our senses by the quality of its properties, some may be relative, but others are very precise because of how matter behaves, as in the case of states of aggregation.

Extensive Properties

Qualitative properties give us information about the objects around us, but most of the time these properties are not enough.

Going further

Qualitative properties allow a general comparison of substances, but they do not fully describe an object: there are many details that are beyond our sensory perception. Therefore, to describe, it is necessary to **measure** these properties. This is especially important for science, because the manipulation of the environment is an essential part of scientific experimentation and requires a

Glossary

Temperature. Average kinetic energy of the particles in a sample of matter.

Pressure. Force exerted by a gas, a liquid or a solid per unit area.

Propane. Gas used as fuel and which is extracted from oil.

Butane. Gas used as fuel, obtained from oil and natural gas and which is intended for domestic and industrial use.

Measure. The comparison of a property with an established pattern to assign a numerical value.

➔ Expected Learning

Identify the extensive (mass and volume) and intensive (melting and boiling point, viscosity, density, solubility) properties of some materials.

Explain the importance of measuring and observing instruments as tools that increase the power of perception of our senses.

SESSION INFORMATION

Week: 3

Sessions: 16, 17

Expected learning outcome: Classify different matter based on their state of aggregation; identify their relationship with the physical conditions of the environment.

CONTENT DELIVERY

Start: Check students' table in the section *Reflect, Explain and Share*. Elicit answers in whole class.

Development: Students should do the activity described in the section *To Integrate*. They will be using the cardboard and markers that they were told to take to class.

Closing: Check students mind maps.

SKILLS DEVELOPMENT

Critical thinking skills: Mind mapping.

EVALUATION OF CONTENT

Students should get their mind map checked by the teacher.

SESSION INFORMATION

Week: 3

Session: 18

Expected learning outcomes: Identify the extensive (mass and volume) and intensive (melting and boiling point, viscosity, density, solubility) properties of some materials.

Explain the importance of measuring and observing instruments as tools that increase the power of perception of our senses.

CONTENT DELIVERY

Start: Elicit the definition of Extensive Properties. Students should give their definition as clearly as possible.

Development: Students should read from the section *Extensive Properties*, the starting on page 17, and the entire page 18. Have students do the recipe analysis.

Closing: Elicit results.

Homework: Students should go back to their Physics book (Second junior high school or Seventh school year) or the Internet to answer the questions in the section *Reflect, Explain and Share*, which refer to the properties of matter.

FIG. 1.22 Measuring length accurately is essential in some activities.

Glossary

Quantitative properties. Characteristics that are likely to be measured, and reported with a numerical result in units.

Malleability. Property of an object to acquire different shapes without breaking.

International System of Units. International agreement on the units to be used for different measurements.

FIG. 1.23 Measuring and quantifying the properties of the substances has many practical applications.

thorough description of the substances. The more you know about a system, the more you will be able to predict what might happen (Fig. 1.22).

The properties of matter that can be measured are called **quantitative properties**.

Depending on the property to be measured, different units or standards of measurement and measuring instruments are used. For example, to measure the length of an object we use a ruler or a tape with units in centimeters or meters, while for measuring its mass, we use a balance or scale, with units in grams or kilograms.

Quantifying has many practical applications in everyday life. Most of the products that we buy are measured under a known pattern, such as grams, kilograms, meters centimeters, liters, and other units of meassurment (pounds, miles, etc.), while services are measured in units of time: hours, minutes, etc.

Reflect, Explain and Share

Imagine that you want to make pancakes. You find recipes in two different cookbooks and find that you need the following ingredients:

Ingredients	Book 1	Book 2
Flour	1 cup	120 gr
Butter	1 stick and a quarter	112.5 gr
Sugar	1/2 cup	75 gr
Eggs	1 and 1/2	97.5
Milk	1 cup	150 mL
Salt	2 teaspoons	30 gr

What are the differences in the recipes? Which recipe is qualitative and which one is quantitative? Which recipe would allow you to prepare pancakes of the same quality every time? Discuss with your classmates the importance of quantifying the properties of substances and write a conclusion in your notebook.

Among the quantitative properties we have the extensive properties, which are related to the external chemical structure, and which depend on the amount of matter that an object has and that can be easily measured, for example, the mass or volume.

Imagine you have a piece of clay and suddenly you divide it into two parts, which properties change? Though its color, texture and **malleability** will remain the same, the new portions will be lighter and will occupy less space than the original piece.

Mass is the measure of the amount of matter that an object has (Fig. 1.23).

The official unit of the **International System of Units** for this property is the kilogram (kg), but it can be measured with other units:

Gram (g)	1000 g = 1 kg
Pound (lb.)	2,205 lb. = 1 kg
Ounce (oz.)	35.27 oz. = 1 kg

To measure the mass of an object, a scale or balance is used. Liquids and gases also have a specific mass, but it is not as simple to measure.

SKILLS DEVELOPMENT

Naturalistic skills: Observing details.

EVALUATION OF CONTENT

Students should get their analysis checked by the teacher.

Reflect, Explain and Share

Although they could be considered synonyms, mass is not the same as weight. When in common language it is said that something is "weighed" on a scale or balance, in fact what is being done is measuring its mass (in kilograms). Visit http://goo.gl/u06a2, work on the activity and then answer the following questions in your notebook:

- What is the difference between mass and weight?
- What is gravity?
- How do you calculate the weight of an object?
- If a person goes to the moon, what changes: his mass or his weight? Why?

FIG. 1.24 To measure the mass of a liquid, a container is required.

Measuring the mass of a liquid substance is a little more complicated than measuring a solid object, since liquids cannot be placed directly on the scale (Fig. 1.24).

To measure the mass of a fluid, an empty container is placed on the balance and it is measured. After that, the liquid is poured into the container and then it is measured again. The liquid mass is calculated by subtracting the measurement of the mass of the empty container from the mass of the vessel containing the liquid. In the case of gases, the procedure is the same, with the difference that the container to be used must be sealed to prevent gas dispersion. The volume is the amount of space occupied by an object, and just as the mass, it is another extensive property of matter.

FIG. 1.25 Although both of these materials have a mass of 1 kg, they have a different volume.

Volume and mass are two properties that while related to each other, they are independent, since they really depend on the type of matter that makes up the object or body to be measured, for example, 1 kg of lead (Pb) occupies little space and, unlike it, 1 kg of Styrofoam occupies more space (Fig. 1.25).

The volume of an object can be measured with measuring cups, pipettes, test tubes and burettes, but they are not very effective in measuring the volume of solids. The volume of a solid can be calculated, taking into account its three spatial dimensions: length, width and height as long as it is a regular body; in other words, with a geometrical shape or combinations of them. The unit that measures length is the meter (m), therefore, volume is measured in cubic meters (m^3), and this unit is formed by the multiplication of three units: width, length and height.

When you want to measure small bodies, instead of the meter you can use the centimeter (cm), in this case, the unit of volume is the cubic centimeter (cm^3). When dealing with liquids, the volume is typically measured in milliliters (mL) or liters (L) if it is large volume. We can convert milliliters to cubic centimeters using the following equality: $1\ cm^3 = 1\ mL$.

In case you need to measure the volume of an irregular solid like a rock, we use a measuring instrument for liquids, in which you put a certain volume of water, or another liquid that does not dissolve the solid, and drop it in, the volume of fluid that moves or increases in the measuring instrument is the volume of the irregular solid.

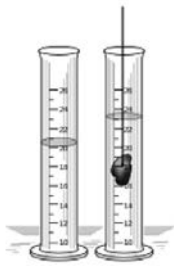


FIG. 1.26 To measure the volume of an irregular object, you can measure the amount of fluid that moves inside an instrument, such as a test tube.

There is a very interesting phenomenon for mass and volume, related to the Kinetic Molecular Theory of Matter. This theory explains the change in the state of matter, and other phenomena that occur in nature. When the temperature rises, the volume of the bodies increases too, this is because when molecules vibrate, they occupy a larger space, though their state of aggregation doesn't. In this case, the mass remains constant because the amount of particles forming the object doesn't change (Fig. 1.26).

Only water shows an exception when transforming its states due to changes in temperature. When water freezes, it occupies more space, because frozen water molecules form crystals, and the macroscopic effect we observe is an increase in volume (Fig. 1.27).

FIG. 1.27 Crystals of frozen water have different shapes, which take up much space.

SESSION INFORMATION

Week: 4

Session: 19

Expected learning outcomes: Identify the extensive (mass and volume) and intensive (melting and boiling point, viscosity, density, solubility) properties of some materials.

Explain the importance of measuring and observing instruments as tools that increase the power of perception of our senses.

CONTENT DELIVERY

Start: Check students' answers to the activity in the section *Reflect, Explain and Share*. Elicit answers and have students write them down on the board. For the section *Reflect, Explain and Share* you can check the answers on page 161.

Development: Students will read page 19 and do the activity described in the section *To Integrate* on top of page 20.

Closing: Students should hand in their 3-column chart.

Homework: Students should take to the following class five small objects or products from their kitchen.

SKILLS DEVELOPMENT

Critical thinking skills: Summarizing.

Visual/Spatial skills: Charting information.

EVALUATION OF CONTENT

Students should get their chart checked by the teacher.

SESSION INFORMATION

Week: 4

Sessions: 20, 21

Expected learning outcomes: Identify the extensive (mass and volume) and intensive (melting and boiling point, viscosity, density, solubility) properties of some materials.

Explain the importance of measuring and observing instruments as tools that increase the power of perception of our senses.

CONTENT DELIVERY

Start: Remind students of the definition of Intensive Properties. (Check page 20 for a definition) and have students write it down on the board.

Development: Students should read page 20. Ask comprehension-check questions about the information on the book.

Closing: Students should do the activities described in the section *Get started!* Clearly explain what they should do with the kitchen objects they were asked to take to class. Elicit answers.

➔ Expected Learning

Identify the extensive (mass and volume) and intensive properties (melting and boiling point, viscosity, density, solubility) of some materials.

Explain the importance of measuring and observation instruments as tools that extend the power of perception of our senses.

To integrate

Write a 3-column chart in your notebook describing: features, measuring units and measuring instruments for the extensive properties of matter. Compare it with your classmates, complete the information if necessary and keep it in your portfolio of evidence.

Closing up!

The extensive properties of matter are common measurements in our daily activities, and many of the products we buy and consume are sold in units of mass, such as fruit, cement or laundry detergent, as well as in units of volume: like gasoline, cooking oil and laundry bleach.

Intensive Properties

FIG. 1.28 Regardless of the amount of salt in each container, the compound remains the same.

Intensive properties are related to the internal chemical structure of matter, and do not depend on the amount of material that an object or substance has, since they are a constant feature (Fig. 1.28). These are properties that define each substance and that collectively describe and differentiate them from others. If you cut a sheet of white paper in half, the pieces will be smaller, but it will remain white, so we say that color is an intensive property.

Other intensive properties of matter are: temperature as a change of state from solid to liquid, the boiling temperature in which liquids turn into gases and other properties such as viscosity, density and solubility.

Get started!

Groups according to their similarities

Classify the products.

You need:

1. Look around the kitchen cupboard at home and choose five products or objects.
2. Notebook.

What to do

1. In your notebook, copy the table below and describe the properties of the five objects you chose, as exemplified.

Describe

Which column was easier to describe? Why?

Reflect: Which properties define objects better? Why?

Observe and explain: If you had to describe these objects to a person who does not know them, what properties would you use? Why?

2. Compare your answers with the class and draw a conclusion together. Register it in your notebook.

Object	Physical characteristics of the object	Characteristics that depend on the matter the object is made of
Sugar bag	- Content 1 kg - Bag of 18 cm × 12 cm	- Plastic bag - Content: opaque yellowish white crystals - Water-soluble crystals - Sweet tasting crystals
1.		
2.		
3.		
4.		
5.		

20

SKILLS DEVELOPMENT

Critical thinking skills: Remembering.

Naturalistic skills: Doing experiments, observing details.

EVALUATION OF CONTENT

Check students' tables and answers they give.

Going further

One of the most used properties is the melting and boiling temperature of matter. Recalling what the Kinetic Molecular Theory of Matter, says, we know that the increase in temperature in an object causes the particles in the state of aggregation to become disordered and apart from each other.

To change from a solid to a gas state and vice versa, most substances must go through the liquid state, but some substances, such as iodine (I) and naphthalene, seem to do it directly from solid to gas and vice versa. Each change has been named in order to be recognized (Fig. 1.29).

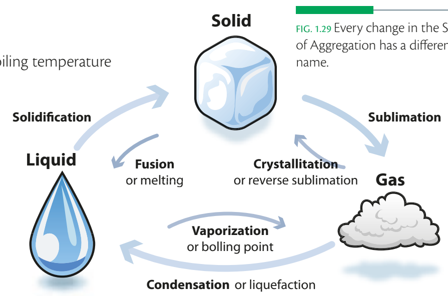


FIG. 1.29 Every change in the State of Aggregation has a different name.

Change in the State of Aggregation	Name
Solid to liquid	Fusion or melting
Liquid to gas	Boiling or vaporization
Gas to liquid	Condensation or liquefaction
Liquid to solid	Solidification or freezing
Solid to gas	Sublimation
Gas to solid	Deposition, inverse sublimation or crystallization

Glossary

Threshold. The step between one place or condition to another.

Melting point. The exact temperature at which, a material changes its state from solid to liquid.

Boiling point. The exact temperature at which, a material changes its state from liquid to gas.

A solid substance can be heated without changing its physical state, but when it reaches a certain temperature **threshold** it will become a liquid (Fig. 1.30). The temperature at which this change occurs is known as **melting temperature (or melting point)**. Also, a liquid can be heated to a certain temperature at which it will become gas. This temperature is called **boiling temperature (or boiling point)** (Fig. 1.31).

FIG. 1.30 Melting ice.

Both the melting and the boiling temperature are typical properties of substances and are constant because they always repeat; however, they are affected by atmospheric pressure, with the increase in altitude above sea level they decrease, so to provide melting and boiling data the level of the sea is taken into account. The change of physical state in a substance is not an immediate event, because not all particles of a substance reach the amount of kinetic energy at the same time; if water is heated, it evaporates slowly and throughout the duration of the process the temperature remains stable at 100°C even if you continue heating it, the same happens in the fusion of water at 0°C.

Temperature is measured with an instrument called thermometer. There are a variety of models, some are made with a mercury column, others with a column of alcohol, others have electronic sensors connected to a computer, but what all of them have in common is that they estimate the heat energy of a substance. What we observe is the increase in the volume of matter when it is heated.

Thermometers can be calibrated in three different scales: Centigrade (° C), which is the one we use more often, Fahrenheit (° F), which is used only in some countries, and Kelvin (°K), or absolute scale, also called scientific scale, and adopted by the International System of Units (Fig. 1.32).

FIG. 1.31 Water boils at 100° C.

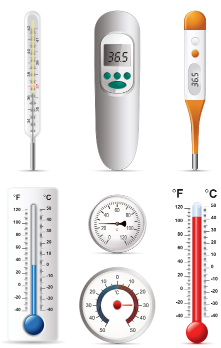


FIG. 1.32 Different kinds of thermometers.

Kells

SESSION INFORMATION

Week: 4

Session: 22

Expected learning outcomes: Identify the extensive (mass and volume) and intensive (melting and boiling point, viscosity, density, solubility) properties of some materials.

Explain the importance of measuring and observing instruments as tools that increase the power of perception of our senses.

CONTENT DELIVERY

Start: Ask students to look at the pictures of water in the book and ask them: What happens with the cubes of ice after a while? ask further similar questions to analyze the water state and characteristics.

Development: Students should read page 21, read the chart and look at the diagram. Ask them comprehension-check questions. It's advisable to draw models of what happens in each case, so that students comprehend the names.

Closing: Explain the three kinds of thermal measures and help them do conversions from one scale to another.

Homework: Divide the group in teams. Ask students to take some sour cream, glue and syrup along with a measuring spoon or medicine-measuring cup.

SKILLS DEVELOPMENT

Critical thinking skills: Observing details, defining concepts.

EVALUATION OF CONTENT

Students should be able to answer your comprehension-check questions.

Kells

SESSION INFORMATION

Week: 4

Sessions: 23, 24

Expected learning outcomes: Identify the extensive (mass and volume) and intensive (melting and boiling point, viscosity, density, solubility) properties of some materials.

Explain the importance of measuring and observing instruments as tools that increase the power of perception of our senses.

CONTENT DELIVERY

Start: Prepare some questions on cards to ask your students, like: When a substance is condensed, what happened to it? (It turned from gas to liquid). Make a competition.

Development: Divide the group in teams. Ask students to take out the materials that they were told to bring. and take similar samples. Ask them questions to analyze their density, viscosity and stickiness, like: *Which substance is stickier*? What's density? What's viscosity? What's stickiness? What's solubility? Explain further examples of each concept.

Closing: Organize teams of four people. Students should make a substance study including physical properties (density, boiling point, etc.) the following class.

FIG. 1.33 Viscosity is a property that can only be effectively seen in liquids.

Another intensive property of matter is viscosity, which is the ability of a substance to deform and which is related to the ability to flow through a tube. It is important to note that this property can only be applied to fluids, that is on liquids and gases. A substance is viscous when you cannot easily deform it or when it doesn't flow easily.

Viscosity changes with temperature, most substances become more viscous when temperature decreases. At a given temperature, the viscosity is an intensive property, because no matter the mass quantity that a substance has, it will flow the same way. For example, honey will always be more viscous than water, whether we compare small or large masses of the substances. (Fig. 1.33).

Viscosity is an important property in certain technology products, for example, in oil used by internal combustion engines. There is confusion between this concept and two other terms: thick, which is only used for very viscous liquids, and sticky, that has to do with the adherence of a material (Fig. 1.34).

FIG. 1.34 Instrument used to measure the viscosity of car oils.

Density is another property of matter, and it is defined by the mass of a substance divided by the volume it occupies. Although mass and volume are extensive properties, by making the ratio between them, the dependence on the amount of matter is eliminated.

$$Density = \frac{mass}{volume}$$

In general, density is specified in units of either g/mL or g/cm^3. If, for example, the density of a substance is 3 g/mL, it indicates that 3 g of the substance occupy a volume of 1 mL; if there are 6 g of the substance, twice the mass, then the volume occupied will also be the double: 2mL.

There are some instruments called hydrometers or densitometers, which are used to measure density, and which compare the density of a known substance with the one of the material that we want to measure (Fig. 1.35). However, the easiest and most practical way is to measure the mass and volume as precisely as possible, and apply the ratio by dividing the mass data by the volume data. Density is also useful for predicting what will happen if two substances are put together: one substance floats when it is less dense than another, and sinks when it is denser (Fig. 1.36).

FIG. 1.35 There are several models of hydrometers.

The solubility of a substance indicates its ability to dissolve into another substance. This property is usually measured in the units of mass of the first one, called solute, per the units of volume of the second, called solvent. For example, the solubility of table salt (sodium chloride, NaCl) in water is 359 g/L, in other words, to completely dissolve 359 g of salt, you require 1 liter of water.

Solubility is an intensive property, because it depends on the chemical properties of the substances; water is the best, most abundant and commonly known solvent, but some substances do not dissolve in it and in that case, some other solvents may be used, such as alcohol, gasoline, paint thinner, acetone, and many more (Fig. 1.37).

The solubility of one substance into another depends on its properties and temperature; for instance, if you have a glass of water and put a large amount of salt in it, there will be a point in which although you stir it vigorously, part of the salt

FIG. 1.36 Oil is less dense than water, that is why it floats.

FIG. 1.37 Sugar has a certain solubility.

22

Kells

SKILLS DEVELOPMENT

Critical thinking skills: Defining concepts.

Naturalistic skills: Observing details, categorizing.

EVALUATION OF CONTENT

Students should present their substance study report. They should also actively participate in the experiment.

will remain undissolved at the bottom of the glass. In order to dissolve the salt, it is necessary to heat the mixture, because then, the space between the water molecules will become broader and it will allow more salt molecules to accommodate between them (Fig. 1.38).

To integrate

In teams, develop a proposal for a lab practice to measure or calculate boiling and melting points, viscosity, density and solubility of a liquid, for example: ethanol, for which you can find information on the Internet and in printed texts.

Compare your proposal with the ones from the other teams and with your teacher's guidance, put it into practice, record the results and prepare a report that you will add to your portfolio of evidence. What problems did you face? How did you solve them?

Closing up!

Melting and boiling temperatures are valuable data to identify unknown substances and, in conjunction with data from other extensive properties, they are the first step for **chemical analysis**.

FIG. 1.38 Saturated sodium chloride solution in water. If heated, more salt will dissolve.

Expected Learning

Identify the components of mixtures, and categorize as homogeneous or heterogeneous.

Experimenting with Mixtures

Homogeneous and Heterogeneous Mixtures

All matter has different characteristics and properties, although in some cases two or more types of matter share some or many of these properties, there is always something that distinguishes them. Properties such as color, odor or taste are difficult to measure, whereas others, such as mass, density, volume and temperature can be accurately determined in controlled conditions.

In nature, and in everything around us, it is virtually impossible to find pure substances, in general, they are mixed with each other. For chemistry it is essential to study mixtures and understand them in order to comprehend the dynamics of chemical changes (Fig. 1.39).

FIG. 1.39 There are several components in the trash, all of them made of matter, and together they constitute a mixture.

Going further

Mixtures are formed by substances that even though they are together, they are not chemically bonded; for example, seawater contains mainly a mixture of these two **compounds,** water and salt.

Most of the objects that surround us are mixtures of two or more substances in varying amounts: milk is a mixture of water with proteins, vitamins, fats and minerals. Even you, yourself, are a mixture, because inside of you there are many chemical substances, such as water, **hemoglobin**, sodium chloride, **glucose**, oxygen and carbon dioxide, among others. An essential property of mixtures is that the different substances that comprise them do not lose their qualitative properties but also preserve and mix. The different substances that form part of a mixture are called components. If you dissolve coffee in water (assuming this is a single substance), you will get a mixture that has two components, if you add sugar, the mixture will have three components.

There are different types of mixtures, the homogeneous and heterogeneous. When the mixture is homogeneous, the particles of one substance are evenly distributed inside another and the components in it cannot be recognized because they are formed by a single phase.

Homogeneous means, "equal"; a homogeneous mixture looks uniform and it has the same composition throughout the whole mixture; that is, if you take samples from various parts in the mixture, they will always have the same composition.

Glossary

Chemical Analysis. Set of techniques and processes necessary to identify unknown substances.

Compound. A substance consisting of two or more elements connected in such a way, that form a type of matter with particular properties that make a new substance.

Hemoglobin. It is a protein that allows oxygen and carbon dioxide to be transported within the erythrocytes from the lungs to all organs.

Glucose. It is a sugar used by tissues as a precursor to obtain energy when combined with the oxygen from breathing.

SKILLS DEVELOPMENT

Naturalistic skills: Observing details.

Critical thinking skills: Predicting, defining concepts.

EVALUATION OF CONTENT

Students should be able to identify homogeneous and heterogeneous mixes.

SESSION INFORMATION

Week: 5

Sessions: 25, 26

Expected learning outcome: Identify the components of mixtures and categorize as homogeneous or heterogeneous.

CONTENT DELIVERY

Start: Write "Homogeneous" and "Heterogeneous" on the board. Elicit definitions and write them on the board. Then, show a homogeneous and a heterogenous mix. Ask them questions so they can see what homogeneous and heterogeneous mean. For instance: Can water and oil mix? What kind of substance is it, homogeneous or heterogeneous? What about coffee?

Development: Students should read pages 23 and 24. Ask them comprehension-check questions regarding homogeneous and heterogeneous mixtures, contrasting their answers with the definitions they first gave and wrote on the board.

Closing: Organize teams of four people. Students should do the activities in the section *Reflect, Explain and Share* on page 24 and present a mind map the following session. Remind them the evaluation parameters (follow the projects rubrics, on page 157).

SESSION INFORMATION

Week: 5

Sessions: 27, 28

Expected learning outcome: Identify the relationship between the variation for the concentration of a mixture (mass percentage and volume) and its properties.

CONTENT DELIVERY

Start: Explain what you will evaluate in their project and mind map. (See the projects rubrics, page 157).

Development: Students should present their activities results.

Closing: Use the projects rubrics on page 157 to give students a "researcher status": novice, in process or expert. Then, ask teams to self-evaluate their teamwork; using the same projects rubrics.

Homework: Divide the group in teams. Each team should take a glass of espresso (strong coffee), some drinking water and small plastic cups for drinks sampling.

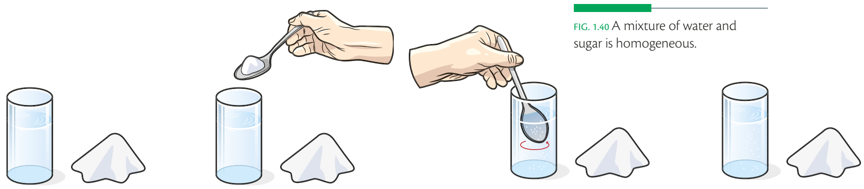


FIG. 1.40 A mixture of water and sugar is homogeneous.

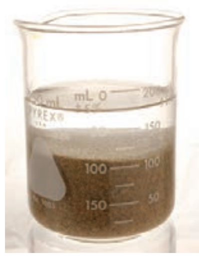


FIG. 1.41 A mixture of water and sand is heterogeneous because you can recognize its components at a glance.

FIG. 1.42 Samples taken from different layers of a heterogeneous mixture have a different composition.

For example,when you mix sugar and water, what you get is a homogeneous mixture or a solution (Fig. 1.40, page 24).

There are other mixtures that are radically different from the homogeneous, in which it is easy or fairly easy to tell at a glance the different components that form them. They are called heterogeneous mixtures.

The heterogeneous mixtures are formed by substances whose particles are not distributed one into the other, some go to the bottom of the container and settle or remain suspended (float). An example of a heterogeneous mixture is made with water and sand: although the two components are in the same container, they can be recognized at a glance.

Each of the portions of a heterogeneous mixture is known as a phase; for example, if we mix oats with milk, oats would be one phase and milk would be another. To distinguish the different phases of a heterogeneous mixture, we mention their characteristics. If we use the examples above, water and milk can be called liquid phase, and sand and oats can be called solid phase (Fig. 1.41).

The term heterogeneous means not equal and refers to the fact that the composition of the mixture is not the same through it all: the samples you take from different parts of the mixture will have a different composition. If you mix water and oil, and take a sample from the top of the mixture, you will see that it only consists of oil. If you take a sample from the bottom of the mixture, it will only consist of water; however, if you take a sample from the place where the two phases meet called interphase, you will have water and oil (Fig. 1.42).

Glossary

Solute. Substance that is dissolved in another, generally its molecules adjust within the solvent.

Dissolution. It is a homogeneous mixture of two or more substances in different proportions. Also called solution.

Solvent. It is the largest fraction of a solution capable of dissolving another substance.

Reflect, Explain and Share

- Check the website http://www.sined.mx/sined/aprendiendo/CURSO-56.htm and work with the resource presented there.
- Do the activities proposed and note the results.
- Develop a mind map on a white sheet of paper where you integrate the information you worked with.
- Compare your work with your teammates and complement it. Add it to your portfolio of evidence.

Expected Learning

Identify the relationship between the variation of the concentration of a mixture (mass percentage and volume) and its properties.

The best description of a mixture of this nature is when the components and their proportion into the mixture are mentioned; we call this concentration.

The concentration is the relationship between the amount of **solute** and **solution**. The solute is the substance that is found in smaller proportions in the solution, and the solvent is the substance in greater proportions.

For example, if you mix 5 ml of alcohol with 10 ml of water, the solute will be the alcohol, and the solvent the water, but if the amounts are inverted and you mix 5 ml of water with 10 ml of alcohol, the solute will be the water and the alcohol the **solvent**.

SKILLS DEVELOPMENT

Critical thinking skills: Analyzing data.

Logical/Mathematical skills: Experimenting.

Metacognitive skills: Self-monitoring, self-evaluating.

EVALUATION OF CONTENT

Students should actively participate in the presentations. Check their mind map information and quality.

Solutions are necessarily homogeneous mixtures and can be described qualitatively by estimating the concentration of solute in it, when there is little, they are called dilute solutions. When there is a lot, they are known as concentrated, and if a point is reached when no more solute can be dissolved, they are called saturated. At this point, the excess of solute is separated from the mixture and it can be observed, like in the case of heterogeneous mixtures.

The concentration can be measured and for that purpose, different ways of expressing it have been invented; the most common and easiest to understand is the concentration expressed in a percentage and there are three ways of doing it: mass percent concentration, volume percent concentration and a combination of them, the mass concentration percentage by volume (Fig. 1.43).

FIG. 1.43 Concentration depends on the amount of a substance that is added to a solvent.

The mass percent concentration is used, in the labeling of products and it is as follows.

$$\textit{Mass of solution (g)} = \textit{mass of solute (g)} + \textit{mass of solvent (g)}$$

And the percentage is calculated:

$$\textit{Concentration } (\% \tfrac{m}{m}) = \frac{\textit{mass of solute}}{\textit{mass of solution}} \times 100$$

The mass percentage (mass%) indicates the quantity of solute mass (in grams) that is dissolved in 100 g of solution. The higher the mass percentage of a solution, the more concentrated it will be (Fig. 1.44).

When a solution has a mass concentration of 20%, it means that for every 100 g of solution, 20 g are of solute.

In general, this way of expressing the concentration is used when a solid solute is dissolved in a liquid solvent. If the type of solvent is not indicated, or if it is an aqueous mixture, then it is to be understood that the solvent is water.

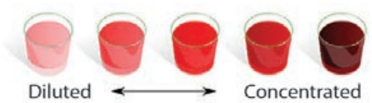


FIG. 1.44 Diluted and concentrated solutions.

Reflect, Explain and Share

Reflect on the question; write your answer in your notebook, and the arguments that led you to it.

- What solution is more concentrated: a solution of table salt in water, at 35% in mass, or a sugar solution in water at 70% in mass? Why?

Share your point of view with the class, and record the conclusion you reach together in your notebook.

Every time a calculation of the mass percent concentration is made, the units used should be the same, these may be grams, kilograms or any other unit of the same type; In the case of two different units, it is necessary to make the proper conversion (Fig. 1.45).

With the proper data it is possible to calculate the concentration of a solution by applying the formula mentioned above. It is shown in the following example:

FIG. 1.45 To express the mass concentration of a solution, it is necessary to measure the mass of the solute and the solution.

SESSION INFORMATION

Week: 5

Sessions: 29, 30

Expected learning outcome: Identify the relationship between the variation for the concentration of a mixture (mass percentage and volume) and its properties.

CONTENT DELIVERY

Start: Divide the group in teams and ask them to serve a really small sample of the espresso that they were told to bring and smell it (completely out of sugar) Then, ask them to take another sample half coffee and half water and smell it. What difference do they perceive? Why do they think there's a smell difference?

Development: Have students read again the bottom of page 24 and the entire page 25. Then, have them do seven problems with the formula, like these: What's the concentration in a solution of salt in water at 46% in mass? What's the concentration in a solution of oil in water at 12% in mass?

Closing: Students should answer the questions in the section *Reflect, Explain and Share*. Elicit answers. For the section Reflect, Explain and Share you can check the answers on page 161.

Homework: Students should get three labels from three different products.

SKILLS DEVELOPMENT

Logical/Mathematical skills: Experimenting/solving problems.

Naturalistic skills: Categorizing according to perception.

EVALUATION OF CONTENT

Students should be able to answer the questions in the last activity correctly.

SESSION INFORMATION

Week: 6

Sessions: 31, 32

Expected learning outcome: Identify the relationship between the variation for the concentration of a mixture (mass percentage and volume) and its properties.

CONTENT DELIVERY

Start: Remind students of the formula to determine the concentration of a solute. Write it on the board.

Development: Students should read page 26 up to the section *Closing Up!* Help students with further practice to understand how they can define the concentration of a defined component in a mixture.

Closing: Students should do the section *To Integrate* using the food labels they were supposed to get.

Homework: Divide the group in teams. Each team should get: a glass half-full of water, three small coins, a piece of Styrofoam, a spoonful of sugar, 10 g of clean sand, three drops of food coloring, a spoon.

What is the mass concentration of a solution of 300 g containing 20 g of calcium chloride ($CaCl_2$)?

Solute mass 520 g **Solution Mass 5 300 g**

$$\text{Concentration } (\%\ \frac{m}{m}) = \frac{\text{mass of solute}}{\text{mass of solution}} \times 100 = \frac{20\text{ g}}{300\text{ g}} \times 100$$

$$= 0.67 \times 100 = 6.7\%$$

FIG. 1.46 Because of its characteristics, it is more practical to measure the volume than the mass in a liquid.

Thus, we know that the concentration of a mixture having 20.0 g of calcium chloride in 300 g of solution is 6.7 % in mass.

The volume percent concentration is often used when the solute is liquid and measuring its volume is more practical than measuring its mass. This way of expressing concentration is used to measure the **alcoholic strength** shown in beverages and it is calculated by using the following formula:

$$\text{Concentration } (\%\ \frac{V}{V}) = \frac{\text{volume of solute}}{\text{volume of solution}} \times 100$$

The volume percentage (volume %) indicates the amount of volume of solute (in milliliters) that is dissolved in 100 ml of solution. In contrast to what happens with the mass solution, the volume of solution is not equal to the sum of the volumes of the solute and the solvent (Fig. 1.46).

Finally, the mass percent concentration in volume may be the most common because it is the most **coherent** with the state of aggregation of the solute. It's expression is similar to the previous formulas:

$$\text{Concentration } (\%\ \frac{V}{V}) = \frac{\text{mass of solute}}{\text{volume of solution}} \times 100$$

GLOSSARY

Alcoholic strength. Quantity of alcohol contained in an alcoholic solution, such as alcoholic beverages.

Coherent. Convenient, consistent, logical.

To integrate

Look for labels of different products that express percentage concentrations; record them, and calculate the amount of each component contained in the product.

On a piece of cardboard, reproduce the product label and the calculations you did, illustrate and work with the class to organize an exhibition in the school.

Keep photos of the exposition in your portfolio of evidence.

Closing up!

Regardless of the type of expression that is used in the percentage concentration, the higher the percentage is, the greater the concentration will be.

→ Expected Learning

Choose from different methods of separating mixtures based on the physical properties of its components.

Methods of Separating Mixtures Based on the Physical Properties of their Components

FIG. 1.47 A fish tank contains several components, some form homogeneous and other heterogeneous mixtures with the water including fish. To separate these, various procedures should be used.

We often need to separate one or more components from a mixture when we want to isolate them; because it is the way we need them.

In the kitchen, we commonly make mixtures and separations. For example, to cook spaghetti, first it is mixed with water to cook it, and once it is cooked, the spaghetti is separated from the water for further preparation. In Chemistry, apart from those simple procedures there are others that require a higher degree of complexity, because the separation should be as complete as possible (Fig. 1.47).

SKILLS DEVELOPMENT

Logical/Mathematical skills: Solving problems.

EVALUATION OF CONTENT

Students should do the activities in the section *To Integrate* and have them checked by the teacher.

Get started!

Pure and Mixed Substances

Work in teams to do the activity.

You need:

- Your notebook to record observations.
- A glass half full of water
- Three small coins
- A piece of Styrofoam
- A spoonful of sugar
- 10 g of clean sand
- Three drops of food coloring of any color
- A spoon

Precautions:
At the end of the experiment, be careful when disposing of the water and sand. Sand can clog the drain.

Procedure:

1. Place all the materials in the glass of water, stir well with a spoon for a few moments and let the mixture sit.

Describe:
What is the mixture like? Is it a homogeneous or a heterogeneous mixture? What do you need to do to determine the type or types of mixture you have in the glass?

2. Discuss how you would separate each of the components of the mixture

Reflect:
Can all the components of the mixture be separated in the same way? Is there more than one way to separate any of the components? Why do you think this is so? Record the answers in your notebook.

Observe and explain:
What parameters did you use to decide between one or another way to separate the components? Is there a component that cannot be separated? Why?

3. Compare your answers with the class and record the conclusions you reached.

Going further

There are ways of separating mixtures, some only apply to the homogeneous mixtures, others to the heterogeneous, and some others can be equally applied. Depending on the properties of the components in the mixture we can decide the ideal procedure. A mixture can be separated because each of these components has different physical properties.

Glossary

Immiscible. It is a substance that cannot be dissolved in another one and form a solution.

Decanting

Decanting is a separation method based on the density difference of two substances that are **immiscible** with each other; this is, that they are in different phases forming a heterogeneous mixture. It is used when you want to separate a solid from a liquid or two liquids that do not mix. This separation method works well when the less dense component is a liquid and it consists in pouring the liquid that remains in the upper part of the mixture, into a different container. (Fig. 1.48 and Figure 1.49).

When the mixture is only between immiscible liquids, it is possible to use a separating funnel, a pear-shaped container with a lid. To use a separating funnel, first make sure that the lid is closed, then the mixture of the liquid is added. Finally, the lid is opened to drain the fluid that is below the one of higher density (Fig. 1.50, page 28). Once out, the lid is closed to stop the other liquid from passing.

FIG. 1.48 Kitchen strainers are used as instruments to separate mixtures.

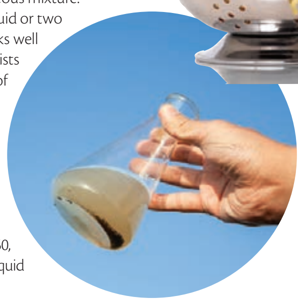


FIG. 1.49 Water and sand form a heterogeneous mixture which can be separated by decantation.

SESSION INFORMATION

Week: 6

Sessions: 33, 34

Expected learning outcome: Choose from different methods to separate mixtures based on the physical properties of its components.

CONTENT DELIVERY

Start: Students should read the bottom of page 26, in which methods to separate mixtures are introduced.

Development: Students should do the experiment described in the section *Get Started!* Students should be able to identify the components that can be separated from the ones that cannot. For the subsection *Reflect* you can check the answers on page 161.

Closing: Teams will be presenting one of methods to separate mixtures described on pages 27 to 29. They should read the information about the method, do further research about it and give a presentation during the following two sessions.

SKILLS DEVELOPMENT

Naturalistic skills: Observing details, categorizing.

Critical thinking skills: Analyzing.

Logical/Mathematical skills: Experimenting.

EVALUATION OF CONTENT

Students should actively participate in the experiment.

SESSION INFORMATION

Week: 6

Sessions: 35, 36

Expected learning outcome: Choose from different methods to separate mixtures based on the physical properties of its components.

CONTENT DELIVERY

Start: Explain what you will evaluate in their concept presentations. (See the projects rubrics, page 157).

Development: Students should present their definitions.

Closing: Use the projects rubrics on page 157 to give students a "researcher status": novice, in process or expert. Then, ask teams to self-evaluate their teamwork; using the same projects rubrics.

FIG. 1.50 Separation funnel ready to be used.

It is common that the interface cannot be completely separated from the mixture, so what happens is that the densest part is let out before the interface, then the interface is let out into a different container and finally the less dense liquid is collected in another container.

Reflect, Explain and Share

- Find pictures in magazines, books or the Internet to show the process of decanting, copy them in white sheets of paper, and add an explanation of the process.
- Compare your album with the class and keep it in your portfolio of evidence.

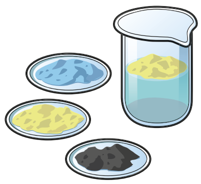


FIG. 1.51 Filtration is used to separate a heterogeneous mixture of a solid and a liquid. The filter paper retains the solid and lets the liquid pass.

Filtration

Solvent extraction is a method used to separate heterogeneous mixtures of solids with liquids, and it is based on the difference between the size of the particles in the components of a mixture and the openings of a filtering material, it could be drained through a cooking strainer to a plate. Paper filters are commonly used in chemical labs because of the low cost and high efficiency. To carry out a filtration, you need a funnel, paper filters that lets liquids pass, but retains solids, and a container to collect the liquid that is filtered (Fig. 1.51).

Magnetic Separation

The **alloys** and **oxides** in ferromagnetic materials, such as iron (Fe), nickel (Ni) and cobalt (Co) are attracted to magnets; this is a property that is used to separate heterogeneous mixtures containing them. To perform this procedure, a magnet or an electromagnet is passed over the mixture, fragments of ferromagnetic materials adhere to the magnet and then they are removed from it. Magnetic separation is a method used in many industries for recycling, because it is one of the first methods that can be used in the selection of waste when it is not separated.

GLOSSARY

Alloy. It is a homogeneous mixture with metal properties, composed of two or more elements, in which at least one is a metal.

Oxide. Chemical substance formed by the union of a metal with oxygen.

Crystallization

Distillation is a technique used to obtain crystals from a solid dissolved in a liquid, it is only applied to homogeneous mixtures, and the liquid solvent needs to evaporate. Every substance has its own boiling point that is reached gradually, so the entire amount of the substance doesn't need to reach the same temperature; if the particles at the top are in contact with a heat source, such as sunrays, they will evaporate and leave their place to those below.

In mixtures of a liquid with a solid, the latter has a higher boiling point, so the liquid particles are the ones that evaporate. This is the method used to obtain the salt we consume. Sodium Chloride (NaCl) is extracted from sea water, from large areas that are flooded with it and are left for a while until the sunrays evaporate the water and turn the salt into crystals (Fig. 1.52).

FIG. 1.52 Copper sulfate II ($CuSO_4$) crystals obtained from an aqueous solution by crystallization.

Extraction Using Solvents

It is a method used to separate components in a mixture using their solubility in different solvents. Every time you make tea, for example, you are applying the method of separating mixtures because some substances in the leaves and flowers of the plants are soluble. Therefore, you can extract them when you put them in hot water because they are more soluble in this medium. This method is often used in combination with another one, such as crystallization, because certain solvents are easier to evaporate than others.

SKILLS DEVELOPMENT

Reading skills: Scanning.

Interpersonal skills: Teaching others.

Critical thinking skills: Formulating questions.

Listening Skills: Understanding the message.

Metacognitive Skills: Delivering content, self-monitoring, self-evaluating their presentation.

EVALUATION OF CONTENT

Follow the projects rubrics, Teacher's Guide page 157.

Distillation

It is a technique used to separate homogeneous mixtures when both components are liquids. It is based on the fact that each substance has a different boiling point, and when the mixture is heated, at some point one of its components will evaporate; this can be recovered, condensed and put aside in a different container.

To use the distillation method, the liquid mixture is placed in a round-bottomed flask, which is connected to a thermometer and a glass condenser. Then, the mixture is heated until it boils and one of its components evaporates (Fig. 1.53).

When vapor passes through the glass condenser, it cools down and condenses, forming a liquid again. Thus, the components of the mixture go from liquid to gas and back to liquid, but each one does it at a different temperature. In the industry of oil refining a very similar method is used to separate the different compounds in the mixture called crude oil.

This principle is also useful to separate alcohol obtained by fermenting different fruits and vegetables, such as grapes, corn, sugar cane, etc. It constitutes the basis for the wine and liquor industries, as well as for industries that use alcohol as an alternative fuel for internal combustion engines.

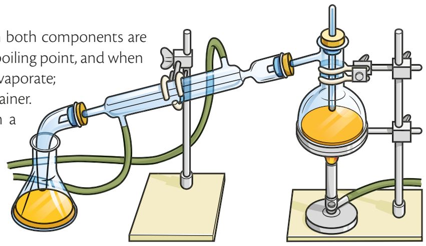


FIG. 1.53 Distillation requires equipment with multiple components.

To integrate

A mixture may often be separated using more than one technique. Look at the example shown in the table below, where the mixture is classified as homogeneous or heterogeneous, and two techniques to separate components are provided:

Make a copy of the table and add the mixtures; if necessary, research the characteristics of the components:

Mixture	Homogeneous or heterogeneous?	Separation technique #1	Separation technique #2
Salt dissolved in water	Homogeneous	Crystallization	Distillation

- Water with iron filing, water with chloroform, water with sugar and stones.
- Compare your table with the class and put it in your portfolio of evidence.

Closing up!

Mixture separation methods are not rigid procedures or prescriptions. To apply them, it is necessary to know the characteristics of their components and based on that, infer the best technique or combination of techniques to get the expected results.

Pollution and Concentration of Mixtures

Decision Making Related to Pollution in a Mixture

To operate, human societies require materials and energy. Low populated rural areas have been able to use natural resources in a way that they does little damage to the environment. Frequently, humans use natural resources intensively and extensively and this generates large amounts of waste. This, among other things, results in chemical and physical changes that alter or change the environment in which we live.

Expected Learning

Recognize that the components of a mixture may have contaminants, although they are not visible to the eye.

SESSION INFORMATION

Week: 7

Sessions: 37, 38

Expected learning outcome: Choose from different methods to separate mixtures based on the physical properties of its components.

CONTENT DELIVERY

Start: Students might end up giving their presentations on separation methods. Otherwise, have students name the methods and give a short description about them.

Development: Have students complete the table in the section *To Integrate* in teams. Elicit answers.

Closing: Have students make a mind map about separation methods including some drawings that illustrate each one.

SKILLS DEVELOPMENT

Critical thinking skills: Mind mapping.

Visual/Spatial skills: Graphing information.

EVALUATION OF CONTENT

Students should get their table and mind map checked by the teacher.

SESSION INFORMATION

Week: 7

Session: 39

Expected learning outcome: Recognize that the components of a mixture may have contaminants, although they are not visible to the eye.

CONTENT DELIVERY

Start: Ask students the introductory questions in the section *Get Started!* Elicit answers in whole class.

Development: Have students read the bottom of page 29 and page 30, section *Going further.* Then, draw a nine-cell table to play tic-tac-toe. Prepare questions regarding pollutants such as: How are pollutants classified? What is a biogenic pollutant? What is an anthropogenic pollutant. Mention two examples of biogenic pollutants; mention two examples of anthropogenic pollutant? Are most substances mixtures? How are pollutants usually found?

Closing: Students should write down the comprehension-check questions and answer them.

Homework: Organize students in teams. Each team should take to the following class, the materials described at the bottom of the page to do the experiment.

Glossary

System. Set of things, neatly interrelated, that contribute to a particular object.

Environmental pollution. When a system contains components that represent a risk to people or to biodiversity welfare.

If any strange substance, even when part of a **system**, exceeds a certain concentration level and represents a health risk, it is considered a **pollutant**.

Get started!

Can we disappear a pollutant if we dilute it?

When gases are released into the atmosphere and wastewater to a river or to the sea, it is sometimes thought that the atmosphere and the sea are so immense, that the pollutant will end up diluting to the point of "disappearing ".

1. Form teams of four or five members and discuss dilution and answer the question: if a pollutant is diluted, does it disappear?
2. Share your ideas with the class and add to your portfolio of evidence.

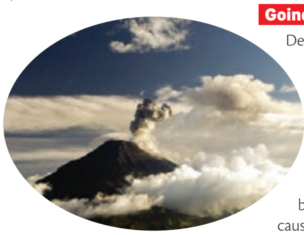


FIG. 1.54 Volcanic eruptions emit huge amounts of pollutants into the atmosphere that, although they affect living beings, are part of the natural dynamics of the Earth.

Going further

Depending on their origin, pollutants are classified as biogenic and anthropogenic. Among the first are those that are not involved with human actions, such as the gases and dust from volcanic activity (Fig. 1.54), soil erosion and decomposition of organic matter. Among the anthropogenic pollutants are those that are the result of human activities, such as those generated by industrial activity, traffic and transportation and energy use.

We have mentioned that most substances are part of mixtures, and pollutants are no exception to this. Pollutants are found in different states of matter and may be visible at a glance or go unnoticed to our senses, until we realize that something is causing health problems in people, animals or the vegetation in the environment. Finding the "agent" or the pollutant is not always easy (Fig. 1.55, page 30).

Chemistry, like other sciences, cannot solve by itself the problems caused by pollution, but it gives us valuable tools to understand and find alternative solutions, especially to cope with anthropogenic pollution.

FIG. 1.55 To identify unknown substances, chemists use various techniques and devices like the gas spectrometer. This picture shows part of the equipment to identify semi-volatile organic compounds at the National Institute of Ecology.

Hands on Chemistry!

DO POLLUTANTS DISAPPEAR?

Introduction

In this activity we will simulate the presence of a pollutant using food coloring mixed in water, and we will make some dilutions to check its permanence in the mixture.

You will need:

- 6 transparent glasses of about 200 ml
- A small bottle of food coloring (like the one you used in the first experiment)
- Tap water
- A 100 ml graduated test tube or a graduated beaker.
- A stirring rod or a spoon.

SKILLS DEVELOPMENT

Critical thinking skills: Mind mapping.

Reading skills: Scanning, reading for detail.

EVALUATION OF CONTENT

Students should actively participate in the tic-tac-toe game. They should also get their answers to the questions checked by the teacher.

Procedure

Work in teams.

1. Number the six glasses in progressive order. Put a mark to identify them and put them on a light-colored surface.
2. Add 100 ml of water to the first glass and 50 ml to the following glasses.
3. Add five drops of food coloring in the glass marked with the number 1 and stir the mixture. Observe and describe what happens. Pay special attention to the color of the mixture and its intensity.
4. Take 50 ml from the mixture in the glass marked with the number 1, and add it to the glass marked with the number 2. Describe what happens.
5. Take 50 ml from the glass marked with the number 2 and mix it with the glass marked with the number 3; continue like this until you reach the glass marked with the number 6.

Explain

Individually prepare a written report where you register the results you got when mixing the food coloring with water and when diluting it. You can extend your explanation by using drawings. Answer the following questions.

1. What happens with the food coloring as it dilutes?
2. Is there colorant in glass number 6?
3. Describe what happened in other teams. Is the result the same? Are there differences? Which ones?
4. If there are still traces of the colorant in glass number 6, how many times would you have to dilute it to make it invisible?
5. If the colorant were a contaminant, would the glass where you cannot see the colorant be polluted?
6. Find two examples where diluting a pollutant is an alternative to pollution and also find two examples where it is not.
7. Do you have a question? Ask it.

Show your report to the teacher and add this work, including the references you used, to your *Hands on Chemistry!* portfolio of evidence.

In the previous activity, we observed that although the contaminant was not visible at first glance, it could be present. In a sample of water, the effect of pollution on living organisms will depend on the type of this pollutant and on the minimum amount required to cause the effect. In nature, water has different chemical compounds that come from the lithosphere, atmosphere and biosphere. These are in contact with the liquid and have influence on its physical and chemical properties. In the table there is a list of these compounds.

Water quality or purity depends on its use. Sometimes we perceive pollutants because water changes in taste, smell or appearance.

Glossary

Suspension. Heterogeneous mixture of non-soluble particles dispersed in a liquid medium. The size of the dispersed particles is larger than 10 000 nm. They settle by gravity and can be filtered.

Water Components

Source	In **suspension**	In **colloidal dispersion**	In solution
Lithosphere	Sands, clays, soils	Clays, soils	Na^+, K^+, Ca^{2+}, Mg^{2+}, Fe^{2+}, Cl^-, SO_4^{2-}, HCO_3^-, NO_3^-, PO_4^{3-}, F^-
Atmosphere	Powder, particles	Powder, particles	O_2, N_2, CO_2, H_3O^+, HCO^{3-}
Biosphere	Algae, bacteria, plants, animals	Organic macromolecules, viruses	O_2, N_2, CO_2, H_2S, CH_4, NH_4^+, NO_3^-, SO_4^{2-}

Source: *The Chemical Society*, Mexico, UNAM Faculty of Chemistry, 1994.

Water pollutants in liquid form generally come from household waste, and from agricultural and industrial activities. On the other hand, physical solid pollutants include sand, clay, ashes, fat, tar, paper, rubber, wood, metals and plastics; temperature also falls in this category because it affects biodiversity in various ways.

Among water chemical pollutants we can find soluble salts, such as chlorides, sulfates, nitrates, phosphates, carbonates, acids, alkalis and dissolved gases, such as sulfur dioxide, ammonia, chlorine and hydrogen sulfide. Many of these chemicals come from industrial activities, but the various products used in cars and in household cleaners also contribute predominantly.

Glossary

Colloidal dispersion. They also form mixtures that are between the limit of homogeneity and heterogeneity. The particles are between 10 and 10 000 nm. They can settle but cannot be filtered.

SESSION INFORMATION

Week: 7

Sessions: 40 - 42

Expected learning outcome: Recognize that the components of a mixture may have contaminants, although they are not visible to the eye.

CONTENT DELIVERY

Start: Have a student read the introduction to the experiment. Clarify what you will evaluate (see the projects rubrics on page 157).

Development: Students should do the experiment. It is advisable that you do it yourself so that they can see what to do and how to do it. Ask students to answer the questions regarding the experiment, which can be found on top of page 31.

Closing: Students should read the end of page 31 and page 32 up to the section *Closing up!* Students should complete their mind map about pollutants with information from both pages. (They worked in their mind map three sessions ago).

SKILLS DEVELOPMENT

Logical/Mathematical skills: Experimenting.

Naturalistic skills: Observing details.

EVALUATION OF CONTENT

Students should actively participate in the experiment.

SESSION INFORMATION

Week: 8

Sessions: 43, 44

Expected learning outcome: Recognize that the components of a mixture may have contaminants, although they are not visible to the eye.

CONTENT DELIVERY

Start: Organize trios. Ask students to reread the information on page 32 (up to the section *Closing Up!*)

Development: Each trio should make five to seven questions about the information related to contaminants.

Closing: Mix up trios so that each member in the new trio has different questions to ask his/her partners to check concept comprehension.

FIG. 1.56 Electron microscope image of *Vibrio cholera* bacteria, responsible for the disease called cholera; it can be found in contaminated water with fecal matter.

Organic pollutants, including metabolism waste from living beings, food processing waste, industrial chemicals, solvents, oils, colorants, insecticides and detergents, tend to deplete oxygen in water or become toxic for living beings. Biological pollutants including bacteria, fungi, protozoa and viruses can cause various diseases, such as salmonella, dysentery, hepatitis and cholera. (Fig. 1.56). Most organic pollutants are decomposed by chemical and biological processes, and are considered degradable or biodegradable, but others, such as fats, plastics, pesticides and detergents are not, and their decomposition takes years. These types of components are known as organic refractory components and include insecticides, such as DDT, chlordane and endrin, as well as nitrate, phosphate and sulfate ions, and heavy metals such as mercury (Hg), lead (Pb) and cadmium (Cd).

The case of DDT is interesting because in the twentieth century it was heavily used to combat insect pests that damaged crops or transmitted diseases, but it eventually showed carcinogenic effects (Fig. 1.57).

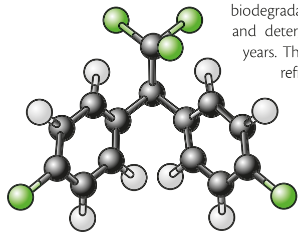


FIG. 1.57 Dichloro-Diphenyl-Trichloroethane ($(ClC_6H_4)_2CH(CCl_3)$ molecule (DDT). Used decades ago as an insecticide, it is practically insoluble in water and very soluble in organic solvents and animal fats.

ICT

To learn more about molecules and observe, both in their structure and form, go to: http://www.worldofmolecules.com/

Closing up!

Pollution is a serious problem affecting our environment, we cannot always detect it with our senses or we have become so accustomed to it, that we show indifference to this problem. One of the objectives of Chemistry is to inform citizens so they can make the right decisions and stop pollution on the planet through sustainable consumption.

→ Expected Learning

Identify the functionality of expressing the concentration of a mixture in units of percent (%) or parts per million (ppm).

Identify that different concentrations of a pollutant in a mixture have different effects on health and on the environment, in order to make informed decisions.

Decision Making Related to: Concentration and its Effects

Most materials are mixtures of various substances (heterogeneous or dissolutions) and it is very important to know the amount of each component in these mixtures (concentration), especially in substances that can be harmful, or negatively alter the interaction of some materials with others. This is the case when they are combined, when they react or when we consume them in some way.

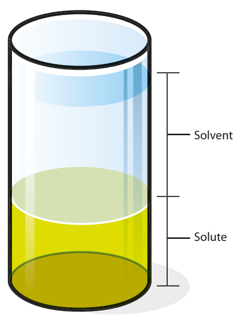


FIG. 1.58 The percentage of a solution is expressed as parts of a solute that exist in a total of 100 parts of solution.

There are other ways of expressing the concentration in a quantitative way; that is, with numbers indicating the proportion of the solute or solutes in the mixture.

The way to express the concentration is by using percentages: the proportion of one thing in a whole, taking into account that the thing we refer to represents one part of 100 parts.

The percentage of a solute is defined as the parts of solute in a total of 100 parts of solution, where the concentration of solute in the solution would be 30% (figure 1.58).

The dissolutions (heterogeneous mixtures) that exist in our environment, such as ocean water, have varying concentrations of salt that are within the limits of 3 to 5% m/v. The Dead Sea (Fig. 1.59 , page 33), which is actually a salt lake, has a high concentration of salt: about 15% m/v.

SKILLS DEVELOPMENT

Interpersonal skills: Working as a team member, teaching others.

Critical thinking skills: Formulating questions.

EVALUATION OF CONTENT

Students should actively participate in the question-making process.

FIG. 1.59 The high concentration of salts in the Dead Sea, which is 15 % m/v, allows people to float on it easily.

FIG. 1.60 In places like Mexico City, what we call smog is the result of not only by gaseous pollutants, but also of suspended solid particles. Although they are in small concentrations, they can damage health.

In the air, the volume proportion of oxygen (O_2) is about 21% of the total volume of air, 21% v/v. In our body, blood also contains different proportions of this gas, an average concentration of about 17% m/v.

However, in the air, another of the ingredients that is very diluted is carbon dioxide (CO_2), with a concentration of 0.035 % v/v. If we go beyond the natural components of the air and consider the solid particles that pollute it, there is an average percentage concentration of 0.00000000005 % m/v in relation to 100mL in many cities, although the amount varies. To express concentrations in small proportions, we use a ratio called: parts per million (ppm). It refers to the parts of solute that exist per million in the solution as a whole.

Therefore, the ratio of one part per million, (1 ppm) is equal to one milligram of solute per liter of solution.

As mentioned before, the expression in ppm is useful to refer to concentrations of pollutants in the water or in the air; with this information, we can easily notice the slight increases in its concentration which, even though they are minor, they can have effects such as smog (Fig. 1.60, page 33).

From an early age, our parents and family taught us that there are substances at home, in the field or the street, we should stay away from (Fig. 1.61).

We classify these substances as poisons, that even in very small concentrations, cause failure in the organism or even death.

There are well-known poisons, such as those that come frome some snakes or other animals, but virtually any material could have harmful effects on the body, depending on its concentration.

There are other substances, generally considered harmless, that can cause damage if they are consumed in large quantities. For example, water consumed in excessive amounts in a short period of time can cause "water intoxication". This is because our body is a mixture in which water acts as a solvent. It becomes unbalanced when the salts that maintain the functioning of cells are diluted, causing them to collapse.

Another case in which we can put our health at risk is taking medicine without a prescription, especially painkillers used to relieve pain, antacids to reduce heartburn, antihistamines to reduce the effects of cold or antipyretics to reduce fever. All these medicines are designed to be taken in a specific dosage. In many cases these doses are exceeded because the symptoms do not disappear or they do not act as fast as we would like. Consuming excessive doses can cause serious and harmful side effects. That is why it is necessary to follow a doctor's recommendation.

FIG. 1.61 At home, school or on the street we have learned to stay away from substances with signs like this.

ICT

To learn more about the substances that have been used as poisons, read the article "Poison, Poisoned and Poisoners" published in the magazine *¿Cómo ves?*, available on the following website: http://www.comoves.unam.mx/numeros/articulo/90/venenos-envenenados-y-envenenadores

33

SESSION INFORMATION

Week: 8

Sessions: 45, 46

Expected learning outcomes: Identify the functionality of expressing the concentration of a mixture in units of percent (&) or parts per million (ppm).

Identify the different concentrations of a pollutant in a mixture have different effects on health and on the environment, in order to make informed decisions.

CONTENT DELIVERY

Start: Ask students for an explanation of concentration of a substance. Explain that you will read about substances concentration and its effects.

Development: Students should read the starting segment on page 32 and the entire page 33. Ask comprehension-check questions. Organize teams. Students should draw a picture that represents the ratio ppm, poisons, water intoxication, medicine that is taken without prescription.

Closing: Students should prepare the research explained in the section *To Integrate*, which is on top of page 34. Have them do research one session prior to delivering their results. Remind them of the evaluation parameters (check page 157 for further information).

SKILLS DEVELOPMENT

Critical thinking skills: Remembering information.

