DREYFOUS

Subject Guide

CHEMISTRY

DREYFOUS

TABLE OF CONTENTS

Course Description

The Dreyfous Secondary Level Science series offers courses in which students are able to appreciate science as part of their daily lives and not simply as a school subject that is unrelated to them or their environment. The usefulness and application of scientific concepts become evident throughout these lessons. The series features an interdisciplinary approach based on projects and research that demonstrates how the topics are integrated and work together in real life. This series seeks to develop evaluative, research, and problem-solving skills by adopting the 4Cs of 21st-century education: *Creativity, Collaboration, Critical Thinking, and Communication*.

Each course in the series provides for the development of a group project, which will be worked on as the lessons advance and will connect the topics studied to the real world. Special sections will also be introduced to help students appreciate the integration and usefulness of science in the real world. Each lesson contains *supplementary documents* that will help both teacher and student to work with the concepts studied. These documents consist of a descriptive log, vocabulary, worksheets containing concept and application exercises along with their answer keys, laboratories, and study guide. Finally, suggested *links* to online resources are included in order to expand the content and provide fun facts related to the topics being studied.

Course Framework

The Chemistry course comprises twelve units, carefully structured into different lessons. The number of lessons per unit varies, depending on the scope and depth with which the different topics are discussed and developed. Each lesson contains an interactive presentation that outlines and explains the content of the topic to be studied. Each presentation includes concept definitions, specific examples, explanations, and multiple examples and applications of concepts, as well as daily life skills.

Each unit begins with a section titled *Hidden Chemistry*, which acts as the unit's opening. This section can be found in the first lesson of each unit. It introduces everyday chemical phenomena related to the main topic of the unit under study. In addition to introducing the topic at hand, this section is intended to guide students through the process of creating their group project. For this project, students must research the phenomena presented in this section and explain them. They should use their creativity to present them in a scientific journal at the end

of the course. The teacher may use different teaching strategies to guide students in the development of this project.

This is followed by an introductory activity titled *Let's Explore*! It consists of a short activity aimed primarily at exploring the students' prior knowledge of the lesson's topic. This may consist of a written exercise or a short activity. This activity is followed by the lesson content, presented in the form of text, diagrams, examples, animations, interactive activities, and videos, among others. Following the content is the *Laboratory*, which supplements the conceptualization process.

Finally, the lesson closes with one of the following special sections:

Why Does This Happen? – Articles or videos that show the scientific explanation for everyday chemical phenomena.

Techno-Chemistry – Shows a video or text article about commonly used technological applications of the topic studied in the lesson.

Science Connections – Shows videos or texts that demonstrate how the topic studied in the lesson is integrated with other sciences.

Lessons also include two worksheets: *I Understand!* and *Applying What I Know*. These worksheets reinforce the concepts studied in each lesson. The activities are varied and flexible, with the purpose of satisfying the particular needs and interests of each student. Practice activities are designed to make students aware of the strengths and weaknesses in their knowledge of the content, so they can gradually take control of their own learning process. The teacher, as an integral and essential part of this process, will be responsible for stimulating, mentoring, guiding, and periodically evaluating each student's learning progress. Lessons also include a *study guide*, which presents the main ideas and the vocabulary studied, along with its definitions.

Lessons

Each unit is made up of different lessons, divided into topics, macro concepts, and skills. In turn, each lesson consists of five key elements: course presentation or content, digital format (PDF) documents, internet links, special sections, and a descriptive log.

- **Descriptive Log.** This is the detailed lesson plan. It includes the lesson's specific objectives, standards, and expectations, teaching strategies and resources, keywords, internet links, skills and processes, and references, among others. The teacher will have sole access to the lesson descriptive logs.

- **Lesson Content.** Each presentation contains detailed explanations of the lesson's concepts and skills, as established by the objectives. In addition, it contains the following elements, which systematically contribute to the development of the intended learning outcomes for students:

▪ **Activity.** It includes a series of carefully selected activities to allow the student to practice the skills and concepts discussed. The Activity is designed to periodically assess the learning progress of students before moving on to other topics and skills.

▪ **Demonstration/Steps.** It features formal demonstrations of the processes to be followed in an activity or in solving a problem.

▪ **Animation.** It gives access to explanations, procedures, or graphics that provide a visual portrayal of the concepts and skills discussed in the section. It helps address the students' conceptual understanding and development.

▪ **Tabs.** These can be found on the right or left side of the presentation. Tabs can be expanded to show flowcharts, biographies, notes, photos, explanations, suggestions, reminders, or necessary background knowledge.

