Fundamentals of CHEMISTRY

DREYFOUS

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Course Description

Introduction

The “Fundamentals” series was developed and updated based on the Puerto Rico Core Standards curricular designs and the Curriculum Framework created by the Department of Education.

This series presents course content in a dynamic, innovative, and recreational manner. It also gives students the opportunity to appreciate science as part of their daily life and not just as an academic subject that has nothing to do with them or their surroundings. This approach encourages the study of this discipline by placing scientific research, skills and processes within reach.

The “Fundamentals of Chemistry” course introduces the study of chemistry, its important concepts and its application to everyday life. This course was developed to broaden the students' experience in this area of science. It is aimed at the study of matter, its properties, changes and factors that affect it.

Philosophy of the Series

The “Fundamentals” series is created with the purpose of building on the scientific knowledge expected to be covered at each level while integrating new knowledge into the classroom in an accessible way. The new scientific discoveries, analyses, and theories used in this series reflect this new wave of knowledge that will be present in our future, without losing sight of the standards and expectations of the grade corresponding to the course.

The series is composed of worksheets that integrate different levels of thinking. For example, the “Comprehend” worksheet requires the student to review the content that was taught in order to answer the exercises it contains, while the “Apply” worksheet encourages students to analyze in depth what they have learned.

The “Let's Do Science” lab sheets constitute another area of education: learning by practicing. This implies that students, after having reviewed the lesson and having completed the “Comprehend” and “Apply” documents, can put their knowledge into practice through a scientific demonstration of an experiment or through the qualitative and quantitative analysis of different substances.

The “Fundamentals” series will serve as a bridge to convey the knowledge that students will need in upper-level courses.

Series Overview

The idea of science can be intimidating, so the series aims to provide knowledge in an accessible way through advanced terms and topics that fit the student's grade level. Thus, showing the link and correlation of science to everyday life. In addition, a better dynamic in the classroom is aspired and the negative expectations and preconceptions that students may have about science are transformed into positive experiences.

Through this series, we hope to expose students to new scientific trends, facilitate the exploration of the scientific method as a useful tool even outside of the laboratory, and develop essential skills such as critical thinking, interpreting data, analyzing results, making measurements, converting units, working in teams, and identifying and classifying properties or characteristics.

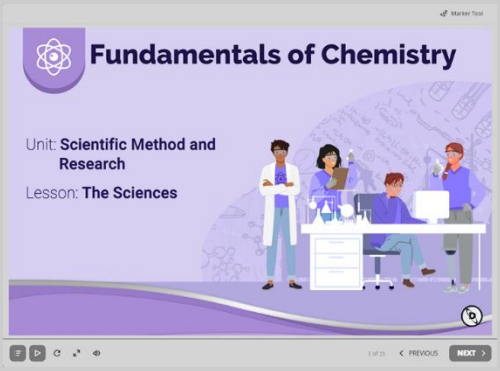
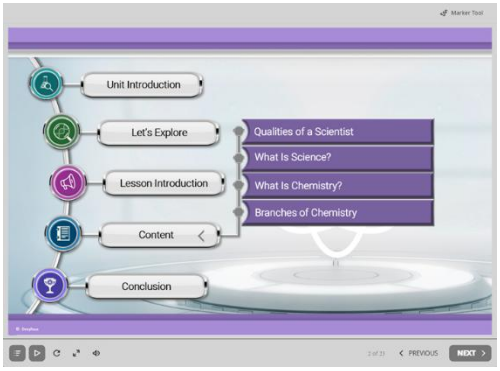
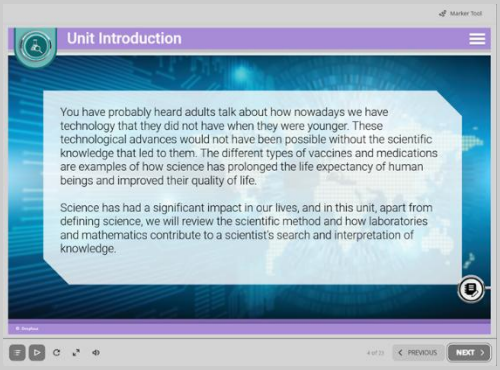
Thematic Focus