Visual/Spatial skills: Graphing data.

Interpersonal skills: Working as team members.

EVALUATION OF CONTENT

Students should get their drawings checked by the teacher. They should actively participate in the research production.

SESSION INFORMATION

Week: 8

Session: 47

Expected learning outcomes: Identify the functionality of expressing the concentration of a mixture in units of percent (&) or parts per million (ppm).

Identify the different concentrations of a pollutant in a mixture have different effects on health and on the environment, in order to make informed decisions.

CONTENT DELIVERY

Start: Remind students that the objective of the research is to find side effects of pollutants in water.

Development: Have students present the results of the activity in the section *To Integrate*, which is explained on top of page 34 and that they should have developed the previous session or for homework.

Closing: Have students self-evaluate their performance using the same projects rubrics described on page 157.

Homework: Organize teams. Each team will be presenting one of the topics mentioned on pages 34 and 35.

To integrate

Find information on maximum contaminant levels allowed in water. Review the units they are expressed in, and ask your friends and neighbors if they know about any water monitoring results from your community. If not, search for that information, and if possible, compare the data of the water in your community with the maximum levels of pollutants permitted.

In teams, share your results and information, and together write your conclusions in your notebooks and present them to the class.

Closing up!

Around us there are all kinds of natural or synthetic materials, and most of them are mixtures: the wood in our chairs, the air we breathe and even the water we drink; however, in these mixtures that are around us, there are undesirable substances that can damage the environment or our health directly. Since the possibility of a substance to harm is directly related to its quantity, it is important to know the different ways of expressing concentration.

Glossary

Hypothesis. Is a proposed or a possible explanation for a phenomenon under study.

Law of the conservation of mass. States that in any closed system, the mass remains constant.

Phlogiston. Hypothetical substance proposed by the end of the seventeenth century to explain why materials could be burned.

The First Chemical Revolution

Lavoisier's Contributions: The Law of Conservation of Mass

The curiosity of human beings in understanding nature has led to the accumulation of scientific knowledge that can go from the discovery of fire (Fig. 1.62), the study on how to control it, the development of technology for making a gaseous substance become liquid by applying pressure, to the production of plastic for containers, or as occurs with a simple disposable lighter.

In general, the development of scientific knowledge begins with the observation of a phenomenon, asking questions about it and developing a tentative explanation or **hypothesis**, which is then tested through experimentation. If the experiments are not consistent with the hypothesis, then another hypothesis or explanation is given and re-tested using further experimentation.

FIG. 1.62 The mastery of fire introduced major changes in primitive societies.

The perception and explanation of natural phenomena has changed throughout history, because with time, we have had access to more tools and techniques to test and verify or correct these phenomena. There are many examples of this, like the changes in atomic models throughout history and the perception of how materials are made. This is the example we will focus on next since it led to the formulation of one of the most important laws in science: the **law of conservation of mass**.

The ancient Greeks believed that the world was formed by four basic elements: earth, water, fire and air, and that they were combined to form another type of material. According to the Greek's conception, bones were composed of two parts of fire, one part air and one part earth.

Since making a bone by mixing 2ml of fire, 1 ml of air, and 1ml of earth was impossible, the existence of a fifth element was immediately proposed, a substance to act as "glue", giving cohesion and support to the mixture of the elements: ether. Thus, if when putting fire, air and earth together no bone was obtained, it was concluded that it was because ether was missing and that since it was the quintessence of materials; it was only available to the gods.

Similar to the ether approach, and looking for an explanation to why burning materials could produce a flame, some scientists of the late seventeenth century proposed the existence of a new substance called **phlogiston**. According to this theory, all bodies and materials contained a certain amount of phlogiston that was released into the air when burned. The fact that the ashes obtained by burning a piece of wood were lighter than the piece of wood itself was explained by arguing that, when burned, a body released all of its phlogiston to the air, causing the decrease of its weight.

SKILLS DEVELOPMENT

Interpersonal skills: Working as a team member, teaching others.

Critical thinking skills: Summarizing.

Reading skills: Scanning, reading for detail.

Metacognitive skills: Self-monitoring, self-evaluating.

EVALUATION OF CONTENT

Use the projects rubrics to give them a researcher status.

The major flaw in this theory is that not all ash produced by burning materials weighs less than the original. When some metallic materials, such as mercury, lead and copper, are heated by the fire, a **calx** is formed, a powdery substance that weighs more than pure metal. Therefore, if the phlogiston theory stated that any substance would release its phlogiston to the air when heated and burned, and a less weight residue was obtained, how would one explain that some substances when heated, gained weight? How was it possible that if a substance lost phlogiston, it weighed more? Scientists of the time sought to explain this contradiction by arguing that perhaps what happened was that phlogiston had a negative mass, so that when phlogiston was lost, mass was gained. But this explanation came into conflict with the case of wood turning into ashes.

Glossary

Calx. A residual substance formed when a metal is exposed to fire or heat for a long time.

The Importance of Measurement in Experiments

To provide an answer to the dilemma and sensing the importance of quantitative data on an experiment by isolating its study sistem, Antoine Laurent Lavoisier (Fig. 1.63), made careful and systematic measurements. He put a specific amount of mercury (a liquid gray metal) in a glass flask that he closed and weighed on a scale. Then, he put the mercury over an open flame, and after a few days a red calx was formed.

When Lavoisier measured the mass of the system, he found out that the mass was the same as before the calx was formed; but when he opened the flask and perceived that air rushed inside of it, he realized that this mass inside the flask along with the calx, was greater than the system before removing the lid (Fig. 1.64).

Today we know that when mercury is heated (Hg), it combines with oxygen in the air (O_2) to produce a new substance, known as mercury oxide (HgO). As the HgO contains oxygen it weighs more than the Hg alone, while the air (which is a mixture of different gases), weighs less since it loses oxygen. Now, the mass gain of Hg when forming HgO is equal in magnitude to the loss of air mass, because oxygen is extracted from this last one. That's why the mass of the system is maintained despite a change in the substances.

In addition to providing sufficient arguments to deny the existence of phlogiston, Lavoisier's results also served as a foundation to affirm that in the transformation of a substance into another during a chemical change, the mass remains constant (Fig. 1.65). This is known as the Law of Conservation of Mass; matter, and therefore mass, doesn't just appear and disappear, but the atoms and molecules that make up the substances are arranged differently to form different substances.

FIG. 1.63 Antoine Laurent Lavoisier working in his laboratory.

Closing up!

With Lavoisier's works, chemistry was no longer seen as a mystical science and consolidated as a quantitative discipline. These changes in the way of explaining the world are the reason why this stage is known as the First Chemical Revolution.

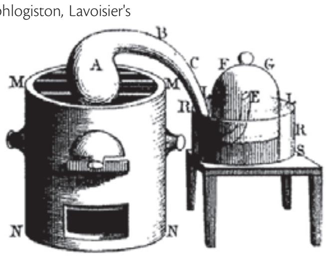


FIG. 1.64 Laboratory material used by Lavoisier for his experiment with mercury.

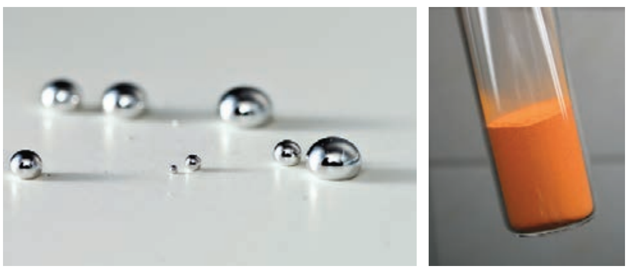


FIG. 1.65 Mercury (Hg) is a silvery-white liquid metal, while the mercury oxide (HgO) is a brick-red powder.

SESSION INFORMATION

Week: 8

Session: 48

Expected learning outcomes: Identify the functionality of expressing the concentration of a mixture in units of percent (&) or parts per million (ppm).

Identify the different concentrations of a pollutant in a mixture have different effects on health and on the environment, in order to make informed decisions.

CONTENT DELIVERY

Start: Remind students of the evaluation rubrics (page 157).

Development: Students should give their presentations. Segment presentations; help students make themselves clear; ask comprehension-check questions to the audience.

Closing: Ask students to self-evaluate their performance.

SKILLS DEVELOPMENT

Interpersonal skills: Working as a team member, teaching others.

Critical thinking skills: Summarizing.

Reading skills: Scanning, reading for detail.

Metacognitive skills: Self-monitoring, self-evaluating.

EVALUATION OF CONTENT

Use the projects rubrics to give them a researcher status.

SESSION INFORMATION

Week: 9

Sessions: 49 - 54

Expected learning outcome: Integrate unit content to create a product.

CONTENT DELIVERY

Start: Briefly explain what you will evaluate in their projects: Relevant, clear information, visuals, comprehension-check questions and further information.

Development: Students should present their projects. Assign time according to your class length. Help as necessary.

Closing: Students should ask their comprehension-check questions to their partners. Then, ask them to self-evaluate their presentations using the same presentation parameters described in the projects rubrics.

Project: *Explore, Experiment and Experience. Integration and Application of Knowledge*

FIG. 1.66 Obtaining salt deteriorates the regions where it is produced, to the point of making these regions practically sterile land areas.

Science and chemistry in particular are present in our everyday life activities. We can see this in the substances we are in contact with, the ones we use or those our bodies are made of.

If you reflect a little, you will realize that everything around us is a mixture of substances and how they transform concerns to chemistry. This does not imply that the separation of mixtures was achieved only through chemical study, since from ancient times salt has been separated from sea water (Fig. 1.66). It was not until recent decades that mankind understood how much this practice damages the ecosystems and how important it is to protect fresh water, to give it a proper use, to recover it and to recycle it, since it is a limited natural resource and it is becoming increasingly scarce (Fig. 1.67).

FIG. 1.67 With the increase in the demand for freshwater, having wastewater treatment plants has become essential to reuse it.

Planning your project ➔ Introduction

Form teams with some of your classmates. Every member of each team must contribute and participate, as well as take responsibility for the assigned tasks, everyone must be compatible and supportive and respectful to other member's points of view.

When teamwork is done following these parameters, it becomes more efficient and rewarding than individual work, since all the effort is shared and contributions to the project are more valuable.

Once your team is formed, collect all the information you have in your portfolios, notebooks and from this textbook, and based on this information, discuss and choose one of the following questions to develop your project:

- How does the salt industry work and what is its environmental impact?
- What can we do to recover and reuse water from the environment?

The central question you choose to develop your project must respond to personal concerns, problematic situations that you, your family or community face and the opportunities you have to develop proposals that may help you solve one or more of these situations.

The following table includes reflection questions that will serve you as a guide; to answer them, state what you already know or do some research using library resources such as books, scientific journal articles, science magazines, the Internet or by consulting specialists:

Once you choose your topic, you must decide the type of project you will do. You can do

Question	Answer	Source
How is common salt obtained?		
Where are the salt industries located?		
What characteristics does salt have?		
What methods are used to obtain salt?		
Can the production of salt cause environmental damages? Which ones?		
How does water get to our homes?		

36

SKILLS DEVELOPMENT

Reading skills: Scanning, Reading for detail.

Interpersonal skills: Teaching others, working as a team member.

Critical thinking skills: Formulating questions.

Listening skills: Understanding the message.

Metacognitive skills: Delivering content, self-monitoring, self-evaluating their presentation.

EVALUATION OF CONTENT

Follow the projects rubrics, Teacher's Guide page 157.

How much drinking water is available for humans?		
What happens to the water we throw away?		
How are pollutants removed from water?		
What are the alternatives we have to make better use of the water?		
In case none of the topics suggested satisfy you and your team, and based on the content of this unit, what other questions would you suggest to help you with your project?		
Explain your choice for any of the topics or questions and the situations it would help you solve.		

a science, a technological or a civic project; as each of these projects have particular characteristics, their development and activities to achieve the goals, will be different as well.

The scientific project is a way to obtain knowledge about a particular problem based on experimentation. When designing an experiment, you need to do extensive research, in order to know about the problems you will face, their status and the different ways they have been addressed before. With this, you can establish the premises from which you will depart, and from which you will obtain the necessary elements to state a hypothesis; to validate such hypothesis, a specially designed experiment must be performed to find different alternatives based on the knowledge of the properties of matter, and on the basic principles of chemistry (Fig. 1.68).

FIG. 1.68 When performing a scientific project, experimentation is essential.

The main objective of a technological project is to solve a well-defined problem by making a device or by organizing a process; in order to achieve this objective, it is necessary to identify the problem as well as all the different aspects that relate to it and to use this knowledge in the design and manufacturing of this device or process.

A technological product does not always work the first time it is used. The product should be tested following the same procedures as for a scientific project; in other words, the development of a hypothesis and the experimentation with models or prototypes, which will allow correcting errors, modify the designs and taking it to practice knowing it will work according to the stated objectives.

The civic project also seeks to solve a specific problem and, as the technological project, it is necessary to have all the information related to it, the difference is that the goal must reach the community to raise awareness about the problem encountered and to propose alternative solutions that are generally related with changing behaviors and habits.

As in the other cases, you must do research using scientific parameters and since it is necessary to know the points of view of people to validate a hypothesis, experimentation is changed for opinion research by using questionnaires, interviews, surveys and monitoring achievements after implementing a public information strategy or a campaign to solve a problem.

Selecting the type of work requires evaluating the advantages and disadvantages of each of them, as well as the importance of the contributions the project will have. To select the type of project you will do, talk it over with your team and use the following table as a guide to take an appropriate decision to do it.

Using the table above as a guide will also help you and your teammates establish the goals and the hypothesis of the project in a clear way.

SESSION INFORMATION

Week: 9

Sessions: 49 - 54

Expected learning outcome: Integrate unit content to create a product.

CONTENT DELIVERY

Start: Briefly explain what you will evaluate in their projects: Relevant, clear information, visuals, comprehension-check questions and further information.

Development: Students should present their projects. Assign time according to your class length. Help as necessary.

Closing: Students should ask their comprehension-check questions to their partners. Then, ask them to self-evaluate their presentations using the same presentation parameters described in the projects rubrics.

SKILLS DEVELOPMENT

Reading skills: Scanning.

Interpersonal skills: Teaching others.

Critical thinking skills: Formulating questions.

Listening skills: Understanding the message.

Metacognitive skills: Delivering content, self-monitoring, self-evaluating their presentation.

EVALUATION OF CONTENT

Follow the projects rubrics, Teacher's Guide page 157.

SESSION INFORMATION

Week: 9

Sessions: 49 - 54

Expected learning outcome: Integrate unit content to create a product.

CONTENT DELIVERY

Start: Explain what you will evaluate in their projects following the rubrics on page 157.

Development: Students will present their projects. Assign time according to your class length, help as necessary.

Closing: Students should ask their comprehension-check questions to their partners. Then, ask them to self-evaluate their presentations using the same presentation parameters described in the projects rubrics.

Project: *Explore, Experiment and Experience. Integration and Application of Knowledge*

Type of work	Advantages	Disadvantages	Possible Contributions
Scientific			
Technology			
Social			

Planning your project ➔ **Development**

To plan the activities of your project, it is essential to develop a project timetable, because it will allow you to organize all the activities you will do, the time required for them and the sequence to follow. The project is planned to take place in two weeks. Use the table below as a guide and assign activities, time completion and the person responsible for each activity.

During the development of the project there are several activities to be done, which will depend on the type of work, and the topic you choose.

If you decide to work on the topic of the salt industry operation and a scientific project, you will need to be informed about the chemical and physical processes related to the industry. You could plan a hypothesis and research to test the different methods to find out the effect of salt on ecosystems, and based on the results, suggest recovery strategies, as well as new, less aggressive methods to obtain this product.

PROJECT TIMETABLE

Central question and name of the project:

Team members:

Phase in Project	Aspects to cover	Activity	Time	Responsible
Beginning	Selection of the topic.	Research and discussion.		
	Selection of the type of work.	Discussion and agreements.		
	Hypothesis development.	Discussion and agreements.		
	Goals development.	Discussion and agreements.		
Development	Bibliography research.	Different resources research.		
	Design of the necessary activities.	Write the design of the project taking into account the next questions: What to do? How to do it? What to use? How can we get the materials? How much will it cost?		
	Design of the instruments to obtain and analyze results.	Development of tables, graphs and models.		
Closing	Results analysis.	Discussion.		
	Hypothesis validation.	Comparison of the hypothesis with the results.		
	Conclusions.	Discussion and agreements.		
	Communication.	Instrument selected by the group.		
	Project evaluation.	Work characteristics analysis.		
	Self-evaluation.	Personal participation analysis.		

SKILLS DEVELOPMENT

Reading skills: Scanning, reading for detail.

Interpersonal skills: Teaching others, working as a team member.

Critical thinking skills: Formulating questions.

Listening skills: Understanding a message.

Metacognitive skills: Delivering content, self-monitoring, self-evaluating their presentation.

EVALUATION OF CONTENT

Follow the projects rubrics, Teacher's Guide page 157.

If you decide to work on a technological project, in addition to the investigation on the characteristics of salt and the operation of the salt industry, you would have to design a device that allows you to evaporate water in an efficient and economical way without causing any damage to the ecosystems and focused on a sustainable hypothesis based on the efficiency of your design, and the experimentation would be focused on testing a model or a prototype. You would have to make a **prospectus** in which you suggest that by using your design, an **alteration** in the procedure would be reached.

In case you decide to do a social project under the topic of recovery and reuse of water, the process would be similar but with a different purpose and content.

You would have to do some research based on the uses and the way to make the most out of water in the community, its availability and quality, as well as potential wasting of water sources. In your research you would need to include techniques and tips that you can use to recover and reuse water, both domestically, in every home, school or building, as well as in the community with **wastewater** treatment. Your hypothesis then, would state that with a well-directed information campaign you could sensitize people to recover and reuse water in their homes and a brochure could be distributed to later conduct a survey to see if people changed their habits; from the analysis of the survey, you may conclude whether the distribution of the pamphlet was enough or whether you need to implement other strategies (Fig.1.69).

As you may have noticed, not only do scientific projects follow the parameters of science work, they are also present in the other two types because science-based proposals cause a positive reaction on people. The purpose of understanding and learning chemistry, is to educate citizens for them to take appropriate and informed decisions and to change their behavior of consumption.

Part of the development of the project is obtaining results; to do so, it is necessary to know the characteristics of the models and prototypes that you will put into practice and how you will analyze the information obtained in order for you to build graphs and diagrams, to analyze the information properly, to examine and reflect whether you have achieved your goals, to validate your hypothesis and to determine if your contribution will allow a better use of natural resources.

Glossary

Prospectus. Set of analysis and studies made with the purpose of exploring or predicting the future in a given subject.

Alteration. It refers to the change or process of transformation.

Wastewater. Water that has been already used and comes from homes, towns or industrial areas, it is usually mixed with dirt and debris.

FIG. 1.69 A useful resource for surveys is the telephone interview.

Planning your project ➔ Closing

Finishing the activities in your project successfully, implies several different aspects, starting from the analysis of the results, considering that from this analysis, you will be able to draw conclusions, evaluate if the goals were achieved or not, and explain the reasons in each case. It is important to notice that, the hypothesis can be either validated or rejected as well, and make new and innovative proposals for future projects.

The information and data gathered from tables and graphs, evaluation of the models, their performance and success as a technological product, or from the achievements in the proposals for the civic project, will help you with the analysis of the results (Fig. 1.70). The results of your work, your commitment as well as the goals you achieved, can be evaluated through the development and application of rubrics.

Another relevant moment in the project is the communication phase, which is a way to present the results of your project; there are many ways to do this, from a simple exhibition to the organization of a lecture; in any case, one of the most important aspects that should be highlighted, is the validity of your considerations, based on the presentation of concise, honest and verifiable results from your experimental work.

FIG. 1.70 The use of technology makes the analysis of results easy.

SESSION INFORMATION

Week: 9

Sessions: 49 - 54

Expected learning outcome: Integrate unit content to create a product.

CONTENT DELIVERY

Start: Explain what you will evaluate in their projects following the rubrics on page 157.

Development: Students will present their projects. Assign time according to your class length, help as necessary.

Closing: Students should ask their comprehension-check questions to their partners. Then, ask them to self-evaluate their presentations using the same presentation parameters described in the projects rubrics.

SKILLS DEVELOPMENT

Reading skills: Scanning, reading for detail.

Interpersonal skills: Teaching others, working as a team member.

Critical thinking skills: Formulating questions.

Listening skills: Understanding a message.

Metacognitive skills: Delivering content, self-monitoring, self-evaluating their presentation.

EVALUATION OF CONTENT

Follow the projects rubrics, Teacher's Guide page 157.

SESSION INFORMATION

Week: 10

Sessions: 55 - 59

EVALUATION

CONTENT DELIVERY

Start: Students should answer page 40 prior to taking the unit assessment. Go through the answers; help them with techniques to study content they do not clearly remember; such as mind maps, questionnaires, partner discussion, drawings, etc.

Development: Students are to take the unit assessment. You can find it in the Teacher's Guide pages 141 to 144 along with the answer key.

Closing: Check their assessments, record the score and provide with feedback. You might want to use the Attendance and Evaluation formats that you can find the Teacher's Guide pages 158 to 160.

Evaluation

Read the following text carefully.

Even Pure Water is Pure Chemistry

For some reason, in recent decades everything related to chemistry has gained notoriety. To say that something is a chemical is now understood as a synonym for harmful.

In contrast, to promote any product that claims to be healthy, natural and beneficial, a great emphasis is placed on phrases such as: "without chemicals", etc., the irony in these types of statements is that they are, above all, impossible since all matter is necessarily a chemical. Light, energy, space and gravity are immaterial entities, and therefore not chemical, just as plasma from the Sun. Plasma, for example, does not have either isolated nor bonded atoms to form molecules but just contains pieces of atoms.

Anything that is made up of solid, liquid or gaseous matter, i.e., by atoms and molecules or ions, (electrically charged counterparts) is necessarily chemical. For example, air, water, soil, all living things, and even our brains, are very closely related to chemistry.

But, why do people have a prejudice against chemistry? Why this "chemophobia"? Probably, one of the reasons could be that chemical substances are confused with artificial substances. This thought may imply that things made by humans are considered harmful, while what comes from nature is necessarily healthy.

This idea can be contradictory when we consider that toxic, natural substances are abundant; like the poisons produced by bacteria, such as the Clostridium botulinum and its botulinum toxin (one of the most powerful poisons known), as well as those produced by plants, fungi, insects, reptiles and amphibians.

Maybe it is just ignorance mixed with bad publicity, it is true that pollution of water, soil and air is, to some extent, a result of the chemical industry. But it is also true that chemical phenomena takes place not only in laboratories but also in a kitchen, in the atmosphere or within our cells.

Perhaps the solution or a way to change this thought, would be to realize that chemistry could cause problems but provide the solution as well. Finally, to understand better and to accept the natural chemistry of this world, which is made of matter, it is important to learn a little more about it.

In Ojo de mosca by Martín Bonfil Olivera at magazine *¿Cómo ves?*
http://www.comoves.unam.mx/numeros/ojodemosca/62

Based on the text you read, choose the correct answer in each case.

1. Why is the statement "without chemicals" impossible?

a) Because everything we know are mixtures from which chemical products cannot be separated.
b) Because even though it is mentioned in advertising, everything contains chemicals.
c) Because all matter is studied by chemistry.
d) Because chemistry studies everything that happens in the Universe.

2. What is the reason for "chemophobia"?

a) Chemistry has destroyed ecosystems.
b) Chemicals are confused with artificial.
c) Chemistry causes pollution.
d) Chemicals are related with technology.

3. Where do chemical phenomena occur?

a) Only in laboratories.
b) In all industries.
c) Only in the oil industry.
d) Everywhere.

4. What is the solution to the perception of chemistry?

a) Realizing that chemistry can provide a way to solve problems.
b) Remove any advertising referring to damage caused by chemicals.
c) Stop producing chemical products.
d) Prohibit the practice of chemistry.

Underline in the text the sections where you found the answers, share it with a partner and discuss the reasons why they are right or wrong. In case of disagreement, propose ideas to find necessary and complementary information to allow you to reach an agreement.
Evaluate your performance throughout this unit; mark with

SKILLS DEVELOPMENT

Metacognitive skills: Identifying topics to go through.

EVALUATION OF CONTENT

Check the answer key to the unit assessment on page 144.

a check (✓) the indicator which you have achieved under the correct timing column.

SELF-EVALUATION					
	Indicators	Always	Usually	Sometimes	Never
COMPREHENSION	I can ask questions that integrate the contents studied in the unit.				
	I can relate the topics I study to daily events and other familiar situations.				
	I can understand the content covered in class without problems.				
	I can identify my mistakes, difficulties and limitations, and propose actions to overcome them.				
	I can express my point of view and opinion as a contribution to the collective analysis.				
	I can solve problematic situations by applying what I learned.				
SCIENCE SKILLS	I brought to class, all the materials I needed.				
	I did all my work in a neat and clean way.				
	I can explain, share, communicate and contrast my ideas with others.				
	I can ask and answer questions that allow me to integrate the contents I studied in the unit.				
	My hypotheses are consistent and correspond to the activities and the topics in the unit.				
	I can analyze the information I get from several media, and select only what is relevant to reach the purposes I have.				
	I am able to choose the most convenient strategy to solve problems.				
	I can design instruments to register and order data obtained from the activities.				
	I can analyze results to draw conclusions.				
	I can draw conclusions based on the organization and order of the information I have available.				
ATTITUDES	I can successfully do and finish all my work.				
	When I need help, I ask my teacher or my classmates.				
	I'm capable of listening, value, and take into consideration the opinions of others even when they don't agree with mine.				
	I'm honest with the veracity of the information I handle.				
	I can actively participate on a team.				
	I can show my classmates' solidarity.				
	I am a responsible consumer.				
	I propose sustainable behavior.				
	I show respect for biodiversity.				
	I can prevent diseases and accidents during my activities.				
	I show interest, curiosity, creativity and imagination in every activity I do.				

SESSION INFORMATION

Week: 10

Session: 60

SELF EVALUATION

CONTENT DELIVERY

Start: Explain to students why evaluation is important. It is the only way to improve the way of learning.

Development: Get students to answer the self-evaluation and help them reflect upon their learning process.

Closing: Provide with some feedback.

SKILLS DEVELOPMENT

Metacognitive skills: Self-monitoring, self-evaluating.

EVALUATION OF CONTENT

Students should get their self-evaluation instrument checked by the teacher.

SESSION INFORMATION

Week: 11

Session: 61

Expected learning outcome: Identify difficult content in order to write a study plan.

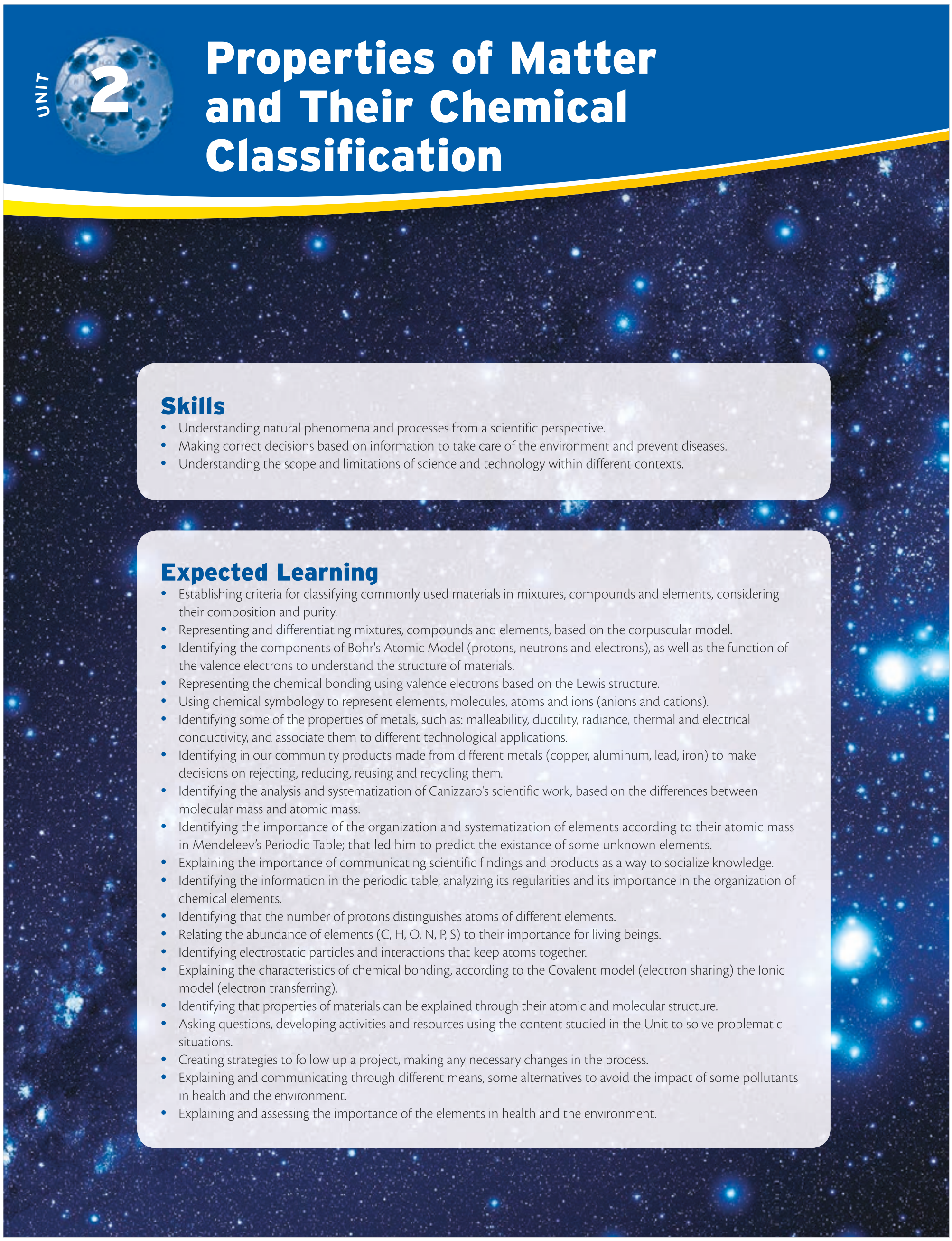
CONTENT DELIVERY

Start: Have students analyze and identify what they could do well in unit 1 as well as what they should improve in unit 2. Ask them, for instance: What topics were easy? Did your previous study plan work? Didn't it work? Why? Did you really follow your study plan? Students should write down their reflections.

Development: Have students check the skills, learning outcomes and key concepts in unit 2. Ask them to identify the topics they consider the hardest ones. Then, they should plan how to study them and do better than the previous unit. Help them with ideas. (Drawing mind maps, discussing with partners, making their own exams, making timelines, making associations, etc.)

Closing: Students should write down their study plan and have it checked.

Homework: Students should take three home products that have a readable label in which the ingredients are listed.



UNIT 2

Properties of Matter and Their Chemical Classification

Skills

- Understanding natural phenomena and processes from a scientific perspective.
- Making correct decisions based on information to take care of the environment and prevent diseases.
- Understanding the scope and limitations of science and technology within different contexts.

Expected Learning

- Establishing criteria for classifying commonly used materials in mixtures, compounds and elements, considering their composition and purity.
- Representing and differentiating mixtures, compounds and elements, based on the corpuscular model.
- Identifying the components of Bohr's Atomic Model (protons, neutrons and electrons), as well as the function of the valence electrons to understand the structure of materials.
- Representing the chemical bonding using valence electrons based on the Lewis structure.
- Using chemical symbology to represent elements, molecules, atoms and ions (anions and cations).
- Identifying some of the properties of metals, such as: malleability, ductility, radiance, thermal and electrical conductivity, and associate them to different technological applications.
- Identifying in our community products made from different metals (copper, aluminum, lead, iron) to make decisions on rejecting, reducing, reusing and recycling them.
- Identifying the analysis and systematization of Canizzaro's scientific work, based on the differences between molecular mass and atomic mass.
- Identifying the importance of the organization and systematization of elements according to their atomic mass in Mendeleev's Periodic Table; that led him to predict the existance of some unknown elements.
- Explaining the importance of communicating scientific findings and products as a way to socialize knowledge.
- Identifying the information in the periodic table, analyzing its regularities and its importance in the organization of chemical elements.
- Identifying that the number of protons distinguishes atoms of different elements.
- Relating the abundance of elements (C, H, O, N, P, S) to their importance for living beings.
- Identifying electrostatic particles and interactions that keep atoms together.
- Explaining the characteristics of chemical bonding, according to the Covalent model (electron sharing) the Ionic model (electron transferring).
- Identifying that properties of materials can be explained through their atomic and molecular structure.
- Asking questions, developing activities and resources using the content studied in the Unit to solve problematic situations.
- Creating strategies to follow up a project, making any necessary changes in the process.
- Explaining and communicating through different means, some alternatives to avoid the impact of some pollutants in health and the environment.
- Explaining and assessing the importance of the elements in health and the environment.

SKILLS DEVELOPMENT

Metacognitive skills: Planning, organizing studies content.

EVALUATION OF CONTENT

Students should get their study plan checked by the teacher.

Diagnostic Evaluation

Instructions

1. Observe the images.

2. Answer the questions in your notebook.
   - Are you able to identify the materials in each of the images shown above?
   - Write down a list of the materials you were able to identify.
   - From the identified materials: which will you classify as chemical elements? Which as compounds? Which as mixtures?
   - Explain the reason for your classification of the materials. Explain what kind of information you are lacking to make the classification.
3. Share your answers with the class.

Classification of Matter

Mixtures and Pure Substances: Compounds and Elements

Everything that surrounds you is made out of matter: the chair you sit on, the ink used to print this book, the air you breathe and even yourself. Even though they all have different appearance and they are made out of different **materials**, all of this things share something in common: they have **mass**, because they are made of atoms.

It is true that the universe has matter, but it also has energy, which doesn't have matter but we know it is there because it shows itself in different forms: the light of a star and the heat of a fire. We can also watch the result of the interaction between energy and matter, for example, we know that our food –which is all matter– will react differently and will change some of its characteristics when we heat it.

Expected Learning

Establish criteria for classifying commonly used materials in mixtures, compounds and elements, considering their composition and purity.

Get started!

Examine the label on three different products that you have at home. For example: a cleaning product or a detergent, a personal hygiene product (body cream or shampoo), a packaged food product (juice or cereal).

- Copy the chart in your notebook and fill it in with the correct information for each product.

Glossary

Material. Matter in a specific space and with specific characteristics.

Mass. The quantity of matter contained in something.

SESSION INFORMATION

Week: 11

Session: 62

Expected learning outcome: Establish criteria for classifying commonly used materials in mixtures, compounds and elements, considering their composition and purity.

CONTENT DELIVERY

Start: Ask students to look at the images in the section *Diagnostic Evaluation* and answer the questions below. Elicit answers.

Development: Students should read the introduction to the topic *Classification of Matter.* Individually, they will do the activities in the section *Get Started!* Which starts on page 43 and ends on top of page 44.

Closing: Elicit students' answers to the analysis they should have completed about the products they should have taken to class.

SKILLS DEVELOPMENT

Naturalistic skills: Observing details, organizing data.

EVALUATION OF CONTENT

Check students' tables.

SESSION INFORMATION

Week: 11

Session: 63

Expected learning outcome: Establish criteria for classifying commonly used materials in mixtures, compounds and elements, considering their composition and purity.

CONTENT DELIVERY

Start: Write "Materials" on the board. Ask students to list some materials they can think of. Elicit answers and have students write options.

Development: Students will read page 44. In case they have vocabulary problems, they will have to look up the term. Dictate the following questions so that students should find the answers: In which groups are materials classified? What's the definition of pure substance? How are pure substances classified? Which are the substances arranged in the periodic table? What forms atoms? What's the name of a substance composed by molecules? What's the name of combined pure substances? Which are the mixtures in which solutions are classified?

Closing: Elicit answers. If there's time, ask students to draw each concept.

Glossary

Pure substances. A material that is composed of only one type of atoms.

Mixture. A material that is made up of at least two different pure substances.

Subatomic particles. Particles that forms the atomic structure: electrons, protons and neutrons.

- Which ingredients are you familiar with? Which ones are unknown to you? Research the ingredients you don't know, and classify them as elements, compounds or mixtures

Product	Ingredients	Classification
Dish soap		

- Share your conclusions with the class. Reflect on the fact that most of the things we use on a daily basis are made out of mixtures of different things.
- Keep your work in your portfolio of evidence.

FIG. 2.1 In everyday language, we use terms like purity to refer to materials such as water and air in nature, even though they are mixtures.

Going further

To have a better understanding of things around us, humans have had the need to classify them. This process is very important to science in order to study and explain different types of materials. All materials are classified into two groups: **pure substances** and **mixtures**.

In general, chemistry uses the term pure substance to refer to a substance that is not combined with another. It is important to distinguish the term substance since in our everyday language we use pure with other meanings, like when we refer to "pure spring water" or to "pure mountain air" (Fig. 2.1).

Most of the materials around us are really mixtures, if we take as an example, spring water, we will see that even though we say it is pure, it is really a mixture of many substances, like salts and other minerals. As long as there are two pure substances combined, we will always have a mixture as a result, and because of that, we can state that mixtures are not pure materials.

Only a very small portion of the properties of matter is related to what we see, since all materials are formed by fundamental particles called atoms. Therefore, we classify pure substances into elements and compounds.

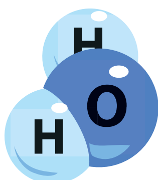


FIG. 2.2 A water molecule is a combination of hydrogen atoms (H) and oxygen atoms (O), which are chemically bonded. This is why this substance is a compound.

The elements are arranged in the periodic table, they are substances formed by only one type of atom (look at the Periodic Table at the end of your book, page 144). For example, in a piece of copper wire, every atom in it is copper; this means that each atom that exists in the wire has the same number of protons in its nucleus. Protons, neutrons and electrons are the **subatomic particles** that form the atoms; they are so small that only when there are many of them together, are we able to see certain properties.

Atoms of different types come together through chemical bonds to form a molecule, so a substance composed of molecules is called a compound. Regular salt or sodium chlorine (NaCl) is made out of sodium atoms (Na) and chlorine atoms (Cl) that are chemically bonded. Another compound is water (H_2O), which comes from the bonding of hydrogen atoms (H) and oxygen (O). If we fill a glass with water at room temperature, we will see it is a liquid, nevertheless, that's only meaningful within a group of water molecules: we cannot say a single molecule is liquid. States of matter are only valid to describe a group of molecules or atoms, not single particles (Fig. 2.2).

Pure substances can be combined and joined without the need to create a chemical bond, these are called mixtures.

In Unit 1, we studied a type of mixture known as a solution. In these types of mixtures, once the blending is done, you will not be able to distinguish its components. Solutions are classified as homogeneous mixtures. There are also heterogeneous mixtures, in which the components are visible at first glance, just as in a salad, tamarind flavored water or the layers of the ground (Fig. 2.3).

FIG. 2.3 A salad is a clear example of a heterogeneous mixture because we are able to distinguish most of its ingredients.

SKILLS DEVELOPMENT

Reading skills: Scanning, reading for detail.

EVALUATION OF CONTENT

Check students' questionnaires.

SESSION INFORMATION

Week: 11

Session: 64

Expected learning outcome: Establish criteria for classifying commonly used materials in mixtures, compounds and elements, considering their composition and purity.

CONTENT DELIVERY

Start: Students should do the classification activities described in the section *Reflect, Explain and Share* on top of the page. Elicit answers in whole class and tell students they will be studying different kinds of mixtures.

Development: Students should read the entire page. Meantime, copy the following terms on the board: Emulsion, colloid, compound. Students should find the definitions in the text. Elicit answers.

Closing: Students should find the Molecular Kinetic Theory (MKT), which explains the behavior of gases and their particles in order to draw each postulate.

Reflect, Explain and Share

Is it homogeneous or heterogeneous mixture?

- In your notebook, classify the following mixtures in a two-column chart, one column for Homogeneous mixture and the other for Heterogeneous mixture: 1) water with oil 2) mayonnaise 3) wood 4) pool water 5) 50 cent coin material 6) saliva 7) blood 8) vinegar 9) mud 10) air.
- Compare your answers with your classmates, then answer: What were your doubts while classifying these mixtures? Did everyone agree with the classification of the mixtures? Which were the hardest mixtures to classify? Why?

Keep your work in your portfolio of evidence.

Glossary

Emulsion. Stable mixture of two liquids that will commonly not mix, like water and oil, and is achieved by constant stirring.

Colloid. Mixture in which particles of one or many substances are scattered on a solvent, even though those particles are bigger than the molecules of the solvent

Centrifugation. Method to separate solids and liquids in mixtures. This method applies a rotational movement that generates a force that settles solids.

Most of the time, it is possible to distinguish between homogeneous and a heterogeneous mixtures. Mayonnaise, for example, is a mixture of: water, eggs, oil and salt. If we observe it, we'll find it homogeneous; normally, water and oil won't mix, but in a jar of mayonnaise we won't see them separately (Fig. 2.4).

However, mayonnaise is classified as an **emulsion**, which is a heterogeneous mixture, due to the fact that little drops of oil are not entirely mixed with water. Another example of an emulsion is milk and body creams. Blood is another example of a mixture that seems homogeneous at a first glance. But blood is really a **colloid**; where the solute is a scattered solid in a liquid.

Without separating the mixture, it is possible to observe the cells that make up blood with an optic microscope (Fig. 2.5). If we leave a blood sample to stand for a while, cells will separate and then settle. This specific characteristic of blood is what allows for the performance of blood tests, since plasma, platelets and red blood cells separate by a **centrifugation** process, and it is easier to analyze them. To understand the existence of different types of mixtures, it is necessary to remember that all materials are made up of tiny particles called atoms. Elements are pure substances formed by atoms of the same type, while compounds have different combinations of atoms, called molecules. When we combine these substances without any chemical reaction we get a mixture.

Depending on how particles scatter around others, the mixture will end up being homogeneous or heterogeneous or in some cases, intermediate mixtures called emulsions or colloids.

The movement and arrangement of the particles of a certain material affect the way they mix with another (Fig. 2.6). All of the particles that make up materials move, even in a solid state, and when they do not move around, they vibrate in their place. To explain the behavior of gases and their particles, the Molecular Kinetic Theory (MKT) was developed. This theory states that:

- Every gas is formed by particles that move constantly at all times, without a pattern or a direction. This type of movement is called: Brownian motion.
- Particles of gases are always colliding against one another all the time and against the particles of the container that holds them without losing energy.
- The particles are so far away from each other that the distance between them is greater than their size.
- Particles do not attract or repel each other.

Figure 2.7 shows that if we put two gases together, the motion of the particles and the big gap between them will allow their bonding, and it will be difficult to distinguish them at first sight.

FIG. 2.4 If we could look closely, we would see that mayonnaise is a heterogeneous mixture, since oil particles are not completely scattered in the middle and are bigger than a single molecule of oil.

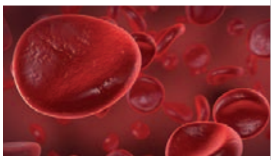


FIG. 2.5 Blood is a mixture composed of plasma, the liquid in which cells are dispersed to accomplish different body functions.

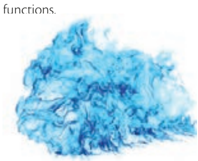
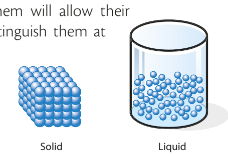


FIG. 2.7 Two gases will always form a homogenous mixture due to the characteristics of the particles on this state of matter.



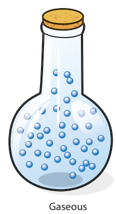


FIG. 2.6 The arrangement of particles that compose materials on different states of matter also affects how they mix with other materials.

SKILLS DEVELOPMENT

Critical thinking skills: Defining concepts.

Logical/Mathematical skills: Abstracting information.

Visual/Spatial skills: Graphing data.

EVALUATION OF CONTENT

Check students definitions and postulates' drawings.

SESSION INFORMATION

Week: 11

Session: 65

Expected learning outcome: Establish criteria for classifying commonly used materials in mixtures, compounds and elements, considering their composition and purity.

CONTENT DELIVERY

Start: Ask students the definitions of mixture, emulsion, colloid, heterogeneous mixtures and homogenous mixtures. Elicit answers.

Development: Students should read the top of the page, which is the closing paragraph of the topic *Classification of Matter*. Then, in pairs, they should work in the activity described in the section *To Integrate* in the middle of the page.

Closing: Check students' concept maps.

Homework for the teacher: Prepare a Bohr model with Styrofoam balls and wire.

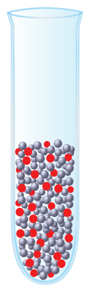


FIG. 2.8 The particles of two liquids have different forces of attraction, which result in different levels of mixtures.

When two liquids mix, their particles move to form a material that are considered a **fluid**, there are average distances between particles called gaps. These gaps between particles will depend on the attraction of the substances before they mix. In the case of water and oil, we will find they are both liquids at room temperature, but when they mix, they result in a heterogeneous mixture. This is mainly because the attraction between water molecules and oil molecules is very different, this restricts the **diffusion** of both molecules, despite the natural movement of particles.

Other liquids that share a similar attraction between their particles will mix homogeneously. For example, water and alcohol which, combine to the natural motion of particles and the gaps between them, allows them to diffuse and mix completely (Fig. 2.8).

The MKT helps us to understand that the classification of homogeneous and heterogeneous mixture is not absolute, since it is based on the gradual physical changes in which substances are combined, as well as the size of the aggregates of particles that are mixed.

To integrate

Concept Map

Make a concept map with the term "material" as the key concept. You could use the following terms as guidance; remember to use arrows to relate one term to another, as well as adding words that explain the relation between words.

Mixtures | Materials | Elements | Solvent
Heterogeneous | Solute | Homogeneous | Compounds
Dissolutions | Pure substances | Concentration

Closing up!

There are plenty of materials around us, many of them are mixtures, and we are now able to observe their properties: shape, size, and color whether solids or liquids. We have learned how the properties relate, as well as the behavior of the particles that conform them.

GLOSSARY

Fluid. A material that can take the shape of its container. Gases and liquids are under this classification.

Diffusion. Process in which the particles of one substance are completely mixed with another substance.

Particle accelerator. Device used on electromagnetic fields to accelerate particles, such as atoms or electrons, making them collide with each other and creating other particles or different types of energy.

Structure of Materials

The Bohr Atomic Model

Today, we know matter is made out of atoms, which are made out of subatomic particles named protons, neutrons and electrons.

Expected Learning

Identify the components of the Bohr Atomic Model (protons, neutrons and electrons), as well as the function of valence electrons to comprehend the structure of the materials.

Going further

Anatomic structure and the way atoms interact are both key factors in understanding modern chemistry. The development of science and technology during the last few years has led to the design of different machines such as **particle accelerators**, with which scientists perform experiments that allow them to study a variety of very small particles that give structure to protons, neutrons and electrons. Matter within atoms is mainly made out of protons and neutrons, which are concentrated in the nucleus, while electrons spin around it. Protons and electrons have electric charges: protons have a positive charge and electrons have a negative charge. As its name implies, neutrons have a neutral charge. An atom that has the same number of protons in the nucleus as electrons around it is a neutral atom.

SKILLS DEVELOPMENT

Visual/Spatial skills: Creating concept maps.

Logical/Mathematical skills: Abstracting information.

Critical thinking skills: Summarizing.

EVALUATION OF CONTENT

Check students' concept maps.

Chemical changes are related to the exchange of electrons between atoms, but it is protons that give an atom an element, its identity. The number of protons or positive charges is identified with the atomic number Z, which is a unique number given to each element. If we know the atomic number of an element, we are able to say how many protons it has, and if it is a neutral atom, we will know the number of electrons (Fig. 2.9).

The mass number is the addition of the particles with significant mass: protons and neutrons. It is always a whole number.

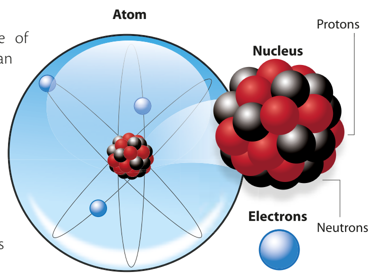


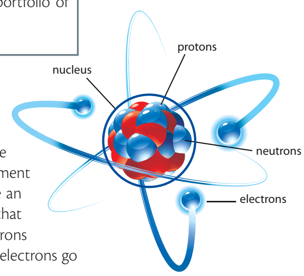
FIG. 2.9 The nucleus of an atom is where mass is concentrated; it is based on protons and neutrons. The electrons spin around it.

Reflect, Explain and Share

Imagining the atom

- Visit: http://www.sined.mx/sined/aprendiendo/CURSO-49.htm and work on the learning object and the activities that are suggested in there.
- On a sheet of paper draw the different models that have been used to explain the structure of the atom throughout the years; state who and when the models were made.
- Answer the questions: What is the difference between the first and the last atomic model? Which of the models helps you to better understand the atomic structure? Why? Do you think scientist still use these atomic models? Why?
- Share your drawings and your answers with your classmates; reach a conclusion.
- Write down the conclusion in your notebook and keep your work in your portfolio of evidence.

FIG. 2.10 Image of Rutherford's atomic model.



Niels Bohr suggested a model based on Rutherford's, showing that the atom had a structure in which the electrons would spin around the nucleus, following circular orbits or levels of energy, and concentrating most of the mass and the positive charges inside the nucleus (Fig. 2.10). This model turned out to be useful to explain the absorption phenomenon and the emission of energy of the elements. When an element is heated; that is, from a substance based on just one type of atom, we can observe an emission of light of a distinctive color (Fig. 2.11) and we see it is an emission spectrum that shows a series of broken lines. This indicates that, when the sample is heated, the electrons absorb a certain amount of energy, raising their energy levels; and for a moment, the electrons go back to their original level, sending out the gained energy in the form of light.

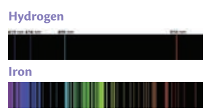
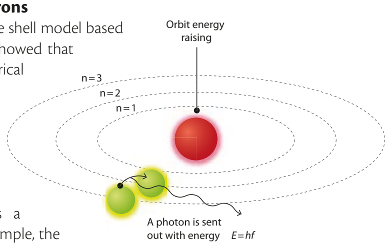


FIG. 2.11 The spectrum emission of hydrogen (H) and iron (Fe) where each line represents the transition of electrons between layers or levels of energy. The more electrons there are in an atom, the more lines will be shown.

Shell model and valence electrons

In 1916, Kossel and Lewis created the shell model based on Bohr's model. The shell model showed that electrons were arranged in spherical layers around the nucleus. This model is useful for explaining the creation of chemical bonds between compounds.

To completely understand the shell model, we have to consider that each layer accepts a limited number of electrons. For example, the first layer only accepts two electrons; eight being the



SESSION INFORMATION

Week: 11

Session: 66

Expected learning outcome: Identify the components of the Bohr Atomic Model (protons, neutrons and electrons), as well as the function of valence electrons to comprehend the structure of the materials.

CONTENT DELIVERY

Start: Students will look at the atom picture on top of the page. Ask students the following questions: What kind of particle is there spinning around the nucleus? Which, do you think, are the particles? Elicit answers.

Development: Ask students to read the topic *The Bohr Atomic Model*, and contrast with the answers they had previously given. Elicit correct answers. Then, ask comprehension-check questions. Elicit answers.

Closing: Students should read the Bohr atomic model description. Show students the Bohr model; ask them questions to analyze how the model explains absorption and emission of energy.

Homework: Organize teams of four members. Students should take 20, 12 x 8 cm white cards (bibliography cards).

SKILLS DEVELOPMENT

Critical thinking skills: Imagining, predicting.

EVALUATION OF CONTENT

Check students answers to the questions,

SESSION INFORMATION

Week: 12

Session: 67

Expected learning outcome: Identify the components of the Bohr Atomic Model (protons, neutrons and electrons), as well as the function of valence electrons to comprehend the structure of the materials.

CONTENT DELIVERY

Start: Ask students some of the same questions you asked yesterday to remind them of the atom particles.

Development: Students should read the section *Shell model and valence electrons*, which starts on page 47 and ends on page 48. Help students with the pictures of the models and ask questions so that students define *Valence* (The number of "exchangeable" electrons).

Closing: Teams should do the matching game described in the section *To Integrate*; once they finish, they might play it.

Homework: Ask students for 30cm of "Velcro".

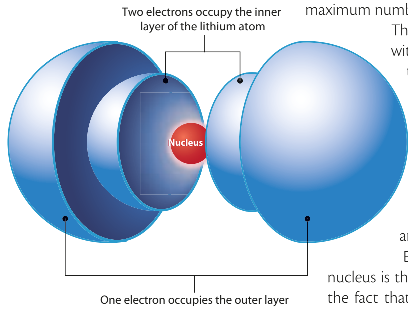


FIG. 2.12 A lithium atom represented with the shell model.

maximum number of electrons accepted (Fig. 2.12).

The valence concept, which is the capability of an element to combine with another to create a compound, also played an important role in the construction of the periodic table.

With Kossel's and Lewis's models, scientists understood that electrons are responsible for that kind of behavior, since they are found in the last layer of the atom, and were called valence electrons; these electrons help in the creation of ions and chemical bonds.

Since valence electrons are further away from the nucleus, they are less attracted by it. This is why, when electrons are near another atom, they can be exchanged.

Electric charges in atoms are balanced: the quantity of protons in the nucleus is the same as the quantity of electrons around it; nevertheless, due to the fact that valence electrons may be exchanged between atoms, atoms will have a positive or a negative charge.

For example, sodium (Na) has 11 protons in its nucleus. If we talk about a neutral atom, it will also have 11 electrons, but since sodium has the ability to release an electron from the upper layer, it ends up having 10 electrons. When the sodium atom releases an electron, the positive charge becomes greater because the nucleus cannot be modified; thus, it will become a positive ion or a **cation**.

Other elements such as chlorine (Cl) have an atomic number of 17, which is the total number of protons (when atoms are neutral they have 17 protons and 17 electrons), but since it has the ability to take on one more electron in its upper layer, the final number of electrons becomes 18. When the atom has a greater negative charge, it becomes a negative ion or an **anion**, and its name changes from chlorine to chloride.

GLOSSARY

Cation. An ion with a positive charge as a result of the loss of electrons in a neutral atom.

Anion. An ion with a negative charge as a result of the gain of electrons in a neutral atom.

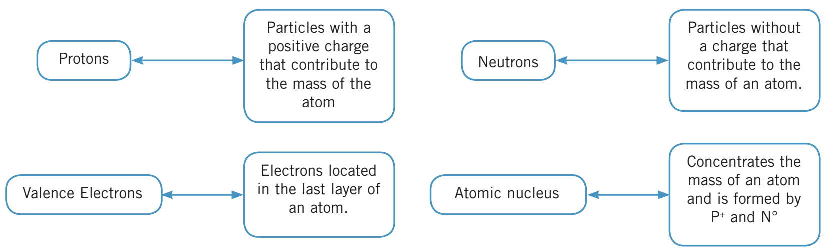
Closing up!

The knowledge acquired about the structure of the atom gave us more data to understand the characteristics and properties of the materials that surround us. However, remember that a large portion of scientific activity includes collecting experimental data, while another portion includes using that data and adjusting it to form different models that explain phenomena in the world.

To integrate

Integrative Activity: Atom and subatomic particles matching game

Create a matching game with white cards. Unlike a traditional matching game, write on the cards information that will match two cards. Play the game with your team. Here are some examples:



Once the game is over, discuss the importance and use of this activity with the members of your team. Keep your matching game in your portfolio of evidence.

SKILLS DEVELOPMENT

Critical thinking skills: Remembering information, summarizing.

Reading skills: Scanning, reading for detail.

EVALUATION OF CONTENT

Check the matching game; students should accurately respond to the introductory questions since they were answered the previous class.

The Chemical Bond

At the end of the 19th century and the beginning of the 20th century, the chemical bond concept referred to the bonding of two atoms in order to create molecules, thus compounds. However, this phenomenon was completely understood when the detailed atom structure and subatomic particles, mainly the electrons, were discovered (Fig. 2.13).

The proposal of the layered model came from the study of **noble gases**. At the beginning of the 20th century, it was unknown that these elements could form compounds. Therefore, Lewis and Kossel suggested that the non-existent **reactivity** of noble gases was due to the fact that electrons were arranged in a stable way around the nucleus, in the spherical layers, which means, that all the layers are occupied with the maximum number of electrons they can contain. Each layer is designated with a letter "***n***", which represents how close the layer is to the nucleus.

For all elements, the external layer (the valence layer), cannot have more electrons in its valence layer than those in the nearest noble gas; for example, helium (He) has two electrons in its upper layer and neon (Ne) has eight electrons.

Another example, sodium (Na) has the atomic number 11, which is the number of protons in the nucleus; therefore, it should have 11 electrons. The arrangement by layers would be as following: in the first layer n = 1, there would be 2 electrons, thus there are nine electrons left to arrange. The second layer, n = 2, would have eight electrons, and so there is one electron left to arrange in the third layer, n = 3, which is the valence for sodium atoms.

All the inner layers must contain the maximum number of electrons and, the last layer, the valence layer, is the one with the lower number of electrons from the total capacity.

Expected Learning

Represent chemical bonding using valence electrons from the Lewis structure.

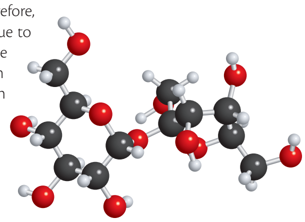


FIG. 2.13 The idea of bonding existed from the beginning of chemistry as a science, but was better understood when the atomic structure became known.

Reflect, Explain and Share

A three-dimensional design

- Work in teams to design a three-dimensional model of an atom according to the layer model.
- Be creative. Preferably use reusable materials.
- Place the electron models over the layers; use small seeds, or paper balls. Be sure to guarantee that they can be removed and placed several times to illustrate the exchange of electrons.
- Choose from the following elements: H, hydrogen; He, helium; Li, lithium; C, carbon; O, oxygen; Ne, neon; Na, sodium; S, sulfur; Cl, chlorine; and Ar, argon.

Show your model to the class.

Glossary

Noble gases. Group of elements characterized for their low capacity to react with lower elements.

Reactivity. The ability of an element or compound to react to another, creating new chemical bonds.

The number of electrons in the valence layer, also called valence electrons, is determined by the position of the element in the periodic table, and directly related to the number of the column or group in which the element is found.

In group 1, all the elements have atoms with one electron on its valence layer, like sodium (Na); in other words, their valence is one; for group two, the valence electrons are 2. But for an element as boron (B), which is located in group 13, it does not mean it has 13 electrons, because that would surpass the maximum number of 8, what it actually means, is that it has 3 valence electrons (Fig. 2.14).

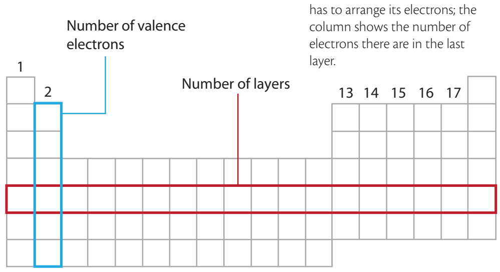


FIG. 2.14 The location of an element in the periodic table, gives us information about the arrangement of electrons on its atoms: the row or period shows the number of layers an atom has to arrange its electrons; the column shows the number of electrons there are in the last layer.

SESSION INFORMATION

Week: 12

Session: 68

Expected learning outcome: Represent chemical bonding using valence electrons from the Lewis Structure.

CONTENT DELIVERY

Start: Tell students to fix the pieces of Velcro in their hands (each part on each hand). Then, organize teams that will play different elements molecules. Have them stick together forming a new compound; for example H2O will be two students playing Hydrogen and one playing oxygen will become water by "sticking" their Velcro "bonds". Take students to an open space so that they can follow your commands to make new compounds.

Development: Students should read the entire page. Help them analyze how chemical bonds occur by taking as many students as you need with their Velcro bands on their hands to simulate chemical bonds but this time, they will be electrons in the valence layer of different molecules.

Closing: Organize teams of four people. Students should make the models explained in the section *Reflect, Explain and Share* for homework and display them the following class. Therefore, give them a few minutes to organize the project.

SKILLS DEVELOPMENT

Bodily/Kinesthetic skills: Setting formations.

Critical thinking skills: Analyzing data.

EVALUATION OF CONTENT

Students should actively participate in the bonds simulation.