▪ **Photograph or image.** A particular explanation is connected to a photo or image, which will be likely accessed by internet.

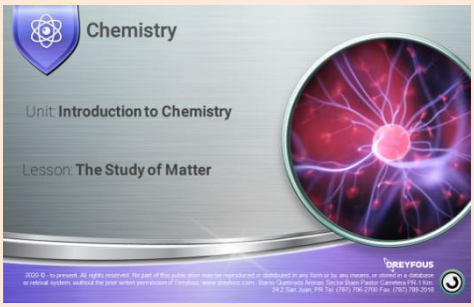
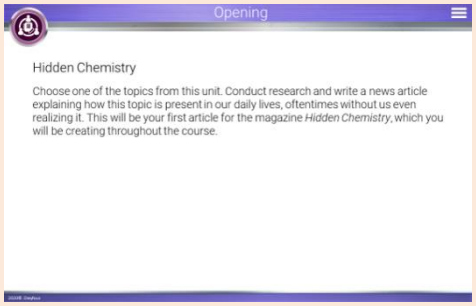
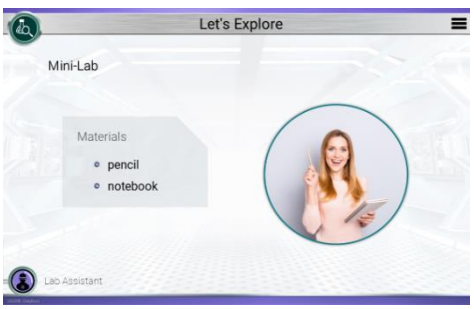
▪ **Video.** Access to a short video related to the topic.

▪ **Internet.** A direct link to a site or internet portal closely related to the topic.

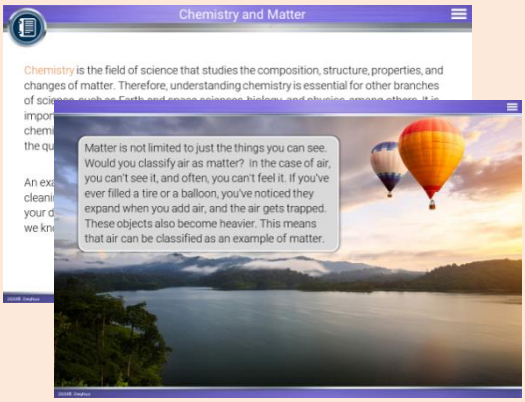
Each of the sections included in the presentation is connected to a particular identifying icon, as shown in the explanation provided. Clicking on the icon will take the presentation immediately to the specific section it represents.

- **PDF documents.** These documents include a copy of the practice exercises, laboratories, and lesson activities. These documents may be printed out for students to work on.
- **Internet Links.** These links provide a direct connection to the internet and may be accessed directly from the presentation. They include additional explanations, examples, applications, or demonstrations that facilitate the students' conceptual development in the skills and topics discussed.

Course Framework: Curricular Components

Lesson content	
Cover 	This is the introduction for the course and the lesson. It identifies the course, unit, and lesson. It contains: ○ Course title ○ Unit and lesson title ○ Image ○ Credits
Directory 	It displays the lesson sections. Each button has a hyperlink to the section it represents. From the second lesson onwards, there is no *Opening* section.
Unit Opening 	This section may only be found in the first lesson of each unit.
Let's Explore! 	This section is included in every lesson.

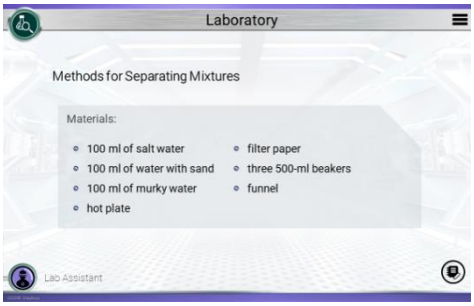
Topics (content)



Development of the content, along with definitions, explanations, examples, and demonstrations.

Special sections

These sections expand on the students' learning experiences.



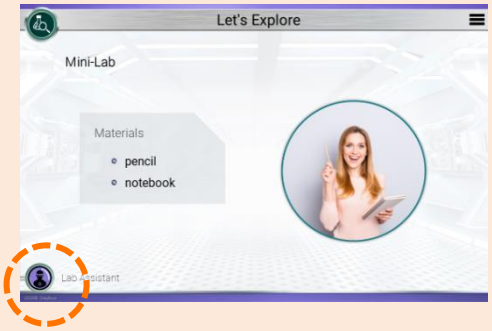
Laboratory. This laboratory activity is included to supplement the conceptualization process.