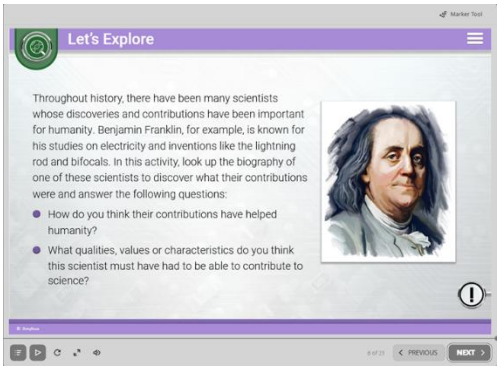
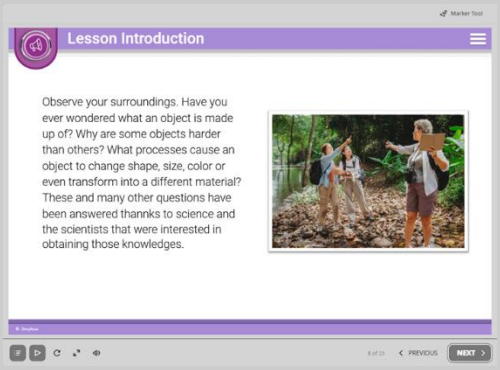
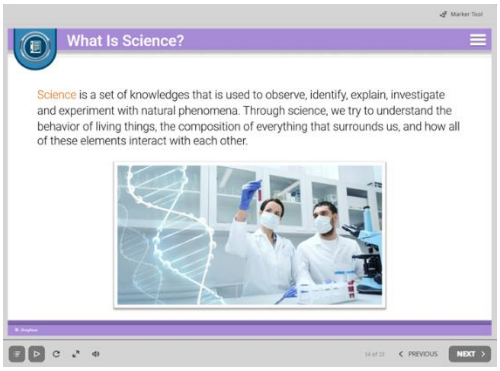
The content of the “Fundamentals” series was designed with a constructivist perspective, where the student will assess prior knowledge and build upon it by exploring new concepts. Each lesson has an exploration section that will allow the student to assess prior knowledge while expanding their learning through the lesson and applying it through the different worksheets. In order to establish a foundation for further building science knowledge, the first unit will review basic concepts common to the different disciplines, such as the scientific method, safety rules, and laboratory instruments. It is from there that we will move on to the exploration of scientific knowledge.

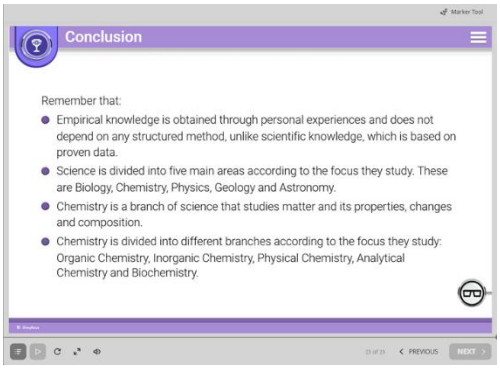
Puerto Rico Core Standards

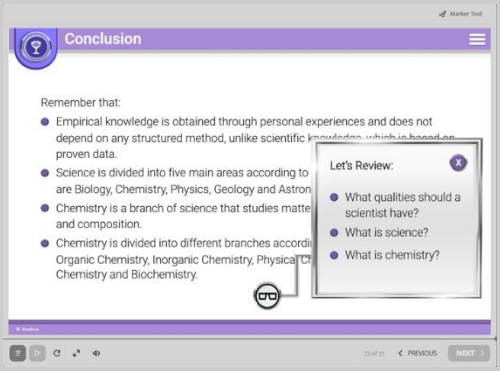
- **Engineering and Technology.** Study and apply science and engineering practices in the design and construction of prototypes to solve problems based on scientific evidence.
- **Physical Science - Chemistry**. Study the structure and composition of matter, as well as the changes and interactions between its particles.