SESSION INFORMATION

Week: 12

Session: 69

Expected learning outcome: Represent the chemical elements, molecules, atoms and ions (anions and cations) according to their chemical symbology.

CONTENT DELIVERY

Start: Students should present their atoms' models. Give feedback including both, praising and aspects to improve.

Development: Students will read the introduction to the section *Dot Diagrams and Lewis Structure*. Explain the two examples little by little. Then, using the models students took to class they should make a table explained in the section *Reflect, Explain and Share*.

Closing: Have students present the information about each model they analyze.

→ Expected Learning

Represent the chemical elements, molecules, atoms and ions (anions and cations) according to their chemical symbology.

FIG. 2.15 The American chemist G. N. Lewis, who lived between the late 19th century and mid 20th century, made important discoveries in understanding chemical bonds.

Dot Diagrams and Lewis Structure

Kossel based his theories on the observations of elements of group 1 and 2 from the periodic table, which created cations with charges 1 and 2 respectively. Lewis (Fig. 2.15) then studied more compounds and realized that the electrons in the molecules where distributed in pairs. Additionally, Lewis suggested a simplified system to represent atoms, in which only the last layer is represented. This diagram is called the Lewis Dot Diagram, because electrons are represented as dots surrounding the atom's symbol and are arranged in pairs in four different positions around the symbol: above, below, to the left and to the right. Thus, this will be the arrangement for a chlorine atom:

With this representation system, chemical bonds are created when two atoms share a pair of valence electrons. For example, two atoms of chlorine (Cl) united by a chemical bond to create a Cl_2 molecule:

Thus, molecules not only have a total number of valence electrons, in this case 14, but each participating atom fills the valence layer to its maximum capacity, eight electrons, reaching the stable arrangement of electrons of a noble gas. Lewis found this recurrence on many compounds, naming it the Octet Rule.

Reflect, Explain and Share

Work in groups with the atomic models created using recycled materials.

- Examine all of the models created by your classmates and write down in your notebook the following information for each of the elements: number of layers in each atom, total number of electrons, and number of valence electrons.
- In your notebook, copy the chart below and examine the bonding possibilities of each element:

Element, symbol	Number of valence electrons	Number of electrons missing to reach the octet rule	Valence (capacity of creating a bond)
Oxygen, O	6	2	2

- After you have examined the valence layer of the models, complete electrons column; this piece of information is necessary for calculating the valence value or the capacity to create a bond.

Lewis diagrams that represent molecules are called Lewis Structures. To successfully draw them:

- First, draw individual dot diagrams for each of the elements that create the compound; the dots represent the electrons and are grouped in pairs.
- Do not forget that the numbers of electrons that do not have a pair on the dot diagram are the ones that will let you know the element's capacity to combine or the element's valence. Chlorine (Cl), for example, has seven valence electrons, indicating that chlorine needs one more electron to complete the octet rule. If we look at the sodium atom (Na), which only has one electron in its last layer, and since it is more possible to lose this last electron, than to gain the seven missing electrons for the last layer, this leaves the internal layers to complete the octet:

SKILLS DEVELOPMENT

Visual/Spatial skills: Building models, charting information.

Critical thinking skills: Summarizing.

EVALUATION OF CONTENT

Students should present their atom model; later, they should participate in the atoms analysis.

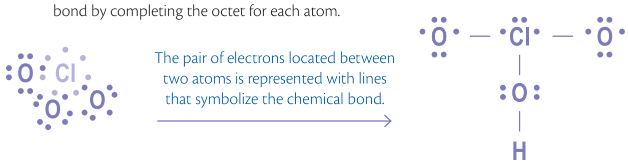
Once the previous information is understood, follow the next steps, to write down Lewis structures for compounds. We will use chloric acid ($HClO_3$):

1. The first step will always be to write down individual dot diagrams for each of the elements involved. Count the valence electrons of each element, take into consideration if there are repeated elements, and get the total number of valence electrons there are in the molecule. This number should be present during the whole process, since at the end the molecule will need to have that number of electrons.

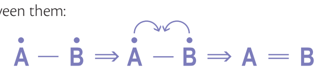
2. Choose the central element by examining the following:

   a. It should be an element with only one atom or the element that is less repeated.
   b. If two or more atoms obey the previous rule, such as in the compound we are using, you should chose as the central atom the element with the greater number of valence electrons. In this case, the central atom will be chlorine (Cl):

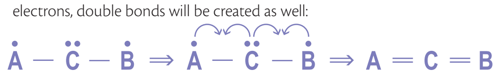
3. Write the other atoms surrounding the central atom; starting with the atoms that are repeated in the structure, in this case it is oxygen. Then, prove the possibility of creating a bond by completing the octet for each atom.



4. Look for unpaired electrons in the atoms.
   a. If you find them in atoms that are one next to the other, use them to create double bonds between them:

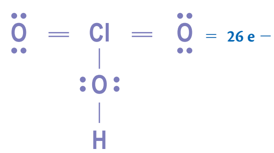


   b. If the unpaired electrons are connected to the same type of atom with a free pair of electrons, double bonds will be created as well:



In the example, chloric acid, the last structure we drew contains unpaired electrons in the oxygen atoms (O), thus it has the capacity to form two double bonds with the central atom: chlorine (Cl). Leaving it without free pairs of electrons, while oxygen atoms contain two pairs of free electrons; do not forget to count the final number of valence electrons in the structure, which have to match the initial number, in this case 26 e−.

It is important to keep in mind that each bond drawn between the two symbols of the elements represents two electrons.



SESSION INFORMATION

Week: 12

Session: 70

Expected learning outcome: Represent chemical bonding using valence electrons from the Lewis Structure.

CONTENT DELIVERY

Start: Ask students for the valence and number of electrons missing to reach the octet rule of the following elements: H, He, Li, C, O, Ne, S, Cl, Ar.

Development: Students will read how to make Lewis Diagrams. The information starts at the bottom of page 50 and ends on page 51. Segment the information and analyze each part along with the group.

Closing: Students should do the activities in the section *Reflect, Explain and Share*, which is on top of page 52. They will have also the following class to complete these tasks.

SKILLS DEVELOPMENT

Critical thinking skills: Remembering, applying information.

EVALUATION OF CONTENT

Check the table students should have completed.

SESSION INFORMATION

Week: 12

Session: 71

Expected learning outcome: Represent the chemical elements, molecules, atoms and ions (anions and cations) according to their chemical symbology.

CONTENT DELIVERY

Start: Show students at least three examples of chemical bonds with dot diagrams.

Development: Students should have finished the activities in the section *Reflect, Explain and Share*. In case they haven't, they might finish by the end of this session.

Closing: Check the table and dot diagrams students made.

Homework: Students should take five small metallic objects.

Reflect, Explain and Share

- Work individually to create dot diagrams for the following elements, write them down on individual cards: H, hydrogen; C, carbon; N, nitrogen; O, oxygen; P, phosphorus; and Na, sodium.
- Write the dot diagram on one side of the card, and on the other side write down the following information: atomic number, number of protons and electrons.
- Once you have finished your cards, get together in groups of 4 and draw a table to show the probabilities of bonding for each element. Follow the example:

Element, symbol	Number of valence electrons	Valence (capacity of creating a bond)	Probability to bond with	Common compound examples
Oxygen, O	6	2		

- Once you gather all the information, make predictions of other elements on the list that could combine. Consider that to reach the octet rule, an atom may bond with more than one atom. Write down the prediction in the corresponding column. Research in books or surf the Internet to find out the different compounds these elements create, write down at least two examples in the last column.

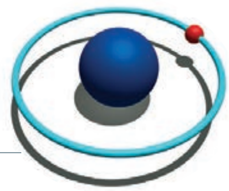


FIG. 2.16 Atomic model by Bohr.

Closing up!

The Shell model suggested by Lewis could be seen as an expansion of Bohr's model due to the fact that it describes subatomic particles inside the atom, but it is also a key tool that contributed to understanding a fundamental part of chemistry: the chemical behavior and reactivity of the elements, topics that we'll continue studying in the following lessons (Fig. 2.16).

What is the Importance of Rejecting, Reducing, Reusing and Recycling Metals?

Expected Learning

Identify some of the properties of metals, such as: malleability, ductility, radiance, thermal and electrical conductivity, and relate them to different technological applications.

Characteristics of Metals

Several contemporary thinkers have called our times "The Media Age", while others consider that our times should be called "The Material Age". This is due to the fact that scientists have developed new materials: some types of polymers, **metal alloys** and several materials that conduct electricity.

GLOSSARY

Metal alloy. Homogeneous mixture of two or more metals or a metal and another element made to obtain a better and specific trait, such as hardness, and better conduction of electricity, among others.

Get started!

Look around for objects that are made out of metal or of a mixture of metals; take into account objects that are not completely made out of metal but that have a metallic part or a metallic component.

- Make a list of at least five objects and their metallic components. In case of doubt, search in books or the Internet for clarification.

52

SKILLS DEVELOPMENT

Critical thinking skills: Remembering, applying information.

EVALUATION OF CONTENT

Check the table and dot diagrams students produced.

- Organize the information in a chart, add a column to describe the physical characteristics you considered in decidingthere was metal in that object (state of matter at room temperature, color, and others)

Object	Metal(s) present Name/symbol	Characteristics
Mom's wedding ring	Gold (Au)	Solid at room temperature, yellow, shiny, cold.

Share your conclusions with the class.. Keep your work in your portfolio of evidence.

Going further

The use of metals is something humans discovered a long time ago. A part of ancient history is based on the discoveries of new metals and the technological improvements achieved with them. The so-called Bronze Age was noted for the discovery of a homogeneous mixture of copper (Cu) and tin (Sn); in other words, bronze. This metal was more suitable to create war objects, such as armors and swords (Fig. 2.17).

The discovery of iron (Fe) was also a turning point in the way materials were used, because in the so-called Iron Age, it was necessary to create furnaces that reached higher temperatures than those that already existed to treat iron. It was also discovered that when mixing iron (Fe) with carbon (C), a harder material was created: steel, an alloy still used today.

Physical properties of metals

Physical appearance is one of the first properties we identify in a metal. In fact, the radiance they have and the characteristic color of some of them, such as yellow for gold (Au), or red for copper (Cu), is a trait that has always caught some attention. One of the characteristics that turned metals into important substances for the production of tools, is that most of them, except for mercury (Hg), are solid at room temperature, and keep that state until they reach high temperatures. In other words, they have high **melting points**.

Another characteristic of solids is that they have a defined shape. A property related to hardness in metals is their tenacity; that is, their resistance to deform or to breake, and due to the cohesion between their atoms and molecules, they cannot lose their shape. A clear example of a metal with this property is steel. There are other metals that will not break but change their shape when force is applied to them, which leads to other two useful properties: malleability, which is the ability to form sheets, that depending on the tal used, how thin the sheet will be. Malleability has made possible the production of cans, car bodies and aluminum foil (Al) (Fig. 2.18).

The second property is ductility, which is the metals resistance to deform; it is useful to create wires or thin thread, depending on the metal used, it can be as thin as a hair. This characteristic allows the existence of several metallic cables, for example, the ones made out of copper that are used in electric installations.

Besides the properties related to the resistance to deform, metals have other traits: they are great conductors of heat and electricity. Since they have little resistance to electricity, as the temperature of a material increases, its particles collide with one another; allowing the material to conduct heat.

Among the best existing conductors are: copper (Cu), gold (Au) and silver (Ag), but the high cost of the last two conductors limits their use on technological applications (Fig. 2.19).

To Read More

To learn more about chemistry through history, read *A Short History of Chemistry* (Breve Historia de la Química) by Issac Asimov.

Glossary

Melting point. Temperature at which a material goes from a solid state to a liquid state.

FIG. 2.17 During the Trojan War, Greeks and Trojans were not only helped by the gods of Olympus, but by metal alloys such as bronze.

ICT

To learn more about the metals that are extracted in Mexico by the mining industry, you can visit the INEGI website: http://www.cuentame.inegi.org.mx/economia/secundario/mineria/#

FIG. 2.18 Aluminum foil is an example of malleability; sheets can be as wide as a tenth of a millimeter.

FIG. 2.19 HD connections are made with a gold overlay, because they are better conductors than copper.

SESSION INFORMATION

Week: 12

Session: 72

Expected learning outcome: Identify some of the properties of metals, such as: malleability, ductility, radiance, thermal and electrical conductivity and relate them to different technological applications.

CONTENT DELIVERY

Start: Show students five metallic objects. Help them make a table like the one in the section *Get Started!* On top of the page. Elicit information.

Development: Students should read the rest of the page and mind map physical properties of metals.

Closing: Elicit metals physical properties: radiance, color, high melting points, tenacity, malleability, ductility, and conductivity. Ask students for the definition of every term to help them understand each property.

Homework: Students should get images of mercury poisoning.

Homework for the teacher: Make copies from the page 54 for half the group and cut the table into pieces by the lines to make a jigsaw puzzle.

SKILLS DEVELOPMENT

Visual/Spatial skills: Charting information.

Naturalistic skills: Observing details.

EVALUATION OF CONTENT

Check students' mind maps.

SESSION INFORMATION

Week: 13

Session: 73

Expected learning outcome: Identify in the community different metal-based products (copper, aluminum, lead, iron) in order to make informed decisions to promote their rejection, reduction, reuse and recycling.

CONTENT DELIVERY

Start: Explain that metals are dangerous to humans in many ways. Have students display the pictures they could get about mercury poisoning.

Development: Organize students in pairs. One of them, will read the table and the other should fix up the pieces (that the teacher should have prepared according to the instructions in the previous page) of information accordingly. Monitor your class.

Closing: Ask students to display the complete jigsaw puzzle.

Homework: Organize teams. Students should do research about consumption of metals, explained in the section *Reflect, Explain and Share* on top of page 55.

Expected Learning

Identify in the community different metal-based products (copper, aluminum, lead, iron) in order to make informed decisions to promote their rejection, reduction, reuse and recycling.

Decision Making Related to: Rejecting, Reducing, Reusing and Recycling Metals

The side effects that some metals have on living beings were discovered and understood little by little and the problems caused were faced. For example, during the 1950's, the first case of massive poisoning by mercury (Hg) occurred in a fishing village located southwest of Japan, named Minamata.

A Chisso corporation plant was established there. This plant used mercury in the production of **acetaldehyde** and it poured their waste directly into the sea, without any type of previous treatment. Some time later, the village population, including pets, began to show symptoms of mercury poisoning: difficulty in walking and speaking, seizures, partial paralysis, even death.

Now we know mercury is a hazardous polluting substance, if it is poured into water it contaminates fish, so if humans eat them, a process of **bioaccumulation** of mercury in tissue starts, and the symptoms of poisoning start showing when it reaches a high level of concentration (Fig. 2.20).

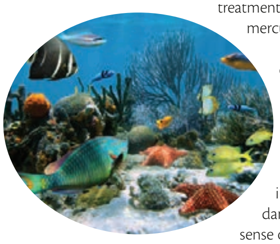


FIG. 2.20 Aquatic ecosystems are the most affected by metal pollution.

Metals and health

We have reflected on the current use of mercury (Hg) and the consequences it can have in our health; however, there are other elements that pollute the environment or cause damage to health called **heavy metals**. Even though the term is kind of ambiguous in the sense of chemical properties, it is a commonly used term in the **toxicology** area.

Most toxic waste ends up polluting bodies of waters and though sometimes the amount of toxic metal in water is not enough to cause the death of fish, they develop health problems, such as: changes in tissue structure, under-growth and underdevelopment, difficulty in swimming as well as behavioral and reproduction disorders. These problems are similar to those in humans; which is why we present a list of some of the most common metals that like mercury, can cause health problems, under certain circumstances.

Glossary

Acetaldehyde. Organic compound used as raw material in the production of plastics, paint, and hairspray, among others.

Bioaccumulation. Accumulative process of toxic substance in living organisms, which in time, reach higher concentrations than those found in food or the environment.

Heavy metals. General term used to name toxic metallic elements with a density of 5 g/cm^3 or greater.

Toxicology. Science that studies, identifies and describes the effects of damaging substances in organisms.

Metals		
Element, symbol	**Common uses**	**Adverse health effects**
Aluminum (Al)	Aluminum foil, pots, cans for food and beverages, mirrors.	Allergies and skin irritation, damage to the nervous system.
Cadmium (Cd)	Batteries, soldering, TV screens.	Bone weakening, damage to the immune system and lungs.
Zinc (Zn)	Alloys: alpaca (Cu-Ni-Zn) Pigment for white paint, deodorants ($ZnCl_2$), and batteries.	Liver damage, intestinal alteration, depression.
Cobalt (Co)	Magnets and magnetic tapes, battery terminal or batteries.	Heart failure.
Copper (Cu)	Alloys: brass (Cu-Zn), bronze (Cu-Sn). Production of wires, coins and tools	Anemia, fever, nausea.
Chromium (Cr)	Alloys: stainless steel, chromed metallic pieces.	Kidney damage
Iron (Fe)	Main steel component, production of forges (windows, stairs, railings, etc.)	Liver and heart damage.
Manganese (Mn)	Steel and other alloys batteries.	Damage to the nervous system.
Lead (Pb)	Car batteries, pigments for white paint, telephone and electric wire overlay.	Anemia, damage to the central nervous system.

ICT

To learn more about other metals that are dangerous to your health and the environment, visit the National Institute of Ecology website: http://www.ine.gob.mx/sqre-temas/763-aqre-metales.

SKILLS DEVELOPMENT

Listening skills: Making references.

Visual/Spatial skills: Solving jigsaw puzzles.

EVALUATION OF CONTENT

Check students' jigsaw puzzles.

SESSION INFORMATION

Week: 13

Session: 74

Expected learning outcome: Identify in the community different metal-based products (copper, aluminum, lead, iron) in order to make informed decisions to promote their rejection, reduction, reuse and recycling.

➔ Reflect, Explain and Share

Metals and health

Copy the chart below in your notebook. Research the metals that are essential for our body to work correctly. Check the daily intake, where they are found and what the consequences are when they are not consumed.

Element, symbol	Essential daily intake	Sources to obtain it	Problems cause by its deficiency

Examine the information you gathered and answer the following:

- Are some of the essential elements part of the heavy metals we have studied? If they are, add a column at the end of the table mentioning the health problems caused by the poisoning of this element.
- Why is it that an element can have both beneficial and toxic properties?

Share and reflect on the information with your team. Write down your conclusions and save your work in your portfolio of evidence.

Curious Facts

The Mad Hatter, from the book *Alice in Wonderland* by Lewis Carrol, is inspired by the fact that in the 19th century mercury was used in the process of creating hats in England, which intoxicated the hatters, and once they showed symptoms of poisoning, they looked as if they were mad (crazy).

Glossary

Biodegradable. Material that decomposes into simpler materials with the help of microorganisms, allowing it to reenter the environment without causing any damage.

Oxo degradable. A material that decomposes after being in contact with oxygen, it breaks into simpler materials to reenter the environment.

The four R's: reject, reduce, reuse and recycle

Once we know about the toxicity of the materials we use on a daily basis, we might think we should get rid of everything at once. However, the solution will bring up more questions, where would everything go? Where should it be disposed of so it will not affect anyone's health or the environment? Moreover, how could we substitute them? In some cases we have viable choices for substitution: mercury thermometers could be replaced with digital thermometers, which are mercury-free, but they need batteries to work and batteries contain other metals, such as zinc, which can be harmful.

When trying to eliminate all metals, we face bigger issues: think about all the different uses metals have, if we discard them one by one, we'll end up without many things. For example, by trying to get rid of copper or lead, then we would have to include electricity, telephone or the copper in the Internet in this.

The solution is to be informed about the characteristics of everyday objects, whether they are beneficial to us or not. A reliable option is to make decisions by following the 4R strategy (Fig. 2.21) (Reject, Reduce, Reuse and Recycle):

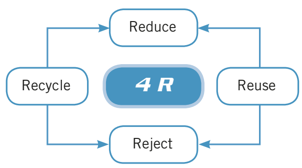


FIG. 2.21 As consumers, the 4Rs helps us make conscious decisions about limited resources or harmful materials.

- Reject: refers to the action of avoiding purchasing and using products that are highly toxic or dangerous to the environment, which are not **biodegradable**, **Oxo degradable**, or which cannot be reused.
- Reduce: refers to the action of consuming fewer of products: purchase only what you need, search for processed products with few packing elements or which state that are biodegradable or can be recycled. It also implies cutting to the minimum the use of materials that are harmful to the environment or health.
- Reuse: Refers to the action of increasing the life of a product, in other words, avoiding getting rid of things when they are still useful. Take into account that when you reuse, the materials should be used as they are, though you can do some slight modifications, but in the end, the objects should be reused for the same purpose they were created, or for a similar use (Fig. 2.22).

FIG. 2.22 Paper can be reused: if you take full advantage to write on it, or if you recycle it to get new sheets of paper.

CONTENT DELIVERY

Start: Students should present the research they did in the section *Reflect, Explain and Share*. Once they finish presenting their research, give feedback, stick to the projects rubrics stated on page 157.

Development: Students should read about the Four "Rs" Method.

Closing: Ask for examples of the Four "Rs" method application.

Homework: With the same team, students should get 20 white, bibliography cards.

SKILLS DEVELOPMENT

Reading skills: Scanning, reading for detail.

Critical thinking skills: Summarizing.

Interpersonal skills: Working as team members.

EVALUATION OF CONTENT

Students should actively participate in the research presentation. Check the examples they can give of the four "Rs" method.

SESSION INFORMATION

Week: 13

Session: 75

Expected learning outcome: Identify in the community different metal-based products (copper, aluminum, lead, iron) in order to make informed decisions to promote their rejection, reduction, reuse and recycling.

CONTENT DELIVERY

Start: Students will go back to pages 54 and 55 to find the most relevant information.

Development: In teams, students should make a matching game with information about adverse effects of metals and the Four "Rs" Method.

Closing: Students are to play the game they produce.

Homework: Students will need a device with Internet access. Organize teams of four people. Each team member will play one of the following characters in the TV show *Chemistry*: Antoine Lavoisier, Stanislao Canizzaro, Dmitri Mendeleev and the TV host. They should do research and use the information on pages 56 to 59 about each scientist's contribution to chemistry. Every character should dress up with a costume made with recyclable materials and paper.

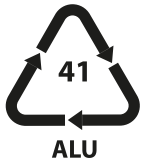


FIG. 2.23 A triangle made out of arrows is the international recycling symbol, if an object has it, then it can be recycled. This symbol also contains codes; number 41 and the letters ALU indicate it is an product made of aluminum..

- Recycling: is the action of taking waste and preparing it to be reused for the same purpose, using a small amount of energy in the process. For example, recycled paper: paper which has already been used, on one or both sides, newspapers, magazines, are treated to obtain a new pulp, which is then processed to generate new sheets of paper.

Metals, such as aluminum can be recycled. Aluminum cans may be processed to obtain the same material with which other objects can be produced (Fig. 2.23).

Overall, the recycling process is carried out in a special plant. We can help by separating waste and this makes it easier for the garbage collector or the recycling center to identify the material. It is necessary to take into account that even if we follow the 4R strategy, we will still produce waste. That is why it is important to know the right way to get rid of some materials. The first thing to do is to avoid mixing the different types of waste: food, used packages, etc., which is why we suggest storing used batteries in plastic containers; you could reuse a plastic bottle with a lid, to store them inside.

Closing up!

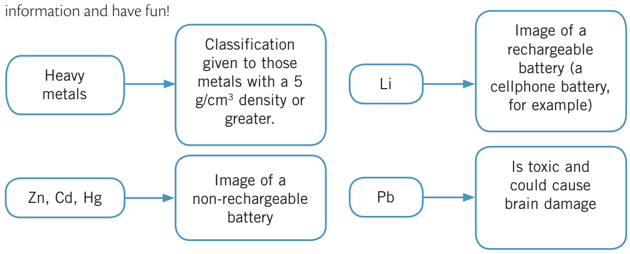
Man has known about metals for centuries, their discovery, their use and technological development. Today, we still use metals with different purposes, because they are ductile and malleable materials, we find them useful in many situations, in addition to their capacity of conducting electricity.

Metals and other everyday materials are very useful, but, if we do not use them responsibly, we could affect the environment or cause damage to our health. To avoid these problems we should make informed decisions to reduce the impact of our actions to keep an environmental balance in our community.

To integrate

Integrative activity. Matching game: the use and effects of metals

Create a matching game with white cards like the one you played previously but use this new information and have fun!



Once the game is over, discuss with your team the importance and use of this activity. Save your matching game in your portfolio of evidence.

➔ Expected Learning

Identify the analysis and systematization of the results, as characteristics of the scientific work achieved by Canizzaro, based on the differences between molecular mass and atomic mass.

Identify the importance of the organization and systematization of elements according to their atomic mass in Mendeleev's periodic table that later led him to the prediction of some unknown elements.

The Second Chemistry Revolution

The Order in the Diversity of Substances: Contributions of Cannizzaro's and Mendeleev's Work

Antoine Lavoisier's contributions changed the way scientists study substances and their transformations. Lavoisier systematized experiments and one of his most meaningful contributions was to recognize that the amount of matter during a chemical transformation remains unchanged.

SKILLS DEVELOPMENT

Critical thinking skills: Summarizing.

Reading skills: Scanning, reading for detail.

EVALUATION OF CONTENT

Check each team's matching game.

Even though the bases that Lavoisier established were fundamental for Chemistry to be considered a science, several years and contributions by other scientists had to be added in order for this science to be consolidated.

When we look at the first discoveries in chemistry, we have to take into consideration that the structure of the atom was still unknown: the equipment and methods scientists had could only observe atoms working as an ensemble. The notion of the atom as an essential particle came up right before Lavoisier's revolution; however, several years passed before finding out how protons, neutrons and electrons interacted.

Get started!

Find information in books or surf the Internet about the scientists that contributed to Chemistry after Lavoisier's revolution.

- What were John Dalton's contributions about the atom?
- What were the main contributions made by Jöns Jaköb Berzelius about atomic weight? What were his other contributions about?
- What is the hypothesis suggested by Amedeo Avogadro about quantity?

Glossary

Atomic weight. Addition of the average mass of the atoms of a single element. Also known as atomic relative mass.

Molecular weight. Addition of the atomic weight of the elements of a compound.

Equivalent weight. Amount of substance of a given element, which has the ability to displace a certain amount of another element when it reacts.

Nomenclature. Set of rules used to name elements and compounds.

Going further

During the times of the first chemistry revolution, not only the bases about the importance of a systematic job within chemistry were made. The discovery of new elements also took place: some of these were gaseous, like oxygen (O), hydrogen (H), nitrogen (N), chlorine (Cl); and some others were solids, such as the metals, cobalt (Co), nickel (Ni), platinum (Pt), manganese (Mg), tungsten (W), molybdenum (Mo), titanium (Ti), uranium (U) and chromium (Cr).

Lavoisier also contributed by organizing the known substances. By 1789, he published a list of what he called simple substances, which are the elements as we know them; overall, he included 33 simple substances. If we examine that list today, we will see that Lavoisier included light and the calorie, which nowadays are known as types of energy, not as substances. Additionally, he included substances like quicklime and silica, which are actually compounds: calcium oxide (CaO) and silica (SiO_2) (Fig. 2.24).

Lavoisier's work had some limitations, however, it remains valuable and it shows the interest chemists had at that time in classifying and learning more about materials.


192 Des Substances simples.
Tableau des Substances simples.

	Noms nouveaux.	Noms anciens correspondans.
[illegible]	Lumière	Lumière.
	Calorique	Chaleur. Principe de la chaleur. Fluide igné. Feu. Matière du feu & de la chaleur.
	Oxygène	Air déphlogistiqué. Air empiréal. Air vital. Base de l'air vital.
	Azote	Gaz phlogistiqué. Mofete. Base de la mofete.
	Hydrogène	Gaz inflammable. Base du gaz inflammable.
[illegible]	Soufre	Soufre.
	Phosphore	Phosphore.
	Carbone	Charbon pur.
	Radical muriatique	Inconnu.
	Radical fluorique	Inconnu.
	Radical boracique	Inconnu.
[illegible]	Antimoine	Antimoine.
	Argent	Argent.
	Arsenic	Arsenic.
	Bismuth	Bismuth.
	Cobolt	Cobolt.
	Cuivre	Cuivre.
	Etain	Etain.
	Fer	Fer.
	Manganèse	Manganèse.
	Mercure	Mercure.
	Molybdène	Molybdène.
	Nickel	Nickel.
	Or	Or.
	Platine	Platine.
	Plomb	Plomb.
	Tungstène	Tungstène.
	Zinc	Zinc.
[illegible]	Chaux	Terre calcaire, chaux.
	Magnésie	Magnésie, base du sel d'Epsom.
	Baryte	Barote, terre pesante.
	Alumine	Argile, terre de l'alun, base de l'alun.
	Silice	Terre siliceuse, terre vitrifiable.

FIG. 2.24 Table of simple substances made by Lavoisier in 1789.

Elements continued to be discovered year after year, and by 1830, 56 elements were known; 30 years later, 62 elements had been discovered. By that time, the first suggestions for creating a periodic table were made. The organization was mostly based on physical characteristics, such as melting points and density, but there were other suggestions based on **atomic weight** –which we now call the relative atomic mass.

Up to that moment, atomic weight was only used as an effective method to calculate reactions, while other chemists saw it as an important characteristic to organize elements. But it was also the source of many confusions, some chemist made their atomic mass calculations but were not able to distinguish them from their **molecular weight** or **equivalent weights**. This confusion prevented chemists not only from organizing the elements, but also affected the development of chemistry by creating conflict while writing down formulas and the **nomenclature** of compounds. For example, some chemists thought the formula for water was HO.

Because of all the disorganization and chaos, the First International Chemist Congress took place in the city of Karlsruhe, Germany in 1860, with the attendance of 140 chemists and where two very important characters: Stanislao Canizzaro, and Dmitri Mendeleev initiated what it is now considered the second chemical revolution.

SESSION INFORMATION

Week: 13

Session: 76

Expected learning outcomes: Identify the analysis and systematization of the results, as characteristics of the scientific work achieved by Canizzaro, based on the differences between molecular mass and atomic mass.

Identify the importance of the organization and systematization of elements according to their atomic mass in Mendeleev's periodic table that later led him to the prediction of some unknown elements.

CONTENT DELIVERY

Start: Choose one character from each team in order to make the TV show. Each character should present his contribution to science. If possible, make a video.

Development: In teams, students should do the research that is explained in the section *Get started!* Elicit answers.

Closing: Students should read the rest of the page. Ask comprehension-check questions.

Homework: Students should create the timeline explained in the section *Reflect, Explain and Share* on top of page 58.

SKILLS DEVELOPMENT

Bodily/Kinesthetic skills: Acting.

Interpersonal skills: Working as team members.

Reading skills: Scanning, reading for detail.

EVALUATION OF CONTENT

Students should be ready to participate in the TV show; all students should actively participate in the research and answer to the comprehension-check questions about the end of the page.

SESSION INFORMATION

Week: 13

Session: 77

Expected learning outcomes: Identify the analysis and systematization of the results, as characteristics of the scientific work achieved by Canizzaro, based on the differences between molecular mass and atomic mass.

Identify the importance of the organization and systematization of elements according to their atomic mass in Mendeleev's periodic table that later led him to the prediction of some unknown elements.

CONTENT DELIVERY

Start: Ask students what they remember about Camizzaro. Elicit answers. Explain that students will wrap up information about Camizzaro's contribution.

Development: Students should read the section *Stanislao Camizzaro's Contributions*. Organize teams. Each team should prepare five to seven questions about it.

Closing: Teams should exchange questionnaires and answer each other's piece of work.

FIG. 2.25 Image of the Italian chemist, Stanislao Cannizzaro.

Reflect, Explain and Share

- Do research on the suggestions made to organize the periodic table before Mendeleev's periodic table. Research in books and on the Internet.
- Use the information to make an illustrated timeline.

Show your work to your group, save your timeline in your portfolio of evidence.

Expected Learning

Identify the analysis and systematization of the results, as characteristics of the scientific work achieved by Canizzaro, based on the differences between molecular mass and atomic mass.

Stanislao Cannizzaro's contributions

At the Karlsruhe Congress of Chemists, the Italian Stanislao Canizzaro, presented his ideas about the distinction between atomic, molecular and equivalent weight, as well as a way to determine atomic weights by using the correct compound formulas.

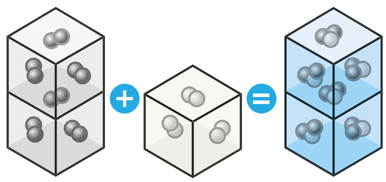
The way in which Canizzaro presented his ideas was brilliant and practically convinced everyone at the congress. Some of the attendees, like Julius Lothar Meyer, were so impressed by Cannizzaro's ideas that he recreated them with his students. Cannizaro's suggestions were born from the ideas of one of his colleagues, Amedeo Avogadro, who by that time had already passed away (Fig. 2.25).

Cannizzaro resumed those ideas to clarify the confusion about atomic weights, formulas and nomenclatures.

Avogadro had suggested considering atoms and molecules as essential components of matter, just as Dalton had suggested in his atomic theory; however, when he made his suggestions, only some scientists considered atoms as something real. Besides, the concept of chemical bonds was not completed and there was no knowledge of how two atoms of the same element could bond together, so only few scientists listened to his suggestion. When Cannizaro picked up Avogadro's ideas, and exposed them to the Karlsruhe Congress, they were finally recognized. Amedeo Avogadro took into account that materials, including gases, were formed by molecules, but most of all, that the volume of a gas, without changes on pressure and temperature, depended on the number of molecules it had. With this, he was able to explain the relationship between the volume of gas that reacted with the number obtained in a chemical reaction.

Cannizzaro's contribution, from Avogadro's ideas, was that the relation between the molecular weight of two gases had the same proportion as the relation between densities of those gases under the same conditions of pressure and temperature, therefore establishing a simple method to determine the molecular weight of gases by using its density, which is a property obtained from the measurement of the known mass volume of a material (Fig. 2.26).

FIG. 2.26 Avogadro's hypothesis explained the experimental observations of gas reactions, as the formed water.



Expected Learning

- Identify the importance of the organization and systematization of elements according to their atomic mass in Mendeleev's periodic table that later led him to the prediction of some unknown elements.

Dmitri Mendeleev's work

Dmitri Ivanovich Mendeleev is considered the father of the Modern Periodic Table; he was a Russian chemist that worked as a professor for a long time. When he suggested an organized periodic table, he was writing a book on chemistry in which he described the elements by their properties.

Working at the same time as Mendeleev, but with each unaware of the other, was the German, Julius Lothar Meyer. He suggested that the properties of the elements were related to their atomic weights and with the volume occupied by an element, it is called the atomic volume.

Meyer made a graph of atomic volumes in relation to the atomic weight of the elements that were known at that time, he then analyzed it by comparing it with the physical properties of the elements, such as density and melting points. He found out that elements with similar characteristics were spotted on a parallel in his graph, which he published in a German scientific magazine in 1870.

SKILLS DEVELOPMENT

Critical thinking skills: Formulating questions.

Reading skills: Scanning, reading for detail.

EVALUATION OF CONTENT

Check students' questionnaires.

Mendeleev, as well as Meyer, took into consideration the atomic weights and the physical properties, but he was the first one to suggest an order for the chemical properties. It became a well-accepted concept, because at that time, they did not relate valence electrons to the table, as we saw in the previous lesson (Fig. 2.27).

Mendeleev considered organizing the known elements and realized there was a certain tendency in the valences. The tendency began from sodium (Na) throughout the other elements. Then he gathered the elements into groups with the same valences, like Li, Na, K, Rb and Cs, which had similar physical and chemical properties.

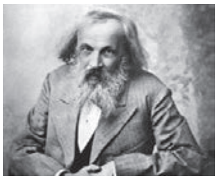


Figure 2.27 The Russian chemist, Dmitri Mendeleev.

On this table, the rows or periods did not have an established size, so Mendeleev noticed some elements were missing in order to complete the tendencies, so he left gaps indicating the missing elements on his table.

Mendeleev named the unknown elements with temporary names according to their location and in relation to the already known elements: eka-boron, eka-aluminum and eka-silicon, taking the eka from Sanskrit that means one, indicating that the unknown element was one place below the known one. Little by little, the elements predicted by Mendeleev were discovered: by 1875 gallium (Ga) was discovered, with the same atomic weight and properties as eka-aluminum; in 1879 scandium (Sc) was discover with the same properties as eka-boron.

Mendeleev's work is an example of the essential need to systematize the knowledge of the materials. He contributed with an order system on which chemistry was established (Fig. 2.28).

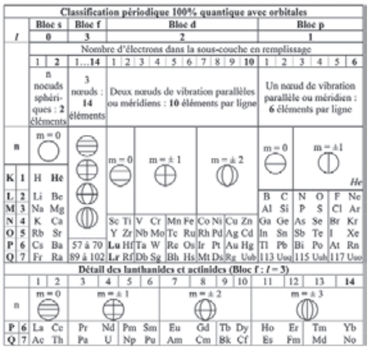


Figure 2.28 Mendeleev's notes on his first attempts to organize the elements.

The importance of communicating science

It is essential for scientists to spread the word about their work for chemistry and science in general to develop faster.

Before science congresses became popular, there were other forms of communication between scientists, which are still used. Since the 18th century, scientific societies were established to promote the exchange of ideas; for example, Lavoisier was member of the Académie Royale des Sciences in France. In England, the Royal Society was one of the first scientific societies and it is still one of the most important.

Mexico established its Academia Mexicana de Ciencias in 1959, with the purpose of being the link to Mexican scientists with different areas. There are other societies specialized in specific subjects, such as the Mexican Chemistry Society (Sociedad Química de México) that has existed for more than half a century.

Closing up!

For chemistry to develop as a science, it was necessary to systematize its methods, just as Lavoisier did during the first Chemistry Revolution. Once it was done, it required several agreements about fundamental ideas, like atoms, molecules and atomic weights; this way, the communication between scientist by societies or congresses became more important. Thus, more scientists were able to know and reflect Cannizzaro's ideas about molecular and atomic weight, aside from the organization of the periodic table suggested by Mendeleev.

Curious Facts

Besides being a committed scientist, Stanislao Canizzaro was a patriot who fought for the unification of Italy. He fought next to General Giuseppe Garibaldi to free Naples. Once they won, he dedicated his life to chemistry, and he became a senator.

Expected Learning

Explain the importance and mechanisms of spreading scientific knowledge, as a way to extend and share knowledge.

To Read More

To learn about chemistry, read *Imagined Chemistry* (Química imaginada) by Nobel prize winner Ronald Hoffman. The book offers reflections about chemistry, famous chemists, elements and periodic tables, together with beautiful images.

Kells

SESSION INFORMATION

Week: 13

Session: 78

Expected learning outcome: Explain the importance and mechanisms of spreading scientific knowledge, as way to extend and share knowledge.

CONTENT DELIVERY

Start: Ask students what they remember about Mendeleev's contributions. Elicit answers. Explain that they will summarize his contributions.

Development: Students should read the section *Dmitri Mendeleev's Work*, which starts at the bottom of page 58 and continues on page 59. Organize teams. They should create a crossword puzzle with information about the section. For example:

Across

1. Mendeleev was a Russian _ _ _ _ _ _ _ _.

Answer: chemist.

Teams should exchange crossword puzzles in order to solve them.

Closing: Students should create a concept map, as explained in the section *To Integrate* on top of page 60. If there is not enough time, they might finish it for homework.

SKILLS DEVELOPMENT

Visual/Spatial skills: Creating crossword puzzles.

Reading skills: Scanning, reading for detail.

EVALUATION OF CONTENT

Check teams full-answered crossword puzzles.

Kells

SESSION INFORMATION

Week: 14

Session: 79

Expected learning outcome: Identify the information from the periodic table analyzing its regularities and importance in the organization of chemical elements.

CONTENT DELIVERY

Start: Organize trios. Every trio should answer the questions in the section *Get Started!* Elicit answers. Help students understand the word "Periodicity", which is crucial to comprehend how elements are arranged in the periodic table.

Development: Students should read the section *The Regularities of the Main Chemical Elements in the Periodic Table,* which starts on page 60 and ends on top of page 61.

Closing: Ask students to see the periodic table in the end of their book, on page 143. Organize pairs. Each person will ask questions to his partner in order to find the atomic and mass numbers of different elements.

ICT

Visit the Mexican Academy of Sciences website. It contains news and information about the different scientific developments reached by Mexican scientific societies: http://www.amc.unam.mx/

To integrate

Concept Map

Make a concept map with the term "Periodic organization" as the key concept. You could use the following terms as guidance; remember to use arrows to relate one term with another, as well as adding words that explain the relationship between words.

Volume
Valence
Atom
Compounds
Weight
Periodic organization
Element
Atomic weight
Density
Molecule

Periodic Table: Organization and Regularities of the Chemical Elements

→ Expected Learning

Identify the information from the periodic table, analyzing its regularities and its importance in the organization of chemical elements.

The Regularities of the Main Chemical Elements in the Periodic Table

The fact that scientists communicated and made agreements was very important to the growth of chemistry. One of the most important scientific milestones was the organization of the elements in which we now call the periodic table.

Even though there were several attempts to find the best way to arrange the elements, the most successful result was achieved by Dmitri Mendeleev, because he took into account the atomic weight of the elements as well as the capacity of their atoms to combine, in other words, their valence. Besides, he discovered that there were unknown elements missing on the table, so he left gaps that later on would be filled with the new elements.

Get started!

The periodic table or periodic system of the elements is called this way because the pure substances (or elements) are organized according to its periodic properties, which implies they get repeated at certain intervals. Periodicity in not an exclusive characteristic of elements, we can find it in many things surrounding us. Reflect and answer the following questions:

- How would you explain the general definition –not considering chemistry– of periodicity? Write it in your own words.
- Write down at least three examples from daily life to which you can apply the term periodic and the reason for doing so.

Share your examples with the class and keep your work in your portfolio of evidence.

Unlike the periodic table design by Mendeleev, current tables have an additional parameter: the atomic number, which is placed next to the element's symbol and serves the purpose of organizing the elements as in an index.

The atomic number and the atomic weight are both useful data related to the structure of the atoms of a certain element, because they allow us to know the number of positive charges inside the nucleus. In other words, the atomic number shows us the number of protons, and from that number, we know the number of electrons. If we also know the atomic mass, we can then have the

SKILLS DEVELOPMENT

Critical thinking skills: Scanning, reading for detail.

Interpersonal skills: Working as team members.

EVALUATION OF CONTENT

Ask for atomic or mass numbers at random.

number of neutrons. In 1913, Henry Moseley, an English physicist, was experimenting with different samples of elements and found out that he always got a whole number with the **x-ray** frequency emitted by each element. This frequency had the same number as the number of protons inside the nucleus of the atom. Moseley named this discovery the atomic number; he also observed the tendency it had to grow when the atomic weight grew.

Since protons are particles that give atoms their identity, they are also responsible for their location in the periodic table. They have whole numbers and if we know this number, it is easier to identify if there's a missing element between two others or if the sequence is complete. This overcomes the conflict that Mendeleev went through, when the elements were organized by their atomic weight, which as we have seen, do not have a whole number.

The structure of the periodic table

Since Moseley established the connection between the amount of protons inside the nucleus and the atomic number, this number is used to organize the elements on the periodic table and it is written next to the element's symbol, beside the atomic mass.

In the periodic table, the elements are organized in numbered columns and rows. The rows are called periods and the columns, groups or families.

The periods are numbered from 1 to 7, which indicate the level of energy in which the electrons are located inside the atom. Therefore, the elements located in the 7th period have more layers than those in the first period. The elements that are together in groups or families have similar chemical properties and the same valences as Mendeleev observed. Most of the current periodic tables have the groups numbered from 1 to 18, but it is still possible to find tables in which the groups have roman numbers followed by the letter A or B.

The International Union of Pure and Applied Chemistry, IUPAC, recommended the use of Arabic numbers in ascending order and without letters for all groups. In any current periodic table we can see that besides the main and the transition group of elements, there are two rows with 14 elements each, which are located bellow the main group of elements of the table (Fig. 2.29).

The reason for this location is that they share physical and chemical properties; the second reason is that if they were to be placed inside the periodic table, this would increase its size making it harder to print it in books or papers. The elements that are separated in the periodic table are called: inner transition elements.

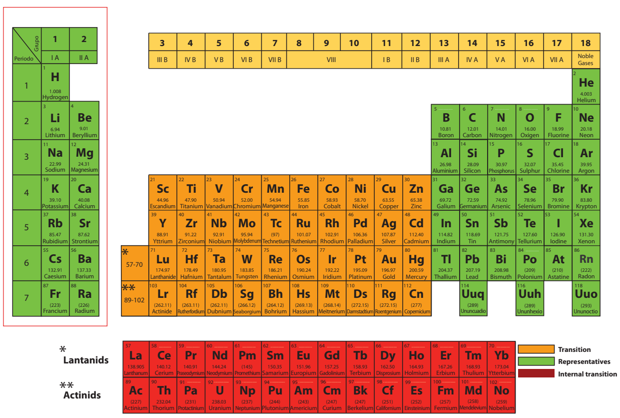


FIG. 2.29 Periodic table showing the main elements in green, the transition elements in orange and the inner transition elements in red.

Curious Facts

Henry Moseley was a young researcher when World War I started in 1914. He enlisted in the British Army as a communication engineer. Unfortunately, he died in combat a year later when he was only 28 years old. Many scientists think that if he had lived longer, he would have made many contributions to science.

Expected Learning

Identify the information from the periodic table, analyzing its regularities and its importance in the organization of chemical elements.

Glossary

X-rays. Invisible electromagnetic radiation that can go through opaque materials, leaving a mark on film. Wilhelm Röntgen discovered them in 1895.

SESSION INFORMATION

Week: 14

Session: 80

Expected learning outcome: Identify the information from the periodic table analyzing its regularities and importance in the organization of chemical elements.

CONTENT DELIVERY

Start: Ask students to open their book to page 143 and locate in the periodic table H, Ca, Al, C, P, O, Cl, Ne; identifying their mass and atomic number. Elicit answers.

Development: Explain that you will be analyzing those periods in the table. Explain that the columns indicate period or number of electrons elements have in the external orbit and rows indicate orbits those elements have. Students will read the entire page. Ask students to locate from the same elements in the start activity, period and orbits. Elicit answers.

Closing: Organize pairs. Students should ask each other questions to locate elements in the periodic table like:

Which is the element in group 2A, period 2? Beryllium.

Which is the element in group 4A, period 3? Silicon.

Allocate a 3-minute practice and then ask students.

SKILLS DEVELOPMENT

Reading skills: Scanning, reading for detail.

Critical thinking skills: Applying.

Visual/Spatial skills: Locating information.

EVALUATION OF CONTENT

Students should be able to locate elements according to the period and group.

SESSION INFORMATION

Week: 14

Session: 81

Expected learning outcome: Identify the information from the periodic table analyzing its regularities and importance in the organization of chemical elements.

CONTENT DELIVERY

Start: Ask students to open their books to page 143. They should find elements according to the description you provide with, like:

Which is the element in period 5, group 1A? Rubidium. Elicit answers in whole class.

Development: Students should read the entire page. Organize trios. They should write at least 5 comprehension-check questions to ask other partners.

Closing: Exchange trios' members and have them ask their questions. Elicit questions and answers.

Project preparation: Organize four teams. Segment the information on pages 63 and 64 into four parts. Assign each part to each team. Have students present the information using visuals. Explain what is to be evaluated (Follow the projects rubrics on page 157).

Properties of the main elements

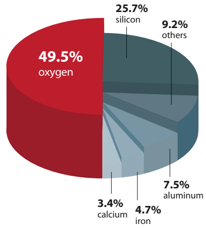


FIG. 2.30 The most abundant elements in Earth's crust are those located in the main group, with the exception of iron (Fe) which is a transition element.

Despite the exceptions, there are general regularities in the periodicity of properties, especially if we focus on groups 1, 2 and from 13 to 18, the so-called main elements. These elements are abundant in our body, Earth, the Solar System and the Universe (Fig. 2.30).

In the main elements, we can easily observe the tendencies followed by certain physical properties, such as the melting point, the boiling point and the density. Inside the groups or families of the main elements, the melting point has the tendency to lower as it changes to a lower group or family. For example, boron (B), which is in the head of group 13, has an atomic number of 5, and a melting point of 2 349 K (**Kelvin**). Meanwhile, the following member of the family, aluminum (Al), has an atomic number of 13 and a melting point of 933.47 K.

In some cases, the reduction is not that drastic and we can even find some exceptions, such as the elements in family 15, in which phosphorus (P) has an atomic number of 15 and a boiling point of 317.3K and the following member of the group, arsenic (As) has an atomic number of 33 and a boiling point higher than 1090 K.

The boiling point is the temperature at which a liquid material changes into a gaseous state, which also follows the tendency to decrease with the location of the elements, but it still has some exceptions. Overall, we can state that the elements found in the upper part of the table melt or boil at higher temperatures than those that are located in the lower part.

Density is another physical property that shows a periodic variation in the main elements. Do not forget that density is the relation between the volume that a certain amount mass occupies of a material (Fig. 2.31).

FIG. 2.31 Lithium (Li) from group 1, has an atomic number of 3 and it's a main element that has such a low density that it floats on water, but due to its chemical characteristics, it also reacts violently in it.

We may find that density increases as we go lower in a group. Therefore, the general tendency of the elements with lower densities is to be located on the upper part of the periodic table, while those with the highest densities are located on the lower part.

Size of the atoms

The properties we have examined for the main elements are physical properties that may be observed **macroscopically** (in a group of atoms); however, these properties are a reflection of what is happening in an atomic level, which we are not able to observe.

The size of an atom is related to different factors; one is the number of electrons, from which will depend the number of energy layers needed for the electrons and finally the electrostatic attraction that the positive charged nucleus applies on the external electrons.

Valence electrons, which are further away from the nucleus, are less attracted by it, not only due to the distance, but because the middle layers create a protective covering between the nucleus and the valence electrons. If we compare the elements in a group, we can observe a tendency to increase from the **atomic radius** as you go lower in the group. In other words, the elements located in the lower part of the table have a bigger atomic size, because they have a greater number of layers, locating the valence electrons further from the nucleus and having more middle electrons creating a stronger protection. For example, in group 13, boron (B) has an atomic radius of 87 pm (**picometer**) while the next member of the group, aluminum (Al) has 118 pm.

The size of the atoms of the main elements decreases from left to right over a period because no more layers are added to the atom, but the nucleus has more protons, with which the effective nuclear charge increases, favoring atoms to have smaller sizes.

An atom will have a smaller size if it has a greater effective nuclear charge, that is, if it attracts the valence electrons, and keeps them closer to the nucleus. If the effective nuclear charge is smaller, then the valence electrons will be located further away and the atom will have a greater size (Fig. 2.32, page 63).

GLOSSARY

Kelvin. Temperature unit previously called Kelvin degrees, from the scale proposed by William Thomson. Lord Kelvin established an initial point of absolute zero, where there is a total absence of particle movement. It is equal to 2273ºC and it is abbreviated with a K. The conversion between the two scales is: ºC 5 K 2273 and K 5 ºC1273.

Macroscopic. Objects or phenomena that can be seen at first glance, because they take place in large groups of particles that make up materials.

Atomic radius. Measured distance between the nucleus and the external or valence layer of an atom.

Picometer. Abbreviation pm. It is an international unit of measurement equal to the billionth part of a meter (0.000000 000 001 m).

SKILLS DEVELOPMENT

Critical thinking skills: Applying, formulating questions.

EVALUATION OF CONTENT

Check students' answers to the introductory activity and questionnaires.

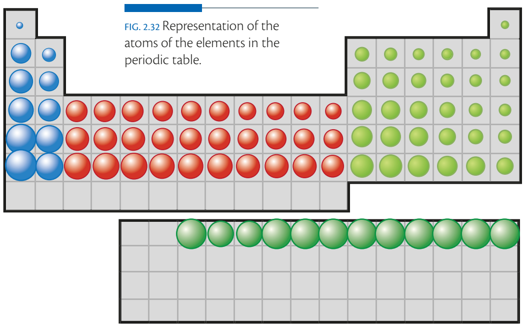


FIG. 2.32 Representation of the atoms of the elements in the periodic table.

Curious Facts

Hydrogen (H) and helium (He) are the most abundant elements in the Universe, because they were formed during the Big Bang. All of the other elements were created later on, in the stars that were born or died during the course of millions of years. On Earth, humans have also been capable of producing synthetic elements by using a particle accelerator.

Metallic Nature, Valence, Number and Atomic Mass

Metals and non-metals

Besides the existing categories of main elements, the transition and inner transition elements, there is another, more general, and older classification of the elements. These categories separate elements into metal and non-metal elements, based on certain physical characteristics. In section 2.3 we discussed the macroscopic characteristics of metals: solids at room temperature (except for mercury), have a metallic radiance, can be molded without breaking, which makes them malleable (ability to form sheets) and are ductile (ability to form wires) and are also great heat and electricity conductors.

Non-metals have the opposite physical characteristics: they may be gaseous, liquid or solid at room temperature, they don't have radiance on their own, which is why they are classified as opaque. If we try to mold non-metal solids, they will break because they are fragile compared to metals; besides they are not conductors of heat and electricity, which is why they are referred to as **insulators**.

If we examine the image showing the metal and non-metal location in the periodic table, it will be clear that, there is a greater number of elements that could be classified as metals, including some of the main elements, as well as all the transition and inner transition elements (Fig. 2.33).

We also find non-metal elements within the main elements. All of the elements within group 1 and 2 are metals (except hydrogen) the first group is named alkali metals and the second one is called alkaline earths. Groups 13 to 17 contain metals and non-metals; finally, group 18, is made up

→ Expected Learning

Identify that the number of protons distinguishes the atoms of different elements.

Glossary

Insulators. Materials which impede the flow of electric energy (electric insulator) or heat (thermic insulator).

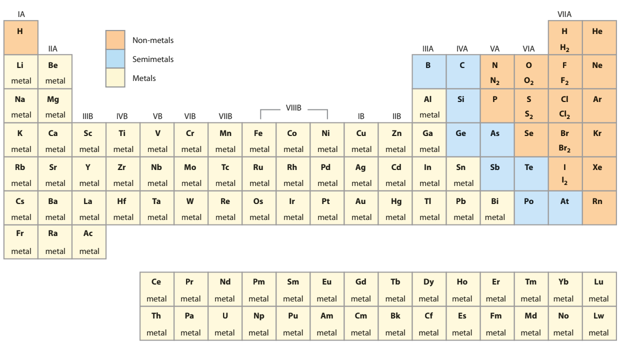


FIG. 2.33 Diagram of the periodic table showing the region of metals in yellow, non-metals in orange and semimetals in blue.

SESSION INFORMATION

Week: 14

Session: 82

Expected learning outcome: Identify that the number of protons distinguishes the atoms of different elements.

CONTENT DELIVERY

Start: Organize pairs. Students will ask each other questions they made the previous class about properties of main elements and size of the atoms. Elicit questions and answers.

Development: Teams who have information about page 63 are to present. Have students ask comprehension check questions to their classmates.

Closing: When students finish their presentations, provide with feedback and have them self-evaluate their performance.

SKILLS DEVELOPMENT

Interpersonal skills: Working as team members.

Reading skills: Scanning, reading for detail.

Critical thinking skills: Formulating questions.

Metacognitive skills: Self-monitoring, self-evaluating.

EVALUATION OF CONTENT

Students should be able to ask and answer questions in the introductory activity. They should actively participate in the presentations.

SESSION INFORMATION

Week: 14

Session: 83

Expected learning outcome: Identify that the number of protons distinguishes the atoms of different elements.

CONTENT DELIVERY

Start: Organize pairs. Students will ask each other questions they made the previous class about properties of main elements and size of the atoms. Elicit questions and answers.

Development: Teams who have information about page 64 are to present. Have students ask comprehension check questions to their classmates.

Closing: When students finish their presentations, provide with feedback and have them self-evaluate their performance.

Project preparation: Organize six teams. Each team will present one of the sections on pages 65, 66, 67. They should look for additional information and prepare either a power point presentation or a poster. Use the project rubrics on page 157 to remind students what you will evaluate in their presentations.

FIG. 2.34 Image of gold, classifies as metal.

FIG. 2.35 Image of sulfur, classifies as a non-metal.

FIG. 2.36 Silicon is a semi-metal with a metallic appearance.

of a mixture of non-metallic elements called noble gases or inert gases.

The metallic and non-metallic nature of the elements is a periodical property that changes gradually by moving lower in a group or to the right in a period; as was done with the physical properties of density, boiling point and melting point we just examined.

Therefore, we define metal as an element, whose atoms tend to lose electrons, more than gain them, to complete the octet, creating positive ions easily (Fig. 2.34).

On the other hand, non-metals are elements whose atoms have valence electrons with a greater number of electrons. So, to complete the octet they tend to gain electrons, creating anions, which is the result of smaller sized atoms.

If you go from left to right in a period, you move towards elements with less metallic characteristics, going gradually from metals to non-metals. This is related to the fact that as you move forward in a period, the atoms within the main elements will be smaller and with more electrons in their valence layer.

In a group, if you go lower, due to the fact that atoms are larger in size, elements will have a greater metallic character (Fig. 2.35). Semi-metals are elements with intermediate properties between metals and non-metals, such as boron (B); silicon (Si); germanium (Ge); arsenic (As); antimony (Sb) and tellurium (Te). All of them are solid at room temperature, and they even have metallic appearance, but are neither ductile nor malleable, they are more breakable, as non-metals. Some of them have the capacity to conduct electricity, with less power as a conductor, but more than the insulator; this is the case of silicon (Si) and germanium (Ge); which are used on chips and other electronic components (Fig. 2.36).

Valence and reactivity

Even though electrons do not represent a significant amount of mass in atoms, they are directly related to the chemical behavior of substances. Valence determines that elements in a group have similar chemical properties, even though there are differences between them according to the number of layers and inner electrons (Fig. 2.37).

According to the corresponding number of group 18, we know that the atoms of the elements within that group have eight valence electrons; in other words, they completed the octet by themselves, without the need to gain or lose electrons. Thus, since they were discovered they had a valence number of 0, which means they did not have the ability to combine, so, it was practically impossible to find a compound that they were part of.

Curious Facts

Noble gases were called this due to the fact that for many years they were thought to have a 0 valence; in other words, they didn't mix with other elements or like this, nobility avoids contact with peasants. Nevertheless, during the 1960's, compounds were synthetized from noble gases with greater atomic mass.

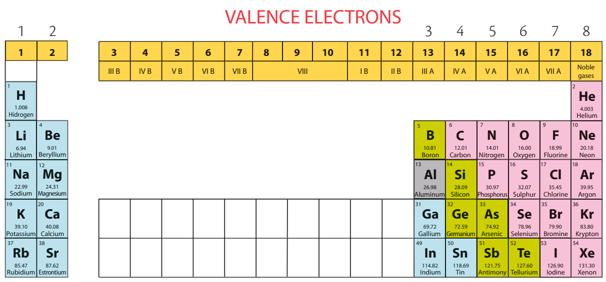


FIG. 2.37 Periodic table with groups numbered from 1 to 18 in orange, and valence electrons of the main elements in blue.

SKILLS DEVELOPMENT

Interpersonal skills: Working as team members.

Reading skills: Scanning, reading for detail.

Critical thinking skills: Formulating questions.

Metacognitive skills: Self-monitoring, self-evaluating.

EVALUATION OF CONTENT

Students should be able to ask and answer questions in the introductory activity. They should actively participate in the presentations.

Kells

Importance of Chemical Elements for Living Beings

Up to this point, we have studied the characteristics of elements by focusing almost entirely on inert materials; in other words, none-living materials. However, we know that the elements in the periodic table make up the existent material of the Universe, including us and every other living being.

Living beings are heterogeneous mixtures of several different materials: substances in gas state, such as oxygen (O_2) which we breath, or in a liquid state, such as water (H_2O), which is the main component of all the living organisms on Earth; and in a solid state, for example, we have calcium in our bones and teeth, to name a few.

Just as atoms are essential particles from which substances and materials are made of, cells are the smallest biological units that make up a living being. Cells alone are heterogeneous mixtures of different substances dissolved in water that create **protoplasm**, which also contains solids that do not dissolve in water, most of them making up structures called **organelles** that carry out different functions inside the cells, the same way subatomic particles carry out and give some characteristics to atoms.