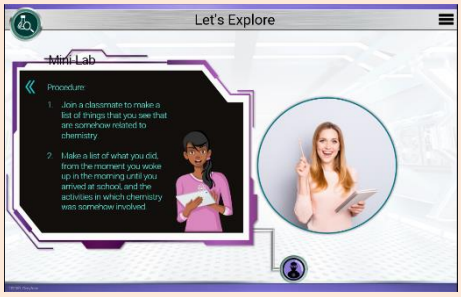
Techno-Chemistry. Application of common technologies related to the lesson topic.

Science Connections It includes texts articles on professions related to the topic studied, recent discoveries or research, among other topics that highlight the relationship between chemistry and other branches of science.

	 Why Does This Happen? This section includes articles or videos that show the scientific explanation for everyday chemical phenomena.

Laboratory Assistant





When students click on the laboratory assistant tab located in the lower right or left corner of some of the *Lesson Content* templates, they will be able to see important notes to complete the laboratory activities.

Button Directory

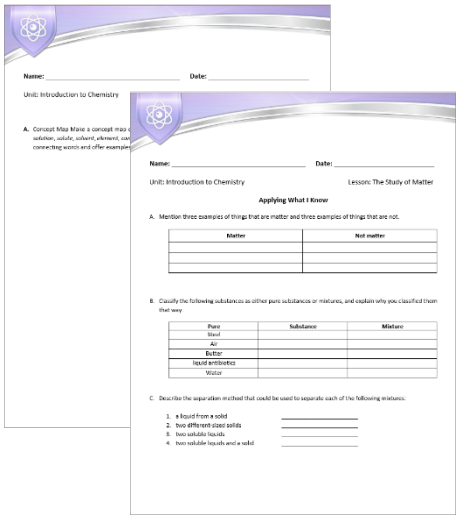
Navigation

	Close		Credits
	Slide		Back

General			
	Information		Video
	Laboratory Assistant		Review
	Reason		Image
	Group Project		Steps
	Question		Web
	Concept Map		Calculator
	Map		Music
	Objectives		Observe
 	Zoom in or out	 	Reading
Special sections			
	Laboratory		Science Connections
	Techno-Chemistry		Why Does This Happen?

Worksheets

Objective activities


Name: _____ Date: _____

Unit: Introduction to Chemistry

A. Concept Map Make a concept map
solution, solute, solvent, element, com
connecting words and offer example

Name: _____ Date: _____

Unit: Introduction to Chemistry Lesson: The Study of Matter

Applying What I Know

A. Mention three examples of things that are matter and three examples of things that are not.

Matter	Not matter

B. Classify the following substances as either pure substances or mixtures, and explain why you classified them that way.

Pure	Substance	Mixture
Steel		
Air		
Butter		
liquid antibiotics		
Water		

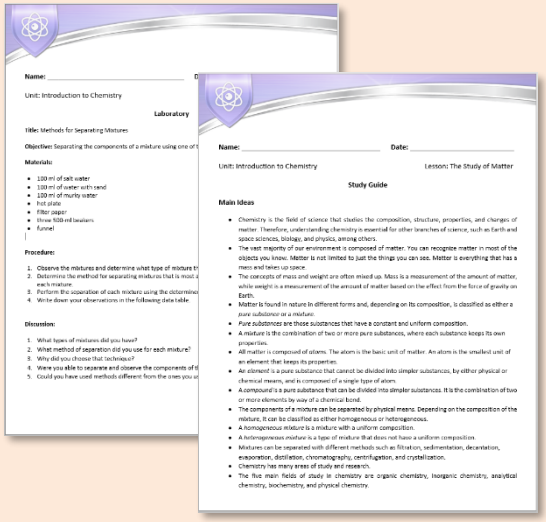
C. Describe the separation method that could be used to separate each of the following mixtures:

1. a liquid from a solid _____
2. two different-sized solids _____
3. two soluble liquids _____
4. two soluble liquids and a solid _____

These activities are featured in every lesson, including the answer key for the teacher.

- I Understand!
- Applying What I Know

Other documents


Name: _____

Unit: Introduction to Chemistry

Laboratory

Title: Methods for Separating Mixtures

Objective: Separating the components of a mixture using one of t

Materials:

- 100 ml of salt water
- 100 ml of water with sand
- 100 ml of murky water
- hot plate
- filter paper
- three 500-ml beakers
- funnel

Procedure:

1. Observe the mixtures and determine what type of mixture t
2. Determine the method for separating mixtures that is most
each mixture.
3. Perform the separation of each mixture using the determine
4. Write down your observations in the following data table.