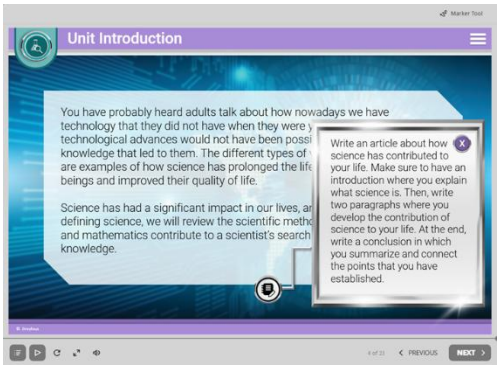
Course Structure: Curricular Components

Lesson Content	
Cover 	The cover page is the lesson presentation that includes the following components: - "Fundamentals of Chemistry" (title of the course); - "Scientific Method and Research" (unit title); - "Science" (lesson title); - course design; - credits.
Table of Contents 	The table of contents presents the sections contained in each lesson. Each button here directs you to the section you clicked; this way you can navigate the lesson more efficiently and smoothly.
Unit Introduction 	The unit introduction is a section that summarizes the most important topics or concepts of each unit and briefly describes them. This section will only be found in the first lesson of each unit.

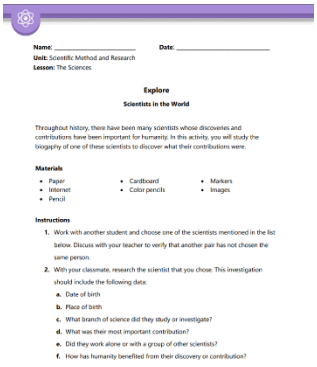
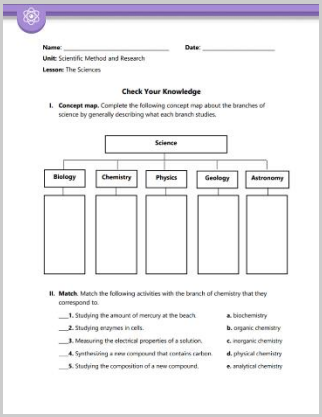
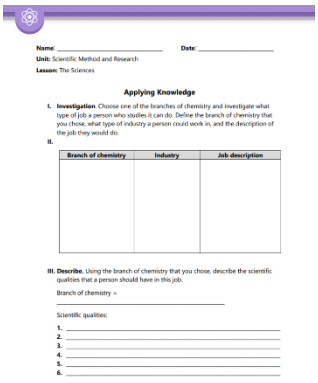
Let's Explore 	"Let's Explore" is an exploratory exercise that exposes the student to a first impression of the topics to be discussed in the lesson.
Lesson Introduction 	The lesson introduction presents the topics to be covered in the lesson, either by means of an example from everyday life or a historical event.
Lesson Topics 	Lesson topics follow the order of introduction, development and conclusion. In addition, they are composed of vocabulary words, key terms, explanations of the topic, examples and, when applicable, practice exercises.

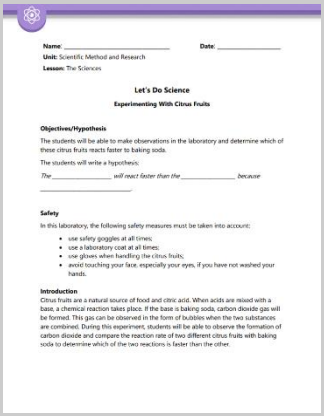
Did You Know?	
	The "Did You Know?" section shows students an example of the material studied in the lesson applied in the real world. This can be seen in examples of professions, historical data, or other.
Conclusion	
	The conclusion section introduces the most important points presented in the lesson. This way, the student can examine and review the content of the lesson.

Windows	
Review	
	The "Review" section is a window that helps the student to revisit the points seen in the lesson. This review is usually presented in the form of short questions.

Activities	
	The "Activities" section presents the student with an activity where they must apply what they have learned in the lesson to an everyday life situation.