Even though the levels of complexity living beings have as well as the functions that our organism carries out make us very different from inert objects, the atoms that make up both of them are the same. The substances that are a part of us, are not different from the substances outside our organism: water in our cells, in our blood or our tears comes from the water we drink (Fig. 2.38).

Complex molecules formed by atoms are found only in living beings, such as proteins; however, the atoms that make them up are the same as any other atom in another material.

→ Expected Learning

Relate the abundance of the elements C, H, O, N, P, S, to their importance for living beings.

FIG. 2.38 The water we drink becomes part of our cells. Thus, it is the same as those in rivers, oceans, lagoons, etc.

Bio elements and biomolecules

The human body is mainly made up of: C, O, H, N, Ca, P, and S; in all, these seven elements make up 99% of the mass of our body. Unlike the Earth's crust, silicon (S), aluminum (Al) and iron are less abundant. Look at the following chart and see what we are made of and compare it with the Earth's crust:

Element	Human body	Earth's crust
Oxygen (O)	64.5%	50.02%
Carbon (C)	19.3%	0.18%
Hydrogen (H)	10.0%	0.95%
Nitrogen (N)	3.2%	0.03%
Calcium (Ca)	1.4%	3.22%
Phosphorus (P)	0.65%	0.11%
Sulfur (S)	0.25%	0.11%
Silicon (Si)	0.002%	25.79%
Aluminum (Al)	0.001%	7.31%
Iron (Fe)	0.0006%	4.18%
Others	0.7%	8.1%

Glossary

Protoplasm. Material that lives inside the cell, which includes cytoplasm, organelles and the nucleus. It is mainly made of water.

Organelles. Structures inside the cell with specific functions and separated from cytoplasm by membranes .The main organelle is the nucleus.

One of the reasons our body is made up of nonmetals mixed with oxygen is because these types of compounds are present in different forms: they may be solids, liquid or gases; the three states of matter that are essential to life. Elements that are essential and are part of living beings are called biogenic elements or bio elements; in other words, they generate life. Around 70 elements make up different forms of life on our planet, and they create compounds with one another; according to their abundance in living beings, they are classified as:

SESSION INFORMATION

Week: 14

Session: 84

Expected learning outcome: Relate the abundance of the elements C, H, O, N, P, S to their importance for living beings.

CONTENT DELIVERY

Start: Introduce the topic by explaining that they will be presenting information to see how C, H, O, N, P and S are crucial part for living beings.

Development: Teams who were assigned the two sections on page 65 are to present. Have students ask comprehension check questions to their classmates.

Closing: When students finish their presentations, provide with feedback and have them self-evaluate their performance.

SKILLS DEVELOPMENT

Interpersonal skills: Working as team members.

Reading skills: Scanning, reading for detail.

Critical thinking skills: Formulating questions.

Metacognitive skills: Self-monitoring, self-evaluating.

EVALUATION OF CONTENT

Students should be able to ask and answer questions in the introductory activity. They should actively participate in the presentations.

65

SESSION INFORMATION

Week: 15

Session: 85

Expected learning outcome: Relate the abundance of the elements C, H, O, N, P, S to their importance for living beings.

CONTENT DELIVERY

Start: Remind students the topic you are analyzing on how six elements are crucial for living beings by asking students questions about the previous lesson.

Development: The Team that was assigned the section *Carbohydrates* on page 66 should present it. Have students ask comprehension check questions to their classmates.

Closing: When students finish their presentations, provide with feedback and have them self-evaluate their performance.

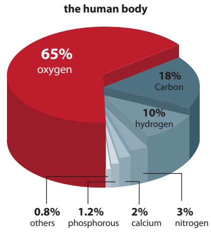


FIG. 2.39 The most abundant elements in the human body are also main elements, but they do not exist in the same proportion as in the Earth's crust.

- Primary bio elements: the six principal elements are C, H, N, O, P and S, and make up almost 99% of living matter; they are the main part of biomolecules. It is important to notice that all of them are nonmetals.
- Secondary bio elements: exist within all living organisms, but in less amounts than the primary bio elements. Calcium (Ca) is the most abundant of them, including other metals as magnesium (Mg), sodium (Na), potassium (K), as well as nonmetals as chlorine (Cl). These are essential for the correct function of organisms.
- Trace Bio elements: are found in minimum quantities in human beings, in proportions equal or less than the 0.1%. They are mostly made up of transition metals, such as: iron (Fe), manganese (Mn), copper (Cu), zinc (Zn), vanadium (V), chromium (Cr), cobalt (Co), selenium (Se), molybdenum (Mo) and tin (Sn). It also includes nonmetals, such as: iodine (I) and fluoride (F); as well as semimetals, such as: boron (B) and silicon (Si). Even though these elements are found in minimum quantities in organisms, they are essential bio elements, because they are part of vital processes. If one of them is missing, a serious unbalance in the organism can lead to death (Fig. 2.39).

Primary bio elements enter our bodies when we eat food, whether it is from animal or vegetable origin. They are not found other ways, they are part of groups of atoms united by chemical bonds, which are called molecules. Molecules that are essential for life are called biomolecules. Our organisms take advantage of biomolecules by transforming them into part of our cells and obtaining energy from them through a series of chemical reactions, this group of reactions is called metabolism.

The biomolecules we consume in meals are primary sources of carbon, hydrogen, oxygen, nitrogen and phosphorous for our bodies. Secondary and trace bio elements also enter our bodies by eating the food that contain them. If we're missing some of these bio elements, the consequences could be devastating; for example, calcium, which is the main component in our bones (Fig. 2.40).

Depending on their structure and function, biomolecules are grouped on different categories, like carbohydrates, lipids and proteins, their characteristics will be described next.

FIG. 2.40 Bones inside our bodies are made up of calcium.

Glossary

Biomass. Total amount of mass that belongs to a part of living beings, ecosystems or the whole Earth.

Heterotroph. Organisms that need to feed themselves to obtain their vital nutrients.

Autotroph. Organisms that produce their own vital substances for their metabolism, through a series of processes

Carbohydrates

Carbohydrates and hydrates of carbon get their names from the general formula $C^n (H_2O) m$, with n equal to or greater than 3. These are the biomolecules with more presence in living beings, because these compounds make up a 50% of Earth's **biomass**. Carbohydrates are important biomolecules for all types of living organisms, because they fulfill several functions, such as: providing energy, which comes from the sugar we eat, store energy, provided by starch, and give structure, like cellulose does to the cell walls inside vegetables.

Human beings and other animals are **heterotrophs**, which are organisms that obtain carbohydrates from plants. Plants are **autotrophs**, organisms that synthesize carbohydrates through a process called photosynthesis, in which carbon dioxide (CO_2) from air and water, and (H_2O) from the ground are turned into glucose. To make this chemical process possible, plants need the energy that comes from the Sun.

One of the most abundant carbohydrates found in nature is glucose; known as a monosaccharide, or simple sugar, which is formed by one molecule with six carbon atoms and can be found: in fruits, honey and even in our blood. Another abundant monosaccharaide in nature is fructose, which can be founded in fruits and vegetables (Fig. 2.41). The combination between two simple sugars is called disaccharide.

FIG. 2.41 Glucose and fructose are found in honey. Common sugar is a disaccharide of glucose and fructose, while lactose, found in milk, is formed by glucose and galactose.

SKILLS DEVELOPMENT

Interpersonal skills: Working as team members.

Reading skills: Scanning, reading for detail.

Critical thinking skills: Formulating questions.

Metacognitive skills: Self-monitoring, self-evaluating.

EVALUATION OF CONTENT

Students should be able to ask and answer questions in the introductory activity. They should actively participate in the presentations.

Lipids

Within this category, we find biomolecules with similar characteristics: insoluble in water, and are mainly used for energy storage inside organisms (Fig. 2.42). The simplest lipids are fatty acids, which are **carboxylic acids** that may have up to 36 carbon atoms, although, the ones that are essential for living beings have between 14 and 20 carbon atoms.

Besides storing energy, lipids have structural functions in animals. Lipids are commonly called fats and do not dissolve in water. That is one of the reasons why if we eat a great amount of fat, lipids will end up building up in our tissues, causing several health problems, starting with obesity.

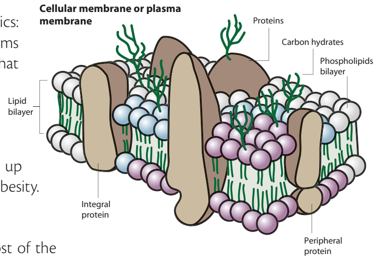


FIG. 2.42 Animal cellular membranes are made out of a lipid bilayer.

Proteins

Proteins are important biomolecules for every living being, because most of the functions made by molecules require a kind of protein. Within animals, proteins have structural functions, for example, collagen, which is part of tissues, such as hair, nails and feathers. Proteins also carry out the function of transporting substances trough the organism, just as hemoglobin transports oxygen trough the blood (Fig. 2.43). They are also related to motion functions; they regulate and balance the metabolism, such as insulin, which is the protein that balances the way we use glucose.

Proteins are made up of hundreds of thousands of amino acid units, formed by carbon, hydrogen, oxygen and nitrogen; some of them also have sulfur.

The diversity of structures of proteins comes from different sizes of their amino acid chains. Every amino acid pair forming a protein is united by a highly stable carbon and nitrogen bond, called a peptide bond. These bonds are hard to breake, which explains why biomolecules are so important and are present in all types of life in the planet.

Glossary

Carboxylic acids. Organic molecules formed by chains of carbons, on one side they have a functional group of carbon formed by the union of a carbon and a group of OH, like an oxygen atom: —COOH.

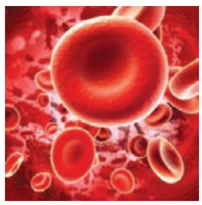


FIG. 2.43 Red blood cells contain hemoglobin, a protein that carries oxygen through our bodies.

Reflect, Explain and Share

Research using books or the Internet to answer the questions:

- We have talked about polysaccharides, Glycogen is a polysaccharide that exists in animals: in which units of monosaccharaides is it located? and what is its function in our organism?
- Common advice we hear from family, friends and even doctors is to avoid the consumption of fats: what would happen if we did not consume enough lipids? What would happen if we did not consume lipids at all? To answer these questions, consult the concepts studied and your research.
- Hemoglobin and albumin are important proteins in our blood. Research their functions.

Share your ideas with the class.

Nutrition

Eating is the way in which humans get bio elements and biomolecules into their organisms; however, when we eat, it is difficult to measure the exact amount of bio elements we include in our meals. To make informed decisions about the food we eat and achieve a balanced diet, nutritionists have suggested a method in which they group food according to the nutrients. In Mexico, the Good Plate is a guide designed to give the Mexican population the dietary elements they need, by incorporating foods that are popular in our country (Fig. 2.44).

FIG. 2.44 The Good Plate.

67

SESSION INFORMATION

Week: 15

Session: 86

Expected learning outcome: Relate the abundance of the elements C, H, O, N, P, S to their importance for living beings.

CONTENT DELIVERY

Start: Remind students the topic you are analyzing on how six elements are crucial for living beings by asking students questions about the previous lesson.

Development: The teams that were assigned the sections *Lipids, Proteins and Nutrition* on page 66 should give their presentations. Have students ask comprehension check questions to their classmates.

Closing: When students finish their presentations, provide with feedback and have them self-evaluate their performance.

Project preparation: Organize teams. Students should take a piece of cardboard and markers.

SKILLS DEVELOPMENT

Interpersonal skills: Working as team members.

Reading skills: Scanning, reading for detail.

Critical thinking skills: Formulating questions.

Metacognitive skills: Self-monitoring, self-evaluating.

EVALUATION OF CONTENT

Students should be able to ask and answer questions in the introductory activity. They should actively participate in the presentations.

SESSION INFORMATION

Week: 15

Session: 87

Expected learning outcome: Relate the abundance of the elements C, H, O, N, P, S to their importance for living beings.

CONTENT DELIVERY

Start: Students should work in the section *Reflect, Explain and Share* in which they should create a menu using The Good Plate. Elicit answers.

Development: The teams you organized the previous session should do the concept map with the list of words in section *To Integrate*.

Closing: Students should display their concept maps around the classroom.

Project preparation: Organize teams of four people. Each team should bring a piece of cardboard and markers to build chemical bonds and a periodic table model.

The main objective for the Good Plate is the intake of bio elements and biomolecules, which are needed for the well functioning of our organism. Thus, the suggestion is that we include the following in each of our meals:

1. Fruits and vegetables, which give us secondary bio elements such as potassium (K) and vitamins.
2. Cereals and tubers, the main source of carbohydrates.
3. Leguminous and animal goods, which provide proteins and trace bio elements such as iron (Fe), zinc (Zn), cobalt (Co) and **vitamins**.

Reflect, Explain and Share

By following the example of the Good Plate, design a one-day balanced menu that includes breakfast, lunch and dinner. Organize your information on a table and fill it with the dishes and ingredients you suggest; also list which bio elements or biomolecules are included on each dish.

Dish	Ingredients	Bio elements/Biomolecules
Breakfast:		
Lunch:		
Dinner:		

Cook one or all of the dishes with your family and explain the benefits of a balanced meal using the eat-well plate as a guide.

Glossary

Vitamins. Biomolecules formed by a group of heterogeneous compounds that cannot be produced by the organism and which keep essential nutrients in the organism.

Closing up!

The classification of elements in the periodic table was a great development in chemistry because the organization was based on the knowledge of atomic structures, which helps explain their behavior as well as to understand certain functions of living beings.

To integrate

Concept Map

Make a concept map with the term "element" as the key concept. Follow the steps you have used before in this type of activity.

Nonmetals | Weight | Atomic radius | Semi metals | Atomic mass | Density

Biomolecules | Reactivity | Bio elements | Melting point | Metals | Boiling point

Chemical Bonds

Expected Learning

Identify the electrostatic particles and interactions that keep atoms together.

Models of Ionic and Covalent Bonds

Now we know that the physical properties of the elements vary according to their location in the periodic table, and that even though bonds need electrons, not all the bonds between elements are the same.

They depend on the characteristics of the atoms that are combined, which are reflected in the properties of the molecules of the resulting bond.

SKILLS DEVELOPMENT

Critical thinking skills: Applying information, summarizing, concept-mapping.

Visual/Spatial skills: Mind-mapping.

EVALUATION OF CONTENT

Students should get their menu and concept map checked by the teacher.

Kossel and Lewis suggested ideas about the arrangement of electrons inside an atom to explain chemical bonds. Kossel's theory was useful to explain how chemical bonds work between elements that were far away from each other on the periodic table, such as sodium chlorine (NaCl). This is possible due to the tendency of chlorine atoms to form the anion chloride Cl^-; it gains the electron needed to complete its layer from a sodium atom, which turns it into a sodium cation Na^+. When it loses an electron, it is left with only electron layers and they bond by creating a compound with the help of an electrostatic force that makes opposite charges attract, creating the so-called ionic bond.

Get started!

Go through your chemistry notes, search in books and your activities for ideas or facts that are related to the different ways atoms get together to form bonds.

1. Organize ideas in a 3-column chart.

Idea or fact studied	Unit or lesson	Its relationship with chemical bonds

2. Complete the table and add a column to briefly explain why you think that fact or concept is related to chemical bonding. Share your findings with the class and keep your work in your portfolio of evidence.

Lewis's theory is more extensive and explains not only the ionic bonds in compounds, but also the ones created without the formation of ions and attraction of electric charges. Lewis suggested a simplified form of representing atoms and their valence electrons, in which he summarizes his theory and helps visualize and understand how bonds are formed. With Lewis's structures, in which valence electrons are paired in groups and interact to fill the valence layers with eight electrons, not only are ionic bonds explained, but it also explains bonds in which the electrons are also shared. These types of bonds are called covalent and are formed between the atoms of elements that are closer in the periodic table.

EXPLORE

Work in teams to create a periodic table and point out the regions where ionic bonds and covalent bonds are formed. Consult the concepts in the unit and find information in additional sources. Use recycled materials to create your diagram.

Share and explain how you represented connections in your work. Keep your work in your portfolio of evidence.

Covalent bonds

When two chlorine atoms bond to form a chlorine molecule (Cl_2), each of the chlorine atoms have seven electrons on their valence layer, so they need one electron to complete the layer. When two atoms of the same element come closer, they share an electron, each in order to complete the layer without losing or gaining electrons (Fig. 2.45). When we come across two atoms of the same element, the connection they make is called a pure covalent bond, because they are formed by sharing the same number of electrons with each other.

On the other hand, in the bonding of two atoms of different elements, electrons are not always fairly shared. According to their individual characteristics, one of the atoms will have a greater capacity to attract electrons towards it. For example, hydrogen chloride HCl (g), hydrogen atoms

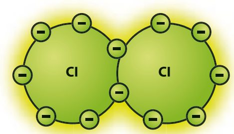


FIG. 2.45 Two chlorine atoms share a pair of electrons, forming a covalent bond.

SESSION INFORMATION

Week: 15

Session: 88

Expected learning outcome: Identify the electrostatic particles and interactions that keep atoms together.

CONTENT DELIVERY

Start: Students should read the bottom of page 68 and complete the table in the section *Get Started* by reading again pages 49 to 51, which is about Chemical Bonds. Elicit answers.

Development: Have students read the entire page 69 and page 70, the information regarding covalent and ionic bonds, ask students to paraphrase the definition of covalent bond (sharing electrons between elements with similar electronegativity) and ionic bond (attraction of electrons from elements with higher electronegativity to electrons from elements with low electronegativity) mean; elicit answers. Organize teams of three or four people. Each team should do the diagram explained in the section *Explore* on page 69.

Closing: Have teams explain the diagrams they create in whole class. Keep the diagrams since students will use them the following class.

SKILLS DEVELOPMENT

Critical thinking skills: Remembering.

Reading skills: Scanning, reading for detail.

Visual/Spatial skills: Graphing.

EVALUATION OF CONTENT

Students should get their periodic table model and chemical bonds diagrams checked by the teacher.

Kells

SESSION INFORMATION

Week: 15

Session: 89

Expected learning outcome: Identify the electrostatic particles and interactions that keep atoms together.

CONTENT DELIVERY

Start: Take out students' models of chemical bonds. Ask students questions again to check the definition of ionic bond and covalent bond. Elicit answers (in the previous session there's a brief definition in the teacher's notes.

Development: Students should do the activities in the section *Reflect, Explain and Share*. Elicit answers in whole class.

Closing: Help students come up with a brief summary on chemical bonds.

Project preparation: Organize 7 teams. Each team will be presenting one of the sections on pages 71 to 73 during the following three sessions. Remind them of the evaluation parameters in the projects rubrics stated on page 157.

will be more attracted towards chlorine atoms, but without completely taking the electrons –the same way it happens with ionic bonds, even though they do not form an anion, chlorine will end up with a partial negative charge while hydrogen will have a partial positive charge (Fig. 2.46).

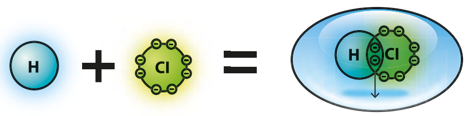


FIG. 2.46 When a pair of electrons is shared between hydrogen and chlorine to create HCl, chlorine applies a greater attraction on electrons.

To distinguish them from the pure covalent bonds, they are called polar covalent bonds. These characteristics help us to distinguish the polar covalent bond by adding the symbol δ+ and δ−; that represent the positive and negative partial charges.

The different attraction capacity each of the atoms have is related to a specific property called electronegativity. This was defined by Linus Pauling in 1932 and means the capacity of an atom in a molecule to attract electrons towards it.

This property changes periodically: it increases as you move up a period, and decreases as you move down in a group. This tendency has an inverse relation with metals, because metals have low electronegativity while elements that are not metals show more, specifically halogens from group 17. Take a look at the Periodic Table at the back of your book.

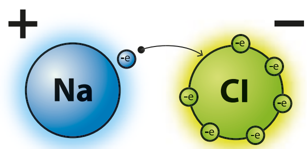


FIG. 2.47 General range of electronegativity in a group and in a period.

Ionic Bonds

As we previously mentioned, ionic bonds do not share electrons. Ionic bonds are formed between the atoms of elements that have different behaviors, generally between metals and nonmetals; this is directly related to electronegativity. The bond between a highly electronegative element- a nonmetal - and an element with little electronegativity –a metal- will result in highly electromagnetic element attracting electrons; thus combining an anion with the cation created by the least electronegative element, only through the interaction of electrostatics. A cation can attract several anions at the same time, which is why in compounds created by ionic bonds, we talk about ion webs. For example, the ionic compound, sodium chloride has a cation for every anion; in its ionic web that can be represented as NaCl (Fig. 2.47).

Covalent bonds may seem completely different to ionic bonds at first sight, and we may say that atoms of covalent bonds "share more" while the ionic bonds are not as "fair" when it comes to electrons. However, Lewis established in his model that both types of bonds come from the extremes of the very same phenomenon, while the polar covalent bond comes from the middle parts.

Electronegativity is very important within this variation between ionic and covalent bonds, if the difference of electronegativity is large enough –in other words, if elements that create bonds are too far away in the periodic table– the higher electronegative atom will completely attract the electrons, creating the ionic bond. However, if the difference of electronegativity is less –elements that form a bond are closer together in the periodic table– atoms will share the electrons, creating a covalent bond.

Reflect, Explain and Share

According to what you already know classify the following formulas as ionic or covalent bonds:

KCl, potassium chloride	O_2, oxygen	CH_4, methane
H_2O, water	$CaCl_2$, calcium chloride	NaF, sodium fluoride

- Analyze the formulas classified as covalent and decide if their bonds are pure or polar.
- In teams, share and explain your decisions while classifying the formulas. Listen to your teammates´ opinions.
- Gather everyone's ideas and write down a general conclusion. Write and clarify your doubts with your teacher. Keep your work in your portfolio of evidence.

SKILLS DEVELOPMENT

Critical thinking skills: Remembering, applying, summarizing.

EVALUATION OF CONTENT

Check students activities and summary.

Relationship Between the Properties of Substances with the Bonding Model: Covalent and Ionic

We have talked about the characteristics of substances related to a material's appearance, for example, radiance and color, as well as conductivity and hardness. In all of those cases we are referring to a macroscopic group of particles that make up a substance: a material is a macroscopic sample, even though their properties are made up of particles, those same properties cannot be observed in individual atoms.

The same thing happens to the properties of materials in all states of matter. We cannot say that there are solid, liquid or gaseous atoms, since states of matter only make sense in groups of atoms. It is the arrangement of those atoms that makes them solid when they are compacted, liquid when slightly separated or gaseous when they are far away from each other. To understand how atoms are grouped to form a material, it is important to understand the interaction that keeps them together (Fig. 2.48).

Materials formed by molecules

Within this classification, there is a great variety of materials, gaseous, liquids and solids. Their state of matter will depend on how strong the attraction between the molecules is.

In these types of materials, we should consider that, on the one hand, there are covalent chemical bonds that are united by atoms that form individual molecules; while on the other hand, we have **intermolecular interactions**. One of the main differences between a covalent chemical bond and an intermolecular attraction is that when a bond needs to be separated, it is essential for a chemical change to occur, in other words, a reaction. To break an intermolecular attraction only a physical change is needed. When a change of state occurs, what happens is that those changes affect the strength of the intermolecular interaction, so molecules that are close together (solids) or further away (gaseous) are changed without affecting their chemical bonds.

Another difference between the covalent chemical bonds that form molecules is the fact that the pairs of electrons between atoms are located in the center and the interaction between them has a defined directionality, while the intermolecular interactions may or may not have a defined **directionality**. Therefore, in order for materials to exist in solid forms, the attraction between the molecules should be stronger, making them stay at a steady point, close to their surrounding molecules. Even though covalent bonds and intermolecular interactions are different phenomena, covalent bond materials are classified in polar and non-polar molecular materials.

Non-polar molecular materials

Non-polar molecular materials are formed by compounds of carbon and hydrogen, and obtained from refining petroleum, which is a heterogeneous mixture of the compounds mentioned above.

Many hydrocarbons exist in a gaseous state at room temperature, such as methane CH_4, others are in a liquid state, such as heptane C_7H_{16} and octane C_8H_{18}, the main hydrocarbons in gasoline. Because of its characteristics, paraffin used to make candles, is a solid non-polar covalent molecule, with a mixture of hydrocarbons with chains form 20 ($C_{20}H_{42}$) up to 40 ($C_{40}H_{82}$) carbon atoms (Fig. 2.49).

The interactions that keep non-polar molecules together exist with the help of instant dipole formation. Molecules with non-polar covalent bonds have a uniform electron distribution; no atom can attract more electrons in the bond. However, because of the natural movement of electrons, most of the electrons move to one side of the molecule within seconds, creating a momentary partial negative charge; while on the other side there is a momentary partial positive charge. Even though it is momentary, molecules that are near the instant dipole could form induced dipoles making molecules attract and stick closer together. These types of interactions are formed on the surface of the molecules, so since the molecules are larger, the interaction force is stronger as well. Lipids are an example of materials formed by non-polar molecules that, due to their size, exist at room temperature as liquids as well as solids.

→ **Expected Learning**

Explain the characteristics of chemical bonding, according to the covalent bond model (electron sharing) and the model of ionic bonds (electron transferring).

FIG. 2.48 The different states of matter are the result of the interaction between the particles that comprise them.

Glossary

Intermolecular interactions. Forces between independent molecules, whether they are different or the same.

Directionality. Characteristic of an interaction that indicates it is located and is given at only one direction.

FIG. 2.49 Hydrocarbons, derivate from petroleum, are several types of substances with different properties, which can be explained as non-polar covalent materials.

SESSION INFORMATION

Week: 15

Session: 90

Expected learning outcome: Explain the characteristics of chemical bonding, according to the covalent bond model (electron sharing) and the model of ionic bonds (electron transfer).

CONTENT DELIVERY

Start: Give students a brief summary of the introduction to the topic on page 71.

Development: The teams that were assigned the sections *Materials formed by molecules and Non-polar molecular materials* on page 71 should give their presentations. Have students ask comprehension check questions to their classmates once they finish with their presentations.

Closing: Provide with feedback and have teams self-evaluate their performance according to the projects rubrics stated on page 157.

SKILLS DEVELOPMENT

Interpersonal skills: Working as team members.

Reading skills: Scanning, reading for detail.

Critical thinking skills: Formulating questions.

Metacognitive skills: Self-monitoring, self-evaluating.

EVALUATION OF CONTENT

Students should be able to ask and answer questions about the session's topics. They should also actively participate in the presentations.

SESSION INFORMATION

Week: 16

Session: 91

Expected learning outcome: Explain the characteristics of chemical bonding, according to the covalent bond model (electron sharing) and the model of ionic bonds (electron transfer).

CONTENT DELIVERY

Start: Ask questions about the two previous sections *Materials formed by molecules and Non-polar molecular materials* to help students remember the main topic.

Development: The teams that were assigned the sections *Polar Molecular Materials, Materials formed by webs of atoms and Ionic Web Solids* on page 72 should give their presentations. Have students ask comprehension check questions to their classmates once they finish with their presentations.

Closing: Provide with feedback and have teams self-evaluate their performance according to the projects rubrics stated on page 157.

ICT

To learn more about petroleum and derivate hydrocarbons, visit the INEGI page: http://cuentame.inegi.org.mx/economia/petroleo/

The fact that these interactions do not have a definite direction, and gather in groups of molecules, even in a solid state, they turn the materials into the ones with the lowest melting points and densities. Solids are also classified as amorphous (shapeless or without a defined form) that is why they are not hard, but malleable. This type of non-polar material can be mixed with other materials with the same characteristics; for example, many substances even in a solid state, can be dissolved in liquids, such as hexane (C_6H_{14}).

Glossary

Crystalline structure. Organized form in which particles of a solid material are arranged.

Polar molecular materials

Polar molecular material are formed with polar covalent molecules. In this case, the intermolecular interactions are stronger than the non-polar, because they have permanent dipoles; the attraction between molecules is achieved with dipole-dipole interaction, which is why polar molecules that have few atoms can exist as solids at room temperature. Permanent dipoles create more directional interactions (Fig. 2.50).

Examples of polar molecules are carbohydrates, including monosaccharaides such as glucose, $C_6H_{12}O_6$, which is solid at room temperature. Carbohydrates form a very particular type of dipole-dipole interaction called a hydrogen bond, which has a defined direction that helps molecules of these materials to arrange. This order and the major force of attraction between molecules indicates that polar molecular materials have slightly high melting points and a higher density, compared to those formed by non-polar molecules. In solid polar molecules, the order they form is called **crystal structure**, which macroscopically turns them transparent and can be considered hard materials. They break when subdued to a mechanical force so they are classified as fragile.

Water (H_2O) is an example of a polar molecular compound, and even though it is a very small molecule, it has a liquid state at room temperature.

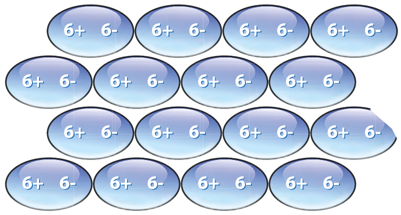


FIG. 2.50 In a solid polar molecule, molecules are arranged according to the interactions of dipoles that form them.

The characteristics of the type of bonding determine how substances will interact; thus, polar materials, whether gas, liquid or solid, may be mixed with others of the same type, just as common sugar (formed by glucose and fructose) can be dissolved in water. Non-polar materials cannot be dissolved in water; the clearest example is water and oil (a mixture of lipids in liquid state).

→ Expected Learning

Identify that the properties of the materials can be explained through their atomic and molecular structure.

Materials formed by webs of atoms

Besides materials formed by molecules, there are materials that do not have individual molecules, because their atoms are all united by chemical bonds one after the other, so it is hard to know where a molecule starts or ends. Recalling the nature of ionic bonds, we can remember that those compounds are conformed by webs of ions that are attracted to each other by electrostatic forces. Every material that is formed by webs has high melting points, so, at room temperature, they are all solids; nevertheless, ionic solids are not the only examples as we'll see next.

Ionic web solids

These materials are part of ionic compounds, such as sodium chloride (NaCl) and other salts. They are formed by the electrostatic attraction between anions and cations, due to the characteristics of their atoms (metals combined with non-metals) (Fig. 2.51).

As they get closer to each other, ions start to generate defined arrangements. Thus the positive charges get surrounded by negative charges, and vice versa, to minimize the repulsion between the same charges. That way, ionic solids have a crystalline look; besides having high melting points, they are hard and fragile when a mechanical force is applied to them. A particular characteristic of these types of compounds is that when they form ions, they can interact with materials with similar characteristics; for example, many salts can be dissolved in water, a polar molecular compound.

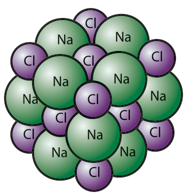


FIG. 2.51 A unit of sodium chloride has a lot of sodium ions which can be neutralized by chlorine ions.

SKILLS DEVELOPMENT

Interpersonal skills: Working as team members.

Reading skills: Scanning, reading for detail.

Critical thinking skills: Formulating questions.

Metacognitive skills: Self-monitoring, self-evaluating.

EVALUATION OF CONTENT

Students should be able to ask and answer questions about the session's topics. They should also actively participate in the presentations.

Covalent web solids

They are the result of combining nonmetal atoms with covalent bonds. Their melting points are really high, because to separate the covalent bond they need to be broken, which requires a lot of energy.

The structure of these types of solids may be organized and crystalline, or less organized; this depends on how the covalent web is stretched, even when it contains the same type of atoms.

An example of this is carbon, which exists in nature with two allotropic forms, two different crystalline structures: diamonds and graphite, which are materials with different appearances and properties. A diamond is crystalline, transparent, and hard, which makes it almost impossible to scratch its surface. Graphite –which is used on pencils– is opaque and grayish, and is malleable (Fig. 2.52).

Even when the same type of atoms joined by covalent bonds conform both materials, the differences are based on the arrangement and direction of these bonds, which will result in different crystalline structures.

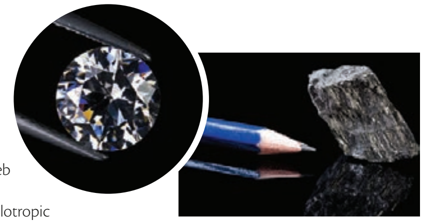


FIG. 2.52 Graphite and diamond may seem as totally unrelated materials, but, because of their characteristics, they are similar. They are both formed by the same type of atom but have different crystalline structures.

Solids with metallic webs

It is the structure by which all metals in the periodic table are formed, as well as their combinations (alloys). Remember the properties of metal atoms: larger size, so the attraction of its electrons is less resulting, in elements with little electronegativity due to its tendency to lose electrons instead of gaining them. These characteristics allow the valence electrons to move freely in a group of metal atoms, thus forming a flow of electrons which surround the positive nucleus, and which is referred to as "sea of electrons" (Fig. 2.53).

There are metals with different densities, but this characteristic, unlike other materials, does not depend on their web, but on the mass of their atoms.

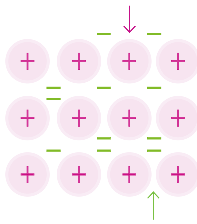


FIG. 2.53 Image of a simplified structure of "sea of electrons", which explains the formation of metallic webs.

Closing up!

Hands on Chemistry!

PROPERTIES OF SOLIDS AND THEIR BONDS

Introduction

Solid materials exist at room temperature due to the existence of interaction between particles that are strong enough to keep them together. Depending on the characteristic of those bonds the materials will have different properties. In this experiment, we will examine different properties to confirm that their behavior is the same as the corresponding models of bonds, according to the characteristics of the components.

You will need (per team):

- Test tube rack
- 5 to 15 test tubes
- Watch glass
- Glass stick (mixer)
- A spatula
- Magnifying glass
- Bunsen burner
- Combustion spoon
- Test tube clamp / holder
- Lighter
- Support or tripod
- Wire cloth to heat
- Beaker or metallic container to use on double boil.
- Water (H_2O) on a dropper

Recommended substances:

- A piece of copper (Cu) wire or sheet.
- A piece of iron (Fe) (nail or iron fillings)
- Sodium chloride NaCL (approx. 1g)

SESSION INFORMATION

Week: 16

Session: 92

Expected learning outcome: Identify that the properties of the materials can be explained through their atomic and molecular structure.

CONTENT DELIVERY

Start: Ask questions about the three previous sections *Polar Molecular Materials, Materials formed by webs of Atoms and Ionic Web Solids* to help students remember the main topic.

Development: The teams that were assigned the sections *Covalent Web Solids, and Solids with metallic webs* on page 73 should give their presentations. Have students ask comprehension check questions to their classmates once they finish with their presentations.

Closing: Provide with feedback and have teams self-evaluate their performance according to the projects rubrics stated on page 157.

Project preparation: Organize teams of four people. Each team should get ready for the lab practice, which is described at the bottom of page 73. Clarify what they should take to class the following session in order to do the experiment.

SKILLS DEVELOPMENT

Interpersonal skills: Working as team members.

Reading skills: Scanning, reading for detail.

Critical thinking skills: Formulating questions.

Metacognitive skills: Self-monitoring, self-evaluating.

EVALUATION OF CONTENT

Students should be able to ask and answer questions about the session's topics. They should also actively participate in the presentations.

SESSION INFORMATION

Week: 16

Session: 93

Expected learning outcome: Identify that the properties of the materials can be explained through their atomic and molecular structure.

CONTENT DELIVERY

Start: Check that all teams have the necessary materials to do the lab practice.

Development: Students are to do the lab practice described on page 74.

Closing: Students should do the synoptic table, which is described at the bottom of the page, in the section *To Integrate*.

Unit project preparation: Organize teams to prepare the final project. Remind teams they should be presenting their unit project during the following week.

- Silicon dioxide (SiO_2) (approx. 1g)*
- Stearic acid $C_{18}H_{36}O_2$ (approx. 1g)
- Common sugar ($C_{12}H_{22}O_{11}$) (approx. 1g)

*Silicon dioxide may be on the form of sand or chunks.

Preventive measures:
- Wear a lab coat and security glasses. Use latex gloves, if possible.
- Do not touch the reactants. In case this happens: wash your hands with plenty of soap and water and tell your teacher.
- This experiment requires the supervision of a teacher.

Procedure

Group in teams.

1. Place each of the substances in different and labeled test tubes. Use the spatula, if needed.
2. Examine the characteristics of the samples. If necessary, use the magnifying glass. Write down your observations.
   A Hardness and fragility test
      1. Take one of the samples with the spatula and put it over the watch glass. Test its hardness or fragility by crushing it with the mixer or the spatula.
      2. Watch what happens, does the substance resist or break?
      3. Repeat the steps with each sample. Do not forget to write down your observations.
   B. Melting point test
      1. Create a double boiling system: turn on your Bunsen burner and place it under the tripod, place the wire cloth on top and heat water in a beaker or in a metallic container.
      2. Before water gets too hot, place the test tubes with samples into the beaker or container. Examine the reaction of each material.
      3. If after five minutes of heating there is no reaction, then the substance has a higher melting point. If you have a combustion spoon, heat the sample directly on the flame. Write down your observations.
   C. Solubility in water test
      1. Take a sample of each substance and place it in a clean and dry test tube. Do not forget to label the tube to know which substance you're working with.
      2. Use the dropper to add water to the tube, up to ¾ of water.
      3. Shake vigorously, do not spill the water. Examine: Which substances dissolved? Which ones didn't?

Explain

Write a report answering the following questions; include a chart of observations and if possible, take photos to illustrate your report. Keep your work in your portfolio of evidence.

1. Gather the information you got from different sources and classify the materials you used according to their reactions.
2. Compare the expected behavior with the one you observed. If there are any differences, try to find a reasonable explanation.
3. Which test do you consider more useful to learn about the nature of bonds within the chosen substances?

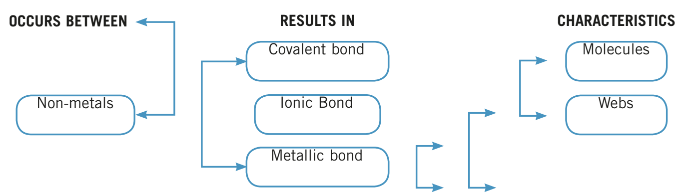
Remember to list your sources of information.

Materials are formed by atoms, so by understanding how they work, their structures and the interactions that keep them together, will help us all to have an integral view of the chemical phenomena that occur around us.

To integrate

Synoptic table

Organize the concepts and ideas in this lesson in a synoptic table. Follow the example to complete and design a new one.



SKILLS DEVELOPMENT

Logical/Mathematical skills: Experimenting.

Critical thinking skills: Summarizing.

EVALUATION OF CONTENT

Check the lab practice and the synoptic table that students produce.

Project: *Explore, Experiment and Experience. Integration and Application of Knowledge*

All matter that conforms the Universe, which we are part of (at least the part we know through scientific research), is made out of atoms.

We get the elements we need by eating and breathing to keep our body alive and healthy and through excretion we get rid of the substances we no longer need or that could be harmful to us.

FIG. 2.54 Car batteries have lead, one of the most harmful heavy metals to health and the ecosystem.

If we lack some of the basic elements or have ingested harmful elements, for example, heavy metals, we can get diseases that affect our tissues and create pathogens that could develop in our bodies (Fig. 2.54).

Health is the most valuable thing we have, and chemistry gives us the necessary information to generate and observe eating habits that allows us to stay healthy as well as take care of the ecosystems we rely on. That is why it is important to be informed and make decisions that will keep us healthy (Fig. 2.55).

FIG. 2.55 Scientific research has allowed us to know the elements that make up our planet and the universe.

Planning your project **➔ Introduction**

Work in small groups. You will need different sources of information: Portfolio of Evidence, notebooks, textbook, etc. Discuss and choose one of the following questions for your project:

- Which chemical elements are essential for the well being of our bodies?
- Which are the health and environmental implications of heavy metals?

Just as in Unit 1, choose a question to reflect on what you have learned in this unit. Use the following chart for guidance:

Question	Answer	Source
Which elements constitute the matter humans are made of?		
In which proportion are elements found in humans?		
How do we get the elements we need?		
Which food contains the elements we need?		
What is the relation between a balanced diet and the intake of the elements our body needs?		
Am I getting the necessary elements in my daily diet?		
Which heavy elements are harmful for my health and the environment?		
In which technological devices are heavy metals used?		
Which are the effects caused by heavy metals on human health and the ecosystem?		
How can heavy metals enter our bodies and the ecosystem?		
Which are the right and the wrong ways to throw away technological devices with heavy metals?		
Which types of heavy metals could you be in contact with?		
What can you do to avoid contact with heavy metals?		
In case none of the topics suggested satisfy you and your team, and based on the content of this Unit, what other questions would you suggest to do your project?		
Explain your choice for any of the topics or questions and the situations it would help you solve.		

SESSION INFORMATION

Weeks: 16, 17

Sessions: 94 - 98

Expected learning outcome: Apply unit content to develop a project.

CONTENT DELIVERY

Start: Briefly explain what you will evaluate in their projects: Relevant, clear information, visuals, comprehension-check questions and further information.

Development: Students should present their projects. Assign time according to your class length. Help as necessary.

Closing: Students should ask their comprehension-check questions to their partners. Then, ask them to self-evaluate their presentations using the same presentation parameters described in the projects rubrics.

SKILLS DEVELOPMENT

Reading skills: Scanning.

Interpersonal skills: Teaching others.

Critical thinking skills: Formulating questions.

Listening skills: Understanding the message.

Metacognitive skills: Delivering content, self-monitoring, self-evaluating their presentation.

EVALUATION OF CONTENT

Follow the projects rubrics, Teacher's Guide page 157.

SESSION INFORMATION

Weeks: 16, 17

Sessions: 94 - 98

Expected learning outcome: Apply unit content to develop a project.

CONTENT DELIVERY

Start: Briefly explain what you will evaluate in their projects: Relevant, clear information, visuals, comprehension-check questions and further information.

Development: Students should present their projects. Assign time according to your class length. Help as necessary.

Closing: Students should ask their comprehension-check questions to their partners. Then, ask them to self-evaluate their presentations using the same presentation parameters described in the projects rubrics.

Project: *Explore, Experiment and Experience. Integration and Application of Knowledge*

FIG. 2.56 To have a balanced diet, it is important to learn about the nutrients we need.

Together with your teammates, select the type of project you will work on: science, technological or civic project. Include advantages, disadvantages and contributions your project brings to your community. Use the chart in Unit 1, page 38 for this purpose.

Planning your project ➔ Development

To plan your activities, it is essential to create a schedule. Use the chart in Unit 1, page 38 as a guide to assign activities, the time it will take and the person responsible for each activity.

The activities to develop will depend on the type of project your team decided to work on. If you choose scientific, you can work on promoting a dietary plan for your community to modify eating habits (Fig.2. 57). In the technological area, you could present the consequences on health or the environment caused by heavy metals, but you must do a bibliographic research on the following:

a. What heavy metals might you and the ecosystem be in contact with? (Fig. 2.56)
b. What are the damages that heavy metals inflict on health and to the ecosystem?
c. What is the best way to avoid contact with heavy metals and dispose of them? (Fig. 2.58)

FIG. 2.57 One of the purposes of the project is to promote the healthy waste of materials.

With this information, you can design a container suited to throwing away, storing, or transporting materials containing heavy metals. In this case, your hypothesis may be: having adequate containers to throw away materials containing heavy metals will prevent health and environmental damages.

For scientific purposes, every experiment should be designed according to the needs of each case, as well as the conditions and the resources you are working with. Every suggestion about technological development should fulfill certain parameters, such as effectiveness, durability, permanence and a cost benefit analysis. The civic suggestions should consider the particular conditions of the community and how to resolve social problems, create civil consciousness and change habits to create sustainable and economical practices.

Recording your observations is a significant part of analyzing the results. A good option is to create tables to draw graphics and models for the analysis to be clearer.

Planning your project ➔ Closing

FIG. 2.58 Most rechargeable batteries contain Cadmium, a highly toxic heavy metal.

Finishing your activities on time will help you analyze the results and draw conclusions. The analysis is based on the information included in tables and graphics.

It is essential to include the description of the work and the method you used, whether the purpose was achieved and the hypothesis was valid or not. Also include future expectations evaluated with the tracking device.

Communication is key to completing your project. An efficient, attractive and fun way we suggest to communicate your projects is to gather information and create a newspaper to spread the word about your project. You can invite classmates, teachers and your family to read newspaper (Figs. 2.59 y 2.60).

FIG. 2.59 The analysis of the results allows us to validate or reject a hypothesis.

FIG. 2.60 Newspapers are a very efficient way to communicate what is happening in your community.

SKILLS DEVELOPMENT

Reading skills: Scanning.

Interpersonal skills: Teaching others.

Critical thinking skills: Formulating questions.

Listening skills: Understanding the message.

Metacognitive skills: Delivering content, self-monitoring, self-evaluating their presentation.

EVALUATION OF CONTENT

Follow the projects rubrics, Teacher's Guide page 157.

Evaluation

Read the following text carefully.

Contamination caused by batteries

José Castro Díaz and María Luisa Díaz Arias

Nowadays, there are no studies that evaluate the environmental impact caused by the inadequate use of batteries in Mexico; we know that several of their components are toxic, thus, environmental pollution and health risk depend on the way, the place and the volume of the waste that is thrown away.

This paper calculates the last 43 years in which the national territory has been contaminated with approximately 635 thousand tons of batteries, which contain elements toxic for the environment and our health (in large proportions), such as carbon(C) or zinc (Zn). There are also elements that represent a risk due to the great volumes in which they are produced; such as the 145,918 tons of manganese dioxide (MnO_2) another toxic element is mercury (Hg) with 1,232 tons; 22,063 tons of nickel; 20,169 tons of cadmium (Cd) and 77 tons of lithium compounds (Li). The toxic substances mentioned before represent almost 30% of the total volume of the aforementioned waste; in other words, approximately 189,382 tons of toxic materials for the period of 1,960 and 2,003.

The previous numbers were calculated according to official data about population, production, importation, and exportation. They were also based on inferences made due to the lack of some data, such as batteries brought illegally into the country, so the information had to be compared with the that of other countries.

It is important to mention that the information referring to the tons of pollutants was underestimated, because batteries inside devices were not counted, even if they were primary, which is the case of lanterns, radios or toothbrushes, or secondary like Ni-Cd,Ni-MH (metallic hydride) or ion-li such as vacuum cleaners and cameras among others. Batteries inside watches were not taken into account either. They have been in use since the beginning of the 1980 decade and contain mercury and lithium oxide.

It is important to state that this paper is justified for several reasons, such as toxicity of the materials with which batteries are made; their inappropriate use and the perception the population has that discarded used batteries are harmful to the environment and health. This has brought about an immediate response for managing appropriate disposal through waste removal programs.

It is difficult to evaluate the health risks and environmental impact due to the exposure to pollutants, because they are deposited throughout the country. Even though it cannot be quantified, it is certain that the toxic component of batteries can be found in minimum quantities in the tissues of organisms inside the ecosystem, including humans, plus pollutants that come from other sources. So, because there is no scientific data about the consequences batteries have, it is necessary to implement methods of prevention, promote research, inform the population about the impact of batteries on their health and the environment, establish recycling centers and reduce the volume of battery consumption.

Extract taken for the National Institute of Ecology
http://www2.inecc.gob.mx/publicaciones/libros/438/cap5.html
(Seen on: June 09, 2013)

77

SESSION INFORMATION

Week: 17

Sessions: 99 - 102

EVALUATION

CONTENT DELIVERY

Start: Students should read page 77 and answer page 78 prior to taking the unit assessment. Go through the answers; help them with techniques to study content they do not clearly remember; such as mind maps, questionnaires, partner discussion, drawings, etc.

Development: Students are to take the unit assessment. You can find it in the Teacher's Guide pages 145 to 147 along with the answer key.

Closing: Check their assessments, record the score and provide with feedback. You might want to use the Attendance and Evaluation formats that you can find the Teacher's Guide pages 158 to 160.

SKILLS DEVELOPMENT

Metacognitive skills: Identifying topics to go through.

EVALUATION OF CONTENT

Check the answer key to the unit assessment on page 148.

SESSION INFORMATION

Week: 17

Sessions: 99 - 101

EVALUATION

CONTENT DELIVERY

Start: Students should read page 77 and answer page 78 prior to taking the unit assessment. Go through the answers; help them with techniques to study content they do not clearly remember; such as mind maps, questionnaires, partner discussion, drawings, etc.

Development: Students are to take the unit assessment. You can find it in the Teacher's Guide pages 145 to 147 along with the answer key.

Closing: Check their assessments, record the score and provide with feedback. You might want to use the Attendance and Evaluation formats that you can find the Teacher's Guide pages 158 to 160.

Evaluation

Based on the text you read, choose the correct answer.

1. Why is the environmental impact caused by the use and the inappropriate handling of batteries in Mexico unknown?
   - **a)** Because Mexico's society does not care.
   - **b)** Because there is no study that evaluates the impact on Mexico.
   - **c)** Because the cost of the studies is too expensive.
   - **d)** Because batteries are efficiently recycled and do not hurt the environment.

2. Why is it that the information about the tons of pollutants from batteries is underestimated?
   - **a)** There is no control over the batteries that are commercialized, used, thrown away or enter the country illegally.
   - **b)** More batteries are used than those reported by the factories that produce them and there is no control over this process.
   - **c)** There is no information about the primary batteries that some devices or watches carry.
   - **d)** Most of the used batteries are thrown to the garbage and there is no quality control over batteries ending up in dumpsters.

3. What types of materials are used in watch batteries?
   - **a)** Mercury and lithium oxide
   - **b)** Manganese and carbon dioxide
   - **c)** Cadmium and zinc
   - **d)** Nickel and hydride metals

4. Why is it difficult to evaluate the health and environmental risks from exposure to pollutants and the inappropriate disposal of batteries?
   - **a)** Because there is no government institution to do the evaluation.
   - **b)** Because most of the components in batteries do not harm the environment or our health.
   - **c)** Because when batteries are in dumpsters, they have no contact with people.
   - **d)** Because they are disposed of all over the country.

5. Which strategy could you use to try to overcome the possible health and environmental impacts of pollutants inside batteries?
   - **a)** Prohibit the production of some types of batteries.
   - **b)** Punish the person that throws used batteries in the trash.
   - **c)** Decreasing the volume of consumption of batteries.
   - **d)** Pay a good price at storing centers.

Underline the parts of the text where you got the answers, share your answers with a partner and talk about the reason why they are correct or incorrect; in case of disagreement, point out the necessary information to clear any doubts.

SKILLS DEVELOPMENT

Metacognitive skills: Identifying topics to go through.

EVALUATION OF CONTENT

Check the answer key to the unit assessment on page 148.

Evaluate your performance throughout this unit; mark with a check (✓) the indicator which you have achieved under the correct timing column.

SELF-EVALUATION					
	Indicators	Always	Usually	Sometimes	Never
COMPREHENSION	I can ask questions that integrate the contents studied in the unit.				
	I can relate the topics I study to daily events and other familiar situations.				
	I can understand the content covered in class without problems.				
	I can identify my mistakes, difficulties and limitations, and propose actions to overcome them.				
	I can express my point of view and opinion as a contribution to the collective analysis.				
	I can solve problematic situations by applying what I learned.				
SCIENCE SKILLS	I brought all the materials I needed to class.				
	I did all my work in a neat and clean way.				
	I can explain, share, communicate and contrast my ideas with others.				
	I can ask and answer questions that allow me to integrate the contents I studied in the unit.				
	My hypotheses are consistent and correspond to the activities and the topics in the unit.				
	I can analyze the information I get from several media, and select only that which is relevant for my purposes.				
	I am able to choose the most convenient strategy to solve problems.				
	I can design instruments to register and order data obtained from the activities.				
	I can analyze results to draw conclusions.				
	I can draw conclusions based on the organization and order of the information I have available.				
ATTITUDES	I can successfully do and finish all my work.				
	When I need help, I ask my teacher or my classmates.				
	I'm capable of listening, value, and take into consideration the opinions of others even when they don't agree with mine.				
	I'm honest with the veracity of the information I handle.				
	I can actively participate on a team.				
	I can show my classmates solidarity.				
	I am a responsible consumer.				
	I propose sustainable behaviors.				
	I show respect for biodiversity.				
	I can prevent diseases and accidents during my activities.				
	I show interest, curiosity, creativity and imagination in every activity I make.				

SESSION INFORMATION

Week: 17

Session: 102

SELF-EVALUATION

CONTENT DELIVERY

Start: Explain to students why evaluation is important, it is the only way to improve the way of learning.

Development: Get students to answer the self-evaluation and help them reflect upon their learning process.

Closing: Provide with some feedback.

SKILLS DEVELOPMENT

Metacognitive skills: Self-monitoring, self-evaluating.

EVALUATION OF CONTENT

Students should get their self-evaluation instrument checked by the teacher.

SESSION INFORMATION

Week: 18

Session: 103

Expected learning outcome: Identify difficult content in order to write a study plan.

CONTENT DELIVERY

Start: Have students analyze and identify what they could do well in units 1 and 2; as well as what they should improve in unit 3. Ask them, for instance: What topics were easy? Did your previous study plan work? Didn't it work? Why? Did you really follow your study plan? Students should write down their reflections.

Development: Have students check the skills, learning outcomes and key concepts in unit 3. Ask them to identify the topics they consider the hardest ones. Then, they should plan how to study them and do better than the previous unit. If a strategy didn't work, then they should find another one. Help them with ideas. (Drawing mind maps, discussing with partners, making their own exams, making timelines, making associations, etc.)

Closing: Students should write down their study plan and have it checked.

UNIT 3

The Transformation of Matter: The Chemical Reaction

Skills

- Understanding natural phenomena and processes from a scientific perspective.
- Making correct decisions based on information to take care of the environment and prevent diseases.
- Understanding the scope and limitations of science and technology within different contexts.

Expected learning

- Describing of some of the manifestations of simple chemical changes such as effervescence, emission of light or heat, precipitation and change of color.
- Identifying the properties of the reactants and the products in a chemical reaction.
- Representing chemical changes through equations and interpreting the information in them.
- Verifying the correct expression of the equations.

SKILLS DEVELOPMENT

Metacognitive skills: Planning, organizing studies content.

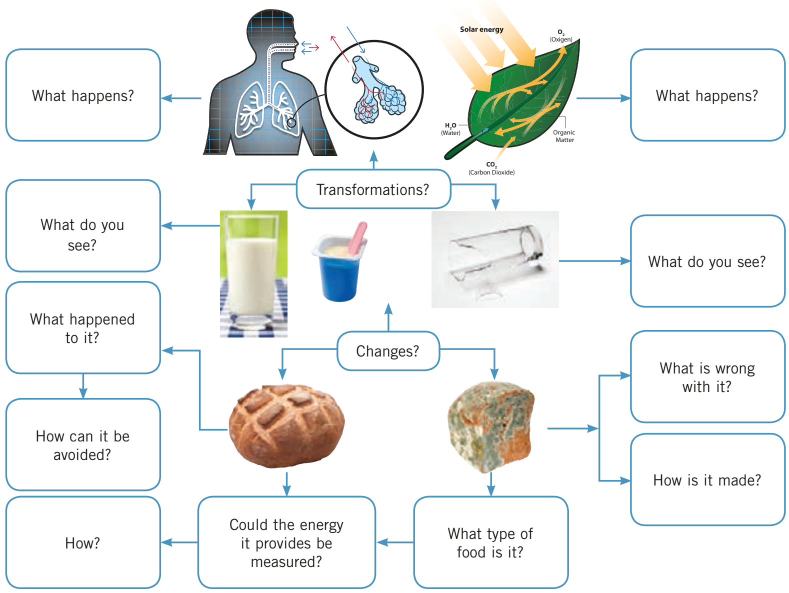
EVALUATION OF CONTENT

Students should get their study plan checked by the teacher.

➔ Diagnostic Evaluation

Chemistry is present in several processes we need in our daily lives, as well as in the creation and transformation of substances and materials. Everything is constantly changing, transforming, but… is every process the same?

1. To remember what you have studied up to this point, fill in the missing information in the following mind map.
2. Compare your map with a partner and take note any differences. Keep your work in your portfolio of evidence to compare this information later on.



Identifying Chemical Changes and the Language of Chemistry

Chemical Equations: Manifestation and Representation of Chemical Reactions

Some types of materials remain without changing for years, others change constantly, but what is true is that not all changes are the same. In this lesson we will study the different types of changes and their description through specific language: the language of chemistry. What do you take into account to affirm that a chemical change has occurred?

➔ Expected Learning

Describe some of the manifestations of simple chemical changes, such as effervescence, emission of light or heat, precipitation and change of color.

SESSION INFORMATION

Week: 18

Session: 104

Expected learning outcome: Describe some of the manifestations of simple chemical changes, such as effervescence, emission of light or heat, precipitation and color change.

CONTENT DELIVERY

Start: Ask a student to read the introduction to the *Diagnostic Evaluation.*

Development: What students are supposed to do is complete the mind map. Help them out with some answers, like: What happens when we breathe? The air goes where? (To the lungs and bronchus). What happens when solar energy gets to leaves? (Photosynthesis occurs).

Closing: Elicit answers in whole class.

SKILLS DEVELOPMENT

Critical thinking skills: Predicting, mind mapping.

EVALUATION OF CONTENT

Check students' ideas to complete the mind map.

SESSION INFORMATION

Week: 18

Sessions: 105, 106

Expected learning outcome: Describe some of the manifestations of simple chemical changes, such as effervescence, emission of light or heat, precipitation and color change.

CONTENT DELIVERY

Start: Have students predict the results of the experiments described in the section *Get Started!* Elicit answers.

Development: Students should read the section *Chemical Equations: Manifestation and Representation of Chemical Reactions*, which starts on page 81 and ends on page 83.

Closing: (Done the following session) Organize teams to do the experiments described in the section *Get Started!* It would be the best to have everyone do the experiments; however, if there is not enough time, you might assign one experiment to one different team. Students should do the analysis described in the section *Hands on Chemistry!* About each experiment.

Get started!

What type of change will it be?

Copy the following list of situations on a piece of paper:

- 1. Pour some water into a glass; add a few drops of both ink and bleach. 2. Heat water until it boils. 3. Cook an egg. 4. Dissolve a spoon of salt in water. 5. Tear a sheet of paper. 6. Heat some sugar until it turns into caramel. 7. Break a pencil in half. 8. Mix sodium bicarbonate with vinegar. 9. Light a match.
- Underline in color the situations where you think there was a chemical change.
- Explain why you think there is no chemical change on the situations you did not underline.
- Did you have any doubts while doing this activity? If you did write them down.
- Compare your answers with your teammates. Did all of you agree? Explain why.
- Keep your work in your portfolio of evidence.

FIG. 3.1 When we tear a piece of paper, substances are still the same and we still have paper. This is a physical change!

When you compared your answers from the previous activity with your classmates, you may have not agreed on the type of changes that happened in each situation. For example, in the cooked egg situation, some classmates may have thought that even if the egg had changes it continues being an egg. Others may have thought it was an egg that experimented changes during cooking, in its physical state, odor and consistency, leading to the formation of new substances. What should we take into account to conclude if there were chemical changes or not?

FIG. 3.2 When a piece of paper is burned, the nature of matter changes. It is a chemical change!

Going further

In both nature and everyday life, we often see physical or chemical changes. When a substance changes its appearance, form or state, but keeps its original matter and has the same characteristics, the substance does not transform, it only changes physically (Fig. 3.1).

On the contrary, if a substance does not keep its original shape during the changing process, and changes into another substance, then the change will be chemical: for example, when we burn a piece of paper, it turns into ashes and smoke. The transformations that happen during a chemical change are called chemical reactions (Fig. 3.2). Even though it is not easy to know when there was a chemical reaction or not, because this process happens constantly in nature, like when we breathe or digest our foods. Chemical reactions can also be reproduced in a laboratory in a controlled environment, which has allowed scientific communities to study the how and why these reactions are produced.

Hands on Chemistry!

IS IT A CHEMICAL OR A PHYSICAL CHANGE?

Work in groups of five to collect all the necessary materials to do each of the activities mentioned in the *Get started* activity.

- Write down questions that will allow you to guide your observations, for example: Are there any changes in the color or odor of the substance? Does it change shape? Is there effervescence? Are gases formed? Is there any noise? Is heat released during the process? Is there any change in the emission of light?
- Answer the questions describing the changes. For example, if there is a change in color, explain first the original color and the color it changed to after the process. If there is any light, describe its intensity, color, duration, etc.
- Draw a three-column table in your notebooks. In the first column, write the activity you did, in the second column, describe what happened in each situation, and in the third column write whether the change was chemical or not.
- Compare the content of the table with your previous answers and write down your results if they are different.
- Share your work with the class and keep it in your portfolio of evidence.