Discussion:

1. What types of mixtures did you have?
2. What method of separation did you use for each mixture?
3. Why did you choose that technique?
4. Were you able to separate and observe the components of t
5. Could you have used methods different from the ones you u

Name: _____ Date: _____

Unit: Introduction to Chemistry Lesson: The Study of Matter

Study Guide

Main Ideas

- Chemistry is the field of science that studies the composition, structure, properties, and changes of matter. Therefore, understanding chemistry is essential for other branches of science, such as Earth and space sciences, biology, and physics, among others.
- The vast majority of our environment is composed of matter. You can recognize matter in most of the objects you know. Matter is not limited to just the things you can see. Matter is everything that has a mass and takes up space.
- The concepts of mass and weight are often mixed up. Mass is a measurement of the amount of matter, while weight is a measurement of the amount of matter based on the effect from the force of gravity on Earth.
- Matter is found in nature in different forms and, depending on its composition, is classified as either a pure substance or a mixture.
- *Pure substances* are those substances that have a constant and uniform composition.
- A mixture is the combination of two or more pure substances, where each substance keeps its own properties.
- All matter is composed of atoms. The atom is the basic unit of matter. An atom is the smallest unit of an element that keeps its properties.
- An *element* is a pure substance that cannot be divided into simpler substances, by either physical or chemical means, and is composed of a single type of atom.
- A *compound* is a pure substance that can be divided into simpler substances. It is the combination of two or more elements by way of a chemical bond.
- The components of a mixture can be separated by physical means. Depending on the composition of the mixture, it can be classified as either homogeneous or heterogeneous.
- A *homogeneous mixture* is a mixture with a uniform composition.
- A *heterogeneous mixture* is a type of mixture that does not have a uniform composition.
- Mixtures can be separated with different methods such as filtration, sedimentation, decantation, evaporation, distillation, chromatography, centrifugation, and crystallization.
- Chemistry has many areas of study and research.
- The five main fields of study in chemistry are organic chemistry, inorganic chemistry, analytical chemistry, biochemistry, and physical chemistry.

These are included in every lesson.

- Laboratory
- Study Guide

Unit Breakdown

Below we have included a breakdown of each unit into lessons, outlining the titles of each unit, as well as the titles, codes, objectives, topics, and concepts of each lesson.

Unit 0. Introduction

At the end of this unit, the students will have accomplished the objectives established in the following lessons.

Lesson 0. Guide for the Development of Scientific Research

Code: C431G0SU00L00

Appendix

- Guide for the Development of Scientific Research

Concepts

- Science fair
- Scientific research

Lesson 1. Scientific Knowledge

Code: C431G0S00L01

Objectives

By the end of this lesson, students will:

- identify information as either a scientific or a non-scientific fact;
- distinguish between science and pseudoscience.

Topics

- Common knowledge or scientific knowledge
- Science and pseudoscience

Concepts

- common knowledge
- empirical knowledge
- observation
- pseudoscience
- reliability
- science
- scientific knowledge
- scientific method

Lesson 2. The Scientific Method

Code: C431G0S00L02

Objectives

By the end of this lesson, students will:

- describe the history and origin of the scientific method;
- explain the role of Galileo in the development of modern science;
- describe the characteristics of the scientific method;
- explain the steps of the scientific method;
- conduct a simple investigation following the scientific method.

Topics

- Introduction
- History and origin
- Definition and characteristics

Concepts

- experimental method
- logical method
- scientific method

Lesson 3. Scientific Research

Code: C431G0SU00L03

Objectives

By the end of this lesson, students will:

- identify the most recent technological advances in the field of science;
- describe how recent technological advances have benefited scientific research;
- identify and describe examples of scientific fraud;
- distinguish reliable sources of information from unreliable ones;
- identify the different classifications into which scientific research can be grouped;
- identify the main characteristics of scientific research.

Topics

- Introduction
- Research and science
- Types of research
- Technology and mathematics
- Validity and reliability
- Scientific fraud

Concepts

- objectivity
- reliability
- research
- scientific fraud
- scientific knowledge
- validity

Lesson 4. Developing Scientific Research

Code: C431G0SU00L04

Objectives

By the end of this lesson, students will:

- identify the dependent, independent, and control variables in different research scenarios;
- identify the different steps in a scientific research;
- develop the first step of a possible scientific research.