Worksheets

Explore  Name: _____ Date: _____ Unit: Scientific Method and Research Lesson: The Sciences **Explore** **Scientists in the World** Throughout history, there have been many scientists whose discoveries and contributions have been important for humanity. In this activity, you will study the biography of one of these scientists to discover what their contributions were. **Materials** • Paper • Internet • Pencil • Cardboard • Color pencils • Markers • Images **Instructions** 1. Work with another student and choose one of the scientists mentioned in the list below. Discuss with your teacher to verify that another pair has not chosen the same person. 2. With your classmate, research the scientist that you chose. This investigation should include the following data: a. Date of birth b. Place of birth c. What branch of science did they study or investigate? d. What was their most important contribution? e. Did they work alone or with a group of other scientists? f. How has humanity benefited from their discovery or contribution?	The "Explore" worksheet presents a task that has the function of introducing the student to the topic of the lesson. This is intended to determine how much the student knows about the topic before beginning the lesson.
Check Your Knowledge  Name: _____ Date: _____ Unit: Scientific Method and Research Lesson: The Sciences **Check Your Knowledge** I. **Concept map.** Complete the following concept map about the branches of science by generally describing what each branch studies. Science Biology Chemistry Physics Geology Astronomy II. **Match.** Match the following activities with the branch of chemistry that they correspond to. ___1. Studying the amount of mercury at the beach. a. biochemistry ___2. Studying enzymes in cells. b. organic chemistry ___3. Measuring the electrical properties of a solution. c. inorganic chemistry ___4. Synthesizing a new compound that contains carbon. d. physical chemistry ___5. Studying the composition of a new compound. e. analytical chemistry	The worksheet "Comprehend" presents the topics discussed in the lesson. This document serves as study material for the student once the lesson is over. It is also useful for the student to identify any topic that they have not mastered and need to re-study.
Apply  Name: _____ Date: _____ Unit: Scientific Method and Research Lesson: The Sciences **Applying Knowledge** I. **Investigation.** Choose one of the branches of chemistry and investigate what type of job a person who studies it can do. Define the branch of chemistry that you chose, what type of industry a person could work in, and the description of the job they would do. II. Branch of chemistry | Industry | Job description III. **Describe.** Using the branch of chemistry that you chose, describe the scientific qualities that a person should have in this job. Branch of chemistry = Scientific qualities: 1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 6. _____	The " Apply" worksheet presents a work that has the function of assessing what the student has learned in the lesson. In this document the student must use what was learned in the lesson to solve a problem of daily life. This should be done at the end of the lesson study.

Let's Do Science  Name: _____ Date: _____ Unit: Scientific Method and Research Lesson: The Sciences Let's Do Science Experimenting With Citrus Fruits Objectives/Hypothesis The students will be able to make observations in the laboratory and determine which of these citrus fruits reacts faster to baking soda. The students will write a hypothesis: The _____ will react faster than the _____ because _____. Safety In this laboratory, the following safety measures must be taken into account: • use safety goggles at all times; • use a laboratory coat at all times; • use gloves when handling the citrus fruits; • avoid touching your face, especially your eyes, if you have not washed your hands. Introduction Citrus fruits are a natural source of food and citric acid. When acids are mixed with a base, a chemical reaction takes place. If the base is baking soda, carbon dioxide gas will be formed. This gas can be observed in the form of bubbles when the two substances are combined. During this experiment, students will be able to observe the formation of carbon dioxide and compare the reaction rate of two different citrus fruits with baking soda to determine which of the two reactions is faster than the other.	The "Let's Do Science" worksheet presents an activity or laboratory in which the student will apply the scientific method to arrive at a conclusion.
Study Guide  Name: _____ Date: _____ Unit: Scientific Method and Research Lesson: The Sciences Study Guide You should know that: • The word science comes from the Latin *scientia* and means knowledge. • Empirical knowledge is obtained through personal experiences and does not depend on any structured method, unlike scientific knowledge, which is based on proven data. • Science is divided into five main areas according to the focus they study. These are Biology, Chemistry, Physics, Geology and Astronomy. • Chemistry is a branch of science that studies matter and its properties, changes and composition. • Chemistry is divided into different branches according to the focus they study: Organic Chemistry, Inorganic Chemistry, Physical Chemistry, Analytical Chemistry and Biochemistry. • A scientific mind is observant and shares its discoveries. • Curiosity and creativity are two characteristics of a scientific mind. • A scientist should be open to hearing different perspectives than their own but verifies explanations before accepting them.	The "Study Guide" is a breakdown of the important points of the lesson and the vocabulary words that appear in the lesson.

Unit Breakdown

Below is the breakdown of each unit into lessons, including the titles of each unit and the titles, codes, objectives, topics and keywords of each lesson.