SKILLS DEVELOPMENT

Critical thinking skills: Predicting, analyzing.

Logical/Mathematical skills: Experimenting.

EVALUATION OF CONTENT

Check students' predictions and experiments.

A chemical change involves a chemical reaction, which is the transformation of one or more substances into others. A simple way to know if there are chemical changes happening is through the manifestations that occur when substances are combined such as in effervescence, the precipitation of solids in liquids or when there is a change of color in a substance.

If two substances are in touch and we observe effervescence or bubbles, it is due to a gas evolution reaction. Effervescence is a manifestation of this chemical reaction, and it can be observed with some **antacids** that are dissolved in water, due to the reaction of the sodium bicarbonate and the citric acid (Fig. 3.3).

When there is an emission of light or heat, it is because energy is freed by a chemical change. Therefore, when you light a match or observe a fireworks display or show, you are looking at a chemical reaction. During the combustion process, a combination of substances burn in presence of oxygen; this reaction is usually manifested with light and heat (Fig. 3.4).

Precipitation is generated when a substance that may be liquid, solid or gaseous is added to a liquid solution, when they react chemically, they will form an insoluble solid that can be separated by dissolution (Fig. 3.5).

A chemical manifestation may also be observed when there is a change of color in the substance; for example, coins, jewelry, cutlery and many other silver objects darken with time. This change of color is due to the reaction of silver with the sulfur in the atmosphere, which is found in the form of hydrogen sulfide, which is a gas that results from the combustion of carbon and petroleum, resulting in silver sulfide. The change in color of silver with sulfur is gradual, it first turns into a yellowish color, and with time, it darkens until finally it turns completely black.

FIG. 3.3 Effervescence shows the release of gas on a chemical reaction, and it can be seen in the form of bubbles.

FIG. 3.4 In every combustion, substances react with oxygen and generate energy in forms of light or heat.

FIG. 3.5 A precipitate is an insoluble solid that is separated from the dissolution.

Reflect, Explain and Share

- Form teams and discuss the answers to the following questions with your partners:
- Gas appears in the following activities: preparing hot tea, lighting a fire, putting on cologne and starting a car. In which of these activities is there a chemical reaction present? Explain why.
- Shrimps turn red when they are cooked. Is there a chemical reaction? Why?
- What happens when we open a bottle of soda? If you think there is a chemical reaction, explain which are the manifestations you observed and which are in this case, the reactants and products.
- Make drawings that represent your answers on a sheet of cardboard.
- Show your work to the class.
- Take pictures of your work and that of your classmates, make a photo album and include it in your portfolio of evidence.

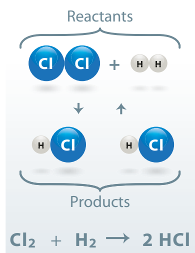


FIG. 3.6 In a chemical reaction the bonds between atoms break and rearrange on a different way.

Reactants and Products in a Chemical Reaction

In a chemical reaction, we can perceive two different parts: the reactants, which are the initial substances that react and the products, which are the final substances that are formed during the chemical reaction. The reactants have completely different properties form the products, because, during the chemical reaction one or more substances are transformed into others very different, as well.. Which are the properties of the reactants? Which ones are those of the products? We will study the chemical reactions to identify the reactants, the products and their properties.

A chemical change happens when, for some reason, bonds between atoms are broken and new atoms are formed; this atomic rearrangement is the chemical reaction (Fig. 3.6).

Expected Learning

Identify the properties of the reactants and the products in a chemical reaction.

Glossary

Antacids. Substance that counteracts the secretion of acids in the stomach.

83

SESSION INFORMATION

Week: 18

Session: 107

Expected learning outcome: Describe some of the manifestations of simple chemical changes, such as effervescence, emission of light or heat, precipitation and color change.

CONTENT DELIVERY

Start: Show students pictures of a hot tea, lighting a fire, spraying perfume, starting a car and ask them in which of the activities there is a chemical reaction and elicit reasons they can give to explain if there's a chemical reaction.

Development: Students should do the analysis explained in the section *Reflect, Explain and Share.*

Closing: Elicit answers. Have students analyze other events like making coffee, a cell phone battery working, fruit spoiling.

SKILLS DEVELOPMENT

Logical/Mathematical skills: Finding relations.

Critical thinking skills: Predicting, analyzing.

EVALUATION OF CONTENT

Check students' answers to the section *Reflect, Explain and Share.*

SESSION INFORMATION

Week: 18

Session: 108

Expected learning outcome: Identify the properties of the reactants and the products in a chemical reaction.

CONTENT DELIVERY

Start: Burn a piece of paper in an open area. Ask students the following questions: What happened to the paper? Why? Do you get the same amount of ashes you had as a paper? Why? What happened to the rest? Where is it? All those questions can be answered with a chemical reaction.

Development: Students should find the definition of chemical reaction, reactant and product in the section *Reactants and Products in a Chemical Reaction* on page 83. (Atoms are broken and new ones are formed). Elicit answers.

Closing: Students should read the section *Acetic Acid*. Help them analyze the formula that explains what happened in the experiment. (Pay special attention to the formulas in the end of the page).

To represent the chemical reaction of vinegar and sodium bicarbonate, for example, it is necessary to distinguish the reactants and the products.

If we know these two substances are able to produce a change, we call them reactants. Gas and substances inside the dissolution are the products. Thus, we can state that in a chemical change, reactants transform into products:

Reactants	Transform	Into products
Vinegar + sodium bicarbonate	⟶	gas + Aqueous dissolution

The properties of a chemical substance rely basically on three aspects: the amount and type of atoms or the elements they are made of, the bonds that keep them together and the arrangement of atoms within space. To express the chemical reaction between vinegar and sodium bicarbonate, it is necessary to use its chemical name, instead of its common name. There are several ways to write the chemical formulas of substances; all of them are models that provide us with important information about the structure of the substances and the arrangement of their atoms.

Let's start with the reactants. Acetic acid is a **hygroscopic**, colorless liquid with a strong scent (vinegar) that is made from **ethyl alcohol**; it is soluble in substances like water, glycerin and acetone, among others. These three models represent the acetic acid molecule.

Glossary

Hygroscopic. Absorbs humidity from the air.

Ethyl alcohol. Liquid that is made from the distillation of wine and other fermented substances.

Acetic acid

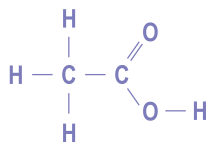
Molecular formula	Half-developed formula	Developed formula
$C_2H_4O_2$	CH_3COOH	

FIG. 3.7 The formula for sodium bicarbonate is $NaHCO_3$.

The representation of the acetic acid formula shows the minimal amounts of substance with its own characteristics, we can find carbon, hydrogen and oxygen.

Sodium bicarbonate is a white, crystalline solid that is highly soluble in water. In its formula, we can find sodium, hydrogen, carbon and oxygen (Fig. 3.7).

When sodium bicarbonate gets in touch with an acid, such as the acetic acid, the bonds between the atoms of the reactants break. Then, the atoms rearrange and form new bonds, resulting in new substances. There are three products of this reaction:

- Carbon dioxide (CO_2). It is the gas released in the reaction. It is colorless, has a softly spicy scent and is highly soluble; in its formula, we find carbon and oxygen.
- Water (H_2O). It is a transparent, odorless and tasteless liquid and a great dissolvent; in its formula, we find hydrogen and oxygen.
- Sodium acetate ($NaCH_3COO$). It is a white, odorless, crystalline solid, which has in its formula sodium, carbon, hydrogen and oxygen (Fig. 3.8).

FIG. 3.8 Sodium acetate is a very different substance from sodium bicarbonate.

The reaction between the acetic acid and the sodium bicarbonate is represented in the language of chemistry, using a chemical equation:

Reactants → Products

$$CH_3COOH_{(l)} + NaHCO_{3\,(s)} \rightarrow NaCH_3COO_{(s)} + H_2O_{(l)} + CO_{2\,(g)}$$

Acetic acid + sodium bicarbonate → sodium acetate + water + carbon dioxide

SKILLS DEVELOPMENT

Logical/Mathematical skills: Doing operations.

EVALUATION OF CONTENT

Students should actively participate in the experiment analysis.

Reactants and products in a chemical equation

Chemical reactions cannot be totally described, because they are complex processes and they are not easy to observe, as in the formation of water molecules from hydrogen and oxygen molecules. To symbolize the chemical reactions we use equations that have several components based on what is being described, explain or even predicted, with a series of symbols (Fig. 3.9).

A chemical equation represents equality; therefore, we will always find two parts called members. The left side in the equation represents the reactants, while the right side represents the products. In between these two members, we draw an arrow instead of writing the "equal" sign (=), to indicate the direction in which the equation is developed.

Reactants ⟶ Products

Look at the following example on how water is formed and analyze the equation:

Reactants ⟶ Products

$$2H_2 + O_2 \qquad 2H_2O$$

In this case, on the reactants' side we have hydrogen (H_2) and oxygen (O_2) molecules, in the middle, there is the arrow that means: "reacts and transforms to"; on the products' side we have the water molecules ($2H_2O$).

If you examine the equation, you will see that besides having symbols, it also has some numbers. The number that appears before a chemical compound is called coefficient, it indicates the amount of molecules involved and multiplies everything there is to its right side; when there is no number, it is equal to one (1). The tiny number that is placed under and after the chemical symbol is called a subscript; it indicates how many atoms of the element there are, and it only affects the symbol that has it. If a molecule changes this number, the compound it represents changes as well (Fig. 3.10).

Observe the equation one more time:

Reactants ⟶ Products

$$2H_2 + O_2 \qquad 2H_2O$$

In the reactants:

The numeric coefficient ($2H_2$) indicates that there are two molecules of hydrogen and the subscript indicates that each molecule has two atoms. To determine the number of atoms that are involved, we multiply the numeric coefficient by the subscript: $2 \times 2 = 4$ hydrogen atoms (Fig. 3.11). To know the number of atoms in the oxygen molecule (O_2), the same calculation has to be done. You may think this is impossible since this molecule does not have a numeric coefficient, but remember that when a molecule does not have a coefficient, its number will always be one (1); therefore, you multiply: $1 \times 2 = 2$ oxygen atoms.

If you are wondering why it is necessary to know the number of atoms involved in the reactants. The answer is that, there should always be the same number of atoms in the products. For example:

Reactants ⟶ Products

$$2H_2 + O_2 \qquad 2H_2O$$

In the products:

To know the number of atoms in two water molecules ($2H_2O$), it is important to follow the next steps:

- First, calculate the atoms of hydrogen: $2 \times 2 = 4$ atoms of hydrogen.
- Then, calculate the number of oxygen atoms: $2 \times 1 = 2$ atoms of oxygen (Fig. 3.12).

→ Expected Learning

- Represent the chemical changes through an equation and interpret the information in it.

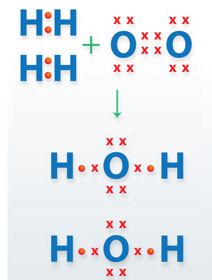


FIG. 3.9 The representation of a chemical reaction, using Lewis's model.

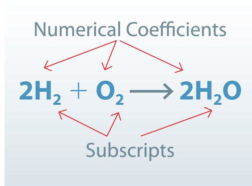


FIG. 3.10 All the numbers have different meanings in chemical equations.

Reactants

$$2H_2 + O_2$$
$$4H + 2O$$

FIG. 3.11 There are four hydrogen atoms and two oxygen atoms on the side of the reactants.

Products

$$2H_2O$$
$$4H + 2O$$

FIG. 3.12 There are four hydrogen atoms and two oxygen atoms on the side of the product.

Kells

SESSION INFORMATION

Week: 19

Session: 109

Expected learning outcome: Represent the chemical changes through an equation and interpret the information in it.

CONTENT DELIVERY

Start: Draw the following symbols and tell them the ones with the cross are Hydrogen atoms whereas the others are oxygen atoms and check how the molecules look when they bond: ⊗Θ⊗ and ⊗Θ⊗ become: 2H2 + O2 → 2 H2O That is read: Two molecules of hydrogen and 2 molecules of water turn into two molecules of water.

Development: Students should read the sections *Reactants and Products in a Chemical Equation.* Segment the information and little by little, go back to the introductory analysis to help students understand what happened.

Closing: Have students balance the formulas and part by part, explain how the reaction occurs.

CH4 + 2O2 →

Answer: $Co_2 + 2H_2O$

4H + 2O →

Answer: $4H_2O$

SKILLS DEVELOPMENT

Logical/Mathematical skills: Finding relations, doing operations.

EVALUATION OF CONTENT

Students should be able to balance the final formulas correctly.

Kells

SESSION INFORMATION

Week: 19

Session: 110

Expected learning outcome: Represent the chemical changes through an equation and interpret the information in it.

CONTENT DELIVERY

Start: Ask students to balance (again) the formulas they studied the previous session. Ask a volunteer to explain how the balance was done.

Development: Students should read the section *Explore*. Segment the information and write examples of each symbol so that students can see how they work.

Closing: Have students do the activity in the section *Reflect, Explain and Share*. Elicit answers.

Project preparation: Organize teams of four members. Each team should get the materials to do the lab practice, which is explained on page 87.

As you may see in the equation, the same number of atoms in the reactants is the same number of atoms in the products.

Reactants		Products
$2H_2 + O_2$	$\longrightarrow$	$2H_2O$
$4H + 2O$	$=$	$4H_2O$

Besides the numeric coefficient and subscripts, there are other important symbols in chemical equations that allow us to explain and to make predictions of the chemical reactions.

EXPLORE

The arrows

If in an equation, the arrow has only one direction between the reactants and the products, it means the reaction is irreversible. $\longrightarrow$

If it has two directions, it means the reaction is reversible; in other words, the reactants are transformed into products and vice versa. $\longleftrightarrow$

If a substance is a precipitated substance, an arrow pointing down is used. $\downarrow$

If the arrow is pointing up, it means that the substance is gasified. $\uparrow$

To indicate the state of matter of the reactants and the products, the first letter of the state of matter is written in parenthesis: (s) solid, (l) liquid, (g) gas, (ac) or (aq) means aqueous dissolution, to name a few.

To indicate that a reaction requires heat, the Greek delta letter (Δ) is added below or above the reaction arrow.

Reflect, Explain and Share

- Copy the following reactions in your notebook and write the name of what each symbol represents and its meaning.

$$2H_{2(g)} + O_{2\,(g)} \longrightarrow 2H_2O_{(l)}$$
$$H_{2(g)} + I_{(g)} \longrightarrow 2H_{(g)} \longrightarrow 2HI_{(g)}$$
$$CaCO_{3(g)} \xrightarrow{\Delta} CaO_{(s)} + CO_{2(g)}\downarrow$$

- Review your answers with another classmate and with your teacher, and once they are checked and corrected, keep them it in your portfolio of evidence.

Expected Learning

of simple chemical equations based on the law of the conservation of mass.

The the law of conservation of mass and its Expression in Chemical Equations

The principle of the law of conservation of mass points out that in every chemical reaction the number of atoms will be the same, even when the products have completely different properties form those of the reactants; therefore, there is no variation in the mass, it remains the same.

We are going to analyze a chemical equation where the mass of the reactants and the chemical reaction are shown. The reactants are sodium hydroxide (NaOH) and hydrochloric acid (HCl); the products are sodium chloride (NaCl) and water (H_2O).

SKILLS DEVELOPMENT

Logical/Mathematical skills: Doing operations.

EVALUATION OF CONTENT

Students should be able to read the formulas in the section *Reflect, Explain and Share* accurately. (See the answers on page 163).

You can find the atomic mass of chemical elements in the periodic table.

Periodic Table Information				
Element	Sodium	Oxygen	Hydrogen	Chlorine
Symbol	Na	O	H	Cl
Atomic mass	23g	16g	1g	35g

$$NaOH + HCl \rightarrow NaCl + H_2O$$

$$Na + O + H \quad H + Cl \qquad Na + Cl \quad 2H + O$$

$$\frac{23 + 16 + 1}{40} + \frac{1 + 35}{36} = \frac{23 + 35}{58} + \frac{2 + 16}{18}$$

$$76 = 76$$

Observe that the mass of the reactant is of 76 g and the mass of the products is of 76 g as well. This means that the principle of the conservation of mass is achieved.

Hands on Chemistry!

MATTER IS TRANSFORMED

Introduction

The law of conservation of mass is one of the bases of chemical equations; this time we will verify how it is fulfilled with a very simple experiment.

You will need:

- 2 effervescent tablets or packs of effervescent powder
- One scale
- Water
- A 300 ml plastic bottle
- A medium sized balloon

Preventive measures:

- Use a lab coat.
- This experiment requires adult supervision.

Procedure

Form teams of five and follow the instructions below. Remember to be careful when you handle the material.

1. Fill the balloon with the effervescent powder or tablets.
2. Pour 150 ml of water into the bottle.
3. Place the balloon and the bottle on the scale and write down the mass.
4. Place the balloon over the mouth of the bottle carefully, so gas cannot escape; drop the powder inside the bottle and observe.
5. Place the bottle on the scale one more time and write down the mass.

Explain

Work as a team to answer the questions and write a report. During the procedure, you may take pictures to illustrate your report. Keep your report in your Hands on Chemistry! portfolio of evidence.

1. Which gas is released inside of the balloon?
2. Which is the mass of the reactants and which is one of the products?
3. How could you explain the law of conservation of mass based on this experiment?

Include your sources in your report.

In a chemical reaction energy is absorbed or released in the form of heat

In chemical reactions, chemical bonds break and rearrange; this action requires energy that is both absorbed and released.

The bonds of the reactants break, thus they release energy, but when new substances are formed, energy is absorbed to create new bonds between the products.

Expected Learning

Identify that a chemical reaction, may absorb or release energy in the form of heat.

SESSION INFORMATION

Week: 19

Sessions: 111, 112

Expected learning outcome: Balance simple chemical equations based on the Law of Conservation of Mass.

CONTENT DELIVERY

Start: Students should do the experiment. Monitor their work.

Development: Once they finish the experiment, go to the book and read the information and example about the law of conservation of mass.

Closing: Ask students the questions that you can find the section *Explain* in the end of the experiment.

SKILLS DEVELOPMENT

Logical/Mathematical skills: Experimenting, finding relations.

EVALUATION OF CONTENT

Students should be able to find the relation between the experiment and the law of conservation of mass.

SESSION INFORMATION

Week: 19

Session: 113

Expected learning outcome: Identify that a chemical reaction may absorb or release energy as heat.

CONTENT DELIVERY

Start: Organize teams of five students. Ask them to make a human chain with their arms. Then, another student should try to "break" the chain. Can he easily break it? Why? Because energy is needed.

Development: Students should read the section *In chemical reaction energy is absorbed or released in the form of heat*, which starts at the bottom of page 87 and up to the section *To Integrate*. Segment the section and make comprehension-check questions.

Closing: Organize teams of four members. Students should work in the activities in the section *Closing Up!* Elicit answers. (Check the answers in the end of the Teacher's Guide).

Homework: Students should take to class a device with Internet access.

FIG. 3.13 Today drug stores sell plastic bags that are used as instant hot or cold pads.

When in a reaction the energy required to break the original bonds is less than the energy needed to form new ones, the energy is released. This type of reaction is known as exothermic reaction. On the contrary, if more energy is required to break the original bonds, the reaction is an endothermic reaction.

Both endothermic and exothermic reactions are applied in technological products; an example of this are the instant pads that the pharmaceutical industry produces, these pads are plastic bags that can be either hot or cold, and are really useful to help athletes that suffer an injury and need an immediate source of heat or cold (Fig. 3.13).

Curious Facts

The British physicist Joseph John Thomson identified the electron as an isolated particle with lower mass than the atom. His work and that of many other scientists has allowed the technological development of products, such as: TVs, computers, cellphones, and other devices.

To integrate

The chemical manifestations, such as effervescence, the emission of light or heat and precipitation, indicate that a chemical change or a chemical reaction has occurred. Due to their complexity, chemical reactions cannot be described; therefore, we use models such as chemical equations that indicate the initial state of the reactants and the final state of the products.

These equations also express the state of matter of both reactants and products. Chemical reactions need energy to break and form new bonds, but energy is always preserved. By using chemical equations, we can prove that mass is constant, as stated in the law of conservation of mass, because if we add the mass of the reactants the result will be the same as the mass of the products.

Closing up!

Copy the following chemical equations on a sheet of paper and follow the instructions below.

$$H_2 + Br_2 \longrightarrow 2HBr$$

$$Zn_{(s)} + CuSO_{4\,(aq)} \longrightarrow ZnSO_{4\,(aq)} + Cu_{(s)}$$

$$6CO_{2(g)} + 6H_2O_{\,(l)} \xrightarrow{\Delta} C_6H_{12}O_{6\,(s)} + 6O_{2(g)} \downarrow$$

1. Individually, write the name of the substance in each of the equations and point out the reactants and the products.
2. Find the number of molecules and atoms of the reactants and the products and check if they are a chemical equation.
3. Describe the equation using symbols.
4. Indicate which reaction they are representing and prove the theory of conservation of mass by pointing out the relationship between the reactants and the products.

Check your answers with a classmate and verify them with the rest of your class and your teacher and keep it in your Portfolio of Evidence.

ICT

To learn more about chemical reactions, visit the following websites: http://www.lamanzanadenewton.com/materiales/aplicaciones/lrq/lrq_index.html http://www.quimicaweb.net/grupo_trabajo_fyq3/tema6/index6.htm There you will find interesting information and fun activities.

Expected Learning

Identify how energy is measured and compare it with the caloric intake of the food you eat.

What Should I Eat?

The Calorie as a Unit for Measuring Energy

Think about all the activities you do every day: talking, walking, eating, reading, thinking, writing, sleeping, keeping the temperature of your body, as well as all vital functions. What makes it possible for you to perform all these activities is energy. The substances needed to obtain energy are contained in the food you eat, and are called nutrients.

SKILLS DEVELOPMENT

Logical/Mathematical skills: Finding relations.

EVALUATION OF CONTENT

Students should answer the final activities accurately. Check the answers in the end of the Teacher's Guide.

Get started!

Which are the nutrients that provide the energy organisms need?

Make a list of the foods you eat in a day.

- Order these foods according to the energy you think they provide. Review that information using your biology book or research on the Internet.

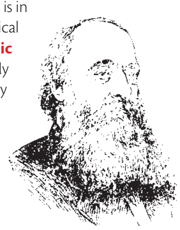
Once you have the information, copy these questions in your notebook and answer them.

- From the examples you wrote, which ones do you eat the most?
- Which of those foods do you eat in smaller amounts?
- What repercussions could this have on your health?
- Which foods do not provide energy but are necessary to consume? Why?

Draw a two-column table on a piece of paper and use one column to write the foods that provide you with energy and nutrients; and the other column to write the ones that do not provide you with any. Keep you work in your portfolio of evidence.

Going further

Energy can manifest in different ways. The energy contained in foods is in the chemical bonds of the substances that comprise them; this chemical energy is released, transformed and used during the **metabolic** processes of organisms to renew and form tissues, to keep the body temperature and to accomplish physical activities. How is the energy contained in food measured?



The unit we use to measure the energetic content of food is the calorie (cal). A calorie is a thermic energy unit that is equal to the amount of heat that must be supplied to raise the temperature of 1 gram of water, to 1 degree Celsius at normal pressure. This energy can also be measured in joules (J), the same unit that is used in physics to measure work or heat (Fig. 3.14).

To measure the energy contained in food, it is convenient to use both types of measuring units: calories and joules, because it is normal to find both units in different types of food. The equivalence between calorie and joules is:

1 calorie (cal) = 4.2 joules (J)
1 joule (J) = 0.23 calories (cal)

Because the amount of energy in both the calorie and the joule is so small, to determine the energetic content of food, larger units are used, such as the kilocalorie (kcal) and the kilojoule (kJ).

The equivalence between kilocalorie and kilojoules is:

1 kilocalorie (kcal) = 4.184 kilojoules (kJ)
1 kilojoule (kJ) = 0.239 kilocalories (kcal)

It is important to take into account that 4.184 kilojoules (kJ) is the international number to measure energy.

Carbohydrates, proteins and lipids are nutrients found in larger proportions in the food we eat and are also our main source of energy, though their caloric contribution is different.

Glossary

Metabolism. Physical and chemical processes that the organisms perform to transform or use energy.

FIG. 3.14 British physicist James Prescott Joule, 1818-1889. The unit of energy is called Joule in his honor.

SESSION INFORMATION

Week: 19

Session: 114

Expected learning outcome: Identify how energy is measured and compare it with the caloric intake from the food you eat.

CONTENT DELIVERY

Start: Ask students to do the first activity in the section *Get Started!* Individually. In pairs, they will answer the questions in the second part and will make the two-column table. Elicit answers.

Development: Have students read the rest of the page.

Closing: Make students convert kilocalories to kilojoules from three foods students listed in the first activity.

Following the formula stated in the book. For example:

150 kcal x 4.184 kj = 627 kj

7800 kj x 1 / 4.184 = 1864 kcal

262 kcal x 4.184 = 1096 kj

Homework: Students should get three labels with nutritional information from processed foods and a device with Internet access.

SKILLS DEVELOPMENT

Verbal/Linguistic skills: Listing.

Critical thinking skills: Analyzing.

Reading skills: Scanning, reading for detail.

Logical/Mathematical skills: Doing operations.

EVALUATION OF CONTENT

Check students' activities and mathematical operations.

SESSION INFORMATION

Week: 20

Session: 115

Expected learning outcome: Identify how energy is measured and compare it with the caloric intake from the food you eat.

This page and the following are developed together.

CONTENT DELIVERY

Start: Students should do the analysis described in the section *Reflect, Explain and Share.* Elicit three examples at least to check the information analysis students are able to do.

Development: Students should read the rest of the page. Ask comprehension-check questions.

Closing: Students should do the activities in the section *Reflect, Explain and Share* on page 92 in teams of five members. They will need the list they did in the first activity and a device with Internet access to complete their data analysis.

Reflect, Explain and Share

Analyzing nutritional information

- Look in your home kitchen for products with labels containing nutritional information and choose the one with the most information in it (Fig. 3.15).
- Analyze the way the information is presented on the label, and identify the nutrients it has.
- On a sheet of paper or in your notebook, write down the following information:
- Size of the portion, total number of portions, total amount of kcal (energy content), the total amount of fat kcal, proteins and carbohydrates (Fig. 3.16).
- Paste the label you got the information from on the sheet of paper or in your notebook, if you cannot do it, take a picture or make a copy of it.
- Answer the following questions: Is it important that processed foods contain this information? Why? What about non-processed foods? How could you calculate the amount of kcal it contains?
- Share your work with the class and keep it in your portfolio of evidence

Amount of calories according to the type of food

Nutrient	Calories in 1 g
Carbohydrates	4
Fats	4
Proteins	9

FIG. 3.15 Food is our source of energy.

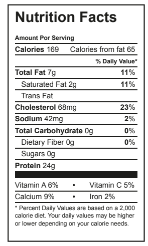

Nutrition Facts
Amount Por Serving
Calories 169 Calories from fat 65
% Daily Value*
Total Fat 7g 11%
Saturated Fat 2g 11%
Trans Fat
Cholesterol 68mg 23%
Sodium 42mg 2%
Total Carbohydrate 0g 0%
Dietary Fiber 0g 0%
Sugars 0g
Protein 24g
Vitamin A 6% • Vitamin C 5%
Calcium 9% • Iron 2%
* Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs.

FIG. 3.16 Packaged foods include information about the nutritious and energetic content

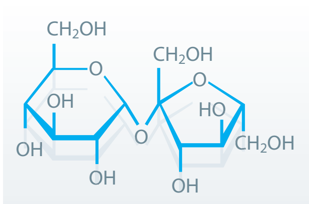


FIG. 3.17 Common sugar is made out of two molecules of sugar (disaccharide). Its molecular formula is: $C_{12}H_{22}O_{11}$

Carbon hydrates or carbohydrates provide immediate energy to the organism. They are present in the form of sugars, starch, and cellulose. We can find carbohydrates mainly in cereals, such as rice, wheat and corn; in tubers like potatoes and sweet potatoes, as well as in sugar. It is important to include them in our diet, but in excess, they are chemically transformed into fat molecules, that accumulate and cause health problems, such as obesity and arteriosclerosis (Fig. 3.17).

Lipids or fats are the most important energy reserve organisms have. We can find them, for example, in oils, some types of meat and meat products, such as bacon and pig lard; in milk and other dairy products, and in nuts, among others. In our body, fats are digested in the intestine; the lipase **enzyme** turns them into glycerol and fat acids, such as palmitic acid $CH_3(CH_2)_{14}COOH$. The chemical reactions of lipid oxidation release a lot of energy, because from each gram, we obtain 39 kilojoules (kJ) or around 9 kilocalories (kcal).

The body uses these proteins to build and repair cellular structures and tissue. We can find proteins in meats, milk, fish, egg and some vegetables such as beans and soy.

Proteins are polymers of other simpler substances called amino acids. There are 20 different types of amino acids, and from their combinations and quantities, thousands of different proteins in shape and function can be formed. Some amino acids can be synthetized or built in our cells such as alanine and glycine. There are others called essential amino acids, because they are vital for our body, such as methionine and tryptophan, and we obtain these from foods (Fig. 3.18).

GLOSSARY

Enzymes. Molecules of protein that regulate the speed and the sequence of chemical reactions.

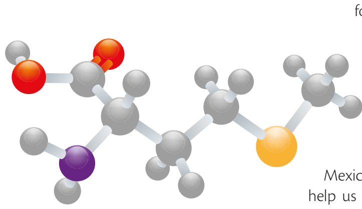


FIG. 3.18 Model of a methionine molecule, one of the essential amino acids found in food. Its molecular formula is: $C_5H_{11}NO_2S$.

To integrate

To know about the nutritious value and caloric contribution of foods there are tables, such as the ones the Mexican Nutritional System promotes that can help us chose the best foods and improve our diet. Look at the information presented in the page 91.

SKILLS DEVELOPMENT

Critical thinking skills: Applying, analyzing.

Reading skills: Scanning, reading for detail.

EVALUATION OF CONTENT

Check students' food analysis.

Average energy required by children and teenagers (10 to 18 years) of both sexes. In kcal per day			
Men		Women	
Age (years)	Kcal/day	Age (years)	Kcal/day
10-11	2.140	10-11	1.910
11-12	2.240	11-12	1.980
12-13	2.310	12-13	2.050
13-14	2.440	13-14	2.120
14-15	2.590	14-15	2.160
15-16	2.700	15-16	2.140
16-17	2.800	16-17	2.130
17-18	2.870	17-18	2.140

Table 1. Source: FAO/OMS/ONU, *Necesidades de Energía y de Proteínas*, Serie Informes Técnicos 724, Ginebra, OMS, 1985.

Nutritional value and caloric contribution of some foods							
Food	Unit	Weight (g)	Energy (Kcal)	Energy (KJ)	Proteins (g)	Lipids (g)	Hydrates of carbon (g)
Apple	Piece	106	55	231	0.3	0.2	14.7
Broccoli	Cup	92	26	108	2.7	2.4	4.6
Jalapeño pepper	Piece	78	23	98	1.1	0.5	4.6
Tomatoes	Piece	113	20	85	1	0.2	4.4
Boiled nopal	Cup	149	22	92	2	0.1	4.9
Natural orange juice	Cup	120	54	227	0.8	0.2	12.5
Boiled rice	Cup	47	60	252	1.1	0.1	13.2
Bolillo	Piece	20	61	254	1.9	0	12.8
Corn tortilla	Piece	30	64	268	1.4	0.5	13.6
Boiled beans	Cup	86	114	475	7.6	0.5	20.4
Steak	Grams	30	36	149	7.2	0.8	0
Fish fillet	Grams	40	36	152	7.5	0.5	0
Ham	Slice	42	44	183	6.8	1.5	0.8
Chicken breast	Grams	25	40	166	7.2	1	0
Fresh cheese	Grams	40	58	244	6.1	2.8	2
Fried egg	Piece	44	90	377	6.3	7	0.4
Pork meat	Grams	40	105	440	6.8	8.5	0
Milk	Cup	240	148	617	7.9	8	11.2

Table 2. Information taken from the Mexican Nutritional System. (May 30, 2013).

SESSION INFORMATION

Week: 20

Session: 115

Expected learning outcome: Identify how energy is measured and compare it with the caloric intake from the food you eat.

This page is complement from the previous.

CONTENT DELIVERY

Start: Students should do the analysis described in the section *Reflect, Explain and Share* on page 90. Elicit three examples at least to check the information analysis students are able to do.

Development: Students should read the rest of the page. Ask comprehension-check questions.

Closing: Students should do the activities in the section *Reflect, Explain and Share* on page 92 in teams of five members. They will need the list they did in the first activity and a device with Internet access to complete their data analysis. They will be presenting the analysis the following session.

SKILLS DEVELOPMENT

Critical thinking skills: Applying, analyzing.

Reading skills: Scanning, reading for detail.

EVALUATION OF CONTENT

Check students' food analysis.

SESSION INFORMATION

Week: 20

Session: 116

Expected learning outcome: Identify how energy is measured and compare it with the caloric intake from the food you eat.

➔ Reflect, Explain and Share

How much energy does the food you eat provide?

- Form teams of five to work on the following activity.
- Write a list of the average food and amounts you eat during one day (include beverages).
- Research in your school library, on the Internet or on food labels about the caloric contribution that the foods and beverages from your list have.
- Examine if the information is on kJ or kcal and if necessary make equivalences so all your data are on kcal.
- With the information you have, answer as a team the following questions: how many kcal does the food you eat in a day provide? Are there any differences in the amount of kcal consumed by the rest of the members on your team? Why is there a difference?
- Compare your information with the table on the previous page to know if it is healthy to consume that amount of energy. What are the consequences for your health if you consume less or more kcal?
- With your answers, ideas and research results write a paper individually, and share with the class. Keep your work in your portfolio of evidence.

FIG. 3.19 Learn how to choose your meals by considering the caloric contribution and nutrients that improve your health.

An inadecuate essential for everyone; but it is even more important for teenagers, since they are developing.

A poor diet results in a deficient nutrition and can cause diseases, such as anemia, obesity or diabetes. These may be prevented or cured if you pay attention to the amount of kilocalories you consume, as well as the food choices you make to obtain the energy your body requires. Having a balanced diet, drinking water and doing exercise are preventive measures you need to adopt in order to take care of your health (Fig. 3.19).

Decision Making Related to: Food and Caloric Intake

How much energy does a person need to consume?

The human body needs to keep a balance between the energy it gets from foods and the energy it spends, this is known as an energetic balance. When a person consumes less or more energy than needed, this balance is lost and it reflects on health.

The energetic needs of each person depends on the energy they consume in a day. In general, the human body uses energy in several processes that are classified in three categories:

- Basal metabolism 60%
- Physical activities 30%
- Digestion and absorption of nutrients 10%

➔ Expected Learning

Relate the amount of energy a person requires according to its own characteristics regarding gender, physical activity, age, efficiency of its body, etc., to decide on a proper diet.

The basal metabolism is the set of processes that require an exchange of energy at rest, such as breathing or circulation. It is the minimum energy required that our bodies spend in order to keep the metabolic functions of cells in the organism.

Physical activities are the functions a person does voluntarily, like running, walking, studying or reading, amongst others; the energy spent in this category varies.

Food provides energy but also makes us spend it; this is called Thermic Food Effect, since we invest energy on eating, digesting and absorbing the nutrients.

It is almost impossible to make an exact estimate of the energy a person spends; however, there are institutes that calculate daily energy needs. An example would be the calculus of the daily energy requirements for a school age person, made by the World Health Organization (WHO), which is of 50 kcal per kg. Another example is the calculus made by the Recommendation of Food Intake for Mexican people (2008), which establishes that kindergarten kids require an average of 1300 kcal per day, while primary school kids require 1579 and teenagers between the ages of 12 and 14 need an average of 2183 kcal a day.

CONTENT DELIVERY

Start: Ask students to identify the caloric intake they need per day on page 91. Elicit answers.

Development: Students should present their data analysis about the activities they completed in the section *Reflect, Explain and Share* the previous lesson.

Closing: Have students plan how they can modify their eating habits to avoid obesity.

SKILLS DEVELOPMENT

Critical thinking skills: Remembering.

Reading skills: Scanning, reading for detail.

EVALUATION OF CONTENT

Students should actively participate in the presentations of data analysis.

Week: 20

Session: 117

Expected learning outcome: Relate the amount of energy a person requires according to its own characteristics regarding gender, physical activity, age, efficiency of his body, etc. to decide on a proper diet.

It is important to remember that not everyone needs the same amount of food intake, because the energy spent varies according to several characteristics, such as gender, age, physical activities, efficiency of our body and some environmental factors (Fig. 3.20).

Physical activity requires a different amount of energy depending on the intensity it requires: low, moderate or intense. The information in the following table includes all the activities we perform that require energy, including sleeping; if the physical activity is greater, then the intake of calories will increase too.

FIG. 3.20 The activities shown in these pictures consume different amounts of energy.

Calories consumed during physical activities

Activity	Calories consumed per hour
Riding a bicycle	174
Jogging	654
Playing basketball	450
Playing soccer	450
Playing volleyball	274
Swimming	300
Walking	198
Sleeping	60

GLOSSARY

Atherosclerosis. Hardening of blood vessels, especially arteries, due to the accumulation of fibers, lipids and mostly cholesterol.

Energetic balance. It refers to the balance between the calories eaten and the calories used for daily activities and vital functions.

Due to their reproductive condition, the energy requirements of women are very specific. During pregnancy, women need additional energy and nutrients that will help the growth and development of the fetus (Fig. 3.21). During the lactation period, more energy is required to produce milk and to feed the baby. Even environmental factors have a great influence in the energy requirements of a person. For example, in hot weather, like tropical and subtropical environments, the energy needed is less than that in cold weather to keep the normal body temperature.

FIG. 3.21 Women have different energetic needs during pregnancy.

Choosing the right diet using chemistry

The nutritional situation of the population in our country is complex, diverse and it faces many difficulties. The Health and Education Departments, as well as some research institutes and universities, have pointed out that being overweight and obesity in general. Other diseases, such as arterial hypertension, **atherosclerosis**, diabetes mellitus, have increased over the last few years as a result of an inadequate diet.

Children and teenagers are a very vulnerable group concerning eating habits, because they are constantly influenced by advertisings leading them to eat and drink food with saturated fats and excessive carbohydrates (Fig. 3.22). If their habits include minimum movement and almost no physical exercise, the consequences lead to health damage. In this context, science gives us the knowledge and ways to understand the world; but it also gives us powerful tools to recognize if what we eat satisfies or not our needs of both mass and energy.

Our knowledge in chemistry helps us take decisions with the right information on what and how much to eat, in order to achieve an **energetic balance** as well as a nutrients balance.

Living beings are made out of chemical substances. When we analyze the average chemical composition of a human body with a 65 kg mass, we will find that the proportions of some of its components are:

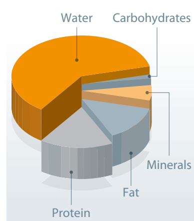


FIG. 3.22 Proportion of the main components of the human body related to the corporal mass in a 65 kg person.

CONTENT DELIVERY

Start: Ask students to find the foods with the most calories in the table on page 91. Elicit answers. Ask if students think everybody will get fat with that food. Elicit answers.

Development: Students should read the section *How much energy does a person need to consume?* which starts on page 92 in pairs, they should make 7 comprehension-check questions about the section. Elicit examples at random.

Closing: Students should exchange notebooks with other pairs in order to answer the questions they created. Elicit answers.

Homework: Organize teams. They should take the following class two pieces of cardboard, markers and a device with Internet access.

SKILLS DEVELOPMENT

Reading skills: Scanning, reading for detail.

Critical thinking skills: Predicting, formulating questions.

EVALUATION OF CONTENT

Students should get their fully answered questionnaires checked by the teacher.

SESSION INFORMATION

Week: 20

Session: 118

Expected learning outcome: Relate the amount of energy a person requires according to its own characteristics regarding gender, physical activity, age, efficiency of his body, etc. to decide on a proper diet.

CONTENT DELIVERY

Start: Organize teams of four people. Each team should make a graph with the food they took for breakfast. As further information, they should find the number of calories they take in average. Elicit information.

Development: Students should read the section *Choosing the right diet using chemistry*, which starts on page 93 and continues up to the section *To Integrate* on page 94.

Closing: Students should make the informative poster described in the section *Closing up!* On page 94.

ICT

To learn more about sugars, read the article found in the magazine *¿Cómo ves?* called "Sugar: Facts and Myths" (Azúcar: hechos y mitos), on the website: http://www.comoves.unam.mx/

Components	Corporal mass percentage (%)
Water	61.6
Proteins	17
Fat	13.8
Minerals	6.1
Carbohydrates	1.5

The performance of our bodies and the activities we do require us to gain mass and energy day after day. The calorie intake suggestion establishes that carbohydrates should provide between 55 and 60%, fat 25 or 30%, and proteins 10 or 15% of the daily needs. For children and teenagers, the energy intake suggested is: 25% for breakfast, 30% for lunch and 15% for dinner, the missing 30% should be distributed in two snacks throughout the day (Fig. 3.23).

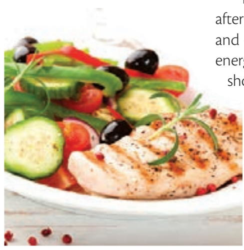


FIG. 3.23 A proper diet should always be complete, varied and balanced.

To integrate

So far, we have talked about the main nutrients our bodies need, such as carbohydrates, lipids and proteins, as well as some minerals like iron, water, and other substances from different groups, as vitamins. But what should we eat in order to get them? The research project you choose at the end of this unit will be a good opportunity to help you answer that question.

All the substances that take a part in nutrition are equally important, but the carbon hydrates or carbohydrates provide immediate energy.

Carbohydrates are molecules formed by carbon, hydrogen and oxygen and there are many types of them. The simplest ones are the monosaccharaides, such as glucose ($C_6H_{12}O_6$), and there are disaccharides, which are formed by two units of monosaccharaides, such as saccharose or common sugar ($C_{12}H_{22}O_{12}$) (Fig. 3.24). Another type of disaccharide is lactose or milk sugar.

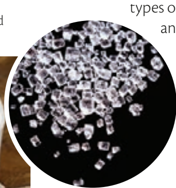


FIG. 3.24 Saccharose is commonly known as sugar, a disaccharide formed by glucose and fructose.

Polysaccharides are formed by many monosaccharaides bonded together, as in amylose, amylopectin, cellulose and glycogen. Polymers amylose and amylopectin form starch, a substance present in vegetables that helps to store carbohydrates. We digest starch due to the enzyme amylose that is found in our saliva. Glycogen or animal starch is a polymer that stores glucose inside the liver and the muscles. Cells make quick chemical reactions between glycogen and water to keep the levels of glucose in blood and provide the energy we need between meals.

Closing up!

Snacks at school

Form teams of three or four to work on the following activity.

- Once everyone in your classroom is on a team, answer the following questions together: Do the snacks you eat during recess match the criteria of a healthy diet? Why? Where could you find information that helps you improve your snacks?
- Visit the next website and read the document about the "Strategies against being overweight and obesity": http://www.sep.gob.mx/work/models/sep1/Resource/635/1/images/acuerdo_lin.pdf
- Explore the content of the document and read the annex, "Criterios Técnicos en el tema: bases científicas y técnicas para la elaboración de los criterios" in Spanish.
- Based on the suggestions in the previous document, each member of the team should recommend a school snack that includes the calories and nutrients needed, and that meets the five principles of a healthy meal: complete, balanced, varied, hygienic and adequate.
- Create a poster with your school snack suggestions and write a small paragraph to explain why they are part of a healthy diet. Keep your work in your portfolio of evidence (Fig. 3.25).

FIG. 3.25 A healthy snack includes fruits, vegetables, water and other prepared meals that contribute with the 15% of the nutriments needed.

SKILLS DEVELOPMENT

Reading skills: Scanning, reading for detail.

Critical thinking skills: Applying information.

EVALUATION OF CONTENT

Check students' posters.

The Third Chemical Revolution. Lewis's and Pauling's Contributions

Tracing the Structure of the Materials: Lewis's and Pauling's Contributions

Each compound has particular physical and chemical characteristics, because of the different elements that make them up. For example, the chemical bond between sodium, and chlorine will create a substance with unique properties: sodium chloride (NaCl) or common salt (Fig. 3.26). The way in which atoms are united, that is, the way they bond and interact with each other, is what determines most of its properties.

To explain the behavior of matter, scientist have built models that are based on the idea that matter is formed of tiny particles, which are called atoms; when a substance is made out of the same types of atoms, they are called elements. Up to this day, around 118 different elements have been identified, and when these elements combine, we can create an almost infinite number of compounds, which we can see all around us.

Why do atoms of different elements react? How are atoms and ions kept together in molecules and ionic compounds?

Going further

There are electric forces in nature that keep atoms together when they form compounds. When atoms interact with each other, the distribution of their electric charges causes attraction and repulsion of forces. If the forces of attraction are stronger; they allow the formation of chemical bonds (Fig. 3.27). Electrons on the external layer of the atom are the subatomic particles that are directly related to the way bonds are created. Try to understand why, when chemical bonds are studied, valence electrons are taken into account the most.

To form a bond between two atoms, it is essential that the external electrons are located in the middle of the nucleus of both atoms; this way the electrons are attracted by the atoms and will not repel each other's nucleus.

The way in which electrons are distributed within atoms shows that the external orbit can handle a maximum of eight electrons. The chemist, Gilbert N. Lewis, realized that when atoms combine they tend to have a more stable electronic configuration; this is achieved when one atom gives electrons and the other receives them or shares them, in order to equal the number of electrons noble gases have in their last orbit; that is, eight electrons. Lewis developed a graphic way to recognize the valence electrons and to make sure that the total number of electrons would not change during a chemical reaction. Lewis's representation uses the symbol of the chemical element and draws a dot around it for every valence electron that atom has (Fig. 3.28).

Reflect, Explain and Share

- Work in pairs. Draw the following elements using Lewis's dot structures: sodium, potassium, magnesium, calcium, aluminum, silicon, phosphorous, sulfur, chlorine, helium and neon. You can use your table of elements to identify the valence electrons of the different groups.
- Once you finish, review and verify your work as a group, by showing the representations you made on the board and with the help of your teacher make any correction if necessary. Once your work is checked, keep it in your portfolio of evidence.

Expected Learning

Explain the importance of Lewis's work referring to his proposal about the stability of atoms in a chemical bond.

FIG. 3.26 Sodium and chlorine are elements with different physical and chemical properties when separated, when combined, they form sodium chloride, commonly known as salt.

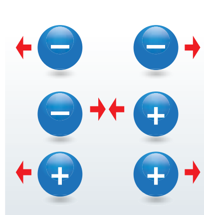


FIG. 3.27 Electric charge interactions. Equal charges repel while opposite charges attract.

FIG. 3.28 Lewis's dot structures representing valence electrons within atoms.

SESSION INFORMATION

Week: 20

Session: 119

Expected learning outcome: Explain the importance of Lewis' work referring to his proposal about the stability of atoms in a chemical bond.

CONTENT DELIVERY

Start: Organize pairs. Half of the pairs will to go back to pages 49 to 51 and should find how Lewis represents chemical bonds. The other pairs will go back to pages 69 and 70 to find what a covalent bond means and what a ionic bond means. Once they find the information, they should share it with the other pair. Elicit answers on the board.

Development: Students should read the introduction to the section *Tracing the Structure of the Materials: Lewis and Pauling's Contributions*. Ask students the following comprehension-check questions: What causes attraction and repulsion of forces? What is essential to form a bond? How many atoms can there be in the external orbit? Elicit answers.

Closing: Students should make the diagrams described in the section *Reflect, Explain and Share*. Elicit answers and have students make the diagrams on the board.

SKILLS DEVELOPMENT

Critical thinking skills: Remembering, applying information.

Reading skills: Scanning, reading for detail.

EVALUATION OF CONTENT

Students should get their diagrams checked by the teacher.

SESSION INFORMATION

Week: 20

Session: 120

Expected learning outcome: Explain the importance of Lewis' work referring to his proposal about the stability of atoms in a chemical bond.

CONTENT DELIVERY

Start: Students should make the Lewis diagrams of the following elements: C, O, F, Li, H, and N. You might assign one element to pairs or small groups. Once they finish, have a student make the diagram on the board.

Development: Students should read the entire page and the top of page 97, check how electrically neutral bonds occur, how the electric charge in covalent bonds occur and how they are represented.

Closing: Ask students to represent some bonds like: CH4O, HF, HF3, H2O Elicit answers on the board, check them in whole class.

Glossary

Ionization energy: Minimum energy that is required to separate an electron from an isolated atom or an ion on basal state.

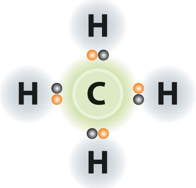


FIG. 3.29 To complete the octet, carbon shares four valence electrons and establishes four covalent bonds with hydrogen atoms.

In molecules with atoms of the same type, like in the case of H_2, electrons involved in the bond are also called bonding electrons. They are located between the nucleuses of the atoms and act as a "screen" that helps decrease the repulsion force between the positive charges of both nucleuses, helping the atoms stay together (Fig. 3.29).

The bonding electrons are located between two or more nucleuses or near a particular nucleus, depending on the force of attraction that the nucleus has on them.

As you may remember, there are different types of chemical bonds. The ionic bond is found between the transfers of one or more electrons from metallic atoms to nonmetallic atoms.

In general, the composition of most of the ionic compounds happens because of the combination of an alkaline metal from group 1A, or an alkaline earth metal from group 2A with a halogen from group 7A or oxygen (Fig. 3.30). Since metals have low **ionization energy**, they tend to form cations (ions with positive charge) and, on the contrary, halogens and oxygen tend to form anions (ions with negative charge).

In the case of the formation of the lithium fluoride molecule, the electrostatic attraction that forms the ionic bond appears between the ion lithium, with positive charge and the ion fluoride, with negative charge. The resulting compound is electrically neutral, as the Lewis's representation shows:

$$\cdot Li + :\ddot{F}\cdot \longrightarrow Li^{+}\,:\ddot{F}:^{-}$$

FIG. 3.30 Lithium is an alkali metal that is used in alloys that conduct heat in electric batteries. It is present on several minerals.

The covalent bond generally presents compounds formed by nonmetallic elements that have high-ionized energy and do not give electrons easily, which is why valence electrons do not get transferred from one atom to another, but they share in order to achieve a stable molecular structure. Covalent compounds are more abundant than ionic compounds; among them we have water molecules (H_2O), saccharose ($C_{12}H_{22}O_{11}$), alcohol (C_2H_6O) and the antibiotic amoxicillin ($C_{16}H_{19}N_3O_5S$). There are several elements that form diatomic molecules with covalent bonds in their atoms, such as hydrogen (H_2); nitrogen (N_2), oxygen (O_2), fluoride (F_2), chlorine (C_{12}), bromine (Br_2) and iodine (I_2).

To illustrate how bonds are formed, we will use hydrogen as an example. When two hydrogen atoms are close enough, the positive charge of each of the nuclei attracts their respective electrons; that attraction brings them closer until they share a valence electron and create a covalent bond. Thus, two atoms of hydrogen united within the molecule H_2 are more stable than an individual atom. The following diagram shows Lewis's representation of the formation of a molecule. In it, the line between the elements represents shared electrons (H — H):

$$\cdot H + \cdot H \rightarrow H:H \rightarrow H-H \rightarrow H_2$$

valence electrons → shared pair → covalent bond → hydrogen molecule

In the case of the formation of a fluorine molecule (Fig. 3.31) its atoms have seven valence electrons and only share one to form a covalent bond, as shown in the following diagram:

$$:\ddot{F}\cdot + \cdot\ddot{F}: \rightarrow :\ddot{F}:\ddot{F}: \text{ or } :\ddot{F}-\ddot{F}:$$

FIG. 3.31 Fluorine is the most abundant halogen in Earth's crust. It is found in several minerals, such as fluorite (CaF_2).

In the formation of the F_2 molecule there are two bonding electrons. The other non-bonding electrons are called free pairs.

So far, we have examined molecules with simple covalent bonds, in which a pair of electrons is shared; however, there are other covalent compounds, which share two or three pairs of electrons to complete the octet.

Thus, between two atoms there are double bonds when two pairs of electrons are shared or triple bonds when three pairs of electrons are shared. Between the atoms that form multiple bonds, we have carbon, oxygen, nitrogen and sulfur.

SKILLS DEVELOPMENT

Logical/Mathematical skills: Finding relations.

Visual/Spatial skills: Making diagrams.

Critical thinking skills: Applying information.

EVALUATION OF CONTENT

Check students' diagrams.

A carbon dioxide molecule (CO_2) forms two double bonds because carbon and oxygen share two pairs of electrons to complete their octets, just as it is shown in the following Lewis's model:

In the case of the nitrogen molecule (N_2), each nitrogen atom shares three electrons to complete the octet, so it forms three covalent bonds or a triple bond. Lewis's model represents it as follows:

Glossary

Crystallography. Study of the growth, shape and geometry of the crystals. Most of the minerals are in crystal form.

Using the Electronegativity Table. Linus Pauling's Electronegativity Scale

At the same time Lewis was building his atomic model to explain chemical bonds, the American chemist, Linus Pauling, studied **crystallography**, math and quantum physics toexplain why two electrons with the same charge could be together without repelling each other during a bond. We have already studied that atoms form bonds by losing, gaining or sharing electrons.

When the bond is established between atoms of the same element, bonding electrons are shared equally, but most compound bonds are formed between different types of atoms, thus, electrons are more attracted by certain atoms. Pauling suggested the electronegativity concept to categorize atoms according to their forces of attraction between electrons; he also developed a method to calculate relative electronegativity in most elements.

Due to Pauling's work, we know than nonmetallic elements have more electronegativity, because they are more able to attract electrons than metallic elements. Fluorine is the element with the greatest electronegativity so it is given a value of 4.0; the next one is oxygen with 3.5. On the other hand, Cesium has the lowest electronegativity, with a value of 0.7, and is found at the end of group 1A in the periodic table.

The size of the atoms is also related to electronegativity, thus smaller atoms have more electronegativity, because their valence electrons are closer to the nucleus (Fig. 3.32).

In the periodic table, electronegativity increases from left to right in periods (rows) and from up to down in groups (columns), just as it is shown in the following table.

➔ Expected Learning

Explain Pauling's contributions to science regarding the analysis and systematization of the results using the electronegativity table.

Electronegativity of the elements

H 2.1																	He
Li 1.0	Be 1.6											B 2.0	C 2.5	N 3.0	O 3.5	F 4.0	Ne
Na 0.9	Mg 1.2											Al 1.5	Si 1.8	P 2.1	S 2.5	Cl 3.0	Ar
K 0.8	Ca 1.0	Sc 1.3	Ti 1.5	V 1.6	Cr 1.6	Mn 1.5	Fe 1.8	Co 1.9	Ni 1.9	Cu 1.9	Zn 1.6	Ga 1.6	Ge 1.8	As 2.0	Se 2.4	Br 2.8	Kr
Rb 0.8	Sr 1.0	Y 1.2	Zr 1.4	Nb 1.6	Mo 1.8	Tc 1.9	Ru 2.2	Rh 2.2	Pd 2.2	Ag 1.9	Cd 1.7	In 1.7	Sn 1.8	Sb 1.9	Te 2.1	I 2.5	Xe
Cs 0.7	Ba 0.9	La 1.0	Hf 1.3	Ta 1.5	W 1.7	Re 1.9	Os 2.2	Ir 2.2	Pt 2.2	Au 2.4	Hg 1.9	Tl 1.8	Pb 1.9	Bi 1.9	Po 2.0	At 2.1	Rn

Low Medium High

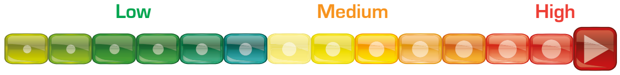


FIG. 3.32 The position of an element in an electronegativity chart is determined by the affinity of the atoms in an element to attract electrons.

SESSION INFORMATION

Week: 21

Session: 121

Expected learning outcome: Explain Pauling's contributions to science regarding the systematized analysis results using the electronegativity table.

CONTENT DELIVERY

Start: Elicit the definition of electronegativity: (It is the force of attraction of an element nucleus towards pairs of electrons).

Development: Ask students to look at the periodic table at the bottom of the page and tell what the table shows; which elements have the highest and the lowest electronegativity. Elicit answers. Have students read the page as well as the top of page 98 and ask them to analyze the table again through comprehension-check questions like: Which element has the highest electronegativity? Which element has the lowest one? Which is a nonpolar covalent bond? Which is a polar covalent bond? What is the electronegativity in an ionic bond?

Closing: Have students do the activity in the first section *Reflect, Explain and Share* on page 98. Elicit answers.

SKILLS DEVELOPMENT

Visual/Spatial skills: Locating information.

Reading skills: Scanning, reading for detail.

Critical thinking skills: Applying information.

EVALUATION OF CONTENT

Check students' tables.

SESSION INFORMATION

Week: 21

Session: 122

Expected learning outcome: Represent the formation of a compound in a simple chemical reaction using Lewis structure and identify the type of bond according to its electronegativity.

CONTENT DELIVERY

Start: Ask students to make a similar table to the table they already completed (on top of the page) but analyzing H – H, Cl – Na, and H – O. Elicit answers.

Development: Students should read the rest of the page. Help them analyze how Lewis and Pauling models work.

Closing: Students should complete the table in the second section *Reflect, Explain and Share*, which starts on page 98 and ends on top of page 99. Elicit answers.

In case students cannot finish, they might finish the following class.

Based on electronegativity values, certain ranges have been established to predict the types of bonds; for example, if the difference of electronegativity between atoms is between 0.0 and 0.4, shared electrons bond almost symmetrically, forming a nonpolar covalent bond. When the difference is greater than 0.4, but less than 1.8 a polar covalent bond is formed. However, if the electronegativity difference is 1.8 and higher the result will be an ionic bond.

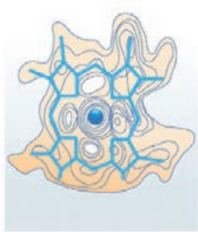


FIG. 3.33 Location of atoms in a molecule obtained by crystallography techniques using x-rays.

Reflect, Explain and Share

About electronegativity

- Work individually and classify the bonds of the following atoms in ionic, nonpolar covalent or polar covalent bonds. Take into account their electronegativity values.

Molecules	Electronegativity difference	Type of bond
O - H		
Cl - As		
O - K		
Cl - Cl		
Mg - O		

Expected Learning

Represent the formation of a compound in a simple chemical reaction using Lewis's structure and identify the type of bond according to its electronegativity.

Lewis and Pauling suggested models based on the incorporation of an electron and on the arguments of how molecules are formed and with this they started what it is known as The Third Chemical Revolution. Lewis took into account Rutherford's works and suggested an anatomic model that explained how the external electrons of an atom bond to form molecules. In his model, he considered that within a chemical change the nucleus and inner electrons of an atom stayed intact.

He also stated that in a chemical reaction, electrons located in the external layer or valence layer electrons of an atom are given, gained or shared. Lewis stated that the atom tends to have a pair number of valence electrons to obtain a more stable configuration, with eight electrons in its last layer and two electrons in helium's case, and that valence electrons are arranged in the space in a symmetrical way at the vertices of a cube. Pauling went further in the study of covalent bonds and developed the electronegativity concept to explain that the pair of electrons shared in a bond may get closer to one atom than to another, which results in a positive polarity and a negative polarity on each side of a molecule. The molecule acts as a dipole, and each of its extremes may attract the extremes with opposite charges of other molecules (Fig. 3.33).

Reflect, Explain and Share

- Work in pairs to complete the following table:

Atoms	Valence electrons	Lewis structure	Electrons that are given, shared or received when a bond is formed	Resulting element
Na				
Cl				
O				
Ca				

SKILLS DEVELOPMENT

Logical/Mathematical skills: Finding relations.

Critical thinking skills: Analyzing data, ordering.

EVALUATION OF CONTENT

Check students' tables.

- Write the chemical reaction between Na and Cl and draw Lewis's structure of this reaction. Identify the type of bond that is formed between its atoms.
- Which is the reaction of a compound formed by O and Ca? Draw Lewis's structure of this reaction. Identify the type of bond.