Topics

- Stage 1: The beginning
- Stage 2: Research
- Stage 3: Finding meaning
- Stage 4: Publication

Concepts

- APA format
- challenging the hypothesis
- conclusions
- control variable
- data analysis
- dependent variable
- experimental method
- independent variable
- rationale
- theoretical framework
- variables

Lesson 5. Practice Sheets

Code: C431G0SU00L05

Objectives

By the end of this lesson, students will:

- correctly draft a research question and hypothesis for a scientific research project;
- use questions to analyze the data represented through tables or graphs;
- reach and draft conclusions based on data analysis;
- create and draft an original experimental design for a potential formal research project.

Topics

- Research draft
- Question and hypothesis
- Hypothesis: If..., then...
- Data analysis
- Experiment

Lesson 6. Mathematics: The Language of Science

Code: C431G0SU00L06

Objectives

By the end of this lesson, students will:

- explain the importance of the International System of Units;
- mention and describe the units of the International System of Units;
- convert measurements to scientific notation;
- distinguish between accuracy and precision in measurements;
- use significant figures in measurements and calculations;
- determine the correct units to use for certain measurements.

Topics

- The International System of Units
- Prefixes of the International System of Units
- Scientific Notation
- Measurements in the experiment

Concepts

- accuracy
- ampere
- candela
- international measurement system
- kelvin
- kilogram
- meter
- mole
- precision
- scientific notation
- significant figures

Lesson 7. Getting to Know the Science Laboratory

Code: C431G0SU00L04

Objectives

By the end of this lesson, students will:

- identify safety symbols in the laboratory and determine what they mean;
- identify the most common laboratory equipment and its uses;
- prevent accidents in the laboratory.

Topics

- Safety in the laboratory
- Laboratory equipment and its uses

Concepts

- carcinogenic
- contamination
- corrosive
- irritating
- meniscus
- MSDS
- pollution
- radiation
- safety
- toxic

Unit 1. Introduction to Chemistry

At the end of this unit, the students will have accomplished the objectives established in the following lessons.

Lesson 1. The Study of Matter

Code: C431G0SU01L01

Objectives

By the end of this lesson, students will:

- describe the characteristics of chemistry and distinguish it from other branches of science;
- describe the importance of the study of chemistry for humanity;
- identify and describe the classifications of matter;
- distinguish between the different branches of chemistry;
- design and use a process that applies the adequate methods to separate mixtures and identify the substances present in them by considering their properties;
- offer examples of the usefulness and application of these processes in the real world (filtration, chromatography, etc.);
- analyze the properties of solutions according to the properties of their components.

Topics

- Chemistry and matter
- Classification of matter
- Branches of chemistry

Concepts

- atom
- centrifugation
- chemistry
- chromatography
- compound
- decantation
- distillation
- element
- evaporation
- filtration
- heterogeneous mixture
- homogeneous mixture
- mass
- matter
- mixture
- pure substances
- sedimentation
- solute
- solvent
- weight

Lesson 2. Properties and Changes in Matter

Code: C431G0SU01L02

Objectives

By the end of this lesson, students will:

- classify matter based on its composition;
- distinguish between the chemical and physical properties of matter;
- identify examples where chemical or physical properties of matter are essential for a specific use;
- explain how the law of conservation of mass is evident in chemical reactions;
- differentiate between intensive and extensive properties of matter.

Topics

- Physical and chemical properties
- Physical and chemical changes

Concepts

- change of state
- chemical properties
- extensive property
- gas
- intensive property
- liquid
- physical changes
- physical property
- plasma
- solid

Lesson 3. The Structure of Atoms

Code: C431G0SU01L03

Objectives

By the end of this lesson, students will:

- identify and describe the most important events in human history that led to the development of the modern atomic theory;
- define and distinguish between the concepts of *electron*, *proton*, and *neutron*;
- depict an atomic model and identify its components;
- distinguish between the atomic number and atomic mass of an element;
- define the term *isotope*.

Topics

- The development of modern atomic theory
- Discovery of electrons, protons, and neutrons
- Atomic numbers and atomic mass

Concepts

- atom
- atomic mass
- atomic number
- electron
- isotopes
- law of definite proportions
- law of multiple proportions
- mass number

- neutron
- nucleus
- nuclide
- proton
- unified atomic mass unit (dalton)

Lesson 4. Electrons

Code: C431G0SU01L04

Objectives

By the end of this lesson, students will:

- compare the energy levels of an electron inside an atom;
- illustrate an atom's valence electrons using the Lewis' structure diagram.