Unit 1: Scientific Method and Research

This unit is about how scientific discoveries have given way to the technological advances we have achieved today. Some examples of these achievements are vaccines, medicines, computers, cell phones, among others. All of these technological advances have impacted the lives of human beings by improving our quality of life and prolonging life expectancy.

At the end of this unit, the student will have completed the objectives that are found in the following lessons.

Lesson 1. The Sciences
Code : C467G0SU01L01
Objectives:
At the end of this lesson, the student will be able to:

- Identify the different branches of chemistry.
- Describe the qualities of a scientific mind.
- Associate scientists and professionals related to the branches of chemistry.

Topics

- Qualities of a Scientist
- What Is Science?
- What Is Chemistry?
- Branches of Chemistry

Keywords
analytical biochemistry, biochemistry, chemistry, inorganic chemistry, organic chemistry, physical chemistry, science, scientist

Lesson 2. Research and the Scientific Method
Code: C467G0SU01L02
Objectives:
At the end of this lesson, the student will be able to:

- Describe the different steps of the scientific method.
- Identify the variables in a scientific investigation.
- Distinguish between an observation and an inference.

Topics

- Scientific Method
- Variables
- Observations and Inferences

Keywords
control group, dependent variable, experimental group, hypothesis, independent variable, inference, measuring, observation, research, variables

Lesson 3. Mathematics: The Language of Science
Code: C467G0SU01L03
Objectives:
At the end of this lesson, the student will be able to:

- Explain the importance of the International System of Units.
- Describe the units in the International System of Units.
- Convert measurements into scientific notation.
- Use significant figures in measurements and calculations.
- Determine which units are appropriate for certain measurements.

Topics

- International System of Units
- Scientific Notation
- SI Prefixes
- Measurements in Experiments

Keywords
accuracy, International System of Units, measurement, precision, scientific notation, significant figures, unit of measurement

Lesson 4. The Laboratory
Code: C467G0SU01L04
Objectives:
At the end of this lesson, the student will be able to:

- Recognize instruments commonly used in a laboratory.
- Identify the different parts of a microscope.
- Recognize the safety symbols used in the laboratory.
- Explain the safety measures to be followed in a laboratory and their importance.

Topics

- Laboratory Instruments
- Safety Symbols
- Safety Measures

Keywords
carcinogen, contamination, corrosive, irritant, laboratory, radiation, safety, toxic

Unit 2: The Structure of Matter

Matter is everything that has mass and occupies space. In order to classify matter, it is observed and studied by the properties it contains, as well as the changes it goes through.

At the end of this unit, the student will have completed the objectives found in the following lessons.

Lesson 1. Matter and Its Properties
Code: C467G0SU02L01
Objectives:
At the end of this lesson, the student will be able to:

- Define matter.
- Identify the properties that distinguish matter.
- Compare chemical and physical properties.

Topics

- What Is Matter?
- Classifying Matter
- Properties of Matter
- Changes of Matter

Keywords
chemical change, chemical property, extensive property, intensive property, mass, matter, mixture, physical change, physical property, physical state, property, pure substance, volume

Lesson 2. Qualitative Properties of Matter
Code: C467G0SU02L02
Objectives:
At the end of this lesson, the student will be able to:

- Describe matter qualitatively.
- Identify qualitative properties of matter.

Topics

- Qualitative Properties

- Physical States of Matter

Keywords
Clarity, compressibility, density, elasticity, gas, liquid, magnetism, opaque, qualitative, property, solid, solubility, translucid, transparent

Lesson 3. Quantitative Properties of Matter
Code: C467G0SU02L03
Objectives:
At the end of this lesson, the student will be able to:

- Describe matter quantitatively.
- Recognize the measurements of the International System of Units (SI).
- Calculate quantitative properties like density, volume and mass.

Topics

- Quantitative Properties
- Mass, Volume and Density

Keywords
Density, length, mass, quantitative properties, temperature, volume

Unit 3: Atoms and the Periodic Table

Matter has different properties that distinguish some objects or substances from others. In order to understand these differences between objects or substances, it is necessary to study the structure of atoms, the elements and their relationship to the periodic table.

At the end of this unit, the student will have completed the objectives found in the following lessons.