Create a Lewis's structure and determine the type of bonds of the following molecules:

CCl_4	Carbon tetrachloride	HCN	Hydrogen Cyanide
Cl_2	Chlorine	SO	Sulfur monoxide
NaBr	Bromide sulfur		

Get together with another pair to form groups of four to verify your answers. Keep your work in your portfolio of evidence.

Closing up!

In the creation of scientific knowledge, a lot of people dedicate their lives exploring, asking questions, creating hypotheses and experimenting. They do it repeatedly, sometimes they get answers and other times they learn from their mistakes until they get satisfactory results, which they publish and debate with other scientists to improve their arguments and then ask more questions.

Science is a young cultural product, if we start from the point where Galileo Galilei made his discovery 400 years ago. Under this social construction of knowledge, there are people who stand out because of their creativity, imagination and discoveries. Gilbert N., Lewis and Linus Pauling are the types of people that transcend because of their contribution to explain the laws of nature and how things work. Knowledge of nature through science and technological development is in constant change. What aspects of this knowledge do you think will be recognized as the fourth chemical revolution in a near future? Write the answer to this question in your notebook and share with the class.

Curious Facts

Scientists also have fun. On May, 2013, IBM scientists presented "the smallest movie in the world", in which they attempt to manipulate matter at the tiniest level possible to organize atoms and create a cartoon. To make the film, atoms were moved by a device that uses a very thin and slim needle over a copper surface that attracts or repels atoms and molecules in a specific location. This is achieved with the help of a scanning electronic microscope with a tunnel effect that expand atoms by 100 million. The microscope weights two tons and works with a temperature of 268ºC, to reduce particle vibrations. The movie is called *A Boy and His Atom*, a minute and 35 seconds long, it tells the story of a boy named Atom who dances and plays with an atom. and follows its movements while hopping and dancing. Scientists developed it as a part of their studies to find new forms of storing information in smaller spaces.

To Read More

If you want to learn more about atoms and their relationship with mankind, read this interesting book *From Atom to Man* (Del átomo al hombre) by Horacio García, Santillana, Mexico, 2002

ICT

To learn more about how the movie we mentioned was filmed, visit the following websites: http://www.abc.es/ciencia/20130503/abci-pelicula-pequena-mundo-atomos-201305031129.html http://www.research.ibm.com/articles/madewithatoms.shtml

Comparison and Representation of Measurement Scales

Scales and Representation

In the everyday world, we are able to touch and see things in a conscious way. Everything that exists has a specific size that allows you to identify and differentiate almost all objects and technological products which are created this way so they can be manipulated. (Fig. 3.34).

FIG. 3.34 To brush your hair, you need a comb or a brush and a mirror, things that should have a proper size to help you.

→ Expected Learning

Compare astronomical and microscopic scales using the human scale as a reference.

SESSION INFORMATION

Week: 21

Session: 123

Expected learning outcome: Represent the formation of a compound in a simple chemical reaction using Lewis structure and identify the type of bond according to its electronegativity.

CONTENT DELIVERY

Start: Go through or finish checking students' tables and analysis, described on pages 98 and 99 in the section *Reflect, Explain and Share.*

Development: Ask students to summarize in a mind map or synoptic table nonpolar covalent bond, polar covalent bond, electronegativity.

Closing: Check students' summaries. If there is time, you might want to use the video that is mentioned in the ICT note.

Homework: Students should take to class a device with Internet access.

SKILLS DEVELOPMENT

Critical thinking skills: Summarizing.

EVALUATION OF CONTENT

Check students' summaries.

SESSION INFORMATION

Week: 21

Session: 124

Expected learning outcome: Compare astronomical and microscopic scales using the human scale as a reference.

CONTENT DELIVERY

Start: Organize teams of four people. Have teams do the activities in the section *Get Started!* Elicit answers. Tell students that you will study how scales help count things we cannot directly perceive with our senses.

Development: Using the same teams, one of the students in each team should read the section *Going Further* aloud while the rest listens. Once they finish, they should retell what their partner said. Elicit answers.

Closing: Students should do the activities in the section *Reflect, Explain and Share*; they will need the device with Internet access that they were told to take to class in order to watch the video that is mentioned in the activity.

Get started!

Big things and small things

Read the following statements individually:

- "There are around 32 million bacteria on one square centimeter of your skin"
- "In our galaxy, the Milky Way, there are between 200 thousand and 400 thousand million stars, and our sun is just one of them"

Form groups of four and answer the following questions. Discuss your answers with the members of your team and write your conclusions in your notebook:

- How are stars and bacteria counted?
- Which instruments are used to see bacteria and the stars?
- If you could count 10 bacteria per second, how much time will it take you to count the 32 million on your skin?
- If it takes you a second to count 10 stars, how much time will it take you to count all the stars in our galaxy?

GLOSSARY

Firmament. Celestial vault that contains the stars.

Going further

The perception of the world of ancient times was limited to what the senses could perceive. However, it is obvious that some things were a lot more they could sense, for example, the immensity of the **firmament** or the presence of worms in rotten meat.

The best explanation some cultures could think of was that these events happened because different gods controlled the world by divine powers.

Human capacity to reason about what happens around us caused the generation of different ideas about divine explanations. The Greek philosopher, Democritus of Abdera (Fig. 3.35), suggested 24 centuries ago that things were made out of tiny particles that could not be divided, which established the idea of the possible existence of such small things that could not be seen at a glance. Another example is Eratosthenes of Cyrene, another Greek who 22 centuries ago calculated the Earth's circumference using a creative method and establishing the basis that the world was larger than what was thought.

FIG. 3.35 Democritus established the bases to think about a smaller world that the one we know.

Reflect, Explain and Share

Visit the following website to read more about Eratosthenes's method to measure the Earth's circumference, and then watch the video at the bottom of the page: http://goo.gl/OwRjS

After watching the video, answer the following questions in your notebook:

- What observations did Erastosthenes make to convince himself that the Earth was round?
- What method did he use to calculate the Earth's circumference?
- Which were his conclusions?
- Why do you think this discovery extended the view of the size of the world?

Form teams to share and discuss your answers. With this information, create an illustrated poster to show your work to the rest of your group. Take pictures and keep them in your portfolio of evidence.

More recently, with the formal development of science in general and especially of chemistry, the world's perception changed radically, leaving divine explanations behind to focus on provable scientific arguments that came as results of experimentation.

SKILLS DEVELOPMENT

Interpersonal skills: Working as team members.

Listening skills: Understanding the message.

Critical thinking skills: Applying information.

EVALUATION OF CONTENT

Check students' activities are complete.

The perception of the world, according to our senses, is limited to what we call human **scale**, we already know about the existence of a smaller world, which is on a **microscopic scale**, also called microcosm, and about another world on a larger scale, an **astronomical** scale called cosmos.

To understand the dimension of astronomical and microscopic scales, we use as reference the human scale and The International Unit System (SI) that has standardized these measurements using the metric system and the English system (Fig. 3.36).

The universe is so big that most of theknown measures have been calculated by using different indirect methods mostly based on the speed of light, which is an enormous measure: 299.792.458 m/s on vacuum. Due to this, multiples of the SI units or special units called astronomical units were created to refer to the size of things, which are shown in the following table:

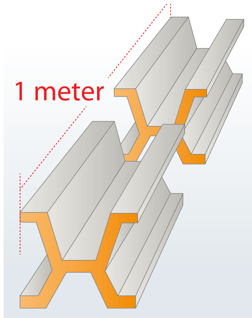


FIG. 3.36 Measurement patterns of one meter according to the SI.

Base unit	Astronomical unit	Equivalence with the meter
Meter (m)	Mega meter (Mm)	10^6 meters = 1,000,000 m
	Gigameter (Gm)	10^9 meters = 1,000,000,000 m
	Exa meter Em)	10^{18} meters = 1,000,000,000,000,000,000 m
Average distance between the Earth and the sun	Astronomical Units (UA)	1.49×10^{11} meters = 149,597,870,700 m
Speed of light	Light years (ly) (distance that light travels in a year)	9.46×10^{15} meters = 9,460,528,404,880,000 m

As shown in the chart above, astronomical units are enormous measurement units, impossible for humanity to go through with the technology we have, at least for now (Fig. 3.37). We know the astronomical scale characteristics due to the technological progress of different instruments, such as the telescope and the radio telescope. Chemistry has used these instruments to develop techniques that allow the analysis of the characteristics of light that comes from the stars, because of that we know about their basic composition. For example, we know stars are composed mainly of hydrogen and helium at high temperatures. 2% of young stars are made of other heavier elements, as the percentage increases, so does the age of the star.

We were able to learn the microscopic scale with the help of instruments that increase the image of tiny objects, from a simple **magnifying glass** to **optic microscopes** with a high capacity, with which we can watch cells, bacteria, and other microorganisms. Atoms and molecules have been photographed with the help of powerful **electronic microscopes** and the assistance of a computer that interprets that information (Fig. 3.38).

GLOSSARY

Scale. Size or proportion in which a plan or idea is developed.

Microscopic. Too small to be seen without the use of a microscope.

Astronomical. Of enormous magnitude.

Magnifying glass. Lens that enlarges an image.

Optic microscope. Device that combines a series of magnifying glasses that enlarge the image of tiny objects.

Electronic microscope: Device that uses a beam of electrons instead of light to create an image of tiny objects.

FIG. 3.37 The Pleiades are a group of young stars located 450 light years from Earth.

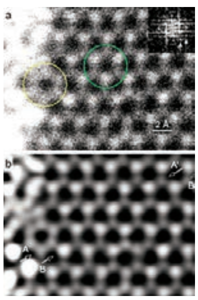


FIG. 3.38 Carbon atoms forming a molecule.

SESSION INFORMATION

Week: 21

Session: 125

Expected learning outcome: Compare astronomical and microscopic scales using the human scale as a reference.

CONTENT DELIVERY

Start: Show students some images of galaxies and images of blood under the microscope. Ask them if they identify what is shown. Elicit answers.

Development: Organize teams of three or four students. Each student will read a segment from the page and the top of page 102. With books closed, each team should make a cartoon depicting the information on how scales have helped humans analyze tiny or humongous objects.

Closing: Individually, students should make an album. The instructions can be found in the section *To Integrate* on page 102.

Homework: Students will need a calculator.

SKILLS DEVELOPMENT

Visual/Spatial skills: Identifying objects, making cartoons.

Critical thinking skills: Summarizing.

EVALUATION OF CONTENT

Check that students are able to identify why scales are useful.

SESSION INFORMATION

Week: 21

Session: 126

Expected learning outcome: Relate the mass of substances with the mole to determine the amount of substance.

CONTENT DELIVERY

Start: Ask students to find the atomic mass number of the following elements: H, O, Cl, Na, F. Have students copy the numbers on the board.

Development: Students should read on page 102, the section *Measuring Unit: Mole*. The core of the section is the last part, where students can see how to measure the atomic mass of different molecules. Study the example with your students. With the help of the information they first copied on the board, have them practice with different compounds.

Closing: If there is time, students should complete the table on page 103. If there were not enough time, they could complete it the following class.

Glossary

Conventionalism. Group of opinions or procedures based on false ideas that are followed by society.

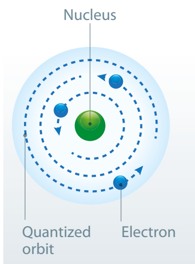


FIG. 3.39 Atomic model of oxygen according to Bohr. An atom like this one has an atomic radius of 60 pm.

Just as in the astronomical scale, special units have been created to express the dimensions of the microscopic scale, such as meter submultiples, which are shown on the table:

Microscopic unit	Meter equivalence
Micro meter	10^{-6} meters = 0,000 001 m
Nano meter	10^{-9} meters = 0,000 000 001 m
Angstrom	10^{-10} meters = 0,000 000 000 1 m
Pico meter	10^{-12} meters = 0,000 000 000 001 m

Chemistry has a special interest in microscopic scales, because even when we can observe and experiment with chemical changes on a human scale, it is important to explain these changes on a microscopic scale, which is where matter dynamics, the bond between atoms and molecules, electronic exchanges and bond formation is explained. We do not have the devices necessary to see these with clarity yet, but some models have been developed to get us closer to the answers of how matter behaves (Fig. 3.39).

To integrate

Make a photographic album in which you include objects at a human, astronomical and microscopic scale; write a caption under each picture that indicates its dimension with the right unit. Show your album to your group and organize a photographic exhibition at your school. Keep your album in your portfolio of evidence.

→ Expected Learning

Relate the mass of substances with the mole to determine the amount of substance.

Measuring Unit: Mole

One of the foundations of chemistry is the importance of using the right proportions on reactants and products of chemical reactions, as a way to sticking to the law of the conservation of mass.

It may seem like it is just following a **conventionalism** that creates difficulties in the dynamics of chemical reactions with all of the subscripts and coefficients, but actually the practices of saving and observing these proportions is really important.

Mostly in laboratories and industries, drastic mistakes and misuse of materials could occur if these regulations or laws are not followed and as a consequence, economical loss or even environmental damage could happen. To create a chemical reaction in a lab, it is necessary to combine the right amounts of each reactant; we will never use a "handful" or "a bit" and it is also important to know the exact amount of a product not just "some product"; thus, the way to program a chemical reaction will depend on its equation.

In chemical equations, the reactions and the amount of reactants and products are expressed in measuring units based on the atoms and the molecules involved. This means analyzing the microscopic world on a scale that is far beyond our senses, but that is necessary to take them to the practical world at the human scale, where molecules can be counted. Due to this,the mole concept was incorporated in chemistry. When substances in a chemical reaction are analyzed with an equation, atoms or molecules can be counted, as well as the atomic or molecular mass, whose units are called Atomic Mass Units (a.m.u.) (Fig. 3.40).

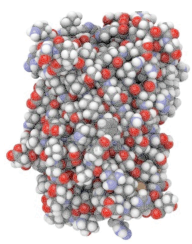


FIG. 3.40 Model of a protein molecule this is one of the largest compounds, with hundreds of thousands of atoms.

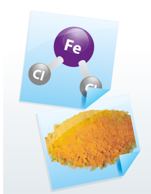


FIG. 3.41 Iron chloride is a salt formed by an atom of iron and two atoms of chlorine, as a reactant it is only a yellowish solid.

Atomic mass is taken from the periodic table, because it shows the mass that an atom has on each element on ideal conditions, that is, without combining or forming ions. The molecular mass is the addition of the atomic masses of the elements involved in a molecule; for example, the molecular mass of iron chloride II ($FeCl_2$) is 129.751 (a.m.u.)(Fig. 3.41) and it is obtained as follows:

Atomic mass of chlorine 35.453 × 2 atoms = 70.906 (a.m.u.)
Atomic mass of iron 55.845 × 1 atoms = 55.845 (a.m.u.)
Therefore: 70.906 + 55.845 = 129.751 (a.m.u.)

102

SKILLS DEVELOPMENT

Reading skills: Scanning, reading for detail.

Logical/Mathematical skills: Doing operations.

EVALUATION OF CONTENT

Check students' practices.

Reflect, Explain and Share

Work in pairs. Copy the following table on a white sheet of paper.
Based on the previous example, calculate the atomic mass of the compounds that appear on the table, fill in the spaces as shown.

Compound name	Formula	Amount of atoms per element	Operations	Molecular mass of the compound
Sulfuric Acid	H_2SO_4	H = 2 S = 1 O = 4	(1.007 × 2) + (32.065 × 1) + (15.999 × 4) =	98.075 (a.m.u.)
Sodium Chloride	NaCl			
Ammonia	NH_3			
Acetic acid	$C_2H_4O_2$			
Aluminum oxide	Al_2O_3			
Silver nitrate	$AgNO_3$			
Glucose	$C_6H_{12}O_6$			

Work in pairs of students to form teams of four and compare your results. Ask for your teacher's help if necessary. Save your work in your portfolio of evidence.

The study of aspects related to the Law of conservation of mass has its own field in chemistry called stoichiometry, which is the science that studies the quantity proportions and the relationship of mass with the participants of the chemical reactions. It is based on three principles:

- The total number of atoms before and after the reaction does not change. For example, in the reaction:

$$C + O_2 \longrightarrow CO_2$$

Carbon + oxygen → carbon dioxide

There are three atoms before the reaction and three after it, regardless the types of reactants and products involved. (Fig. 3.42).

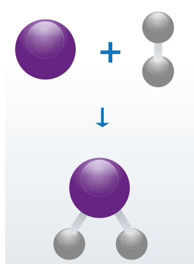


FIG. 3.42 When a carbon atom reacts with an oxygen molecule, a carbon dioxide molecule is formed.

- The number of atoms of each element is the same before and after the reaction. For example, in the reaction:

$$Mg + CuSO_4 \longrightarrow MgSO_4 + Cu$$

Magnesium + cupric sulfate ⟶ magnesium sulfate + copper

In this case, there is an atom of manganese, one of copper, one of sulfur and four of oxygen, before and after the reaction.

- The total addition of the charges, before and after, the chemical reaction remains the same. This means that regardless the exchange of electrons between the atoms in a reaction; the total addition of electrons atoms of each type is still the same (Fig. 3.43).

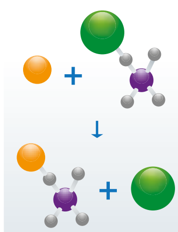


FIG. 3.43 In this reaction copper is substituted by manganese and the proportions remain the same.

Stoichiometry has as a foundation in the law of conservation of mass, and when modifications in reactants or products are needed, we use an equation balance.

SESSION INFORMATION

Week: 22

Session: 127

Expected learning outcome: Relate the mass of substances with the mole to determine the amount of substance.

CONTENT DELIVERY

Start: Students might need to finish with the table on top of the page. Otherwise, check the results they got in whole class.

Development: Students should read the rest of the page 103. Ask them the following comprehension-check questions: What's the name of the chemistry field that studies aspects related to the Law of Conservation of Mass? Which are the principles of the Law of Conservation of Mass? Elicit answers. Help students with visual examples to understand each principle.

Closing: Help students get the atomic mass of different compounds: NaCl, H2O, CO2.

Homework: Organize teams of four or five students. Students should bring the materials listed on page 104, in the section *Hands on Chemistry!*

SKILLS DEVELOPMENT

Reading skills: Scanning, reading for detail.

Logical/Mathematical skills: Doing operations.

EVALUATION OF CONTENT

Check students' results to the last practice.

SESSION INFORMATION

Week: 22

Sessions: 128 - 130

Expected learning outcome: Relate the mass of substances with the mole to determine the amount of substance.

CONTENT DELIVERY

Start: Check that students have all the materials they need in order to do the experiment.

Development: Teams should do the experiment that is explained in the section *Hands on Chemistry!* Pages 104 and 105. Guide them little by little, monitor that everyone actively participates in the experiment.

Closing: Individually, students should write a report. The instructions about it are in the last section of the lab practice (page 104, in the section *Explain*).

Homework: Students should create a handbook in the form of a table. The instructions are in the section *To Integrate* on page 103. Ask them for a piece of cardboard or any other large piece of paper to build their table.

So far, we have worked with atoms and molecules that are impossible to directly count. The key to take these tiny quantities to the macroscopic and practical world is to substitute atomic mass units and assign the gram as a unit. With this, the mole concept is formed; the mole of an atom or molecule is the expression of the atomic or molecular mass in grams.

By using this resource, it is possible to design, program and measure with precision the amount of reactants needed in an experiment, from grams to kilograms, and from kilograms to tons. Observe the following table and use it as a reference.

Element	Atomic mass	Mass of a mole	Compound	Atomic mass	Mass of a mole
Cadmium	112.411 (a.m.u.)	112.411 g	Potassium iodide	166.002 (a.m.u.)	166.002 g
Mercury	200.59 (a.m.u.)	200.59 g	Vanadium oxide	181.879 (a.m.u.)	181.879 g
Strontium	87.62 (a.m.u.)	87.62 g	Copper sulfate	159.607 (a.m.u.)	159.607 g
Bromine	79.904 (a.m.u.)	79.904 g	Hydrochloric acid	36.46 (a.m.u.)	36.46 g

FIG. 3.44 Measuring mass is an important process at chemical laboratories.

Moles have a tight relationship with subscripts and coefficients of chemical equations.

In the case of subscripts, they are part of the process of calculating the molecular mass, and consequently, that of the mole.

Regarding the coefficients it indicates the amount of moles in the reaction (Fig. 3.44).

For example:

$$2NaCl + H_2SO_4 \longrightarrow Na_2SO_4 + 2HCl$$

Sodium chloride + sulfuric acid ⟶ Sodium sulfate + hydrochloric acid

Two sodium chloride moles are combined with a sulfuric acid mole and produce a sodium sulfate mole and two hydrochloric acid moles, that is:

(58.442 g × 2 = 74 g de Na Cl) + (97.075 × 1 = 97.075 g de H_2SO_4) ⟶ (119.05 g × 1 = 119.05 g de $NaSO_4$) + (36.46 g × 2 = 72.92 g de HCl).

Hands on Chemistry!

HOW MUCH SPACE DO MOLES TAKE?

Introduction

There is the wrong idea that liquids do not have any mass, while, in fact, any substance that takes up space has mass. Even though we are used to measuring liquids in liters, they can also be measured in grams.

You will need:

- The following reactants:
- Sodium chloride.
- Iron oxide II.
- Aluminum hydroxide.
- Calcium carbonate.
- Sodium bicarbonate.
- Potassium nitrate.
- Periodic table and calculator.
- Grain scale.
- Six pieces of aluminum foil to measure on the balance.
- A spatula.
- Mortar and pestle.
- Six 25 cm test tubes with lids, for storing.
- A rack.
- A black marker
- Tags

SKILLS DEVELOPMENT

Logical/Mathematical skills: Experimenting.

Writing skills: Writing process.

EVALUATION OF CONTENT

Check students' experiment and report.

Preventive measures:
Always work with clean materials to avoid contamination of the reactants.
Never combine reactants for fun since they can cause great damage.

Procedure
Work in teams of five and follow instructions carefully.

1. Research the reactants formulas.
2. Calculate the mass of a mole of sodium chloride.
3. Calculate the mass of 0.1 mole of the reactant.
4. Measure the resultant amount on the scale and place it in the mortar.
5. Grind all crystals perfectly in the mortar; place the powder in a test tube with a lid and cover it.
6. Use the black marker and a tag to label the tube with the name of the reactant.
7. Draw a line on the test tube that shows at the height reached by the reactant.
8. Place the tube on the rack.
9. Wash and dry the mortar, the pestle and the spatula. Repeat steps 2 to 8 with each of the other reactants.
10. Compare the quantities in each test tube.
11. Once you finish your observations, do not return the reactant to its original package because it can be contaminated, keep it in the tube for future experimentation.

Explain
Answer the following questions individually and write a report. Keep the report for your *Hands on Chemistry!* portfolio of evidence.

1. Did all test tubes reach the same line?
2. If all test tubes had the same amount of the reactants in moles, why didn't they reach the same line?
3. Is there any connection between the molecular mass and the amount of space the reactant took? Which is it?

Based on the mole measuring procedures of the reactants it is possible to predict the amount of products that will result in a chemical reaction.

The mole concept has another important aspect discovered by the Italian scientist Amadeo Avogadro (Fig. 3.45) in the beginning of the 19th century. A mole of any substance has 6.022×10^{23} particles, atoms or molecules depending on the case; this number is known as the Avogadro's number (N). Therefore, the number of particles in a chemical reaction where the number of moles is known, can be calculated.

FIG. 3.45 Amadeo Avogadro calculated the amount of particles embedded in a gaseous mole.

To integrate

Create a handbook in the form of a table. Locate all the compounds that have been mentioned in this and the previous units. List them in your notebook in alphabetical order.

On a white sheet of paper, copy the table below with all its columns and add all the rows you need, depending on the number of compounds you find. Fill in the table as in the example.

Name of the compound	Formula	Elements that compose it	Mass of a mole
Silver chloride	AgCl	Silver and chlorine	143.321 g.

Discuss the use of this handbook with your classmates and save it in your portfolio of evidence.

Closing up!

The chemical language includes qualitative and quantitative descriptions of matter, as well as the changes it goesthrough and the use of the human, astronomical and microscopic scales to answer the questions humans have.

Biology classifies human beings in taxonomic categories while chemistry uses transformations expressed by chemical equations and special units, as the mole, to measure and write quantities of compounds and elements.

Curious Facts

Calcium carbonate is the main component of rocks as limestone or marble; it is part of the Earth's crust in a 4% abundance. It is widely used by organisms and is found in seashells, corals or eggshells.

SESSION INFORMATION

Week: 22

Sessions: 131, 132

Expected learning outcome: Relate the mass of substances with the mole to determine the amount of substance.

CONTENT DELIVERY

Start: Check students' reports in case they didn't finish it the previous session. Otherwise, have students get the moles of different simple compounds.

Development: Students should read the text and do the activity *To Integrate* using the large piece of paper and all compounds they can find in the book.

Closing: Check students' tables.

SKILLS DEVELOPMENT

Reading skills: Scanning, reading for detail.

Logical/Mathematical skills: Doing operations.

Critical thinking skills: Analyzing.

EVALUATION OF CONTENT

Students should get their tables checked by the teacher.

SESSION INFORMATION

Week: 23

Sessions: 133 - 138

Expected learning outcome: Apply unit content to develop a project.

CONTENT DELIVERY

Start: Briefly explain what you will evaluate in their projects: Relevant, clear information, visuals, comprehension-check questions and further information.

Development: Students should present their projects. Assign time according to your class length. Help as necessary.

Closing: Students should ask their comprehension-check questions to their partners. Then, ask them to self-evaluate their presentations using the same presentation parameters described in the projects rubrics.

Project: *Explore, Experiment and Experience. Integration and Application of Knowledge*

FIG. 3.46 We use chemical knowledge to make products that are essential to our hygiene.

Studying chemistry and science in general allows us to make informed and sustainable decisions in our daily life. One of the most important aspects of staying healthy is to watch our hygiene habits. To do it, we use chemical products that help us, not only to stay clean, but also to eliminate **pathogenic microorganisms** that may be around us (Fig. 3.46).

Not all cleaning products are the same, some are highly aggressive to the environment; in fact, some detergents include compounds whose molecules cannot be broken down by the environment and turn into pollutants that destroy entire ecosystems, including living beings. There are other products that are ecofriendly and that do the same job: cleaning. Using your knowledge of chemistry will help you to choose the right product to achieve **sustainable consumption**.

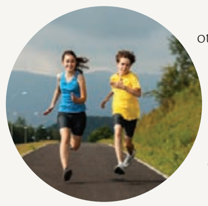


FIG. 3.47 Energy used in athletic activities comes from food and air.

Another important aspect in your daily life is your eating habits. Based on your chemical and biological knowledge you could choose the right type of food to eat to have a balanced diet and do your activities in places were the air quality is optimal (Fig. 3.47).

Glossary

Pathogenic microorganisms. Microscopic living being capable of producing a disease.

Sustainable consumption. Responsible consumption behavior that implies buying just what is needed and products that are ecofriendly.

Planning A project ➔ Introduction

Work in small groups and use the sources of information mentioned in previous units. Discuss and choose one of the following questions for your project:

- How is soap produced?
- Where does the human body obtain its energy?

As in the previous projects, the election of the question must be made to answer personal doubts and to allow you to create suggestions to solve one or many personal, familiar or community problems.

Use the following table, to state reflecting questions. Once you have created your questions, do some reliable research to answer them:

Question	Answer	Source
What uses does soap have at a personal level, at home, at your school, in the community and in industry?		
What types of soap or similar products damage the environment?		
How is soap produced?		
How much does soap cost and how much does it cost to produce it?		
What methods exist to economize on the use of soap?		
How could you produce home made soap and how much would it cost?		
How is the energy provided by food measured?		
How are food and oxygen combined to provide energy?		

SKILLS DEVELOPMENT

Reading skills: Scanning.

Interpersonal skills: Teaching others.

Critical thinking skills: Formulating questions.

Listening skills: Understanding the message.

Metacognitive skills: Delivering content, self-monitoring, self-evaluating their presentation.

EVALUATION OF CONTENT

Follow the projects rubrics, Teacher's Guide page 157.

How much food do we need to eat to have the right amount of energy for our activities?		
What are the health consequences of eating more than what we should?		
In case none of the topics suggested satisfy you and your team, and based on the content of this module, what other questions would you suggest to do your project?		
Explain your choice for any of the topics or questions and the situations it would help you solve.		

Now, consider the type of project you will work on. Remember that you can do a science, a technological or a civic project; but but your choice must be based on the topic and in agreement with your teammates. If you chose the first question, it may be a good choice to develop a science or a technological project, but if you chose to work on the second question, it may be convenient to develop a civic project.

FIG. 3.48 The purpose and hypothesis of your project must respond to your own concerns.

Next step, copy the table from Unit 1, page 38, assign responsibilities and work together to fill the chart.

Finally, establish the purposes and objectives in the medium and long-term of your project, as well as your reasons to do it. It is also the moment to suggest a hypothesis of your work. Do not forget to make suggestions according to the chosen topic (Fig. 3.48).

FIG. 3.49 The production of soap is based on a chemical process that can be done at home.

Planning A project **➔ Development**

To plan the activities it is essential to create a schedule. Use the table in in Unit 1, page 38 and create your timetable.

During the project's development, the activities that will be done depend on the type of work and topic you select.

If you decide to work on a technological project, besides doing all the bibliographical research, you must develop a manual to produce soap at home, prove it works and present it in an attractive way to the audience (Fig. 3.49).

In case you decide to use the second topic or central question to develop your project, your research would be different because it would be directed at creating proper diets considering personal needs such as age, height, corporal mass, basal metabolism and physical activities.

In a civic project, it would be suitable to write a document with the researched information including the advantages and disadvantages of having a proper diet and considering the cost difference of processed food or pre-cooked food and one you have cooked (Fig. 3.50 and 3.51).

FIG. 3.51 In every project it is important to foresee the cost it will have.

FIG. 3.50 The Good Plate is a valuable guide based on the best foods to create a menu; besides, it is important to include food from your region.

SESSION INFORMATION

Week: 23

Sessions: 133 - 138

Expected learning outcome: Apply unit content to develop a project.

CONTENT DELIVERY

Start: Briefly explain what you will evaluate in their projects: Relevant, clear information, visuals, comprehension-check questions and further information.

Development: Students should present their projects. Assign time according to your class length. Help as necessary.

Closing: Students should ask their comprehension-check questions to their partners. Then, ask them to self-evaluate their presentations using the same presentation parameters described in the projects rubrics.

SKILLS DEVELOPMENT

Reading skills: Scanning.

Interpersonal skills: Teaching others.

Critical thinking skills: Formulating questions.

Listening skills: Understanding the message.

Metacognitive skills: Delivering content, self-monitoring, self-evaluating their presentation.

EVALUATION OF CONTENT

Follow the projects rubrics, Teacher's Guide page 157.

SESSION INFORMATION

Week: 23

Sessions: 133 - 138

Expected learning outcome: Apply unit content to develop a project.

Project: *Explore, Experiment and Experience. Integration and Application of Knowledge*

Based on the information you have, you can now design the activities you need to fulfill your purposes. Take into account that every activity needs to resolve a problem or a specific question to resolve social problems, create awareness and change habits to create sustainable and economical practices.

The registration of the observation is a significant part to analyze the results in the best way possible. A good option is to create tables, to draw graphics and models for the analysis to be easier.

Planning A project ➔ Closing

FIG. 3.52 A fun way to know about scientific development is by reading scientific journals or science magazines.

Finishing your activities on time will help you analyze the results conclusions.

Communication is a key moment to finish your project, because it will be your opportunity to spread the word about your findings, suggestions and ideas.

Today, there are technological resources such as the Internet and social networks that allow us to promote information immediately and simultaneously to lot of people. Another alternative is to create a presentation or an interactive resource by using software, to elaborate and edit a video on your computer or use pamphlets, triptychs, and posters and image galleries create a newspaper, record live news or just some audio to make a radio transmission and include sound effects instead of images (Fig. 3.52 and 3.53).

In all the previous examples, communicating with the audience can be achieved in a direct or an indirect way. When direct communication is used, prepare a suitable presentation to present the information to an audience. Examples of these types of resources are: lectures, specialist's panels, a discussion table, a debate, or forums, organizing a congress, an exhibition or a convention.

A different option in which you can communicate your results is by preparing interactive presentations, but the most important thing in any case is to include a transformative and meaningful activity (Fig. 3.54).

FIG. 3.53 Pamphlets are resources to communicate and interest an audience about a specific topic.

FIG. 3.54 Using interactive presentations and games is a fun and practical way to present your results.

CONTENT DELIVERY

Start: Briefly explain what you will evaluate in their projects: Relevant, clear information, visuals, comprehension-check questions and further information.

Development: Students should present their projects. Assign time according to your class length. Help as necessary.

Closing: Students should ask their comprehension-check questions to their partners. Then, ask them to self-evaluate their presentations using the same presentation parameters described in the projects rubrics.

SKILLS DEVELOPMENT

Reading skills: Scanning.

Interpersonal skills: Teaching others.

Critical thinking skills: Formulating questions.

Listening skills: Understanding the message.

Metacognitive skills: Delivering content, self-monitoring, self-evaluating their presentation.

EVALUATION OF CONTENT

Follow the projects rubrics, Teacher's Guide page 157.

Kells

Evaluation

Read the following text carefully.

Energy and calories; the equivalence of daily intake

FIG. 3.55 Electric energy is carried through a conductor.

The concept of energy is applied to the consumption of nutrients and the amount of energy that people require to live, in other words, nutrition. This implies that the human being is an energy transformer that works permanently or constantly. From the physical point of view, energy is neither produced nor lost, it is just transformed from one form to another. For example, a car requires fuel that is transformed into movement. Movement requires effort, the same as traveling requires effort; an elevator uses electricity to lift a specific load (Fig. 3.55).

In the field of physics, there are several ways to measure energy; the most common one is the "Joule" that is represented by units of $kg.m^2/seg^2$.

The calorie came about as a unit of "heat" when it was thought it was a substance that had to be measured since it could be delivered in the form of "heat". So, a calorie was the amount of heat necessary to increase the temperature of a gram of water by one centigrade. Then, it was established that a calorie was 4,1868 joules. Thus, 2,000 Kcal were 8373600 joules.

Knowing that a person requires a daily average of 2,000 kcal, we deduce he or she consumes 8.369,8 kilojoules; in other words, 8,3 megajoules. The equivalent energy required to keep a 100 watt light bulb on for 23 hours and 15 minutes.

- One light bulb needs 100 watts.
- 1watt = 1 joule / second (energy over unit of time).

Thus, each second 100 joules of electric energy is transformed into light and heat by the light bulb.

In one day, 100 joules × 3,600 (seconds/hour) × 24 hours: 8.64.000 joules to keep the light bulb illuminated.

The average consumption of a person is 2,000 kcal per day.

- 1,000 calories: 1kcal: 4.184 kilojoules.

2,000 kilocalories are equal to 8.369.800 joules per day.

The electrical consumption of 8369800 joules required 83,698 seconds. Since each hour has 3,600 seconds, then it would be 23,249 hours (almost a day: 96, 8726%)

- 23,249 Hours is the same as 23 hours 14 minutes 57, 96 seconds.

Definitely, the human body, like all living organisms eats (ingests fuel) to work for a certain time (a day). Energy is transformed daily and measured in kilocalories (what people use to avoid the subscript kilo by calling it calorie).

109

SESSION INFORMATION

Week: 24

Sessions: 139 - 144

EVALUATION

CONTENT DELIVERY

Start: Students should answer page 109 and 110 prior to taking the unit assessment. Go through the answers; help them with techniques to study content they do not clearly remember; such as mind maps, questionnaires, partner discussion, drawings, etc.

Development: Students are to take the unit assessment. You can find it in the Teacher's Guide pages 149 to 151 along with the answer key.

Closing: Check their assessments, record the score and provide with feedback. You might want to use the Attendance and Evaluation formats that you can find the Teacher's Guide pages 158 to 160.

SKILLS DEVELOPMENT

Metacognitive skills: Identifying topics to go through.

EVALUATION OF CONTENT

Check the answer key to the unit assessment on page 152.

SESSION INFORMATION

Week: 24

Sessions: 139 - 144

EVALUATION

CONTENT DELIVERY

Start: Students should answer page 109 and 110 prior to taking the unit assessment. Go through the answers; help them with techniques to study content they do not clearly remember; such as mind maps, questionnaires, partner discussion, drawings, etc.

Development: Students are to take the unit assessment. You can find it in the Teacher's Guide pages 149 to 151 along with the answer key.

Closing: Check their assessments, record the score and provide with feedback. You might want to use the Attendance and Evaluation formats that you can find the Teacher's Guide pages 158 to 160.

Evaluation

Going back to nutrition, all of our activities (including energy reserves, also known as eating) imply that we transform some kind of energy into another.

The daily use of energy is divided into 3 main parts:

- The first one is the metabolic index of rest and the basic energy that the organism needs to perform elemental activities everyday: keeping our temperature, breathing, blood flow, digesting, feeding, thinking, speaking, etc.
- The second one is needed for physical activities we develop: sports, working, or being at home, are known as activity factors.
- The third factor is injury; it is applied in cases where there is a disease, surgery, or recovery of a surgery or a disease.

The efficiency with which a person transforms their body's energy reserves into another, will always vary according to the organism; it depends on body mass, age, gender, biological state (pregnancy), thermic effect of exercise, and the changes induced by the ingestion of food.

The body's energy reserves are mostly in the form of fats and, in less proportion, carbohydrates. In a person in optimal physical condition they represent 15% and 0.5% of the total weight of the person. That is why when someone is overweight, the energy reserves appear shown as an excess of fat in tissue.

Seen on: Martin Macek, of the section: nutrition, on:
http://www.zonadiet.com/nutricion/energia.htm#justificacion (seen on: July fifteen, 2013)

Based on what you read choose the correct answer:

1. Which is the most common way to measure energy?

a) Joules
b) Calorie
c) Kilocalorie
d) Watt

2. We know a person requires a daily average of 2,000 kilocalories, what is this amount of energy equal to?

a) A car traveling an hour distance.
b) The energy an elevator uses to lift a load
c) Enough energy to keep a 100 watt light bulb lit for almost a day
d) Raising the temperature of a gram of water one centigrade.

3. How do we use the energy we consume daily?

a) To keep the basic metabolism of the body, breathing, thinking, and speaking.
b) On physical activities only: walking, moving our arms and legs, running, etc.
c) Helping the body recover when it has been damaged or diseased.
d) In the metabolic index of rest, physical activity and the injury factor.

4. What determines the efficiency of a person to transform energy?

a) Corporal mass, height
b) Sex or gender and the age of the person
c) Of the biological state and ingestion of food
d) All of the above.

5. What happens when a person is overweight?

a) The excess energy is turned into waste without been used.
b) Most of the energy is accumulated in fat tissue.
c) Energy is transformed into proteins.
d) Most of the energy is stored as carbohydrates.

Underline in the text, the sections where you obtained your answers, share them with a partner and discuss them. In case you disagree in your answers, look for additional information that helps you to reach to an agreement.

Evaluate your performance throughout this unit; mark with a check (✓) the indicators you have achieved in the correct column.

SKILLS DEVELOPMENT

Metacognitive skills: Identifying topics to go through.

EVALUATION OF CONTENT

Check the answer key to the unit assessment on page 152.

	SELF-EVALUATION				
	Indicators	Always	Usually	Sometimes	Never
COMPREHENSION	I can ask questions that integrate the contents studied in the unit.				
	I can relate the topics I study to daily events and other familiar situations.				
	I can understand the content covered in class without problems.				
	I can identify my mistakes, difficulties and limitations, and propose actions to overcome them.				
	I can express my point of view and opinion as a contribution to the collective analysis.				
	I can solve problematic situations by applying what I learned.				
SCIENCE SKILLS	I brought to class, all the materials I needed.				
	I did all my work in a neat and clean way.				
	I can explain, share, communicate and contrast my ideas with others.				
	I can ask and answer questions that allow me to integrate the contents I studied in the unit.				
	My hypotheses are consistent and correspond to the activities and the topics in the unit.				
	I can analyze the information I get from various media, and select only the relevant one to reach the purposes I have.				
	I am able to choose the most convenient strategy to solve problems.				
	I can design instruments to register and order data obtained from the activities.				
	I can analyze results to draw conclusions.				
	I can draw conclusions based on the organization and order of the information I have available.				
ATTITUDES	I can successfully do and finish all my work.				
	When I need help, I ask my teacher or my classmates.				
	I'm capable of listening, value, and take into consideration the opinions of others even when they don't agree with mine.				
	I'm honest with the veracity of the information I handle.				
	I can actively participate in a team.				
	I can show solidarity to my classmates.				
	I am a responsible consumer.				
	I propose sustainable behaviors.				
	I show respect for biodiversity.				
	I can prevent diseases and accidents during my activities.				
	I show interest, curiosity, creativity and imagination in every activity I make.				

SESSION INFORMATION

Week: 24

Sessions: 139 - 144

SELF EVALUATION

CONTENT DELIVERY

Start: Explain to students why evaluation is important. It is the only way to improve the way of learning.

Development: Get students to answer the self-evaluation and help them reflect upon their learning process.

Closing: Provide with some feedback.

SKILLS DEVELOPMENT

Metacognitive skills: Self-monitoring, self-evaluating.

EVALUATION OF CONTENT

Students should get their self-evaluation instrument checked by the teacher.

SESSION INFORMATION

Week: 25

Session: 145

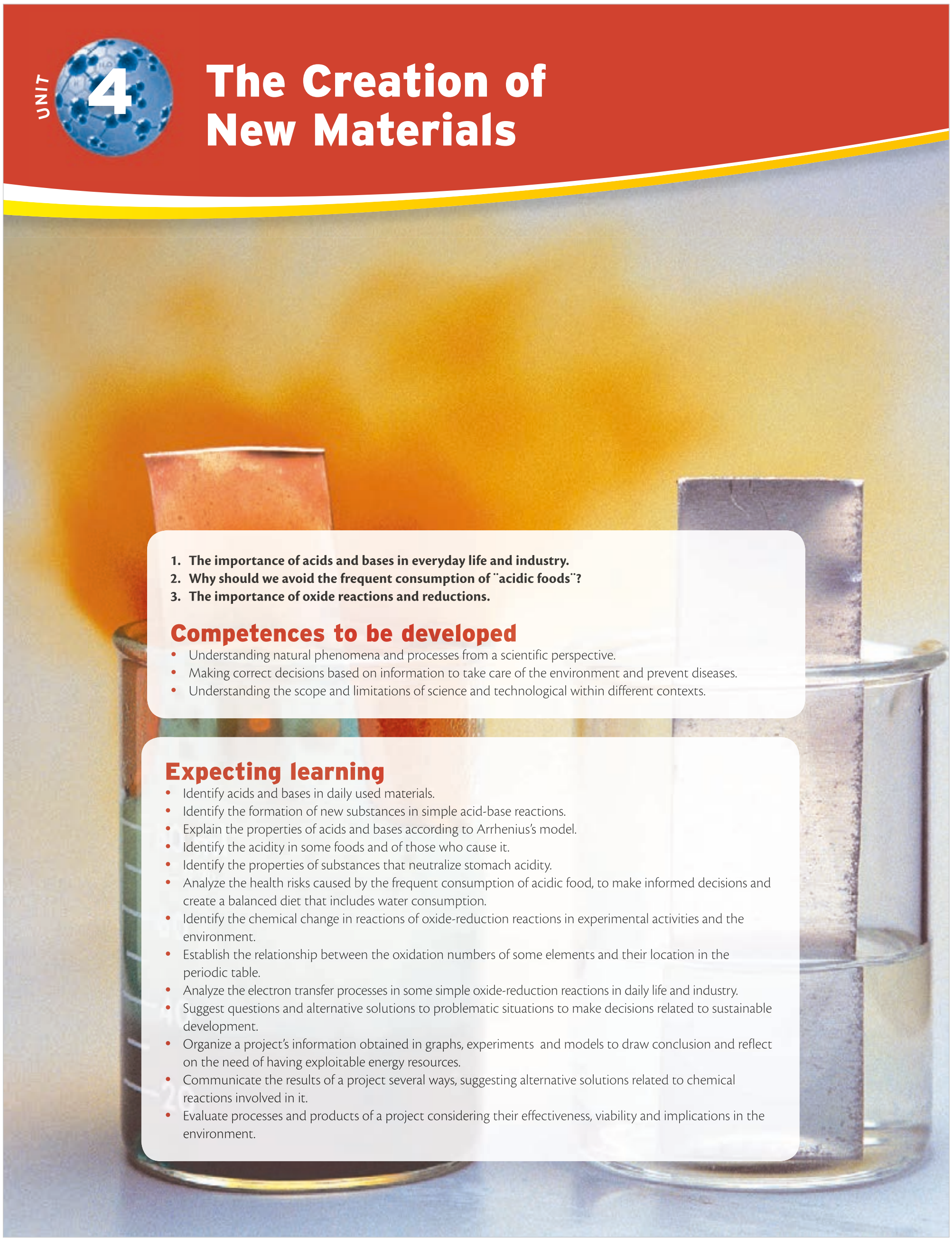
Expected learning outcome: Students will identify unfamiliar topics in order to create a study plan.

CONTENT DELIVERY

Start: Have students analyze and identify what they could do well in units 1 to 3; as well as what they should improve in unit 4. Ask them, for instance: What topics were easy? Did your previous study plan work? Didn't it work? Why? Did you really follow your study plan? Students should write down their reflections.

Development: Have students check the skills, learning outcomes and key concepts in unit 4. Ask them to identify the topics they consider the hardest ones. Then, they should plan how to study them and do better than the previous unit. If a strategy didn't work, then they should find another one. Help them with ideas. (Drawing mind maps, discussing with partners, making their own exams, making timelines, making associations, etc.)

Closing: Students should write down their study plan and have it checked.



UNIT 4

The Creation of New Materials

1. **The importance of acids and bases in everyday life and industry.**
2. **Why should we avoid the frequent consumption of ¨acidic foods¨?**
3. **The importance of oxide reactions and reductions.**

Competences to be developed

- Understanding natural phenomena and processes from a scientific perspective.
- Making correct decisions based on information to take care of the environment and prevent diseases.
- Understanding the scope and limitations of science and technological within different contexts.

Expecting learning

- Identify acids and bases in daily used materials.
- Identify the formation of new substances in simple acid-base reactions.
- Explain the properties of acids and bases according to Arrhenius's model.
- Identify the acidity in some foods and of those who cause it.
- Identify the properties of substances that neutralize stomach acidity.
- Analyze the health risks caused by the frequent consumption of acidic food, to make informed decisions and create a balanced diet that includes water consumption.
- Identify the chemical change in reactions of oxide-reduction reactions in experimental activities and the environment.
- Establish the relationship between the oxidation numbers of some elements and their location in the periodic table.
- Analyze the electron transfer processes in some simple oxide-reduction reactions in daily life and industry.
- Suggest questions and alternative solutions to problematic situations to make decisions related to sustainable development.
- Organize a project's information obtained in graphs, experiments and models to draw conclusion and reflect on the need of having exploitable energy resources.
- Communicate the results of a project several ways, suggesting alternative solutions related to chemical reactions involved in it.
- Evaluate processes and products of a project considering their effectiveness, viability and implications in the environment.

SKILLS DEVELOPMENT

Metacognitive skills: Planning, organizing studies content.

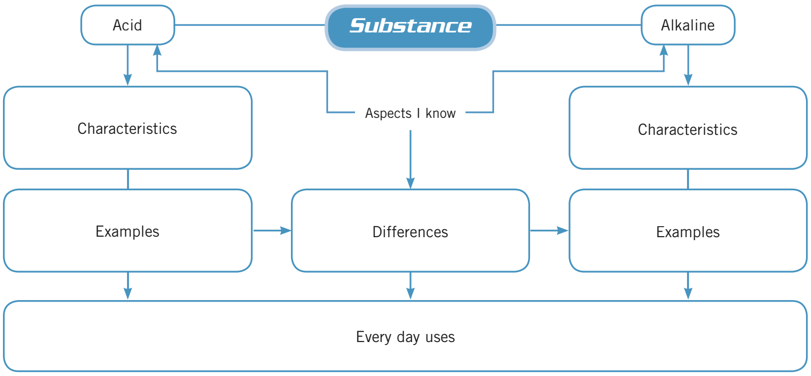
EVALUATION OF CONTENT

Students should get their study plan checked by the teacher.

Diagnostic Evaluation

Acids and bases are not just strange substances that chemists use in their laboratories. Every day, we use many useful substances that can be acids or bases.

1. The following diagram will help you to remember some characteristics you have studied in this science course. Copy it in your notebook and complete it with all the information you can remember.



2. Compare your diagram with your classmates, search for differences, write them in your notebook and keep in your portfolio of evidence to compare with what you will learn in this unit.

The Importance of Acids and Bases in Everyday Life and Industry

The Properties and Representation of Acids and Bases

It is likely that at some point in your life, you might have suffered from a stomachache or stomach discomfort and when you think about what caused it you might have concluded that it was because of something you ate. Your organism's answer to this type of problem or to a dangerous situation may be pain, **diarrhea** and sometimes **fever**.

Glossary

Diarrhea. Excessive and frequent evacuation of semi-liquid feces.

Fever. Increase of body temperature.

Expected Learning

Identify acids and bases in materials used on a daily basis.

Get started!

What kind of food can cause damage?

Write a list of foods that at some point have caused you any discomfort or disease. Then, using different colors underline the reactions the food provoked according to the following options:

- Choose one color to show the foods that caused an allergic reaction.
- Use another color for the ones that caused a burning sensation in your mouth or your stomach.
- With a different color, mark those that caused a stomachache.
- Finally, use another color for those that caused diarrhea.

SESSION INFORMATION

Week: 25

Sessions: 146, 147

Expected learning outcome: Identify acids and bases in materials used on a daily basis.

CONTENT DELIVERY

Start: Elicit the definition of acid and base. Have students write the definitions on the board.

Development: Explain that they will study acids and bases. Ask them to do the *Diagnostic Evaluation*. Elicit some answers.

Closing: Students should read the introduction. Then, they should answer the questions in the section *Get Started!* Elicit answers.

Homework: Students should get the labels of five different products they find at home.

SKILLS DEVELOPMENT

Critical thinking skills: Predicting, getting previous knowledge.

Humanistic skills: Personalizing.

EVALUATION OF CONTENT

Check students' diagrams and answers to the activities in the section *Get Started!*

SESSION INFORMATION

Week: 25

Sessions: 148, 149

Expected learning outcomes: Identify acids and bases in materials used on a daily basis.

Identify the formation of new substances in simple acid-base reactions.

CONTENT DELIVERY

Start: Elicit answers to the activities they completed in the end of the previous session regarding foods that they think caused them stomachache or an upset stomach. Ask students: Why do you think you got a stomachache? Elicit answers.

Development: Students should read the information in the section *Going further.* Have them write five questions on a separate piece of paper and leave the paper on your desk. Once everyone has finished, take papers at random and ask students the questions they wrote. Elicit answers. Then, students should do the activities explained in the section *Reflect, Explain and Share* using the products labels they got from home.

Closing: Students should read the section *Acids and bases can be transformed* (pages 114 and top of page 115) Students should mind map the information.

FIG. 4.1 The products we use every day are substances that have one or several acids or bases.

Going further

There are different types of chemical substances that differ in their properties and characteristics and with which we are constantly in close contact; these include acids and bases or alkalis.

Acids and bases make up an important part of products that we consume at home, in school and in our community on a daily basis.

There are a lot of products made with bases or acids as active agents; and in many cases, one of these substances is used as the main active agent to make the most of their chemical and physical characteristics. Colorants and **extracts** with a nice scent are added making the products commercially attractive.

The products we use that have acids and bases are: household cleaning products, **liquid clog removers**, beauty products, manicure and pedicure products, hair dye, batteries and electric batteries, disinfectants, jewelry cleaners. There are also food products, such as hot sauces, spices, carbonated beverages, vinegar, and pickled chili peppers. (Fig. 4.1).

Remember that in our organisms and in the organisms of other living things there are acids and bases as well. For example, in normal conditions, your blood is slightly basic or alkaline and generally urine can go from slightly acid to slightly alkaline; if you haven't eaten for a while, saliva can become slightly acid and several important substances in the process of digestion will be very acidic, such as the gastric juices in your stomach. When these conditions change, it could be a sign of a medical condition or a **disease**.

Glossary

Extract. A concentrated product obtained from plant or animal substances (scents, flavors, colors).

Liquid clog remover. Product used to remove organic substances that clog the drain.

Disease. an alteration in your health.

Corrosive. Chemical erosion of materials.

Reflect, Explain and Share

Searching for acids and bases

At home, look for at least 5 products with a label and follow the instructions:

- In your notebook, write down the components of each product and find their characteristics on the Internet.
- Identify the substances that are either acid or bases and, if possible, their characteristics as well as the function they have in the product.
- Write an information card for each acid or base you find, and include the chemical formula, properties and uses.
- Share and compare your findings with the class and keep your work in your portfolio of evidence.

FIG. 4.2 Lemon juice is an acid with the typical sour taste of these substances.

Expected Learning

Identify the formation of new substances in simple acid-base reactions.

Acids and bases can be transformed

Acids and bases have different properties that allow us to distinguish them with the help of our senses. They should be carefully handled and not touched, smelled, nor tasted, unless you are doing a controlled experiment. In that case, substances should be diluted in water to not harm the organism.

Acids have a sour taste and when they are touched, they cause a feeling of friction while bases taste bitter and are slippery to touch (Fig. 4.2).

The previous characteristics may help you know if a substance is an acid or a base, but there are other more reliable characteristics. Both acid substances as well as alkaline substances can be solid, liquid or gaseous, depending on the temperature. They are also found as pure substances or as solutions; they can burn your skin and be dissolved in water, they are **corrosive** and strong, and when they are dissolved in water, they conduct electricity.

The difference between them is that when using Litmus paper, acids change from blue to pink; they react with active metals creating salt and releasing hydrogen and with bases they form salt and water, as well as with metallic oxides. Bases, on the other hand, change litmus paper from red to blue; they dissolve fat and sulfur and do not react to metals, but react with acids by creating salts and water.

Due to their characteristics, acids and bases are very useful in the chemical industry. Their production, handling, transportation, and distribution must meet strict safety standards and regulations, because

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SKILLS DEVELOPMENT

Critical thinking skills: Formulating questions, analyzing, mind mapping.

Reading skills: Scanning, reading for detail.

EVALUATION OF CONTENT

Check students' questions, research and mind map.

they can cause great damage to people and property (Fig. 4.3). A very important characteristic of acids and bases is that they can react with each other, and by doing that, they create new substances with different properties like salts and water. This type of reaction is called neutralization. The changes that are produced with the reaction of an acid and a base are represented using chemical equations, as we saw in the previous unit. Let's examine some of the cases:

One of the strongest acids used in industry to clean oxide from metallic surfaces is hydrochloric acid (HCl). Sodium hydroxide (NaOH) is another base that has a lot of daily uses as well, this is commonly known as caustic soda and it is used to produce cleaning products or soap, among others (Fig. 4.4). When both substances combine, they create a type of salt called sodium chloride (NaCl) and water (H_2O).

$$HCl + NaOH \rightarrow NaCl + H_2O$$

FIG. 4.3 Some acids are highly dangerous substances that have to be handled carefully.

Reflect, Explain and Share

Combining acids and bases

Take the cards you wrote in the previous activity from your portfolio.

- Work in teams of four or five and do all the possible chemical combinations of the acids and bases formulas. Write them in your notebook and represent them with their chemical equations.
- Get together with another team to share and compare your work.
- Ask your teacher to check your work and do all the necessary corrections.
- Once you your work is correct go back to your original team and do some research to learn about the salts you obtained and their uses.
- Keep your cards in your portfolio of evidence.

FIG. 4.4 During the manufacturing process of soap, neutralizing reactions take place.

Another case in the use of these reactions is the one resulting from hydrofluoric acid (HF) and calcium hydroxide ($Ca(OH)_2$). Hydrofluoric acid is used to carve and engrave glass (Fig. 4.5) as it is a very strong acid, to stop its reaction, it has to be neutralized with calcium hydroxide, obtaining calcium fluoride (CaF_2) and water from this reaction, represented by the following chemical equation:

$$2HF + Ca(OH)_2 \rightarrow CaF_2 + 2H_2O$$

The following are examples of other neutralization reactions:

Nitric acid + aluminum hydroxide → aluminum nitrate + water

$$3HNO_3 + Al(OH)_3 \rightarrow Al(NO_3) + 3H_2O$$

Phosphorous acid + iron (II) hydroxide → iron (II) phosphite + water

$$2H_3PO_3 + 3Fe(OH)_2 \rightarrow Fe_3(PO_3)_2 + 6H_2O$$

Hydrobromic acid + Magnesium hydroxide → Magnesium bromide + water

$$2HBr + Mg(OH)_2 \rightarrow MgBr_2 + 2H_2O$$

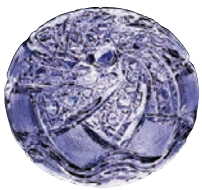

FIG. 4.5 The use of acids is present in art, as in carved and engraved glass.

As you may notice, from the reaction of an acid and a base, we obtain salt (all salts contain a metal, a nonmetal and sometimes oxygen) and water.

So far, we have seen some of the characteristics of acids and bases. To be able to explain them, it is necessary to use a model, because as you know atoms and molecules cannot be seen.

Expected Learning

Explain the properties of acids and bases according to Arrhenius's model.

SESSION INFORMATION

Week: 25

Session: 150

Expected learning outcome: Identify the formation of new substances in simple acid-base reactions.

CONTENT DELIVERY

Start: Ask students comprehension-check questions about acids and bases like: *How do acids taste? What about bases? How do acids feel? What about bases? Can they be solid liquid or gaseous? If so, what changes their state? Can they be dissolved in water? If so, what happens then? What happens with acids when they react with active metals? What happens with bases when they react with active metals? What happens when bases and acids are mixed? What's the formula of Sodium Chloride?*

Development: Students should do the activities in the section *Reflect, Explain and Share*. Check their cards.

Closing: Students should read the other neutralization reactions. Analyze them along with them; so that they can see how they balance.

SKILLS DEVELOPMENT

Critical thinking skills: Remembering.

Interpersonal skills: Working as a team member, sharing information.

Logical/Mathematical skills: Doing operations.

EVALUATION OF CONTENT

Check students' answers to the opening questions, the cards and their participation in the equations balancing exercise.

SESSION INFORMATION

Week: 26

Session: 151

Expected learning outcome: Explain the properties of acids and bases according to the Arrhenius model.

CONTENT DELIVERY

Start: Brainstorm acids and bases characteristics. Have students write them on the board.

Development: Students should read the entire page. And ask them to find Arrhenius proposals regarding salts, acids and bases. Elicit answers.

Closing: Have students analyze little by little the last formula asking them questions like: What's the charge in Hydrogen? What's the charge in Chlorine? Which molecule did they combine with? Why is that, do you think? Help them see that molecules with opposite charge attract each other.

Homework: Students will have a lab practice the following session. Organize teams so each team decides who will take the materials to complete the practice that is explained on page 117.

FIG. 4.6 Image of Swedish chemist, Svante August Arrhenius (1859-1827).

Svante August Arrhenius (1859-1927) was a Swedish chemist who studied in the University of Uppsala; as a PhD student, he researched the conductive properties of the solutions of certain substances. By that time, more efficient batteries had been created than those by Alessandro Volta in 1800, so he had the basic tool to create his model: electricity. In 1884, he presented his doctoral dissertation where he posed a possible explanation for characteristics of acids and bases (Fig. 4.6).

Arrhenius observed that pure water did not conduct electricity, but it could dissolve certain substances. He thought that he could form an electric kind of bridge in which electricity was conducted from one point to another by a dissolution made with salts, acids and bases.

When he analyzed his results, he realized that a common property of these substances was the presence of ionic bonds; he assumed that when in contact with water a dissociation occurred; in other words, ionic bonds were temporarily broken, resulting in fractions of electrically charged molecules capable of conducting electricity.

A series of proposals emerged from the analysis of the salts, acids and bases formulas:

- Salts can be dissociated into positive ions represented by positively charged metal atoms, called cations, as well as negative ions represented by nonmetal atoms or **radicals**, which are the result of combining nonmetals with oxygen, called anions.
- In the case of acids, positively charged hydrogen atoms represent cations, and anions, just as salts represent nonmetal atoms or radicals that result from the combination of nonmetals and oxygen.
- In bases, cations would be positively charged and metal atoms and anions would be represented by the OH- radical, called hydroxyl or hydroxide, which has a negative charge (Fig. 4.7).