Topics

- Behavior of light waves
- The electromagnetic spectrum
- Behavior of the light particle
- Bohr's atomic model

Concepts

- amplitude
- crests
- electromagnetic radiation
- electromagnetic spectrum
- emission spectrum
- excited state
- frequency
- ground state
- photoelectric effect
- photon
- quantum
- radiation
- speed of light
- troughs
- wavelength

Lesson 5. Development of a New Model of Atomic Structure

Code: C431G0SU01L05

Objectives

By the end of this lesson, students will:

- compare and contrast the Bohr atomic model and the quantum mechanical model of the atom;
- relate the energy sublevels and the orbitals of the atom;
- identify and describe why molecular structure is important for the performance of materials design.

Topics

- Electron cloud atomic model
- Quantum numbers and atomic orbitals
- Electron configuration
- Valence electrons

Concepts

- angular momentum quantum number
- Aufbau principle
- electron dot structure
- Heisenberg's uncertainty principle
- Hund's rulemagnetic quantum number
- noble gas notation
- orbital
- Pauli exclusion principle
- principal quantum number
- quantum mechanical atomic model
- quantum numbers
- quantum spin number
- valence electrons

Unit 2. The Periodic Table

At the end of this unit, the students will have accomplished the objectives established in the following lessons.

Lesson 1. The Development of the Periodic Table

Code: C431G0SU02L01

Objectives

By the end of this lesson, students will:

- describe the historical process of the development of the periodic table, from its beginnings to the modern periodic table;
- explain the importance of the periodic table as a tool in scientific processes.

Topics

- Historic development

Concepts

- law of octaves
- periodic law
- periodic table
- triads

Lesson 2. The Periodic Table and Atomic Structure

Code: C431G0SU02L02

Objectives

By the end of this lesson, students will:

- relate electron configuration with the periods in the modern periodic table;
- explain why elements belonging to the same group share similar characteristics;
- identify the properties that determine how elements are organized.

Topics

- The modern periodic table
- Groups of elements
- Periodic trends

Concepts

- actinides
- alkali metals
- alkaline earth metals
- anion
- boron group
- carbon family
- cation
- chalcogens (previously known as amphigens)
- electron affinity
- electronegativity
- group or family
- halogens
- inner transition elements
- ion

- ionization energy
- lanthanides
- main-group elements
- nitrogen family
- noble gases
- octet rule
- oxidation number
- period
- transition elements
- valence electrons

Lesson 3. Classification of Elements

Code: C431G0SU02L03

Objectives

By the end of this lesson, students will:

- use a comparison table to identify the characteristics that distinguish metals, non-metals, and metalloids;
- identify the practical applications of the properties of metals, non-metals, and metalloids using everyday examples.

Topics

- Metals, non-metals, and metalloids

Concepts

- alloy
- ductile
- malleable
- metal
- metalloids or semimetals
- non-metals

Lesson 4. Blocks of Elements

Code: C431G0SU02L04

Objectives

By the end of this lesson, students will:

- interpret the information provided by the periodic table block an element belongs to;
- relate the *s*, *p*, *d*, and *f* blocks with an element's electron configuration;
- predict the electron configurations of elements using the periodic table.

Topics

- The periodic table blocks
- Blocks and electron configuration

Concepts

- *d*-block
- *f*-block
- *p*-block
- *s*-block

Unit 3. Chemical Bonds and Compounds

At the end of this unit, the students will have accomplished the objectives established in the following lessons.

Lesson 1. Formation of Chemical Bonds

Code: C431G0SU03L01

Objectives

By the end of this lesson, students will:

- describe what a chemical bond is and how the electron configuration affects the formation of bonds.

Topics

- Chemical bonds and electronegativity

Concepts

- chemical bond
- covalent bond
- ionic bond
- nonpolar covalent bond
- polar covalent bond

Lesson 2. Ionic Bonds and Compounds

Code: C431G0SU03L02

Objectives

By the end of this lesson, students will:

- explain the formation and properties of ionic bonds and metallic bonds;
- create a model of an ionic bond;
- apply the nomenclature rules when writing the names and formulas of ionic and covalent compounds;
- identify and describe examples of how ionic bonds affect the physical properties of compounds;
- apply ionic charge in the notation of ionic compound formulas;
- apply the formulas of ionic compounds;
- interpret the construction of a chemical formula;
- compare the structures of different substances and draw conclusions about the intensity of the forces between their particles.