Lesson 1. Atoms
Code: C437G0SU03L01
Objectives:
At the end of this lesson, the student will be able to:

- Distinguish between an atom, an element and a compound.
- Describe the structure of an atom and its subatomic particles.
- Recognize the atomic models that led to the current atomic theory.

Topics

- Discovery of the Atom and Atomic Models
- Atomic Structure

Keywords
atom, compound, Dalton's atomic theory, electron cloud, electrons, element, isotope Neutrons, nucleus, protons

Lesson 2. The Periodic Table
Code: C467G0SU03L02
Objectives:
At the end of this lesson, the student will be able to:

- Explain the organization of elements according to their family and periods.
- Calculate the number of subatomic particles of an atom.
- Write electron configurations using Bohr's atomic model.
- Identify valence electrons using Lewis's structures.

Topics

- The Development of the Periodic Table
- The Modern Periodic Table
- Electron Configurations and Valence Electrons

Keywords

atomic mass, atomic number, electron configuration, family, Lewis's structure, period, periodic table, valence electrons

Lesson 3. Classifying Elements
Codes: C467G0SU03L03
Objectives:

At the end of this lesson, the student will be able to:

- Classify elements as metals or nonmetals.
- Describe the main families of elements.

Topics

- Metals, Nonmetals and Metalloids
- Element Families

Keywords

Alkali, metals, alkaline earth metals, boron family, carbon family, halogens, metalloids, metals, nitrogen family, noble gases, nonmetals, oxygen family, transition, metals

Unit 4: Chemical Bonds and Compounds

Every substance or compound is a combination of atoms. When two or more atoms join together, they do so through a chemical bond. In this unit we will learn about what a chemical bond is, how atoms bond together, and what factors cause atoms to bond.

At the end of this unit, the student will have completed the objectives found in the following lessons.

Lesson 1. Chemical Bonds
Code: C437G0SU04L01
Objectives:
At the end of this lesson, the student will be able to:

- Explain how chemical bonds form to produce compounds.
- Describe what the oxidation number of an element represents.

Topics

- Forming Chemical Bonds
- Oxidation Numbers

Keywords
chemical bond, compound, octet rule, oxidation, number

Lesson 2. Types of Bonds and Compounds
Code: C467G0SU04L02
Objectives:
At the end of this lesson, the student will be able to:

- Describe the processes through which substances form compounds.
- Identify the types of bonds in a compound.
- Use Lewis's structure model to represent the formation of compounds.

Topics

- Ionic Bonds and Compounds
- Covalent Bonds and Compounds
- Metallic Bonds

Keywords
anion, cation, covalent bond, covalent compound, crystal, electron affinity, ion, ionic bond, ionic compound, ionization energy, metallic bond, nonpolar covalent bond, polarcovalent bond

Lesson 3. Nomenclature of Inorganic Compounds
Code: C467G0SU04L03
Objectives:
At the end of this lesson, the student will be able to:

- Describe what organic compounds and inorganic compounds are.
- Explain how a chemical formula expresses the exact composition of a compound.
- Write chemical formulas using monatomic ions and polyatomic ions.
- Name compounds correctly using their chemical formula.

Topics

- Nomenclature
- Nomenclature of Ionic Compounds
- Nomenclature of Covalent Compounds

Keywords
chemical formula, inorganic compound, monatomic ion, nomenclature, organic compound, polyatomic ion

Unit 5: Changes in Matter

Matter can change color, size or shape. These changes occur all the time in our surroundings. Depending on the change an object undergoes, it is determined whether it is a physical or chemical change.

At the end of this unit, the student will have completed the objectives found in the following lessons.

Lesson 1. Physical and Chemical Changes
Code: C467G0SU05L01
Objectives:
At the end of this lesson, the student will be able to:

- Explain the effects of physical and chemical changes in matter.
- Identify if the changes in matter are physical or chemical.

Topics

- Physical Changes of Matter
- Chemical Changes of Matter

Keywords
chemical change, combustibility, effervescence, inflammability, physical change, precipitation, reactivity

Lesson 2. Phase Changes in Matter
Code: C467G0SU05L02
Objectives:
At the end of this lesson, the student will be able to:

- Explain the relationship between kinetic energy and the physical state of matter.
- Describe the movement of particles in matter according to its physical state.
- Identify the physical properties of each state of matter.