GLOSSARY

Radical. Group of atoms that work as a unit in a chemical compound, and cannot be changed from one combination to another.

Degradation. Transforming a complex substance into another.

From these proposals, a couple of important statements about aqueous solutions derived:

- An acid is a substance that gives positive hydrogen ions.
- A base is a substance that gives negative hydroxide ions.

Curious Facts

There are some organisms that live in extreme environments called extremophiles. Among them we find the acidophilus that lives in an extremely acidic environment. There is also the Picrophilus oshimae and Picrophilus torridus: if their environment conditions change to neutral, they will die or will not be able to grow.

The corrosive property of acids and bases is associated with the presence of water or humidity; under those conditions, the dissociation takes place. Thus, the ions, which are highly reactive, can be combined with the atoms of the material they are in touch with, therefore, creating new substances and observing corrosion as a change or **degradation** of material or even as a burn (Fig. 4.8).

FIG. 4.7 The radical hydroxyl or hydroxide has a free bond.

Acids and bases in aqueous solutions act as reactants, because each one brings an element or radical that creates the products that are always salts and water; in other words, we have a crossed exchange of ions. Look carefully at the following diagram and pay special attention to the ion symbols:

Crossed ions create salt and water; they follow the rule in which opposite poles attract.

Acid = hydrogen with nonmetal; for example HCl; is dissociated in:

$H^+ + Cl^- \longrightarrow$ NaCl (sodium chloride)

Base = metal with hydroxide; for example NaOH; is dissociated with

$Na^+ + OH^- \longrightarrow$ HOH (water, H_2O)

FIG. 4.8 Corrosion is a phenomenon related to water.

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SKILLS DEVELOPMENT

Logical/Mathematical skills: Doing operations.

Critical thinking skills: Brainstorming.

Reading skills: Scanning, reading for detail.

EVALUATION OF CONTENT

Check students' answers to Arrhenius proposals. Everyone should actively participate to analyze the last formulas.

SESSION INFORMATION

Week: 26

Session: 152

Expected learning outcome: Explain the properties of acids and bases according to the Arrhenius model.

Hands on Chemistry!

TITRATION

Introduction

Neutralization between acids and bases is an important procedure. To identify bases, the use of indicators, such as phenolphthalein and other measuring instruments is necessary; this process is called titration (Fig. 4.9).

You will need:

- Two 200 ml beakers
- A watch glass
- A tripod or a universal ring support
- 100 ml of hydrochloric acid solution (HCL) to the 1.5%
- Phenolphthalein solution in a dropper
- A 50 ml burette
- A Bunsen burner
- 100 ml NaOH solution (sodium hydroxide) at 1%

Preventive measures:

- Wear a lab coat and security glasses.
- Do not touch the reactants. In case this happens: dry the substance with paper towels and then wash your hands with plenty of soap and water and make sure to tell your teacher.
- Do not inhale or drink any of the reactants.
- This experiment requires the supervision of your teacher.

Procedure

1. Work in teams of four or five and follow the instructions carefully.
2. Pour the NaOH solution in a beaker and add some drops of phenolphthalein, stir until you have a homogenous color.
3. Pour the HCl solution in the burette, put a small amount of the solution into the other beaker, and refill the burette up to the 0 ml mark.
4. Pour the HCl into the NaOH beaker drop by drop, and stir it constantly.
5. When the phenolphthalein color changes, close the burette key; at this point, you have just neutralized the base with the acid.
6. Make sure you have NaCl solution. Pour some of the content of the beaker into the watch glass and place it above the fire.
7. Once the water has evaporated, some crystals will remain, examine them! How do they look?
8. If you followed the procedure correctly, you may taste the crystals, how do they taste?

Explain

In your notebook, answer the following questions and write a report. You may illustrate your work. Keep your work in your *Hands on Chemistry!* portfolio of evidence.

1. What happens during neutralization?
2. What will happen if you add more NaOH to the neutralized solution?
3. What will happen if you add more HCl than necessary?
4. What are the practical applications of the neutralization?
5. In which diseases is it imperative to consider neutralization? Why?

Remember to include your sources.

FIG. 4.9 Burettes are the correct instruments to make a titration.

To integrate

Arrhenius's model has some limitations, since it is only based on the dynamic of acids and bases when in an aqueous dissolution. Otherwise, it could not be explained.

Although there are acids that act in absence of water and some salts have acidic or basic properties, in this model, neutralization is reached when there is a solution of salt and water. Johannes Nicolaus Bronsted (1879-1947) and Thomas M. Lowry (1847-1936) developed a more complex model (Fig. 4.10) to help with these limitations.

FIG. 4.10 Johannes Bronsted's portrait.

ICT

To know more about Bronsted and Lowry's acids and bases model, visit the following website: http://prepa8.unam.mx/academia/colegios/quimica/infocab/unidad225.html

CONTENT DELIVERY

Start: Check every team has all the materials to do the lab practice.

Development: Help students do the experiment while all precautions should be taken. Monitor their work.

Closing: Students should write a report following the questions in the subsection *Explain*. Remind students of the writing process: Drafting, revising, proof reading, publishing.

SKILLS DEVELOPMENT

Logical/Mathematical skills: Experimenting.

Writing skills: Writing process.

EVALUATION OF CONTENT

Every team should bring complete materials, everyone should actively participate in the experiment process. Check students' reports.

SESSION INFORMATION

Week: 26

Sessions: 153, 154

Expected learning outcomes: Explain the properties of acids and bases according to the Arrhenius model.

Identify the acidity of some foods and those that cause it.

CONTENT DELIVERY

Session 153

Start: Show students cards with the concepts you can see in the section *Closing Up!* Elicit meaning.

Development: Students should make a concept map.

Closing: Students should write a report card with the information they read.

Homework: Students should take a device with Internet access.

Session 154

Start: Students should read the section *Making decisions: The Importance of a Balanced Diet.*

Development: Organize teams. They should do the activities in the section *Reflect, Explain and Share.*

Closing: Check students' mind maps.

Homework: Organize teams. Students should bring the materials for the lab practice explained on page 119.

Closing up!

Read the words inside each box and make sure you understand their meanings. On a piece of paper, make a concept map with the word "acid" as the key concept. Make sure you use all the terms as well as arrows to relate them.

Neutralization | Taste | Water | Acid | Base | Salt

Corrosion | Dissociation | Anion | Indicator | Cation | Ion

Write a report card with the information you read, and share it with the rest of your classmates. Add your card to your portfolio of evidence.

Why Should we Avoid the Frequent Consumption of "Acidic Foods"?

Making Decisions: The Importance of a Balanced Diet

Expected Learning

Identify the acidity of some foods and of those which cause it.

Mexican food is extremely varied because of the diversity of products we have and grow. You already learned about these many products when you created a balanced diet based on the **Good Plate**; and as you remember, many of these foods are non-processed, although in our diet we also include highly processed foods, such as chips, sodas, sauces and candy.

As you know, some of the acid and base substances are very strong while some others are light; to be sure of the degree of acidity or basic strength (alkalinity) in substances, there are laboratory methods to measure the property of giving ions H+ or OH- in an aqueous environment.

Glossary

Good Plate. Nutritional proposal in a diagram that shows healthy food groups and the recommended intake.

Potentiometer or pH meter. Device capable of measuring the electric potential difference (ionic) of a solution.

PH paper. An especial type of paper that contains indicator substances that change their color with different pH.

Tuber. Part of a subterrain stem, or a root, that tends to thicken.

Going further

Potential of hydrogen pH

It is an ion H^+ concentration scale (specifically H_3O^+, hydronium ions) in a solution. This concentration can be measured with a **potentiometer or** ¨pH meter¨, with a **pH paper** or some other natural indicators.

The pH scale goes from 0 to 14 with a mid-point of 7. All substances having a pH ranging from 0 to 6.9 are acids, the substances with a range from 7.1 to 14 are bases, and the ones that have a pH of 7 are neutral; thus, the farther away from 7 the pH is, the more acid or alkaline there is. Using a potentiometer or pH paper to measure the acidity or alkalinity of substances and food is complex and expensive. The other way to measure them is by using natural coloring, this can be the hibiscus flower, leaves or **tubers**; the most efficient is the colorant from the purple cabbage.

Reflect, Explain and Share

What type of mixture is it?

- Visit http://www.sined.mx/sined/aprendiendo/curso-65.htm and work with the learning object shown there.
- Work on all the activities suggested in the learning object to understand the characteristics of acids and bases better.
- Create a diagram, concept map or mind map where you integrate the information you worked with and keep it in your portfolio of evidence.

SKILLS DEVELOPMENT

Critical thinking skills: Remembering, mind mapping.

Visual/Spatial skills: Mind mapping.

Writing skills: Writing a report.

EVALUATION OF CONTENT

Check students' answers to your introductory questions, their concept maps, report cards and mind maps.

Hands on Chemistry!

CREATING A PH INDICATOR

Introduction

The acidity or alkalinity of a substance is variable. It can be measured according to the colored reaction of some indicators when put on pieces of absorbent paper that change their color in the presence of acids or bases in aqueous solutions.

You will need:

- 500 g of purple cabbage.
- A 1000 ml beaker.
- A kitchen knife.
- A kitchen strainer.
- A stirrer.
- A clothesline.
- Paper scissors.
- 20 ml of sodium hydroxide solution (NaOH) at 1%.
- Pure water.
- Coffee filters.
- A kitchen chopping-table.
- An electric grill.
- A big crystallizer.
- Clothespins.
- 3 100 ml beakers.
- 20 ml of hydrochloric acid solution (HCl) at 1%.

Preventive measures:

- Wear a lab coat
- Be extremely careful while using the knife, the scissors and the hot substances.
- Do not touch the NaOH and HCl reactants. Do not eat or smell any of the the reactants.

Procedure

Work in teams of 4.

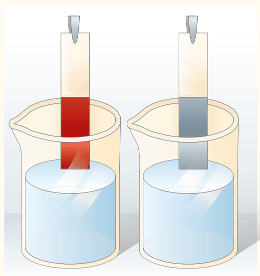
1. Cut the purple cabbage into thin slices, using the knife and the chopping board.
2. Place it in the 1000 ml beaker and add water to cover the cabbage.
3. Place the beaker on the electric grill, until it boils for about 10 minutes; turn off the grill and let the content of the beaker cool down completely.
4. Strain the content of the beaker and pour the liquid part in the crystallizer and throw the cabbage away
5. Place several coffee filters inside the liquid, and leave them until they are dyed uniformly.
6. Hang the pieces of paper on the clothesline (preferably on the shadow) and hold them with the clothespins; let them dry completely and throw away the cabbage liquid, since eventually it spoils.
7. Wash your hands and dry them completely. Cut the filters into strips of 1 cm wide and 5 cm long; save them in the bag you have now your pH indicator paper for this activity and following ones.
8. Pour 20 ml of clean water in one of the 100 ml beakers; introduce the end of one indicator paper strip let it get wet, take it out, and observe it.
9. Pour 20 ml of NaOH in another 100 ml beaker; and follow step 8 again.
10. Pour 20 ml of HCl in the last 100 ml beaker and repeat step 8 once more.

Explain

Answer the following question in your notebook and write a report. You may take pictures of the procedure to illustrate your report. Keep your work in your *Hands on Chemistry!* portfolio of evidence.

1. What color is the pH indicator paper when it is dry?
2. What color is the paper after you dipped inside the 3 glasses?
3. Why do you think the changes happen?
4. If the pH paper is dipped in different acid and base solutions it changes its color as well. How could you know which pH corresponds to each color?
5. Design a lab practice to know to which pH each color corresponds. Ask your teacher for help, do it and write a report about it.

Remember to include your sources.



SESSION INFORMATION

Week: 26

Sessions: 155, 156

Expected learning outcome: Identify the acidity of some foods and those that cause it.

CONTENT DELIVERY

Start: Check that all teams have all the materials they need for the lab practice.

Development: Students should do the experiment while all precautions should be followed. Monitor their work; help them out, as they need it.

Closing: Students should write a report answering the questions in the subsection *Explain*. Remind students of the writing process: Drafting, revising, proofreading, and publishing.

Homework: Organize teams of five students. Teams will need to get 20 samples of different foods in plastic cups, they usually eat and strips of pH indicator.

SKILLS DEVELOPMENT

Interpersonal skills: Working as a team member.

Logical/Mathematical skills: Experimenting, finding relations.

Writing skills: Writing process.

EVALUATION OF CONTENT

All teams should take all the materials they need to do the lab practice; everybody should actively participate in the practice, check students' reports.

SESSION INFORMATION

Week: 27

Sessions: 157, 158

Expected learning outcomes: Identify the acidity of some foods and those that cause it.

Identify the properties of the substances that neutralize stomach acidity.

CONTENT DELIVERY

Start: Students should display the samples they got and try to predict whether they are acid or alkaline food and label each cup "acid" or "alkaline".

Development: Students should read page 120. Ask comprehension-check questions like: In which part of the human body do cells produce hydrochloric acid? What does hydrochloric acid do to food? How is the intestine protected? How does acidity feel? What are some foods that overproduce acid? What's the name of the salts that neutralize acids? What do antacids contain? Check the answers in the text.

Closing: Students should do the experiment that is explained in the section *Reflect, Explain and Share.* Monitor their work; ask them how they think an appropriate diet should be.

Homework: Students should get 20 cards to make a memory game.

Expected Learning

Identify the acidity of some foods and of those who cause it.

Glossary

Pancreatic juice. Pancreatic liquid that goes into the digestive system and has chemical digestive functions.

Bile. Substance produced by the gallbladder that helps in the chemical-digestive function of the digestive system.

FIG. 4.11 The sauces based on chili cause stomach acidity.

Expected Learning

Identify the properties of the substances that neutralize stomach acidity.

FIG. 4.12 There are multiple types of antacid medications available.

To Read More

The healing power of natural antacids

If you want to learn more about acidity in your organism and how to eat healthier, read *The Healing Power of Natural Antacids (El poder curativo de los antiácidos naturales)* by Norbert Treutwein.

Acid foods or food that cause acidity (heartburn)

The food we eat is processed by the digestive system; this happens with the mixture of water we drink, food and saliva. Because water is a neutral substance to the properties of food and the digestive process, the pH of food can be measured through the digestive route. This pH will change at certain points, especially in the first stages.

One of the most dramatic changes of pH takes place in the stomach where some specialized cells produce hydrochloric acid. It is a very strong acid that is used as an agent that breaks down and transforms food into simpler compounds, with the help of other substances, such as enzymes. Of course, since acid can harm the stomach, there are mucus producing cells that cover it.

Before leaving the stomach, the chyme receives other substances: **pancreatic juice** and the **bile** that along with other functions, neutralize the acid pH of the food mixture; otherwise, the cells of the small intestine would be seriously damaged. From this point on, variations in pH are very subtle under normal conditions.

Most of the foods we eat contain a certain amount of acidity, such as citrus, like lemon juice, orange or grapefruit, tomato, chili, hot or highly seasoned dishes, gaseous drink (sodas), coffee, chocolate, among others (Fig. 4.11). Stomach acidity is felt as a burn or an abdominal pain, which is the reaction of our organism to the excess of acidity. It is true that stomach pH is highly acid, but the organism controls its concentration and when it overflows, due to the ingestion of acid food, the digestive tissue is damaged. Other conditions can also cause the sense of stomach acidity; for example, when you eat in large quantities, the gastric juice can be expelled to the esophagus where it spreads through the pharynx and the oral cavity and is perceived as heartburn.

Drinking alcohol and smoking are addictions that can cause stomach acidity, and other toxic effects, which is why it is suggested to avoid these substances.

When you experience stomach acidity, drinking water is not enough, because it requires an acid neutralizer; the logical measure would be to drink a base, but it would be a dangerous solution, because bases are highly corrosive. Nevertheless, there are some salts that when dissolved in water, they neutralize the pH in acids; in chemistry, they have different names: buffer, buffer solutions or shock-absorbing solutions. These types of solutions have acids or bases that do not change pH following this principle, the pharmaceutical industry has developed different medicines whose objective is to attack stomach acidity on different levels, and they are generally called antacids. They come in different presentations, from traditional pills or effervescent powder to chewable tablets, as well as syrups or gels (Fig. 4.12).

The effect of antacids will all be the same, regardless of their presentation: they all have sodium bicarbonate ($NaHCO_3$) salt, calcium

Reflect, Explain and Share

Acidic Foods

Form teams of three to five and do the following activity.

- Gather a sample of 20 different types of food (if you're able, gather some more), especially those that you regularly eat.
- Put each sample in different cups and dissolve them in water if necessary.
- Check if they are acid or alkaline solutions, use the strips of pH indicator paper from the previous activity.
- Write your results in a table, and answer the following questions in your notebook:
- How many foods were acid and how many were bases?
- How often and how much of them do you usually eat?
- Based on your answers, do you think you have a balanced diet? Explain your answer.

SKILLS DEVELOPMENT

Reading skills: Scanning, reading for detail.

Critical thinking skills: Applying information.

Logical/Mathematical skills: Experimenting, finding relations.

EVALUATION OF CONTENT

Check students' answers to the comprehension-check questions. Everybody should actively participate in the experiment; students should also actively participate to create a balanced diet.

carbonate ($CaCo_3$) and weak bases, such as magnesium hydroxide ($Mg(OH)_2$) or aluminum ($Al(OH)_3$), which alone or combined act as buffering agents when they are in touch with water to neutralize the excess acidity.

FIG. 4.13 The excessive consumption of chili causes damages over time.

Health risks caused by the frequent and excessive consumption of acidic foods

It is essential to point out that most of acid foods are not dangerous if they are moderately eaten.

Eating cooked or raw tomato is healthy and recommended, because it provides vitamins, but as everything, when it is eaten in excess, it can damage your health. The same thing happens with chili; its consumption is healthy, as long as it is in small amounts (Fig. 4.13). The excessive intake of milk and dairy as well as of chocolate causes acidity; these foods should be consumed in small amounts too.

The food that is considered "fast food" has great amounts of non-healthy ingredients, such as lemon or salt in excess or a lot of fat, and does not provide any nutritious substance and causes obesity.

To be healthy, you should avoid eating large amounts of food, wearing tight clothes, drinking alcoholic beverages and smoking. The best suggestion for being healthy is to have a balanced diet, always drink water, because it is a neutral substance and dissolves the acid effects of some foods (Fig. 4.14).

The frequent consumption of acid foods has negative consequences on your health that increase and become more dangerous with time. When stomach acidity is frequently present, it causes a disease called gastritis, which is the inflammation of gastric tissue. The intake of acid food is a factor that causes another painful and risky disease like ulcers in the stomach or the esophagus. In serious cases, both of these diseases require surgery to recover (Fig. 4.15).

→ Expected Learning

Analyze the health risks caused by the frequent consumption of acidic food, to make informed decisions and create a balanced diet that includes water consumption.

FIG. 4.14 The consumption of pure and simple water helps your digestive system in the digestion process.

Curious Facts

In the journal *Cancer Epidemiology, Biomarkers & Prevention*, researcher Dr. Scott Langevin stated that acidity increases the risk of larynx and pharynx cancer.

To integrate

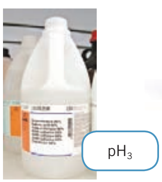
Some scientists associate chronic gastritis with stomach cancer, which can be fatal. It is possible to prevent the mentioned risks by developing healthy eating habits.

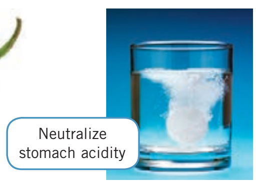
FIG. 4.15 Stomach acidity related diseases may require surgery.

Closing up!

Stomach health matching game

Work in teams of four to create a matching game with white cards. Write on each card, information that can be related and completed using both of them. Play the game with your team. Here are some examples:





Once the game is over, talk to each other and reflect on the importance and use of this activity. Keep your matching game in your portfolio of evidence.

SESSION INFORMATION

Week: 27

Session: 159

Expected learning outcome: Analyze health risks caused by the frequent consumption of acidic food to make informed decisions and create a balanced diet that includes water consumption.

CONTENT DELIVERY

Start: Ask students if they feel their diet is mainly acidic or alkaline. Elicit answers.

Development: Students should read the entire page. Ask comprehension-check questions like: What is mentioned regarding chili? What do fast food mainly contain? What is recommended to be healthy? Elicit answers.

Closing: Organize teams. Students should create a matching game. See the section *Closing up!* For further information. Once they finish it, they should play with it.

Homework for the teacher: Get a piece of oxide metal and one in good condition.

SKILLS DEVELOPMENT

Critical thinking skills: Summarizing.

Reading skills: Scanning, reading for detail.

EVALUATION OF CONTENT

Check students' answers to the comprehension-check questions and the matching game complete and well done.

SESSION INFORMATION

Week: 27

Session: 160

Expected learning outcome: Identify the chemical change in examples of oxide-reduction reactions in experimental activities and the environment.

CONTENT DELIVERY

Start: Show students the two pieces of metal, that the teacher was supposed to get, and ask: What happened to the oxide metal? How do you think it happened?

Development: Have students read the section *Going further* on pages 122 and 123. Show students a Lewis diagram of hydrogen and oxygen; in which oxygen has six electrons in the outer orbit and two hydrogen atoms with only one electron and say: *What will happen? Who will give electrons? (The hydrogen). That reduction is called Oxide. The gaining of electrons is called Reduction because it "reduces" its instability.*

Closing: Show students other Lewis diagrams in which the same reaction occurs such as NaCl (Na has 1 electron in the outer layer, Cl has 7 electrons in the outer layer) Which element is oxidized? Na. Which element is reduced? Cl. If necessary, look for other simple compound formulas in order to have students practice the identification of oxide-reduction.

Homework: Students will need a device with Internet access the following class.

→ Expected Learning

Identify the chemical change in examples of oxide-reduction reactions in experimental activities and the environment.

The Importance of Oxide Reactions and Reductions

Characteristics and Representation of Redox Reactions

A lot of natural reactions that take place in organisms, in the environment, as well as in chemical labs and industry are called oxide-reduction reactions or redox; they cause particularly interesting phenomena, since the atoms change some of the chemical characteristics they had before the reaction.

Get started!

How are metals found in nature?

Most of the metals we use were extracted in mineral forms and they required transforming to be used as we know them.

1. Read the next statements and follow the instructions individually.

- Write down a list with the metals you know and some of their uses; to help you categorize your information, use a table or chart to write your information in it.
- Choose one of those metals to research on the Internet. Which are its natural sources and processes for extraction?
- Write on a card all the information you have, illustrate it and share it in teams of 4.
- In your notebook, write the information of another metal mentioned by one of your teammates. Keep your card in your portfolio of evidence.

Glossary

Empiric knowledge. They way we get and spread knowledge, resulting from experience.

FIG. 4.16 Bronze is an alloy of copper and tin that was used in ancient Mesopotamia to produce several objects.

Going further

The **empiric knowledge** of redox reactions has accompanied humankind from ancient times, for example, the extraction of metals from minerals.

Even though the chemical process that occurred was not known, they were used in the manufacturing process of different objects. In fact, they have marked very significant historical periods such as the Bronze Age and the Iron Age, due to their discovery and use, especially for manufacturing weapons (Fig. 4.16).

Today, we know that the substances are formed by atom bonds which transfer electrons at least partially, between the atoms of the elements (ionic and covalent bonds)..

The word oxidation is commonly used, because we frequently find metallic things, mostly iron, that oxidize; oxidation is seen often as harmful to materials causing objects to become useless (Fig. 4.17).

From a chemical point of view, oxidation is highly important because it creates new substances, even inside our bodies. For oxidation to take place a combination or rearrangement of atoms of different elements is needed; this is defined as the reaction in which an element releases electrons. As its name indicates, in most of these reactions, oxygen is present to capture the electrons that are released, which is why it is called an oxidant agent or simply an oxidant, but this is not the only case. Oxidation can also take place without oxygen; since there is an element or a radical with enough electronegativity to capture the electrons that these reactions cause.

FIG. 4.17 We know oxidation because it destroys objects produced with iron.

$$\text{(Copper) } 2\ Cu^{+} \text{ (oxygen) } O_2 \rightarrow \text{ (copper oxide II) } 2\ CuO$$

$$\text{(Zinc) } 2\ Zn^{+} \text{ (oxygen) } O_2 \rightarrow \text{ (zinc oxide) } 2\ ZnO$$

SKILLS DEVELOPMENT

Critical thinking skills: Predicting.

Logical/Mathematical skills: Finding relations.

EVALUATION OF CONTENT

Students should be able to easily identify which element is oxidized and which one is reduced.

The word reduction has several meanings; in chemistry, it means the reaction in which an element gains electrons. As you will notice reduction seems opposite to oxidation, but they truly are complementary. Whenever oxidation takes place, a reduction also takes place, and even if they are analyzed separately, both phenomena take place in the process, because of what one gains and the other loses.

The concept of oxidation refers to the charges each atom presents in a chemical combination. They may be zero, negative or positive, depending on the amount of electrons they are capable of giving or receiving in one or several bonds in the compound they are part of.

Each bond is created with an electron, thus the more electrons an atom gives, the higher their state of oxidation is and is represented with a positive number. On the contrary, the more electrons it gains, the lower its state of oxidation is, and it is represented with a negative number. When an atom has an oxidation state of zero, it is neutral; that is, it has the same amount of electrons around it than protons in its nucleus (Fig. 4.18).

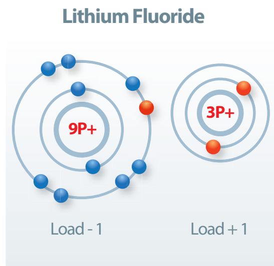
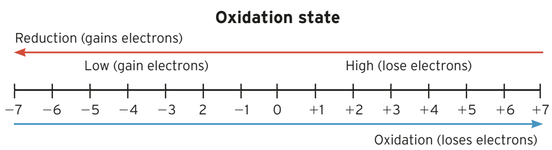


FIG. 4.18 This lithium fluoride diagram shows the reduced fluorine, because it gained an electron and the oxide lithium because it gave an electron.

An oxide reduction reaction happens when firstly, there is a chemical transformation in two or more elements or compounds, and secondly, these change their oxidation state, whether it increases (oxidation) or decreases (reduction). If the process is analyzed this way, the fact that redox reactions take place in elements and compounds that form ionic bonds, as in those formed in covalent bonds, is respected. This is important because compounds may be formed by oxidation and reduction where there is no gaining or losing of complete electrons, which is the case of covalent bonds.



The characteristics within the creation of compounds allow us to explain compounds with the same elements, and with different chemical and physical characteristics, for example:

- Copper chloride (I) ($CuCl$) White solid color.
- Copper chloride (II) ($CuCl_2$) Green and yellowish solid color.

As mentioned before, the oxide-reduction reactions always happen simultaneously. There are many examples of oxide-reduction reactions, some of them happen in nature and are part of the chemical reactions that support life, as in the case of photosynthesis and breathing (Fig. 4.19).

There are many oxide reactions that take place in our bodies, for example the respiration process in each of our cells. The oxide-reduction process also takes place in the transmission of nerve impulses, and in the transformation of molecules such as Adenosine triphosphate (ATP) into adenosine diphosphate (ADP), releasing it to be used in different functions.

The process of breathing is also an example of oxidation and reduction. Every time we inhale O_2, we oxidize erythrocytes and when exhaling, we reduce O_2, converting it into CO_2.

FIG. 4.19 In the leaves of plants, several oxide-reduction chemical reactions take place, amongst them, photosynthesis.

Reflect, Explain and Share

Work in teams of four and answer.

- Write a list of the objects and materials at home that may corrode.
- Research in different sources how to avoid corrosion and what the effects of waste released by petroleum derivatives combustion (gas, diesel, fuel oil), coal and liquefied gas are.
- Draw a chart with your results. Create two electronic presentations, one for each topic (corrosion and combustion) and present them to the group.

SESSION INFORMATION

Week: 27

Sessions: 161, 162

Expected learning outcome: Identify the chemical change in examples of oxide-reduction reactions in experimental activities and the environment.

CONTENT DELIVERY

Start: Ask some comprehension-check questions about the previous session information such as: What is oxide? What is reduction?

Development: Ask students to do the research that is explained in the section *Reflect, Explain and Share* using the Internet.

Closing: Students should present the results of their research.

Homework: Organize teams. The following session students should do a lab practice and they will need some materials. The list is on page 124.

SKILLS DEVELOPMENT

Reading skills: Scanning, reading for detail.

EVALUATION OF CONTENT

Check students' answers to your comprehension-check answers.

SESSION INFORMATION

Week: 28

Sessions: 163, 164

Expected learning outcome: Identify the chemical change in examples of oxide-reduction reactions in experimental activities and the environment.

CONTENT DELIVERY

Start: Check that students have all the necessary elements to do the experiment.

Development: Students should do the experiment, monitor their work; help students by showing them the procedure step by step. Do not continue until all teams are done with each step.

Closing: Check their results. Besides, students should write a report answering the questions in the subsection *Explain*, which is in the end of the lab practice procedure.

Hands on Chemistry!

IS THERE ELECTRICITY IN A LEMON?

Introduction

The function of an electric battery is based on oxide-reduction reactions; they take advantage of these phenomena to create electricity. Every electric battery contains a dissolved electrolyte in an aqueous solution and a pair of electrodes with materials capable of gaining or loosing electrons, this forms an electric current that can be used to turn on a device. Many fruits and tubers can be transformed into electric batteries, because they have water and substances similar to electrolytes inside them and the only thing we need to add is proper electrons.

You will need:

- A big lemon
- A strip of copper, 5 cm long and 1 cm wide
- A strip of steel, 5 cm long and 1 cm wide
- A cutter or a pocketknife
- 2 alligator clip leads
- A voltmeter
- A light bulb or LED for one battery (1.5 V)
- 20 ml of sodium hydroxide solution at 1% (NaOH).
- 20 ml of hydrochloric acid solution at 1% (HCL).

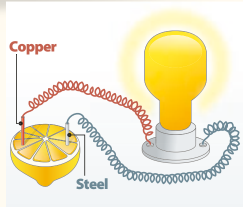
Preventive measures:

- Wear a lab coat.
- Be careful while using the cutter or the pocketknife.
- Be sure to have the voltmeter on the scale of 0V to 1V or from 0V to 10V.
- Do not eat the lemon after the experiment.

Procedure

Work in teams of four, read and follow the instructions carefully.

1. Make two small cuts, 2 cm apart, on the lemon skin.
2. Insert the copper strip as deep as you can in one of the cuts, in the other cut insert the steel strip so they are parallel, be careful that none of the strips touch one another.
3. Leave a part of the strips outside the lemon.



4. Connect one alligator clip lead to the copper strip and the positive terminal of the voltmeter, and with the other clip, connect the zinc strip and the negative terminal. Observe what happens.
5. Plug the wires to the light bulb or led and observe what happens.
6. Work with the rest of the teams, and plug all the lemons together in a series. Observe what happens with the voltmeter.
7. Plug all the lemons to a light bulb and observe.

Explain

Write a report and answer the following questions. You may take pictures of the procedure to illustrate your report. Keep your work in your *Hands on Chemistry!* portfolio of evidence.

1. How much voltage did the lemon generate?
2. With the electricity of the lemon, was it possible to turn on the light bulb? Why do you think that happened?
3. How much voltage did all the lemons generate together?
4. With all the lemons together, did the light bulb turned on? How intense was it? Why do you think that happened?
5. What compounds does the lemon have inside that work as electrolytes?
6. Which of the elements made by electrodes are oxidized and which are reduced? How could you know?
7. What is the chemical equation that describes these experiments?

Remember to include your sources.

GLOSSARY

Anaerobic bacteria. Type of bacteria that survives without the presence of oxygen because it is lethal to most of them.

To integrate

Some home products have an oxidant effect and we take advantage of their chemical characteristics for practical ends. A great example is hydrogen peroxide (H_2O_2), which has several uses. It can be used as a wound disinfectant, because when it reacts it releases oxygen that kills **anaerobic bacteria**, some of them cause infections such as tetanus; it is also used to set hair dyes. Another case is sodium hypochlorite (NaClO), which is mainly used as laundry bleach. It also works as a disinfectant because it attacks bacteria and fungi, it can also be used to clean water so it can be drunk (Fig. 4.20, page 125).

124

SKILLS DEVELOPMENT

Logical/Mathematical skills: Experimenting, finding relations.

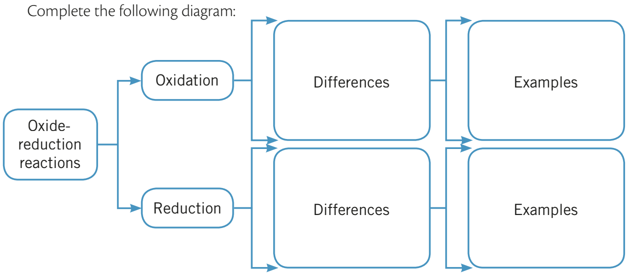
Interpersonal skills: Working as team members.

Writing skills: Writing a report.

EVALUATION OF CONTENT

Students should actively participate in the lab practice. Check their report, as well.

Complete the following diagram:



Once you have finished the diagram, write down which of these compounds can be used at home, how you would use them and what for. Share your work with t the class. Keep it in your portfolio of evidence.

Oxidation Number

In a redox reaction an interesting phenomenon takes place which is related to valence electrons of at least two of the elements in the reaction. These elements can either gain or lose electrons, but that depends on the conditions of the reactions and the properties of each element as well as the amount. To understand this phenomenon it is important to remember the organization of the elements in the periodic table and the valence concept as well as the electronegativity concept.

Reflect, Explain and Share

Remembering basic concepts

Search in your notes, portfolio, and this book, specifically Units 2 and 3 and answer the following questions.

- Which are the characteristics shared by the elements of a group?
- Which are the characteristics shared by the elements of a period?
- What is valence and what is its relationship to the periodic table?
- What is electronegativity?
- What regularity does electronegativity have in the periodic table?

To integrate

As you may remember, bonds are created between balanced electrons of the atoms. The more electronegativity an element has, the more capacity it has to gain electrons, and when electronegativity difference is greater, ionic bonds are created and when the difference is less, covalent bonds are created. Most of the information you need to determine if two elements can form a compound as well as their characteristics can be found in the periodic table. Another piece of information that will allow you to understand the way new compounds are formed and the oxide-reduction reactions is the oxidation number. The oxidation number and the oxidation state are found in an elemental form because they do not gain or lose electrons, their oxidation state is zero or neutral because they have the same number of protons and electrons. If an atom is combined, it can gain or lose electrons, depending on how many bonds it creates, and its oxidation state will no longer be zero. It will now depend on the number of bonds it creates. They will be represented with a negative symbol if it gains electrons, and a positive symbol if it loses them.

FIG. 4.20 Laundry bleach is made out of sodium hypochlorite diluted in water.

Curious Facts

To learn more about the uses of oxidant agents visit: http://www.textoscientificos.com/quimica/inorganica/agentes/oxidantes

Expected Learning

Establish the relationship between the oxidation numbers of some elements and their location in the periodic table.

SESSION INFORMATION

Week: 28

Sessions: 165, 166

Expected learning outcome: Establish the relationship between the oxidation numbers of some elements and their location in the periodic table.

CONTENT DELIVERY

Start: Have students complete the diagram about Oxide-reduction reactions. Check their diagrams.

Development: Students should do the research described in the section *Reflect, Explain and Share* using their book and notebook in order to answer the questions.

Answers:

1. The valence.
2. The energy level.
3. Valence is the number of electrons in the external orbit.
4. Electronegativity is the ability of an atom to attract electrons from another atom.
5. It increases from bottom to top and from left to right.

Closing: Check students' answers to the diagram and research.

Homework: Organize teams of four students. They will need to take to the following class a piece of cardboard and markers.

SKILLS DEVELOPMENT

Critical thinking skills: Remembering.

Reading skills: Scanning, reading for detail.

EVALUATION OF CONTENT

Check students' answers to the diagram and the research.

SESSION INFORMATION

Week: 28

Sessions: 167, 168

Expected learning outcomes: Establish the relationship between the oxidation numbers of some elements and their location in the periodic table.

Analyze the electron transfer processes in some simple oxide-reduction reactions in daily life and industry.

CONTENT DELIVERY

Start: Students should read from the previous page the section *To Integrate* that finishes on page 126. Ask students to summarize it. Elicit one or two examples.

Development: Students should do the activities in the section *Reflect, Explain and Share*. In the end of the section, they will use the cardboard and markers they were told to take to class.

Closing: Go over their answers.

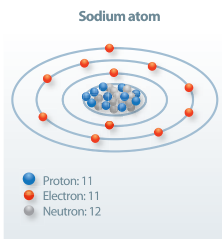


FIG. 4.21 Sodium atoms without bonds have the same amount of protons and electrons; thus, its oxidation number is zero.

These numbers are registered in the periodic table, they are called oxidation numbers and they show how many bonds each atom can form and if it gains or if it loses electrons (Fig. 4.21).

Some elements, like the **noble gases**, are called non-reactants because their oxidation number is zero; other elements like alkali elements of group 1A share two oxidation numbers, zero and +1, some other elements may even have positive and negative oxidation numbers. It is important to mention that all elements can have an oxidation number of zero, but this is not written in the periodic table. Electronegativity is the main factor that determines the oxidation number with which elements are combined; the most electronegative atoms will always gain electrons, therefore their oxidation number is negative; the least electronegative atoms lose electrons so their oxidation number is positive. Look at the Periodic Table at the end of your book and see that Francium is the least electronegative element and Fluorine is the most electronegative, they are found on opposite sides of the periodic table.

As electronegativity increases up to a certain point, the possible combination and variation of the oxidation numbers also increases, so there is not a direct relationship between the location in the periodic table and the oxidation number of the elements; due to these conditions, many periodic table models include electronegativity information and oxidation numbers of the elements.

GLOSSARY

Noble gases. elements of the VIII A group in the periodic table, they are characterized for not creating compounds and when they do, the result is highly unstable.

Reflect, Explain and Share

Electronegativity and oxidation number

In this activity, we will search for regularities in the relationship between oxidation numbers; you will need a periodic table and your notebook.

- Individually, examine your periodic table and write in your notebook a list of the elements that have 3 or more oxidation numbers regardless if they are negative or positive.
- Write down the oxidation number and the electronegativity of each element.

Get together with one of your classmates and form pairs. Together, analyze the information you got and then answer the following questions.

- Are there any elements from groups I, II or III in your list? What do you think the reason is?
- In which groups are most of these elements? What is their relationship to their valence?
- What electronegativity number is the most repeated?
- Which would be the average electronegativity number if you calculate it?
- Are both results similar? Why do you think this is?
- Why do fluorine and oxygen not appear?
- Which elements have a negative oxidation number? Why is that?
- Based on your observations, what do you think is the connection between the oxidation number and electronegativity?

Get together with another pair of students and form teams of four to share and discuss your answers. Write down your conclusions and create a poster and present it to the rest of the group.

Expected Learning

Analyze the electron transfer processes in some simple oxide-reduction reactions in daily life and industry.

Rules of oxidation number

The oxidation number dynamic has a set of basic rules, which are essential to explain:

1. All atoms, without been combined, have an oxidation number zero. Electronegativity does not affect this condition or their location in the periodic table.
2. Hydrogen is the only element that despite its location in the first group of the periodic table has medium electronegativity, so its oxidation number is +1 in most of the compounds it forms, except when it bonds to a metal and they create hydride, its oxidation number would be −1. For example:

SKILLS DEVELOPMENT

Critical thinking skills: Summarizing, analyzing.

EVALUATION OF CONTENT

Check students' summaries and answers to their activities.

$$2H_2{}^{+1} + O_2{}^{-2} \rightarrow 2H_2O \text{ (water)}$$
$$H_2{}^{+1} + Cl_2{}^{-1} \rightarrow 2HCl \text{ (Hydrochloric acid)}$$
$$2K^{+1} + H_2{}^{-1} \rightarrow 2KH \text{ (potassium hydride)}$$

3. The oxidation number of oxygen is −2 in almost all of its combinations; except for peroxide where it is −1, because it is found in the upper part of group VI A. In the remote case it combines with fluorine, the oxidation number of oxygen will be of +2, because it is the only element with more electronegativity than oxygen and it is always combined with the oxidation number of −1; both elements are the most reactants and oxidants of nonmetals while their electronegativity is greater than the other elements (Fig. 4.22). For example:

$$2Cr^{+3} + 3O_2{}^{-2} \rightarrow 2Cr_2O_3 \text{ (chromium oxide III)}$$
$$2H_2{}^{+1} + 2O_2{}^{-1} \rightarrow 2H_2O_2 \text{ (Hydrogen peroxide)}$$
$$O_2{}^{+2} + 2F_2{}^{-1} \rightarrow 2F_2O \text{ (oxygen difluoride)}$$

FIG. 4.22 Fluorine is a yellow gas that is highly reactive, it never loses electrons and when it is combined with sodium it is used in toothpaste to prevent cavities.

4. Metals have a positive oxidation number, except for antimony, which has -3, due to its low electronegativity and, as you will remember, it is located on the left side of the periodic table (Fig. 4.23). For example:

Na (sodium): oxidation number: +1
Al (aluminum): oxidation number: +3
Pd (palladium): oxidation number: +2 and +4

FIG. 4.23 The use of metal is frequent in all of our daily activities.

5. Nonmetals are located on the right side of the periodic table, they have a negative oxidation number if they are combined with metals and a positive one if they are combined with oxygen, which is more electronegative (Fig. 4.24). For example:

P(phosphorus): oxidation number: −3, +3 and +4
N(nitrogen): oxidation number: −3, +2, +3, +4 and +5
C (carbon): oxidation number: −4, +2 and +4

FIG. 4.24 Nonmetals are present in every salt, such as common salt (sodium chloride) and in sodium bicarbonate.

6. When a compound has been formed, the arithmetic addition of the oxidation number of the atoms is always zero (Fig. 4.25). For example:

(hydrobromic acid) HBr: 1 atom of H $= +1 \times 1 = +1$
1 atom of Br $= -1 \times 1 = -1$
Therefore: $(+1) + (-1) = 0$
(Potassium carbonate)K_2CO_3: 2 atoms of K $= +1 \times 2 = +2$
1 atom of C $= +4 \times 1 = +4$
3 atoms of O $= -2 \times 3 = -6$
Therefore: $(+2) + (+4) + (-6) = 0$

7. Ions or radicals also have an oxidation number, which is calculated by the arithmetic addition of the oxidation numbers of the atoms that form it.

(sulfate) SO_4: 1 atom of S $= +6 \times 1 = +6$
4 atoms of O $= -2 \times 4 = -8$
Therefore: $(+6) + (-8) = -2$
(chlorite)ClO_2: 1 atom of Cl $= +3 \times 1 = +3$
2 atoms of O $= -2 \times 2 = -4$
Therefore: $(+3) + (-4) = -1$

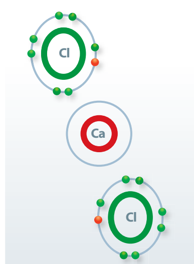


FIG. 4.25 In the case of calcium chloride, the calcium atom gives two electrons and each of the chlorine atoms gains one; the total balance is zero.

SESSION INFORMATION

Week: 29

Sessions: 169, 170

Expected learning outcome: Analyze the electron transfer processes in some simple oxide-reduction reactions in daily life and industry.

CONTENT DELIVERY

Start: Using the periodic table on page 143, ask students to find the oxidation number or numbers from five different elements. Elicit answers.

Development: Have a student read one number of the rules of oxidation number. Help them see the rules through the examples you have in the book.

Closing: Students should do the activity in the section *Reflect, Explain and Share* on page 128. Check the answers.

SKILLS DEVELOPMENT

Critical thinking skills: Applying information.

EVALUATION OF CONTENT

Check students' answers to the activity.

SESSION INFORMATION

Week: 29

Sessions: 171, 172

Expected learning outcome: Analyze the electron transfer processes in some simple oxide-reduction reactions in daily life and industry.

Reflect, Explain and Share

Ions or radicals and their oxidation number

Individually, check your periodic table and calculate the oxidation number of the following ions or radicals:

Name	Formula	Oxidation number	Name	Formula	Oxidation number
Chlorate	ClO_3		Nitrite	NO_2	
Bromide	BrO_2		Phosphate	PO_4	
Iodate	IO_3		Carbonate	CO_3	

Copy your findings on a card and compare it with your classmates'. Correct it if needed and keep it in your portfolio of evidence..

FIG. 4.26 A part of the gases produced by cars are nitrogen monoxide.

There are many chemical reactions, such as the ones we have studied, but the oxide-reduction reactions are characterized by the change of the oxidation number of some atoms. Therefore, to find out if a reaction is redox, analyze the equation and the oxidation numbers of the reactants and the products.

In the air, there is a mixture of several gases; among them nitrogen and oxygen. In their normal conditions, they do not combine, If they are at high temperatures, they react, creating nitrogen monoxide, which eventually forms nitric acid.

Today, this reaction process is an environmental problem, because there are millions of motor cars and other technological products that work at high temperatures, and since they are in touch with atmospheric gases, they produce highly toxic amounts of nitrogen monoxide (NO), which is also a gas and it mixes with air. It is a highly reactive compound that in the presence of oxygen, transforms into nitrogen dioxide (NO_2) (Fig. 4.26). Nitrogen monoxide as well as nitrogen dioxide are atmospheric pollutants, that when combined with rainwater, react and form nitric acid (HNO_3), which contaminates the soil.

Let's examine the chemical changes that take place with their equations:

$$N_2 + O_2 + \text{high temperature} \rightarrow 2\,NO$$

The oxidation number of nitrogen before the reaction is zero and +2 after losing two electrons, thus becoming oxide, while on the other hand, it went from zero to −2 because it gained two nitrogen electrons and it was reduced; due to this situation, the reaction will be an oxide-reduction reaction.

The second event that takes place is the nitrogen monoxide oxidation:

$$2NO + O_2 \rightarrow 2NO_2$$

The oxidation number of nitrogen goes from +2 to +4, it loses two more electrons, so it oxidizes, while atmospheric oxygen goes from zero to −2 and reduces: this is also a redox reaction.

The last reaction in the series of events is the formation of nitric acid:

$$3NO_2 + H_2O \rightarrow 2HNO_3 + NO$$

In this case, the reaction is an oxide-reduction reaction, nitrogen which forms the nitric acid, loses one more electron and achieves the maximum level of oxidation, going from +4 to +5, while the nitrogen that forms the nitrogen monoxide is reduced, going from +4 to +2 by gaining two electrons.

Curious Facts

Some years ago sulfur was added to gasoline in cars as antiknock, which increased the formation of acid rain with sulfur oxide. Therefore, the antiknock components were changed but there were still a lot of nitrogen oxides in the air. New cars include a catalytic converter that reduces said emissions; but since they do not last very long, they have to be changed regularly.

To integrate

An example of the practical uses of the redox reactions to help the law is the use of the alcoholmeter. A large number of car accidents happen because some people drive under the influence of alcohol,

CONTENT DELIVERY

Start: Have students read the information on pages 128 and the top of page 129.

Development: Students should do the activity in the section *Closing Up!*

Closing: Go over their answers. You will find the answer key on page 161.

Homework: Organize teams of four or five students. Each team will bring the materials that are listed on page 129.

SKILLS DEVELOPMENT

Logical/Mathematical skills: Finding relations, doing operations.

EVALUATION OF CONTENT

Check students' answers to the activity.

which is why there are laws to limit the amount of alcoholic beverages that drivers can drink; the limit is of 0.40 mg/L of alcohol in blood and to measure it, a device based on oxide-reduction reactions is used. This device contains a potassium dichromate dissolution with an orange color, that in the presence of alcohol is reduced to ions Cr + 3, of a greenish color, while the ethanol oxides and forms acetic acids.

The amount of dichromate is calibrated to react when the limit is exceeded, so if it changes color, the driver will be sanctioned.

Closing up!

Copy the next examples in your notebook and individually obtain the oxidation numbers of each of them. Underline with one color the ones that oxidize and with another color the ones that reduce.

$Fe_2O_3 + 3H_2 \rightarrow 2Fe + 3H_2O$

$Ca_3(PO_4)_2 + 3SiO_2 + 5C \rightarrow 3CaSiO_3 + 5CO + 2P$

$3KClO \rightarrow 2KCl + KClO_3$

$Cl_2 + 2KOH \rightarrow KCl + KClO + H_2O$

$CuO + H_2 \rightarrow Cu + H_2O$

$2FeCl_2 + Cl_2 \rightarrow 2FeCl_3$

Compare your results with your classmates and ask your teacher for help if necessary.

Hands on Chemistry!

PRODUCING AN ACID

Introduction

An oxygenated acid is characterized by having hydrogen and oxygen in its molecules, and it can be obtained in a lab by a series of redox reactions.

You will need:

- A 600 to 1000 ml Erlenmeyer flask with a rubber lid.
- An ignition teaspoon.
- A detachment bell.
- 50 ml of water.
- A Bunsen burner.
- A 100 ml beaker with water.
- Sulfur powder.
- pH paper strips.

Preventive measures:

Wear a lab coat.

- Be careful with fire.
- Avoid breathing the gases that the ignition teaspoon releases.

Procedure

Form teams of four or five members, read carefully each of the instructions and work together.

1. Place a small amount of sulfur powder on the ignition teaspoon.
2. Prepare the Erlenmeyer flask with 50 ml of water.
3. Turn on the Bunsen burner on the detachment bell and bring the teaspoon with sulfur closer.
4. When the sulfur starts changing its color and emits yellowish gases move the teaspoon away from the fire, place it inside the flask without touching the water; wait until it fills up with gases released from sulfur.
5. Take the teaspoon out of the flask and close it with the lid to avoid losing the gases; at the same time, immerse the teaspoon in the beaker with water to stop the reaction.
6. Shake the flask so that the sulfur gases make contact with the water until they are completely diluted.
7. You now have a sulfuric acid solution; to prove it, use one of the pH paper strips and observe what happens.

Explain

This process is similar to the one that was described before to form nitric acid, so you can use it as a reference. Write a report where you answer the following questions. You may take pictures of the procedure to illustrate your report. Keep your work in your *Hands on Chemistry!* portfolio of evidence.

1. Which compound was formed when you exposed the sulfur to fire?
2. What reactions did you observe? Write down the equations with the help of your teacher.
3. Based on your equations identify the atoms of the elements that became oxidized and reduced.
4. Remember to include the sources of information you consulted.

SESSION INFORMATION

Week: 29

Sessions: 173, 174

Expected learning outcome: Analyze the electron transfer processes in some simple oxide-reduction reactions in daily life and industry.

CONTENT DELIVERY

Start: Check that teams have all they need to do the experiment.

Development: Monitor their work while taking into account all possible precautions. Help them develop the experiment by showing them what to do step by step. Do not leave teams behind.

Closing: Students should write a report about the experiment; it is introduced in the subsection *Explain*.

Homework: During the following week students will be presenting their unit project. Remind them to look at the notes and prepare it.

SKILLS DEVELOPMENT

Logical/Mathematical skills: Experimenting.

Interpersonal skills: Working as a team member.

Writing skills: Writing reports.

EVALUATION OF CONTENT

Check that all students actively participate in the experiment elaboration; check students' reports.

SESSION INFORMATION

Week: 30

Sessions: 175 - 180

Expected learning outcome: Apply unit content in order to build a project.

CONTENT DELIVERY

Start: Briefly explain what you will evaluate in their presentations: Relevant, clear information, visuals, comprehension-check questions and further information.

Development: Students should present their projects. Assign time according to your class length. Help as necessary.

Closing: Students should ask their comprehension-check questions to their partners. Then, ask them to self-evaluate their presentations using the same presentation parameters described in the projects rubrics.

Project: *Explore, Experiment and Experience. Integration and Application of Knowledge*

FIG. 4.27 Corrosion is a big issue in humid regions or areas close to oceans and bodies of water.

The dynamics of chemical reactions is highly connected to our daily lives and keeps us alive., chemical transformations depend on the flow of energy and matter that all living beings need to live; also the balance of ecosystems depends on the adequate group of chemical changes. Chemical transformations also affect our technological societies by manufacturing devices that deteriorate them or impact the environment.

Planning a project → **Introduction**

Work in small groups. You will need different sources of information: portfolio of evidence, notebooks, textbook, etc. Discuss and choose one of the following questions for your project:

- How can we avoid corrosion? (Fig. 4.27).
- Which is impact of fuels and what are some alternative solutions? (Fig. 4.28).

FIG. 4.28 The use of fuel has dangerous consequences, especially for big cities where it is used in large amounts.

The central question you choose to develop your project, must respond to personal concerns, problematic situations that you, your family or community face and the opportunities you have to develop proposals that may help you solve one or more of these situations.

Use the following table as a reference and example of how to create the questions for the topic you chose.

Question	Answer	Source
Are there important corrosion issues in your surroundings? What are they?		
Which are the chemical products derived from combustion that damage the environment?		
Is the use of combustion an environmental problem in your community? Why?		
Which methods are used to avoid the corrosion of materials?		
Which fuels are used in your community?		
Which are cheaper and friendlier alternatives to avoid the corrosion of materials?		
In order to protect the environment, which alternatives can you apply in your community to save combustion and use new sources of energy?		
What impact will either of these topics have in your community?		
In case none of the topics suggested satisfy you and your team, and based on the content of this unit, what other questions would you suggest to ask in your project?		
Explain your choice for any of the topics or questions and the situations it would help you solve.		

Once you have chosen a topic, it is essential to consider what type of project you will be working on, you could do a science, technological or civic project but in agreement with your teammates (Fig. 4.29, page 131). Use the table from Unit 1 page 38, copy it in your notebook as guide to make the appropriate decisions.

Establish your goals and hypothesis clearly. You must prepare questions that lead you to what you need to know, what you want to know and what you want to contribute, keeping in mind a sustainable development.

SKILLS DEVELOPMENT

Reading skills: Scanning.

Interpersonal skills: Teaching others.

Critical thinking skills: Formulating questions.

Listening skills: Understanding the message.

Metacognitive skills: Delivering content, self-monitoring, self-evaluating their presentation.

EVALUATION OF CONTENT

Follow the projects rubrics, Teacher's Guide page 160.

SESSION INFORMATION

Week: 30

Sessions: 175 - 180

Expected learning outcome: Apply unit content in order to build a project.

FIG. 4.29 In a team project, everyone's opinion is important.

FIG. 4.30 In scientific work, it is essential that experiments answer the hypothesis.

Planning a project ➔ Development

To plan your activities it is essential to create a schedule. Use the table in Unit 1 page 38 as a guide to assign activities, the time it will take and the person responsible for each activity.

During the development of the project, you will do different activities. You could plan research in which you test several methods to avoid corrosion. Create a survey in which you ask the affected population about the corrosion process, the economical loses and the benefits of applying a preventive measure.

Based on the information you have, you can now design activities, experiments and products as part of the objectives you have.

In a science project (Fig. 4.30) every experiment should be outlined according to the needs of each case, as well as the conditions and the resources you are working with. Every technological project should fulfill certain parameters, such as effectiveness, durability, permanence and a cost benefit analysis. The civic project (Fig. 4.31) should consider the particular conditions of the community to solve social problems, create awareness and change habits to create sustainable and economical practices.

A part of the development of the project is obtaining results; a good option is to create tables to draw graphics and models so the analysis will be clearer. (Fig. 4.32).

With the information you gathered, you will be able to analyze and reflect as a team if you achieved your proposals and if your hypothesis is valid. You can also specify which are your future expectations and in which extent.

Remember that each project requires planning and a specific and well-defined development.

FIG. 4.31 In social undertakings it is necessary to inform and raise awareness throughout the community.

FIG. 4.32 Creating a graph is important for the analysis process of the results.

Planning A project ➔ Closing

To completely finish your activities, it is important to analyze the results, so that you can reach some conclusions. The results will also allow you to validate or reject your hypothesis and suggest new things in the future. The analysis is based on the information from tables and graphics.

Every research, discovery, opinion or proposal, needs to be communicated to be valid. It is important to tell the rest of the teams how you will communicate your results. As we mentioned in the previous units, there are many ways to do (Fig. 4.33).

FIG. 4.33 Communicating your results is convenient to spread knowledge.

CONTENT DELIVERY

Start: Briefly explain what you will evaluate in their presentations: Relevant, clear information, visuals, comprehension-check questions and further information.

Development: Students should present their projects. Assign time according to your class length. Help as necessary.

Closing: Students should ask their comprehension-check questions to their partners. Then, ask them to self-evaluate their presentations using the same presentation parameters described in the projects rubrics.

SKILLS DEVELOPMENT

Reading skills: Scanning.

Interpersonal skills: Teaching others.

Critical thinking skills: Formulating questions.

Listening skills: Understanding the message.

Metacognitive skills: Delivering content, self-monitoring, self-evaluating their presentation.

EVALUATION OF CONTENT

Follow the projects rubrics, Teacher's Guide page 160.

SESSION INFORMATION

Week: 30

Sessions: 175 - 180

Expected learning outcome: Apply unit content in order to build a project.

CONTENT DELIVERY

Start: Briefly explain what you will evaluate in their presentations: Relevant, clear information, visuals, comprehension-check questions and further information.

Development: Students should present their projects. Assign time according to your class length. Help as necessary.

Closing: Students should ask their comprehension-check questions to their partners. Then, ask them to self-evaluate their presentations using the same presentation parameters described in the projects rubrics.

Project: Explore, Experiment and Experience. Integration and Application of Knowledge

We suggest the following:

- A panel of specialists (Fig. 4.34).
- An online blog (Fig. 4.35).

FIG. 4.34 In a specialists' panel experts gathered to talk about their opinions and discoveries.

The first suggestion requires special organization. A panel is characterized by the organization of a table with the presence of several topic specialists, a moderator, and an audience that listens and occasionally participates with comments or questions.

Each specialist will have time to talk about their points of view and the solutions you suggest to solve problems explaining the associated chemical reactions. The moderator (which may be your teacher) will ask questions to create controversy, having specialists answer. From this moment on, the audience may ask questions or make comments.

The format of the event is determined by the time and the time depends on the amount of people participating, and the amount of interventions. The key moments are:

- Welcoming and introduction of specialists by the moderator.
- Introduction by the moderator.
- Intervention by panelists.
- Controversy stage.
- Questions and comments by the audience
- Conclusion and farewell by the moderator.

Another suggestion to spread your information is by using a blog online. In this case the team or the teacher should be in charge of creating and administrating the blog, you can create yours at: www.blogspot.com.

In this blog, each team should show their results and create a discussion using questions suggested by the administrator; promote the website between family, friends, neighbors, and acquaintances.

At this point, the achievements of the team's project, the personal development, the new knowledge, the abilities you have acquired will be evaluated (Fig. 4.36).

Remember that the evaluation is about the achieved goals during the project.

ICT

To learn more about creating a blog, visit this website: http://www.slideshare.net/MymaLee/como-hacer-un-blog-utilizando-wordpress

FIG. 4.35 Electronic means of information and communication allow interaction between people.

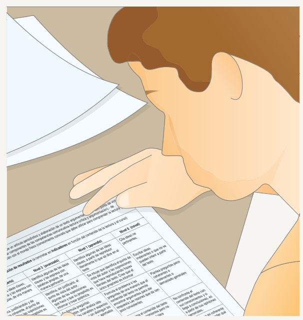


FIG. 4.36 Part of the evaluation process is to reflect about our attitude and the role we play in a team.

SKILLS DEVELOPMENT

Reading skills: Scanning.

Interpersonal skills: Teaching others.

Critical thinking skills: Formulating questions.

Listening skills: Understanding the message.

Metacognitive skills: Delivering content, self-monitoring, self-evaluating their presentation.

EVALUATION OF CONTENT

Follow the projects rubrics, Teacher's Guide page 160.

Evaluation

Read the following text carefully:

Case study: Acidification at El Tajín, Mexico.

Located in the Papantla Municipality of Olarte in Veracruz, El Tajín was one of the most important cities within the gold zone in Mesoamerica. The archaeological site has buildings from 100 a.C. to 600 and 1150 a.C., when the city reached its maximum stage and extension.