Topics

- Formation of ionic bonds
- Ionic compound properties
- Ionic compounds
- Nomenclature of ionic compounds
- Metallic bonds

Concepts

- binary ionic compounds
- electrolyte
- ionic compounds
- lattice energy
- metallic bond
- monatomic ion
- oxide
- oxyanion
- polyatomic ion
- unit formula

Lesson 3. Covalent Bonds and Compounds

Code: C431G0SU03L03

Objectives

By the end of this lesson, students will:

- explain the formation and properties of covalent bonds;
- compare and contrast polar and non-polar molecules;
- create a model of a covalent bond;
- identify and describe examples of how covalent bonds affect the physical properties of compounds;
- apply the nomenclature rules when writing the names and formulas of ionic and covalent compounds;
- compare the structures of different substances and draw conclusions about the intensity of the forces between their particles.

Topics

- Formation of a covalent bond
- Nomenclature of covalent compounds
- Molecular structures
- Molecular formulas

Concepts

- acid
- binary acid
- bond length
- bond-dissociation energy
- covalent bond
- double bond
- hybridization
- molecular formula
- molecule
- oxyacid
- oxyanion
- pi bond
- resonance
- single bond
- structural formula
- triple bond
- VSEPR theory

Unit 4. Reactions and Equations

At the end of this unit, the students will have accomplished the objectives established in the following lessons.

Lesson 1. Chemical Equations

Code: C431G0SU04L01

Objectives

By the end of this lesson, students will:

- explain how chemical equations describe chemical reactions;
- represent chemical reactions using equations;
- balance chemical reactions by changing coefficients;
- describe how chemical equations are related to the laws of conservation of mass and energy.

Topics

- Conservation of mass
- Writing equations
- Balancing chemical equations

Concepts

- chemical equation
- chemical reaction
- coefficient
- law of conservation of mass or matter
- products
- reactants

Lesson 2. Types of Reactions

Code: C431G0SU04L02

Objectives

By the end of this lesson, students will:

- identify a chemical reaction based on the characteristics of substances;
- distinguish between five different types of chemical reactions;
- classify reactions into one of the five types of chemical reactions;
- develop a model that shows the conservation of mass in a chemical reaction.

Topics

- Classifications
- Reactions in aqueous solutions

Concepts

- combustion reaction
- complete ionic equation
- decomposition reaction
- dissociation
- double-displacement reaction
- net ionic equation
- precipitate
- single-displacement reaction
- spectator ions
- synthesis reaction

Lesson 3. Reaction Rate

Code: C431G0SU04L03

Objectives

By the end of this lesson, students will:

- identify and explain the factors that influence the direction of a chemical reaction;
- classify the factors that influence the rate of a reaction.

Topics

- Factors that affect the reaction rate
- Instantaneous rate and reaction mechanisms

Concepts

- activated complex
- activation energy
- intermediary
- rate law
- rate-determining step
- reaction mechanism
- reaction order
- reaction rate

Lesson 4. Chemical Equilibrium

Code: C431G0SU04L04

Objectives

By the end of this lesson, students will:

- define the concept of *chemical equilibrium*;
- identify and describe the factors that affect equilibrium.

Topics

- What is chemical equilibrium?
- Le Châtelier's principle and the factors affecting equilibrium.

Concepts

- chemical equilibrium
- endothermic reaction
- equilibrium constant
- exothermic reaction
- heterogeneous equilibrium
- homogeneous equilibrium
- law of mass action
- Le Châtelier's principle
- reversible reaction

Unit 5. Moles and Stoichiometry

At the end of this unit, the students will have accomplished the objectives established in the following lessons.

Lesson 1. Mole and Avogadro's Number

Code: C431G0SU05L01

Objectives

By the end of this lesson, students will:

- explain what *mole* and *molar mass* are;
- compare and contrast mole as a number and mole as mass;
- describe the use of a mole in chemistry;
- convert moles into particle numbers, and vice-versa.

Topics

- Measuring matter
- Moles and particles

Concepts

- Avogadro's number
- mole

Lesson 2. Mass and the Mole

Code: C431G0SU05L02

Objectives

By the end of this lesson, students will:

- calculate the number of moles in a given mass of an element, and vice-versa.
- calculate the number of moles in an element based on the number of atoms, and vice-versa;
- calculate and predict the number of reactants and products in chemical reactions.