Topics

- The Kinetic Molecular Theory
- The Physical States of Matter
- Phase Changes

Keywords
boiling point, condensation, deposition, evaporation, freezing point, fusion, gaseous, kinetic energy, kinetic molecular theory, liquid, melting point, phase change, physical state, plasma, solid, sublimation, thermal energy

Unit 6: Reactions and Equations

Occasionally, two or more chemical substances can undergo processes to form a new substance. We call these changes chemical reactions. Chemical reactions imply that a chemical change occurred in the original substances. Chemical reactions are divided into two parts: reactants and products.

At the end of this unit, the student will have completed the objectives found in the following lessons.

Lesson 1. Chemical Reactions and Equations
Code: C467G0SU06L01
Objectives:
At the end of this lesson, the student will be able to:

- Determine if the change in matter is due to a chemical reaction or not.
- Operationally define chemical reaction and chemical equation.
- Describe the parts of a chemical equation.

Topics

- Chemical Reactions
- Chemical Equations

Keywords
chemical equation, chemical formula, chemical reaction, compound, product, reactive

Lesson 2. Types of Reactions
Code: C467G0SU06L02
Objectives:
At the end of this lesson, the student will be able to:

- Represent chemical reactions through balanced chemical equations.
- Classify chemical reactions according to their type.

Topics

- The Law of Conservation of Mass
- Balancing Equations
- Types of Reactions

Keywords
balanced equation, decomposition reaction, double replacement reaction, law of conservation of mass, simple replacement reaction, synthesis reaction

Lesson 3. Reactions and Energy
Code: C467G0SU06L03
Objectives:
At the end of this lesson, the student will be able to:

- Distinguish between an endothermic reaction and an exothermic reaction.

Topics

- Heat and Reactions
- Endothermic Reactions
- Exothermic Reactions

Keywords
endothermic reaction, exothermic reaction, heat

Unit 7: Mixtures and Solutions

We can find matter as a pure substance or as a mixture. This unit differentiates between pure substance and mixture, explores the study of the composition of different types of mixtures, how they behave and what methods can be used to separate them.

At the end of this unit, the student will have completed the objectives found in the following lessons.

Lesson 1. Heterogeneous Mixtures
Code: C467G0SU07L01
Objectives:
At the end of this lesson, the student will be able to:

- Distinguish between susbtances, homogeneous mixtures and heterogeneous mixtures.
- Make an outline to represent the system for classifying matter.
- Apply different methods to separate different types of mixtures.

Topics

- Mixtures
- Properties of Heterogeneous Mixtures
- Methods of Separation of Mixtures

Keywords
Chromatography, decantation, distillation, filtration, heterogeneous mixture, homogeneous mixture, magnetism, mixture

Lesson 2. Solutions
Code: C467G0SU07L02
Objectives:
At the end of this lesson, the student will be able to:

- Identify the main properties of a solution.
- Describe the properties of different types of solutions.
- Mention examples of everyday uses for each type of solution.

Topics

- Solutions
- Properties of Solutions
- Types of Solutions

Keywords

Concentrated, solution, diluted solution, oversaturated solution, precipitate, saturated solution, solute, solution, solvent, unsaturated solution

Unit 8: Acids and Bases

Chemical substances can be classified in many ways, including by their pH, which in turn helps determine whether a substance is acidic or basic. Acids and bases have different properties; and these are so common that we can find them in our homes.

At the end of this unit, the student will have completed the objectives found in the following lessons.

Lesson 1. Acids and Bases
Code: C467G0SU08L01
Objectives:
At the end of this lesson, the student will be able to:

- Operationally define an acid substance and a basic substance.
- Describe the general properties of acids and bases.

Topics

- Acids and Bases
- Properties of Acids
- Properties of Bases

Keywords
acid substance, anion, basic substance (alkaline), cation, salt

Lesson 2. Uses and Applications of Acids and Bases
Code: C467G0SU08L02
Objectives:
At the end of this lesson, the student will be able to:

- Classify materials as acidic or alkaline according to their pH.
- Mention everyday applications of acid and basic substances.
- Recognize the risks and benefits of chemical substances that are used in everyday life.

Topics

- The pH Scale
- Applications of Acids and Bases

Keywords
Acid, base, pH, pH scale