Humberto Bravo Álvarez and a team from the environmental pollution section of the *Centro de Ciencias de la Atmósfera* from the *Universidad Nacional Autónoma de México*, studied the effect of acid rain in archeological and historical sites at El Tajín. From August 18, 2002 to April 9, 2003, they gathered 40 samples of rainwater at the site and applied atmospheric path analysis to each sample to determine the route of aerial transportation. The path models were used to identify the regions above the wind (windward) with the probability of helping the concentration of pollutants on the leeward receptors. The analysis showed that 85% of the rain from which the samples were taken at El Tajín corresponded to acid rain (pH < 5.62). The analysis of the path of this acid phenomenon registered a great variation, which indicated that there was not apparent directional reference of transport during those events, and it suggested the importance of local sources. The archeological site of El Tajín is surrounded by possible sources of acid rain, such as petroleum burning industries with a high content of sulfur (like electric centrals and refineries). These sources and even distant ones can cause the toxic acidity of rain at El Tajín.

FIG. 4.37 Image of "Nichos" pyramid, El Tajín, Veracruz, México. Picture: Luis Castro.

Based on what you read, choose the correct answer.

1. Why is El Tajín so important?

a) Because it is a port city in the state of Veracruz.
b) Because it is one of the most important archeological cities in the Mesoamerican gulf.
c) Because it is a city where artistic festivals take place.
d) Because it is an industrial city of the Mexican golf.

2. What are Humberto Bravo and his team studying?

a) The action of river flows within rain season in El Tajín.
b) The effects of wind and hurricanes on the Veracruz coast.
c) The effect of time within archeological sites in the state of Veracruz.
d) The effects of acid rain on the archeological sites of El Tajín.

3. What did the researchers detect in the rain analysis from El Tajín?

a) That most of the rains lack intensity.
b) That most of the samples where acid rain.
c) That most of the rains of the regions were abundant.
d) That none of them have an acid pH.

4. About wind direction, what were their results?

a) There was no direction preference; the wind did not always come from the same direction.
b) That there is a directional preference, the wind always blows from north.
c) That in the region there is minimum wind so the rain clouds do not travel as much.
d) That the dominant winds of this region come from the Mexican gulf every season.

5. What were their conclusions?

a) That rain in El Tajín is free of acid pollutants, regardless of the sulfur industries nearby use.
b) That the presence of acid rain in El Tajín is due to regional pollutants that are not related to petroleum.
c) That the acid rain that falls in El Tajín comes from industries, even though they are far away, that burn petroleum with a high level of sulfur.
d) That regardless of the presence of industries that burn petroleum with sulfur, El Tajín is free of acid rain due to the wind action.

Underline the parts of the text from where you got the answers, share your answers with one of your classmates and talk about the reason why they are correct or incorrect; in case of disagreement, look for the necessary information that would help you both agree.

Evaluate your performance throughout this unit, mark with a check (✓) the options that better represent your achievements.

SESSION INFORMATION

Week: 31

Sessions: 181 - 186

EVALUATION

CONTENT DELIVERY

Start: Students should answer page 133 prior to taking the unit assessment. Go through the answers; help them with techniques to study content they do not clearly remember; such as mind maps, questionnaires, partner discussion, drawings, etc.

Development: Students are to take the unit assessment. You can find it in the Teacher's Guide pages 153 to 155 along with the answer key.

Closing: Check their assessments, record the score and provide with feedback. You might want to use the Attendance and Evaluation formats that you can find the Teacher's Guide pages 158 to 160.

SKILLS DEVELOPMENT

Metacognitive skills: Identifying topics to go through.

EVALUATION OF CONTENT

Check the answer key to the unit assessment on page 156.

SESSION INFORMATION

Week: 31

Sessions: 181 - 186

SELF EVALUATION

CONTENT DELIVERY

Start: Explain to students why evaluation is important. It is the only way to improve the way of learning.

Development: Get students to answer the self-evaluation and help them reflect upon their learning process.

Closing: Provide with some feedback.

Evaluation

SELF-EVALUATION

	Indicators	Always	Usually	Sometimes	Never
COMPREHENSION	I can ask questions that integrate the contents studied in the unit.				
	I can relate the topics I study to daily events and other familiar situations.				
	I can understand the content covered in class without problems.				
	I can identify my mistakes, difficulties and limitations, and propose actions to overcome them.				
	I can express my point of view and opinion as a contribution to the collective analysis.				
	I can solve problematic situations by applying what I learned.				
SCIENCE SKILLS	I brought to class, all the materials I needed.				
	I did all my work in a neat and clean way.				
	I can explain, share, communicate and contrast my ideas with others.				
	I can ask and answer questions that allow me to integrate the contents I studied in the unit.				
	My hypotheses are consistent and correspond to the activities and the topics in the unit.				
	I can analyze the information I get from various media, and select only the relevant one to reach the purposes I have.				
	I am able to choose the most convenient strategy to solve problems.				
	I can design instruments to register and order data obtained from the activities.				
	I can analyze results to draw conclusions.				
	I can draw conclusions based on the organization and order of the information I have available.				
ATTITUDES	I can successfully do and finish all my work.				
	When I need help, I ask my teacher or my classmates.				
	I'm capable of listening, value, and take into consideration the opinions of others even when they don't agree with mine.				
	I'm honest with the veracity of the information I handle.				
	I can actively participate in a team.				
	I can show solidarity to my classmates.				
	I am a responsible consumer.				
	I propose sustainable behaviors.				
	I show respect for biodiversity.				
	I can prevent diseases and accidents during my activities.				
	I show interest, curiosity, creativity and imagination in every activity I make.				

SKILLS DEVELOPMENT

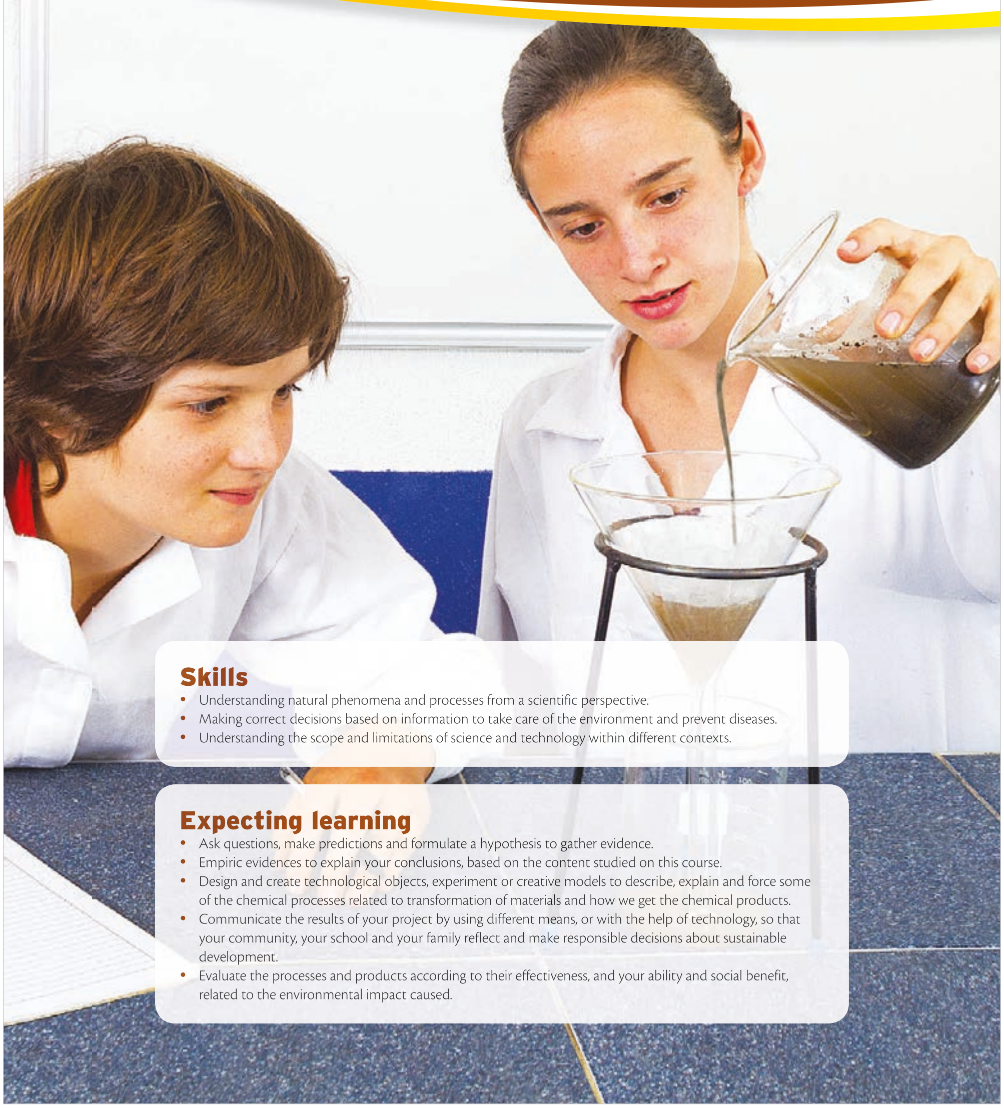
Metacognitive skills: Self-monitoring, self-evaluating.

EVALUATION OF CONTENT

Students should get their self-evaluation instrument checked by the teacher.

Chemistry and Technology

UNIT 5



Skills

- Understanding natural phenomena and processes from a scientific perspective.
- Making correct decisions based on information to take care of the environment and prevent diseases.
- Understanding the scope and limitations of science and technology within different contexts.

Expecting learning

- Ask questions, make predictions and formulate a hypothesis to gather evidence.
- Empiric evidences to explain your conclusions, based on the content studied on this course.
- Design and create technological objects, experiment or creative models to describe, explain and force some of the chemical processes related to transformation of materials and how we get the chemical products.
- Communicate the results of your project by using different means, or with the help of technology, so that your community, your school and your family reflect and make responsible decisions about sustainable development.
- Evaluate the processes and products according to their effectiveness, and your ability and social benefit, related to the environmental impact caused.

SESSION INFORMATION

Week: 32

Session: 187

Expected learning outcome: Identify the final project requirements and format.

CONTENT DELIVERY

Start: Explain to students that for the final unit they will be preparing their project.

Development: Explain the expected learning outcomes and how you will evaluate them.

Closing: Organize teams. They should start their final project by reading pages 136 and 137.

SKILLS DEVELOPMENT

Reading skills: Scanning, reading for detail.

Interpersonal skills: Working as team members.

EVALUATION OF CONTENT

Check students' answers to the first set of questions.

SESSION INFORMATION

Weeks: 32 – 38

Sessions: 188 – 228

Expected learning outcome: Apply course content in order to develop a project.

CONTENT DELIVERY

Start: During seven weeks, students will be preparing their projects helping themselves with the project preparation notes on pages 136 to 139 and the teacher guidance and advice.

Development: Do continuous follow up on their project procedure and advances.

Project: *Explore, Experiment and Experience. Integration and Application of Knowledge*

FIG. 5.1 Chemical contributions to scientific knowledge are the key to improve the environment.

FIG. 5.2 Synthetic fertilizers may help the soil but they also damage it.

Chemistry, like other sciences, has contributed to the technological development of society.Today, we are facing an enormous challenge: creating a clean world for the new generations to come, so they can have natural resources and decent living conditions (Figs. 5.1 and 5.2). You have the chance to be part of this transformation; you are capable of making informed and responsible decisions about the products you use and avoid; you know what you should modify and you can even solve the problems in your community.

The objective for this final project will allow you to apply the knowledge you have acquired throughout the course, as well as to suggest strategies that can benefit your community. As we did with the projects in the previous units, we will give you some guidelines for you to reach your goal.

ICT

To learn more about natural and synthetic rubber , the process of extraction from the three *Hevea brasiliensis*, vulcanization and the uses of rubber, visit this webpage: http://www.quiminet.com/articulos/el-hule-natural-i-el-hule-sintetico-13873.htm (seen on : July 15, 2013)

Planning a project ➔ Introduction

Work in teams, and choose a question to be the topic of your project:

- How is elastic material synthesized?
- What contributions to chemistry have been generated in Mexico?
- What are the benefits and risks of the use of fertilizers and pesticides?
- What are cosmetics made of and how are they produced? (Fig. 5. 3, page 137.)
- What are some of the properties of products that the Mesoamerican cultures used?
- How is chemistry used in different artistic expressions?
- Can I stop using petroleum derivatives and substitute them with other compounds?

Now organize your team, assign responsibilities and state the reflective question to start your project. Use the following table as a guide.

Question	Answer	Sources of information
What are the characteristics of elastic materials?		
What are the raw materials required to produced elastic materials?		
What are the contributions of the Mexican scientific community to chemical knowledge? Where have these contributions been applied?		
How can we use this contribution to improve the quality of life in your community?		

What are fertilizers and pesticides? What types of fertilizers and pesticides exist?		
What are the uses of fertilizers and pesticides?		
What damages do fertilizers and pesticides cause?		
Which alternatives can we use to avoid fertilizers and pesticides?		
Are there clean fertilizers and pesticides? Which are the benefits they have?		
What are cosmetics?		
Why are cosmetics necessary?		
What raw materials are used to produce cosmetics?		
What kind of damage does the cosmetic industry cause the environment and health?		
What kind of options exist that won't harm the environment when producing, distributing and selling cosmetics?		
Which materials were used by Mesoamerican cultures in their daily habits?		
What knowledge did Mesoamerican cultures have about the transformation and use of matter?		
How did Mesoamerican cultures contribut to modern knowledge?		
How does chemistry participate in the development of art?		
Which chemical applications are practical when using materials for art?		
Which oil derivatives are still used nowadays?		
What environmental damage do materials derived from oil cause?		
What existing products or alternative technologies may be developed to avoid the use of oil derivatives and allow us to keep our quality of life? (Fig. 5.4, page 138.)		
Which are the advantages of transforming habits and avoiding using products derived from oil?		
In case none of the themes suit you, which question could you ask based on the content of this unit?		
Why would you choose each of the main questions?		

After choosing a theme, ask as many questions as possible to select the type of project you will work on. Include all contributions you can make to your community, advantages and disadvantages. Remember to use a chart like the one used in previous units for this purpose (Unit 1, page 38).

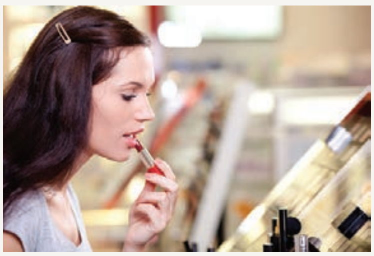


FIG. 5.3 There are some cosmetics that are produced without any synthetic substances.

SESSION INFORMATION

Week: 32 – 38

Session: 188 – 228

Expected learning outcome: Apply the course content in order to develop a project.

CONTENT DELIVERY

Start: During seven weeks, students will be preparing their projects helping themselves with the project preparation notes on pages 136 to 139 and the teacher's guidance and advice.

Development: Do continuous follow up on their project procedure and advances.

SESSION INFORMATION

Week: 32 – 38

Sessions: 188 – 228

Expected learning outcome: Apply the course content in order to develop a project.

Project: *Explore, Experiment and Experience. Integration and Application of Knowledge*

FIG. 5.4 You can avoid using disposable dishes by only washing the dishes you have.

ICT

If you want to learn more about the importance of chemistry in art, visit the web page: http://www.xperimania.net/www/es-pub/xperimania/news/world_of_materials/art_restauration.htm (seen on July 15, 2013)

➔ Expected Learning

Design and create technological objects, experiments or creative models to describe, explain and force some of the chemical processes related to transformation of materials and how we obtain the chemical products.

Planning a project ➔ Development

As in previous units, plan a working schedule for your project. Please consider that this time, you will have more than two weeks to develop your project. You can look back in previous units to use the guiding chart to assign activities, time and responsibilities. You can also use charts, mind maps or any other diagram to register information that you can analyze and create graphs to report results.

You can also include a table like the one below showing the acceptance of your products in your community and support it with a written report showing your research, registration of results and analysis of findings.

Technological object that can be produced	Uses on the community	Acceptance in the community	Effectiveness of the object	Durability	Production costs	Environmental impact
1.						
2.						
3.						
4.						
5.						

➔ Expected Learning

Communicate the results of your project by using different means, or with the help of technology, so that your community, your school and your family reflect and make responsible decisions about sustainable development.

Planning A project ➔ Closing

Because it is the end of the course, we suggest you share and communicate your results outside your school, if possible, to your community. Before you choose how to communicate your projects you should come to an agreement with your team about the communication resource you will use, the parameters, advantages, disadvantages, and the impact of your project in your community.

In previous units we have described different ways and suggestions you could use to communicate your project and results. Feel free to use them or create new ideas to do so, listen to your teammates and agree on how to share your information (Fig. 5.5).

FIG. 5.5 The proper communication of a suggestion can create a change in behavior.

CONTENT DELIVERY

Start: During the following seven weeks, students will be preparing their projects helping themselves with the project preparation notes on pages 136 to 139 and the teacher's guidance and advice.

Development: Do continuous follow up on their project procedure and advances.

FIG. 5.6 Depending on how hard you worked on your project is the level of success you will get.

ICT

In the mexican encyclopedia *Enciclopedia de las Ciencias y la Tecnología en México*, the Organic Chemistry section has a wide history of chemical development in our country:
http://www.izt.unam.mx/cosmosecm/QUIMICA_ORGANICA.html

Expected Learning

Evaluate the processes and products according to their effectiveness, and your ability and social benefit, related to the environmental impact caused.

It is important to consider that communicating your projects and providing well informed results will help people make better decisions about their health and the environment (Fig. 5.6).

Finally, your project should be evaluated in every aspect, therefore we suggest using the following chart.

	Indicators	Yes	Most of the time	Not every time
BEGINNING	Everyone worked on choosing the central questions and the type of project.			
	Everyone worked on the bibliographical research to answer the questions.			
	The team came up with a hypothesis and purpose for the project.			
	Everyone worked on the prediction of results.			
DESIGN AND DEVELOPMENT	Everyone helped with the creation of the chronogram.			
	The task distribution was fair.			
	Everyone's suggestions were taken into account.			
	Everyone worked on their tasks and delivered in time and form.			
	Everyone helped gathering the materials needed for the project.			
	The activities were done by everyone.			
	Everyone helped writing the results.			
	Everyone helped analyzing the results.			
	The conclusions were discussed by everyone.			
	The creation of the report, tables and graphs were done by the whole team.			
COMMUNICATION	The election of the communication resource was discussed by the whole team.			
	Everyone helped with the presentation and organization.			
	Everyone used and improved their abilities to communicate the project to others.			
	You were honest, serious and accurate with the information you presented when you communicated your project.			

Evaluating your project and everyone's performance will help you increase the effectiveness, durability and social benefit of your project, as well as the cost/benefit relation and its environmental impact.

SESSION INFORMATION

Week: 39

Sessions: 229 - 233

Expected learning outcome: Present projects products.

CONTENT DELIVERY

Start: Briefly explain what you will evaluate in their presentations: Relevant, clear information, visuals, comprehension-check questions and further information.

Development: Students should give their presentations. Assign time according to your class length. Help as necessary.

Closing: Students should ask their comprehension-check questions to their partners. Then, ask them to self-evaluate their presentations using the same presentation parameters described in the projects rubrics.

SKILLS DEVELOPMENT

Reading skills: Scanning.

Interpersonal skills: Teaching others.

Critical thinking skills: Formulating questions.

Listening skills: Understanding the message.

Metacognitive skills: Delivering content, self-monitoring, self-evaluating their presentation.

EVALUATION OF CONTENT

Follow the projects rubrics, Teacher's Guide page 157.

SESSION INFORMATION

Week: 39

Session: 234

SELF EVALUATION

Evaluation

Evaluate your performance throughout this unit; mark with a check (✓) the indicator which you have achieved in the correct column.

SELF-EVALUATION					
	Indicators	Always	Usually	Sometimes	Never
COMPREHENSION	I can ask questions that integrate the contents studied in the unit.				
	I can relate the topics I study to daily events and other familiar situations.				
	I can understand the content covered in class without problems.				
	I can identify my mistakes, difficulties and limitations, and propose actions to overcome them.				
	I can express my point of view and opinion as a contribution to the collective analysis.				
	I can solve problematic situations by applying what I learned.				
SCIENCE SKILLS	I brought to class, all the materials I needed.				
	I did all my work in a neat and clean way.				
	I can explain, share, communicate and contrast my ideas with others.				
	I can ask and answer questions that allow me to integrate the contents I studied in the unit.				
	My hypotheses are consistent and correspond to the activities and the topics in the unit.				
	I can analyze the information I get from various media, and select only the relevant one to reach the purposes I have.				
	I am able to choose the most convenient strategy to solve problems.				
	I can design instruments to register and order data obtained from the activities.				
	I can analyze results to draw conclusions.				
	I can draw conclusions based on the organization and order of the information I have available.				
ATTITUDES	I can successfully do and finish all my work.				
	When I need help, I ask my teacher or my classmates.				
	I'm capable of listening, value, and take into consideration the opinions of others even when they don't agree with mine.				
	I'm honest with the veracity of the information I handle.				
	I can actively participate in a team.				
	I can show my classmates solidarity.				
	I am a responsible consumer.				
	I propose sustainable behaviors.				
	I show respect for biodiversity.				
	I can prevent diseases and accidents during my activities.				
	I show interest, curiosity, creativity and imagination in every activity I make.				

CONTENT DELIVERY

Start: Explain to students why evaluation is important. It is the only way to improve the way of learning.

Development: Get students to answer the self-evaluation and help them reflect upon their learning process.

Closing: Provide with some feedback.

SKILLS DEVELOPMENT

Metacognitive skills: Self-monitoring, self-evaluating.

EVALUATION OF CONTENT

Students should get their self-evaluation instrument checked by the teacher.

Chemistry

Unit **1 Assessment**

Date: ______________________________

Name: ______________________________

UNDERLINE THE CORRECT ANSWER

1. Chemical changes of matter are those in which:

a) Matter changes its shape, volume and density.

b) There are no changes in the structure of matter.

c) The material retains its thermal properties.

d) The properties and structure of matter change.

2. Which of the following statements is correct?

a) The study of chemistry is irrelevant in my daily life.

b) The obtained technological products are chemically harmful.

c) The study of chemistry has favored technological development.

d) Chemical technology produces necessarily negative changes.

3. All these phenomena are chemical transformations, except:

a) Combustion.

b) Corrosion.

c) Photosynthesis.

d) Evaporation.

4. When speaking of chemical substances, it is fundamental to determine if they are poisonous to living things or not according to:

a) Dose consumed.

b) Their nature: natural or synthetic.

c) Concentration.

d) Their acidity: acidic or alkaline.

5. Scientific models include the following characteristics except:

a) They are always valid; not according to the experimental evidence.

b) They are representations of reality with central aspects.

c) They are simplified schematics of the phenomenon under study.

d) They are constructed based on the behavior of the variables of interest.

6. An example of a chemical model would be:

a) The water cycle (or hydrological cycle).

b) The origin of species evolution theory.

c) The periodic table of elements.

d) Kepler's laws of planetary motion.

7. In the following risks of drinking alcohol, what is the direct impact on health?
   a) The possibility of being an object of ridicules at a party, meeting or bar against acquaintances or strangers.
   b) The possibility of confusion, motor incoordination, liver damage or being in coma.
   c) The possibility of suffering or causing a car accident by decreasing a reflex response and overconfidence.
   d) The possibility to face vehicular traffic violations, administrative, criminal or even jail.
8. If we say that a level of carbon monoxide in the air of 1500 ppm is "immediately dangerous to life and health", we are referring to:
   a) The toxicity of Co in the blood.
   b) Co permeability in membranes.
   c) Co viscosity in hemoglobin.
   d) The concentration of Co in the air.
9. The alcohol concentration in a beverage is in degrees, and it is a measure of volume / volume. Thus, a drink such as vodka can have a graduation of 50 °. This means that:
   a) There are 50 ml of alcohol in 100 ml of vodka.
   b) There are 50 ml of alcohol in 100 g of vodka.
   c) There are 50 mg of alcohol in 100 l of vodka.
   d) There are 50 g of alcohol in 100 l of vodka.
10. In the next state of aggregation, molecules or particles are strongly bound together by cohesion forces, and they have a definite volume and shape:
    a) Gas.
    b) Liquid.
    c) Plasma.
    d) Solid.
11. In the next state of aggregation, molecules or particles are slightly joined together by cohesion forces, and they have a definite volume and an indefinite form:
    a) Gas.
    b) Liquid.
    c) Plasma.
    d) Solid.
12. Sublimation is a transition state:
    a) Liquid to gas.
    b) Solid to gas.
    c) Liquid to solid.
    d) Solid to liquid.
13. Mayonnaise is an example of:
    a) Crystalline solid.
    b) Colloidal gel.
    c) Colloidal emulsions.
    d) Colloidal foam.

14. Which of the following materials is an example of suspension?

a) Tamarind water.

b) Hibiscus water.

c) Homogenized milk.

d) Refreshment gas.

15. Which of the following is a homogeneous mixture?

a) Vegetable soup.

b) Filing of iron and copper.

c) Caesar dressing.

d) Chamomile tea.

16. Heterogeneous mixtures are those that:

a) Can be easily separated.

b) Components are distinguished at first glance.

c) They are separated by crystallization.

d) Components are not distinguished at first glance.

17. What method of separating mixtures would you use to separate a mixture of cooked pasta in hot water?

a) Evaporation.

b) Filtration.

c) Decanting.

d) Recovery.

18. The principle of mass conservation says that:

a) Energy is neither created nor destroyed; it is only turned into other forms.

b) Matter is indivisible, so it is preserved in a process of transformation.

c) Energy is neither created nor destroyed in all atomic processes.

d) The total mass of the reactants is equal to the total mass of products.

19. Distilled water is an example of:

a) Homogeneous mixture.

b) Dissolution.

c) Pure substance.

d) Alloy.

20. How would you separate the gas from the liquid in a soda?

a) By decantation.

b) By centrifugation.

c) By solubility difference.

d) By extraction or precipitation.

Chemistry

Unit **1 Assessment** Answer Key

1. d
2. c
3. d
4. a
5. a
6. c
7. b
8. d
9. a
10. d
11. b
12. b
13. c
14. a
15. d
16. b
17. b
18. d
19. c
20. c

Chemistry

Unit **2 Assessment**

Date: ______________________________

Name: ______________________________

UNDERLINE THE CORRECT ANSWER

1. The atomic mass of an atom is:

a) The addition of the mass of protons, neutrons and electrons.

b) The addition of the mass of protons and neutrons.

c) The addition of the mass of protons.

d) The addition of the mass of neutrons.

2. The atomic number of an atom is:

a) The total quantity of protons, neutrons and electrons.

b) The total quantity of protons and neutrons.

c) The total quantity of protons.

d) The total quantity of neutrons.

3. The valence of an atom depends on:

a) The total number of electrons in the atom.

b) The difference between the total neutrons and the total protons.

c) The difference between the total electrons and the total protons.

d) The number of electrons in the external orbit.

4. The elements that belong to the same group in the periodic table have all of the following properties in common except for:

a) The atomic mass.

b) The valence or valences.

c) The physical properties.

d) The chemical properties.

5. The elements that belong to the same period in the table of elements are similar in:

a) The atomic mass.

b) The valence or valences.

c) The physical properties.

d) The chemical properties.

6. The following order of elements: aluminum, silicon, phosphorus, sulfur, chlorine and argon is defined because of:

a) Their valence or valences.

b) Their table period.

c) Their atomic number.

d) Their group in the table.

7. All of the following are non-metals properties, except for:

a) Tendency to form anions in aqueous solutions.

b) Good thermal and electric conductors.

c) Usually found in pure state and opaque.

d) Liquefied at relatively low temperatures.

8. Which of the following is metal?

a) Fluorine.

b) Bromine.

c) Iodine.

d) Osmium.

9. According to the octet rule, which group of elements is inert since it has the external electronic layer full?

a) Noble gases.

b) Lanthanides.

c) Alkali metals.

d) Halogens.

10. Which elements in the periodic table are the only two that do not fulfill the octet rule, but the dual or duo?

a) Oxygen and carbon.

b) Silver and platinum.

c) Uranium and iridium.

d) Hydrogen and helium.

11. The atom whose atomic number is different from the proton number is called:

a) Ion.

b) Anion.

c) Isotope.

d) Cation.

12. What changes in an element atoms when they turn into ions?

a) The number of electrons.

b) The number of neutrons.

c) The number of protons.

d) The atomic number.

13. Covalent bonds are formed between:

a) Non-Metals and non-metals.

b) Non-metals and metals.

c) Metals and metals.

d) Anions and cations.

14. What happens with the valence electrons in the atoms of participant elements in ionic bonds?

   a) They detach from atoms and they are shared.
   b) They transfer from metal to non-metal.
   c) They detach from non-metals and are set free.
   d) They are shared in pairs.

15. The resulting substance in a covalent bond is called:

   a) Solid crystal.
   b) Ionic compound.
   c) Molecular compound.
   d) Metallic compound.

16. Who from the following scientists established the elements properties in periodic function of their atomic mass?

   a) Dimitri Mendeleiev.
   b) John Newlands.
   c) Stanislao Canizzaro.
   d) John Dalton.

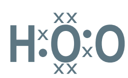
17. What is proposed in the atomic "plum-pudding model" by Thomson?

   a) Electrons can only have certain energy values, that is, energy is quantized.
   b) Atoms make all matter, they are indivisible and tiny.
   c) Atoms look like a tiny solar system where the nucleus is in the center and electrons revolve around it.
   d) Atoms have a continuous part with positive charge and negative charges are scattered around it.

18. Why carbon has a negative valence -4 and a positive valence +4?

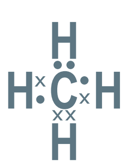
   a) Because it has 4 electrons in the external orbit; therefore, it accepts up to 2 electrons from another atom.
   b) Because it has 4 electrons in the external orbit; therefore it releases up to 2 electrons from another atom.
   c) Because it has 4 electrons in the external orbit so that it is equally probable that it accepts or releases 4 electrons from another atom.

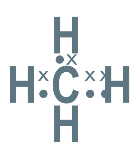
19. What compound corresponds to the following Lewis diagram?

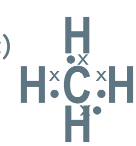


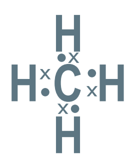
   a) Hydrogen peroxide.
   b) Hydrogen monoxide.
   c) Hydro ion.
   d) Hydroxide anion.

20. Choose the Lewis diagram that corresponds to the methane molecule whose chemical formula is CH4:

a) 

b) 

c) 

d) 

Chemistry

Unit **2 Assessment** Answer Key

1. b
2. c
3. d
4. a
5. a
6. c
7. b
8. d
9. a
10. d
11. c
12. a
13. b
14. b
15. c
16. a
17. d
18. c
19. b
20. d

Chemistry
Unit **3 Assessment**

Date: ______________________________

Name: ______________________________

UNDERLINE THE CORRECT ANSWER

1. Coefficients that balance a chemical reaction equation are:

a) The sum of the masses of protons, neutrons and electrons.

b) The sum of the masses of protons and neutrons.

c) The sum of the masses of protons.

d) The sum of the masses of neutrons.

2. Chemical equations balancing that model reactions are based upon:

a) The principle of conservation of energy.

b) The principle of conservation of charge.

c) The principle of conservation of mass.

d) The principle of conservation of valence.

3. Electrons in the valence layer that may form bonds are the ones that are:

a) Ionized.

b) In orbit 2s.

c) In orbit 1p.

d) Free pairs.

4. Polar molecules are the ones that:

a) Present magnetic properties and have a north and south pole.

b) Have neutral charge but distributed in a non-homogenic way.

c) Present unbalanced electric charge and form ionic bonds.

d) Have specific chemical properties about form.

5. All of the following magnitudes are in the nano scale, except for:

a) An atom radium.

b) A cell mass.

c) An electron mass.

d) A proton mass.

6. In which scale would you set the distance between your house and school?

   a) Nano.

   b) Micro.

   c) Macro.

   d) Astronomic.

7. A proton mass expressed in kg is: 0.000000000000000000000000001672621638 kg. Which of the following is the correct scientific notation?

   a) $1.672621638 \times 10^{-26g}$.

   b) $1.672621638 \times 10^{-31}$g.

   c) $1.672621638 \times 10^{27}$g.

   d) $1.672621638 \times 10^{-27}$g.

8. The mole is the fundamental unit for the ____________________ magnitude.

   a) Molecular mass.

   b) Atomic mass.

   c) Atomic number.

   d) Substance quantity.

9. The idea that equal volume of different gas substances, measured under the same conditions of pressure and temperature, contains the same number of particles is known as:

   a) The principle of conservation of mass.

   b) Gay Lussac Law.

   c) Avogadro's number.

   d) Dalton Atomic Model.

10. How many atoms are there in the carbon isotop 12 in 12g of pure substance?

    a) 6.02×10^{23} atoms.

    b) 12 moles of atoms.

    c) 6.02×10^{12} atoms.

    d) 12×10^{23} atoms.

11. All of the following statements about the Avogadro's number and the mole unit are correct, except for:

    a) 1 mole of something is 6.022×10^{23} elemental units of that thing.

    b) In 12 g of atomic hydrogen there is 1 mole of hydrogen atoms.

    c) The mole is the number of atoms in Carbon 12 that there are 12g in that substance.

    d) The Avogadro's number is used to switch from a macro to a nano scale.

12. The Atom Mass Unit AMU is defined as:

a) 1/12 the mass of a carbon 12 isotope.

b) The atomic mass of carbon 12.

c) The sum of all atomic numbers of carbon isotopes.

d) The total carbon 12 atoms in 1g.

13. The molecular mass of water is:

a) 18 g.

b) 18 moles.

c) 18 amu.

d) 18×10^{23} g.

14. The mass of one water mole is:

a) 18 g.

b) 18 moles.

c) 18 amu.

d) 18×10^{23}g.

15. The mass of 1 carbon dioxide mole is:

a) 16 g.

b) 32 g.

c) 12 g.

d) 44 g.

16. The elements C, H, O, N, S and P are known as:

a) Organic elements.

b) Primary bioelements.

c) Oligoelements.

d) Vital elements.

17. Proteins are formed by simpler structural elements known as:

a) Aminoacids.

b) Carbohydrates.

c) Lipids.

d) Polisaccherides.

18. Metalic elements such as K, Na, Cl, Fe and Ca present in small quantities in living organisms, whose excess or lack may cause health damage are:

a) Primary bioelements.

b) Oligoelements.

c) Vitamins.

d) Minerals.

Chemistry

Unit **3 Assessment** Answer Key

1. a
2. c
3. d
4. b
5. b
6. c
7. d
8. d
9. c
10. a
11. b
12. a
13. c
14. a
15. d
16. b
17. a
18. b

Chemistry
Unit **4 Assessment**

Date: ____________________

Name: ____________________

UNDERLINE THE CORRECT ANSWER

1. A substance, considered acid has a ________________ flavor.

- **a)** Bitter.
- **b)** Sweet.
- **c)** Sour.
- **d)** Bittersweet.

2. A substance with capacity to donate a proton when reacting with water is:

- **a)** A base.
- **b)** A salt.
- **c)** An acid.
- **d)** A hydronium.

3. A substance considered a base has a ________________ flavor.

- **a)** Bitter.
- **b)** Sweet.
- **c)** Sour.
- **d)** Bittersweet.

4. The process through which a molecule separates in ions when it is in contact with water is known as:

- **a)** Electrification.
- **b)** Ionization.
- **c)** Dissociation.
- **d)** Decomposition.

5. Sodium hydroxide ($NaOH$) is:

- **a)** A base.
- **b)** A salt.
- **c)** An acid.
- **d)** A hydroxil.

6. Arrhenius theory is quite adequate to explain behavior in water of:

- **a)** Strong electrolites.
- **b)** Light electrolites.

c) Neutral electrolites.

d) All kinds of electrolites.

7. The most probable pH value for an extremely acid solution is:

a) 2

b) 6

c) 7

d) 14

8. The most probable pH value for an extremely basic solution is:

a) 9

b) 3

c) 7

d) 14

9. pH is a scale that measures concentration of_______________ ions.

a) H^+

b) OH^+

c) OH^-

d) H

10. pH in a sodium bycarbonate at a concentration of 1×10^{-8} M (mole/L) is:

a) -8

b) -6

c) 6

d) 8

11. An acid is a substance that:

a) Transfers electrons.

b) Transfers protons.

c) Accepts protons.

d) Accepts electrons.

12. An ion element or molecule oxidizes if:

a) It gains electrons.

b) It loses electrons.

c) It gains protons.

d) It loses protons.

13. The raise in the oxidation number of an element means that:

a) It is reduced.

b) It is neutralized.

c) It is oxidized.

d) It is crystalized.

14. In the past, it was believed that elements, ions or molecules oxidize when interacting with:

a) O_2

b) H_2O

c) H_3O+

d) O_3

15. The oxidation number of each hydrogen atom in a water molecule is:

a) 1

b) -1

c) 2

d) -2

16. The oxidation number in the ion H_3O+ is:

a) +2

b) +1

c) -1

d) -2

17. The oxidation number of an atom in its elemental form is:

a) 1

b) -1

c) 0

d) -2

18. The sum of the oxidation number of elements that form a molecule is:

a) 1

b) -1

c) 0

d) -2

e)

19. Besides oxigen, ________________ is produced in photosynthesis.

a) H_2O

b) O_2

c) $C_6H_{12}O_6$

d) CH_4

20. Besides carbon dioxide, ______________ is produced in respiration.

a) H_2O

b) O_2

c) $C_6H_{12}O_6$

d) CH_4

Chemistry

Unit **4 Assessment** Answer Key

Match the columns

1. c
2. c
3. a
4. c
5. a
6. b
7. a
8. d
9. c
10. d
11. b
12. b
13. c
14. c
15. a
16. b
17. c
18. c
19. c
20. a

Projects Rubrics

Aspect	Beginner	In process	Expert
Theoretical framework	The introduction is weak or there are major inaccurate aspects.	The introduction does not fit with the rest of the project or there are minor inaccurate aspects.	The introduction provides with accurate and relevant information.
Project evidence	The project has inaccurate data. It is irrelevant or repetitive and it contains questionable evidence.	The project has minor errors or it is not very elaborated.	The project is clearly explained.
Project design and performance	The variables are not controlled. The study object is not focused. There's a lack of data.	Some variables are controlled. The study object is focused. The data has mistakes.	The variables are under control. The study object is clearly focused. There are few data mistakes.
Conclusion	There is not a conclusion or it is not sustained.	There is a conclusion, but it is weakly sustained.	The conclusion is well sustained.
References	The reference list contains one or two sources but the references are incomplete.	The reference list contains three sources with complete references.	The reference list contains four or more sources with complete references.
Language use	The project is not very clear. It lacks organization, coherency or appropriate grammar use.	The project is clear, with a few flaws on organization, coherency or appropriate grammar use.	The project is coherently described and clearly stated with few grammar and spelling mistakes.
Collaborative work	Not all the members of the team presented or participated.	Some of the members of the team presented or participated.	All the members of the team presented or participated.

Chemistry

Attendance and Evaluation List

School: ____________ School year: ____________ Teacher: ____________

Student's name	Unit attendance																Sequences grades			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16				

Chemistry

Attendance and Evaluation List

School: ______________ School year: ______________ Teacher: ______________

Student's name	Unit attendance																Sequences grades			
	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32				

Chemistry

Attendance and Evaluation List

School: ____________________ School year: _______________ Teacher: ________________________________

Student's name	Unit attendance																Sequences grades				Unit Project	Unit grade
	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48						

Answers to the exercises

Important Note: If there are answers that are not here, it is because they depend on students' own perception or knowledge.

Unit 1
Page 15
To Integrate

Because chemistry studies knowledge we have of materials and substances specially its transformation into other substances. It is the science that generates knowledge and technology directly relating its application in everyday life, to produce and improve food, medicine, clothing, etc.

Page 19
Explain, Reflect and Share

What's the difference between mass and weight? That mass refers to the quantity of matter a body has measured in kilograms. Weight refers to the force on an object due to gravity and it is measured in Newtons.

What is gravity? It is the force with which the mass of a body attracts another.

How is the weight of an object calculated? The weight of an object is calculated by multiplying the mass by gravity. The resulting units are Newtons.

If a person goes to the moon, what changes is his weight because the size of the moon is different to that of the Earth, thus its gravity force is different and when the mass is multiplied by gravity, the person's weight will be different.

Page 25
Explain, Reflect and Share

The solution of sugar in water at 70& is more concentrated since the greater the percentage of mass in a solution is, the more concentrated it will be.

Page 27
Get Started!
Reflect

- No, they cannot be separated.
- Yes, there is more than one way.
- Because it will all depend on the characteristics of the substances.

Unit 2
Page 50
Reflect, Explain and Share

Element, symbol	Number of valence electrons	Number of electrons missing to reach the octet rule	Valence (capacity of creating a bond)
Hydrogen	1	1	1
Helium, He	2	0	0
Lithium, Li	1	7	1
Carbon, C	4	4	4
Oxygen, O	6	2	2
Neon, Ne	8	0	0
Sodium, Na	1	7	1
Sulfur, S	6	2	2
Chorine, Cl	7	1	1
Argon	8	0	0

Page 53
Reflect, Explain and Share1

Element, symbol	Essential daily intake	Sources to obtain it	Problems caused by its deficiency
Sodium, Na	The daily quantities may vary according to the source	Sources may vary, they are always part of food	
Potassium K			
Calcium, Ca			
Magnesium Mg			
Iron, Fe			Liver and heart failures
Manganese, Mn			Central nervous system failure
Molybdenum, Mo			
Cobalt, Co			Heart diseases
Copper, Cu			Anemia, fever, nausea
Zinc, Zn			Kidney and intestinal functions, depression

Page 57
Get Started!

- The elements are made of tiny, indivisible particles. All atoms of a given element are identical. The atoms of an element are different from any other element. The atoms of an element combine with other atoms elements to form compounds. Atoms cannot be created or divided into smaller particles, nor destroyed.
- Berzelius found that the average weights of atomic elements are not whole numbers, so he proposed the Law of the definite proportions. He also created new terms used in the chemical language as, catalysis, polymers and allotrope isomer, which define processes or characteristics of certain substances when he analyzed their chemical activity or physical and chemical characteristics.
- Avogadro proposed that the amount of particles of one mole of a gaseous substance is always constant regardless of the type of substance; this is called Avogadro's number.

Page 70
Explain, Reflect and Share

1.

- Ionic: KCl potassium chloride, CaCl2 calcium chloride, NaF sodium fluoride.
- Covalent: H2O water, O2 oxygen, CH4 methane.

2. The pure covalent bond is O2.

Page 74
Hands on Chemistry!

Procedure

2.

A.2 Hardness is a relative and subjective parameter, so in this case, students will make a list and order the materials according to their hardness.

B.3 As in the previous answer.

C.3 Only polar substances dissolve.

Explain

1. Metals, polar and non-polar compounds.

2. The differences can be due to the quality of materials used.

3. Solubility, since a polar substance presents ionic bonds.

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Get Started!

2. Situations with a chemical change:

- 1 Pour some water into a glass; add some drops of ink and some drops of bleach.
- 3 Cook an egg.
- 6 Heat some sugar until it turns into caramel.
- 8 Mix sodium bicarbonate with vinegar.
- 9 Light a match.

3.

- 2 Heat water until it boils, since water is these same compound in another state of matter
- 4 Dissolve a spoon of salt in water. With these two ingredients, we obtain a mixture, but water and salt are still the same substances and keep their characteristics.
- 5 Tear a sheet of paper; even though the shape of the sheet of paper changes, its characteristics are still the same.
- 7 Break a pencil in half; the pencil can still be used after it is broken, and it keeps its characteristics.

Page 83

Explain, Reflect and Share

1. Light a fire and start a car. There is a chemical reaction because in both cases combustion occurs, in which gases that result are different in their chemical characteristics to those of the original compounds.
2. Yes, because the cuticle and tissues of the shrimp change due to the raising of the temperature and transform, acquiring a reddish coloration.
3. CO2 is released, physical and chemical changes occur, the compound that results is consequence of the release of pressure that restricted the reaction.

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Explain, Reflect and Share

First Reaction:

- $2H_2$ (g): Two two-atom molecules of hydrogen in a gaseous state.
- $+$: binds with.
- O_2 (g): A molecule of two oxygen atoms in a gaseous state.
- $\rightarrow$: React and produce.
- $2H_2O$ (l): Two water molecules in a liquid state.

Second Reaction:

- H_2 (g): a two-atom molecule of hydrogen gas.
- $+$: binds with.
- I (g): An iodine atom in a gaseous state.
- $\rightarrow$: React and produce.
- 2HL (g) Two molecules hydriodic acid in a gaseous state.

Third Reaction:

- $CaCO_3$ (s): A molecule of calcium carbonate in solid form.
- $\rightarrow \Delta$: In presence of heat energy, react and produce.
- CaO (s): A calcium oxide molecule in a solid state.
- $+$: binds with.
- CO_2 (g) $\downarrow$: A molecule of carbon dioxide in gaseous state, which precipitates.

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Hands On Chemistry

Explain:

1. Carbon dioxide.
2. The sum of the mass of the reactants is the same as the sum of the mass of products.
3. In a chemical reaction, matter is not created or destroyed, only transformed.

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Closing up!

First Reaction:

Name of the substances:

- H_2 Hydrogen
- Bromine Br_2
- 2HBr hydrobromic acid

Reactants:

- H_2 Hydrogen
- Bromine Br_2

Product:

- 2HBr hydrobromic acid

Number of molecules and atoms:

- H_2: A molecule with two hydrogen atoms.
- Br_2: A molecule with two bromine atoms.
- 2HBr: Two hydrobromic acid molecules; each one with an atom of hydrogen and an atom of bromine.

Is it a chemical reaction?

- Yes, because a new substance is formed.

Description of the equation:

- A hydrogen molecule binds with a molecule of bromine, react and produce two molecules of hydrobromic acid.

Demonstration of the theory of the conservation of matter:

Reactants:

- H_2 mass $= 1 \times 2 = 2$
- Br2 mass $= 79.9 \times 2 = 159.8$
- Sum $= 161.8$

Product:

- 2HBr $2(1 + 79.9) = 2(80.9) = 161.8$
- The mass of reactants and products are equal, so the matter is conserved.

Second Reaction:

Name of the substances:

- Zn zinc.
- $CuSO_4$ copper sulfate II.
- ZnO_4 zinc oxide.
- Cu copper.

Reactants:

- Zn zinc.
- $CuSO_4$, copper sulfate II.

Products:

- ZnO_4, zinc oxide.
- Cu copper.

Number of molecules and atoms:

- Zn: One zinc atom.
- $CuSO_4$: A molecule with one copper atom, one sulfur atom and four oxygen atoms.
- ZnO_4: A molecule with one zinc atom and four oxygen atoms.
- Cu: One copper atom.

Is it a chemical reaction?

- No because there is not indication of sulfur in the products.

Description of the equation:

- It is not a valid equation.

Demonstration of the theory of the conservation of matter:

- The law of conservation of matter does not apply because it is not a valid equation.

Third reaction:

Name of substances:

- $6CO_2$ Carbon dioxide
- 6 H_2O Water
- $C_6H_{12}O_6$ Glucose
- 6 O_2 Oxygen

Reactants:

- $6CO_2$Carbon dioxide
- 6 H_2O Water

Products:

- $C_6H_{12}O_6$ Glucose
- $6O_2$ Oxygen

Number of molecules and atoms:

- $6CO_2$: six carbon dioxide molecules, each with a carbon atom and two oxygen atoms.
- 6 H_2O: six water molecules, each with two hydrogen atoms and one oxygen atom.
- $C_6H_{12}O_6$: A molecule of glucose, with six carbon atoms, hydrogen 12 atoms and six oxygen atoms.
- $6O_2$: Six oxygen molecules, each with two atoms.

Is it a chemical reaction?

- Yes, because new substances are formed.

Description of the equation:

- Six carbon dioxide molecules in gaseous state, bind with six molecules of water in liquid state, react with the presence of energy and produce a glucose molecule in solid form and six oxygen molecules in gaseous state are released.

Demonstration of the theory of the conservation of matter:

Reactants:

- $6CO_2$ Mass $= 12 + 16 + 16 = 44$.
- $44 \times 6 = 264$.
- $6H_2O$ Mass $= 1 + 1 + 16 = 18$.
- $18 \times 6 = 108$.
- Sum = 372.

Products:

- $C_6H_{12}O_6 = (6 \times 12) + (12 \times 1) + (6 \times 16) = 72 + 12 + 96 = 180$.
- $6O_2 = 6\,(16 \times 2) = 6 \times 32 = 192$.
- Sum $= 372$.
- The mass of the reactants and the products are equal, therefore, matter is conserved.

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Get Started!

Two final questions:

- Students' answers may vary according to their own perspective on foods and to personal consumption habits. One positive answer may be that consuming the right and adequate quantity helps to be healthy. A negative answer may be that health deteriorates by excess in the consumption of products, causing obesity or diabetes.
- Foods such as proteins, lipids and vitamins.

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Explain, Reflect and Share

- Yes it is important they contain this information.
- Because with it, it is possible to determine if the diet we have is correct.
- Non-processed foods do not have a nutrition fact label, their approximate nutritional value can be consulted in specialized tables.
- By consulting the nutritional value tables per unit of mass, it may be gram or kilogram, and apply it to the amount of the product, thus an approximation of the Kcal amount contained in it can be calculated.

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Explain, Reflect and Share

- Students' own answers. The list must contain all food eaten in a day, including what students eat between meals.
- Students' own answers. The answers must respect the equivalence between kJ and kcal.
- Students' own answers. The differences between students answers depends on their eating habits.
- Deficiency or excess of food may lead to eating disorders in a short or long term. Deficiency is present in anorexia and bulimia, excess is present in obesity.

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Explain, Reflect and Share

Sodium Na Phosphorous P

Potassium K Sulfur S

Magnesium Mg Chlorine Cl

Calcium Ca Helium He

Aluminum Al Neon Ne

Silicon Si

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Explain Reflect and Share

About electronegativity

Molecules	Electronegativity difference Type of bond	Type of bond
O – H	3.44 – 2.2 = 1.24 < 1.8	Polar covalent
Cl – As	3.16 – 2.18 = 0.98 < 1.8	Polar covalent
O – K	3.44 – 0.82 = 2.62 > 1.8	Ionic
Cl – Cl	3.16 – 3.16 = 0 < 0.4	Non-polar covalent
Mg – O	3.44 – 1.31 = 2.13 > 1.8	Ionic

Explain, Reflect and Share

Complete the following table.

Atoms	Valence electrons	Lewis Structure	Electrons that are given, shared or received when a bond is formed	Resulting element
Na	1	Na	1	Neon
Cl	7	Cl	1	Argon
O	6	O	2	Neon
Ca	2	Ca	2	Argon

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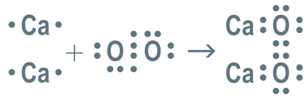
- Lewis's Structure:

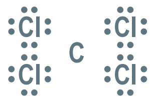
Type of bonding: Ionic.

- Chemical reaction of O and Ca: 2Ca + O_2 to 2CaO
- Lewis's Structure:



Type of bonding: ionic.

- CCl_4, carbon tetrachloride:



Type of bonding: covalent.

- Cl_2, chlorine:

Type of bonding: covalent.

- NaBr, bromide sulfur:

Type of bonding: ionic.

- HCN, hydrogen cyanide:

Type of bonding: covalent.

- SO, sulfur monoxide

Type of bonding: covalent.

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Get Started!

Big things and small things

- Stars and bacteria are counted by having an estimate of the quantity they can fit on a small region and multiplying this small fraction by the total space they occupy.
- To see bacteria we use microscopes. To see stars, we use telescopes.
- It would take 3,200,000 seconds, or 53,333.33 minutes, or 888.88 hours, or 37.07 days to count 32 million of bacteria.
- If we consider the number of stars in the galaxy to be 400,000,000,000, it would take 40,000,000,000 seconds, or 666,660,000,000, minutes, or 11,110,000,000 hours, or 462,962,962.96 days, or 1268,391.67 years.

Explain, Reflect and Share

- Eratosthenes observed that at the same time of the day, the shadows of structures of equal height in different cities produced a shadow of different length.
- He measured the shadow that two sticks of the same size produced at the same time in different cities and the distance between these cities. With this data, he could calculate that the difference between the shadows was of a 4º angle.
- With this data, he determined that the Earth was round and also calculated its circumference was of 40,000 km.

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Explain, Reflect and Share

Compound name	Formula	Amount of atoms per element	Operations	Molecular mass of the compound
Sulfuric Acid	H_2SO_4	H = 2 S = 1 O = 4	(1.007 × 2) + (32.065 × 1) + (15.999 × 4)=	98.075 u.m.a.
Sodium Chloride	NaCl	Na = 1 Cl = 1	(1 × 1) + (35.5 × 1) =	36.5 u.m.a.
Ammoniac	NH_3	N = 1 H = 3	(14.01 × 1) + (3 × 1) =	17.01 u.m.a.
Acetic acid	$C_2H_4O_2$	C = 2 H = 4 O = 2	(12.01 × 2) + (4 × 1) + (16 × 2) =	60.02 u.m.a.
Aluminum oxide	Al_2O_3	Al = 2 O = 3	(26.98 × 2) + (16 × 3) =	101.96 u.m.a.
Silver nitrate	$AgNO_3$	Ag = 1 N = 1 O = 3	(107.9 × 1) + (14.01 × 1) + (16 x 3) =	169.91 u.m.a.
Glucose	$C_6H_{12}O_6$	C = 6 H = 12 0 = 6	(12.01 × 6) + (1 × 12) + (16 × 6) =	180.06 u.m.a.

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Hands On Chemistry

Procedure:

1.

- Sodium chloride NaCl
- Iron oxide II FeO
- Aluminum hydroxide Al $(OH)_3$
- Calcium carbonate $CaCO_3$
- Sodium bicarbonate $NaHCO_3$
- Potassium nitrate KNO_3

2.

- One mole of NaCl
  - •Na – 22.99
  - •Cl – 35.45
  - •22.99 + 35.45 = 58.44 g

3.

- 0.1 mole of NaCl
  - •58.44 g × 0.1 = 5.844 g

9.

- One mole of iron oxide II FeO
  - •Fe – 55.85
  - •O – 16
  - •55.85 + 16 = 71.85 g
- One mole of aluminum hydroxide Al $(OH)_3$
  - •Al – 26.98
  - •O – 16 × 3 = 48
  - •H – 1 × 3 = 3
  - •26.98 + 48 + 3 = 77.98 g
- One mole of calcium carbonate $CaCO_3$
  - •Ca – 40.08
  - •C – 12.01
  - •O – 16 x 3 = 48
  - •40.08 + 12.01 + 48 = 100.09 g
- One mole of sodium bicarbonate $NaHCO_3$
  - •Na – 22.99
  - •H – 1
  - •C – 12.01
  - •O – 16 x 3 = 48 g
  - •22.99 + 1 + 12.01 + 48 = 84
- One mole of potassium nitrate KNO_3
  - •K – 39.1
  - •N – 14.01
  - •O – 16 × 3 = 48
  - •39.1 + 14.01 + 48 = 101.11 g

Explain:

1. No, they did not reach the same line.
2. Because moles depend on the atomic mass, which is different for each of the elements or compounds.
3. Yes, there is, because the molecular mass determines the quantity of moles in grams therefore, it determines the space this particular quantity of matter occupies.

Unit 4

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Hands on Chemistry!

Procedure

6. They are opaque white and have a cubic shape.
7. It is common salt table.

Explain

1. The two compounds are separated and from new substances, in this process both substances lose their chemical characteristics acidity and alkalinity.
2. There will be an excess of this substance and the mixture will have acidic properties.
3. There may be many, including stopping voluntary

Explain:

1. The two compounds are separated and form new substances, in the process both substances lose their chemical characteristics, acidity and alkalinity.
2. There will be an excess of this substance and the mixture will have alkaline properties.
3. There will be an excess of this substance and the mixture will have acidic properties.
4. There may be many, including stopping voluntary corrosion processes, preventing dangerous substances to be disposed to the drainage and prevent gastric diseases.
5. In gastritis and gastric ulcer, because the tissues are damaged or exposed to corrosive action of acids; neutralization prevents further damage and helps recovering health.

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Hands on Chemistry!

Creating a pH indicator

Explain

1. It is dark purple.
2. With clean water, the paper does not change tone. In sodium hydroxide (NaOH), the paper turns blue and with the hydrochloric acid (HCl), the paper turns red.
3. Because the dyes extracted from the cabbage, change their pH characteristics, including color.
4. By comparing the resulting colors in the pH paper with a pattern of preset colors.

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Hands On Chemistry!

Explain:

1. Between, 0.9 and 1.4 volts
2. Yes, it was possible, because the current is enough to make the bulb filament to heat.
3. Each lemon adds its own voltage to the rest of the lemons.
4. Yes, the bulb turned on with greater intensity because the voltage is higher.
5. The lemon has mostly citric acid.
6. The copper oxides and it produces a positive pole. The zinc is reduced because it produces a negative pole.
7. The chemical equation is:
   $C_6H_8O_7$ + Zn + Cu (aqueous solution)
   to
   Zn− + $C_5H_7O_5$ + Cu + −COOH

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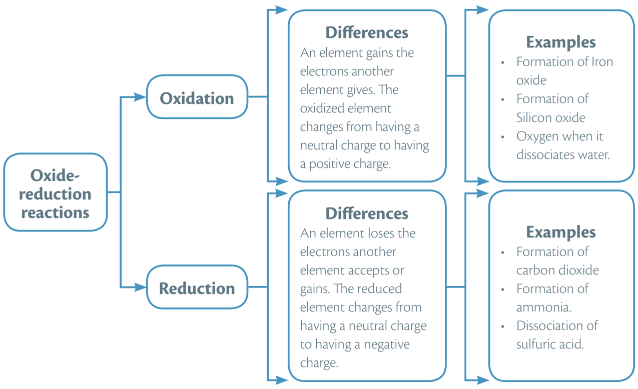

To Integrate

Explain, Reflect and Share

Remembering basic concepts

- The valence, having one electron in the last energy layer, they are metals, non-metals or metalloids.
- The energy level their electrons have and a similar atomic radius.
- The valence is the quantity of electrons an atom has in its last layer and that are involved in the formation of bonds. The valence is the same as the group number in the periodic table.
- Electronegativity is the ability of an atom to attract electrons from another atom.
- It increases from bottom to top and from left to right.

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- Students' own answers.

PAGE 128

Explain, Reflect and Share

Ions or radicals and their oxidation number

Name	Formula	Oxidation number	Name	Formula	Oxidation number
Chloride	ClO_3	−1	Nitrate	NO_2	−1
Bromite	BrO_2	−1	Phosphate	PO_4	−3
Iodate	IO_3	−1	Carbonate	CO_3	−2

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Closing Up!

- $Fe_2O_3 + 3H_2 \rightarrow 2Fe + 3H_2O$
  Hydrogen oxides and iron reduces.
- $3KClO \rightarrow 2KCl + KClO_3$
  Chlorine from KCl reduces and from the other oxides.
- $CuO + H_2 \rightarrow Cu + H_2O$
  Copper reduces and hydrogen oxides.
- $Ca_3(PO_4)_2 + 3SiO_2 + 5C \rightarrow 3CaSiO_3 + 5CO + 2P$
  Carbon oxides and phosphorus reduces.
- $Cl_2 + 2KOH \rightarrow KCl + KClO + H_2O$
  Chlorine from KCl reduces and the other one oxides.
- $2FeCl_2 + Cl_2 \rightarrow 2FeCl_3$
  Chlorine from $FeCl_2$ oxides and from Cl_2 reduces.

Hands on Chemistry!

Explain:

1. Sulfur oxide was formed.
2. $S + O \rightarrow SO$ (sulfur monoxide)
   $SO + H_2O \rightarrow H_2SO_4$
3. Sulfur oxides and oxygen reduces.

Chemistry is a textbook that allows you to question the world and how it works in a logical, systematic and skeptical way as you enjoy, understand and experience chemistry in a lively way.

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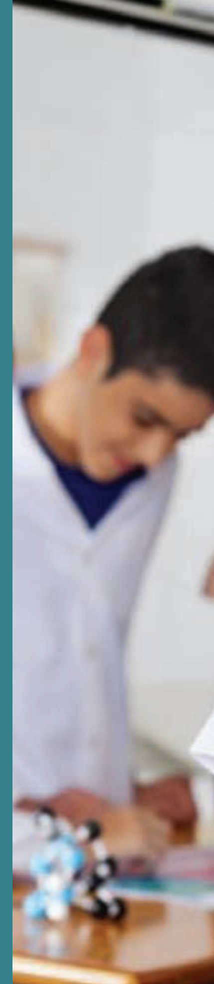

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