Topics

- Molar mass
- Application of molar mass
- Mole and the chemical formula

Concepts

- molar mass

Lesson 3. Stoichiometry and Moles

Code: C431G0SU05L03

Objectives

By the end of this lesson, students will:

- define stoichiometry and explain its relation to the law of conservation of mass;
- apply the steps to solve stoichiometry problems.

Topics

- What is stoichiometry?
- Stoichiometry calculations

Concepts

- molar ratio
- stoichiometry

Lesson 4. Limiting Reactant

Code: C431G0SU05L04

Objectives

By the end of this lesson, students will:

- define the concept of limiting reactant;
- perform stoichiometric calculations to identify the limiting reactant in a reaction;
- calculate the quantity of moles or grams of a product based on the quantity of moles or grams of two reactants, one of which is in excess.

Topics

- Why does a chemical reaction stop?
- Determining a limiting reactant

Concepts

- excess reactant
- limiting reactant

Lesson 5. Percent Yield

Code: C431G0SU05L05

Objectives

By the end of this lesson, students will:

- differentiate between theoretical yield, actual yield, and percent yield;
- calculate the percent yield of a chemical reaction.

Topics

- What is percent yield?

Concepts

- actual yield
- theoretical yield

Unit 6. States of Matter

At the end of this unit, the students will have accomplished the objectives established in the following lessons.

Lesson 1. Kinetic Molecular Theory

Code: C431G0SU06L01

Objectives

By the end of this lesson, students will:

- compare the properties of solids, liquids, and gases;
- describe the relationship between the properties of solids, liquids, and gases through the kinetic theory of matter;
- distinguish between an amorphous solid, a liquid crystal, and plasma.

Topics

- Kinetic theory of gases
- Kinetic theory of liquids
- Kinetic theory of solids

Concepts

- amorphous solid
- capillarity
- crystalline solid
- diffusion
- dipole-dipole forces
- effusion
- elastic collision
- fluid
- Graham's law
- hydrogen bonds
- ideal gas
- intermolecular force
- kinetic energy
- kinetic molecular theory
- London dispersion force
- real gas
- surface tension
- temperature
- unit cell
- viscosity

Lesson 2. Phase Transition

Code: C431G0SU06L02

Objectives

By the end of this lesson, students will:

- interpret changes in the state of a substance based on the kinetic molecular theory of matter;
- analyze the effects of temperature and pressure on state changes;
- create a model to predict and describe changes in the particle movement, temperature, and state of a substance when there are changes in energy (added or subtracted).

Topics

- Changes that release energy
- Changes that require energy

Concepts

- boiling point
- condensation
- deposition
- equilibrium
- equilibrium vapor pressure
- evaporation
- freezing
- heat
- melting
- melting point
- molar enthalpy of fusion
- molar enthalpy of vaporization
- phase
- phase diagram
- sublimation
- triple point
- vapor pressure
- vaporization
- volatile liquid

Lesson 3. Gas Laws and Combined Gas Law

Code: C431G0SU06L03

Objectives

By the end of this lesson, students will:

- describe Boyle's and Charles' laws in view of the kinetic theory and their applications in everyday life or in familiar artifacts;
- calculate and predict the effects of pressure and temperature changes on the volume of a gas;
- explain the reaction of gas volumes based on the kinetic theory of gases.

Topics

- Gas pressure
- Boyle's law
- Charles' law
- Gay-Lussac's law
- Combined gas law

Concepts

- absolute zero
- barometer
- Boyle's law
- Charles' law
- combined gas law
- Dalton's law of partial pressure
- Gay-Lussac's law
- pascal
- pressure gauge

Lesson 4. Ideal Gases

Code: C431G0SU06L04

Objectives

By the end of this lesson, students will:

- compare and contrast ideal gases with real gases.

Topics

- Avogadro's law
- Ideal gas law

Concepts

- ideal gas law
- Avogadro's law
- molar volume

Unit 7. Solutions and Mixtures

At the end of this unit, the students will have accomplished the objectives established in the following lessons.

Lesson 1. Heterogeneous Mixtures

Code: C431G0SU07L01

Objectives

By the end of this lesson, students will:

- describe suspensions;
- identify the properties that distinguish colloids.

Topics

- Suspensions
- Colloids

Concepts

- Brownian motion
- colloid
- heterogeneous mixture
- homogeneous mixture
- suspension
- Tyndall effect

Lesson 2. Solutions

Code: C431G0SU07L02

Objectives

By the end of this lesson, students will:

- describe the properties and different types of solutions;
- explain the concept of solubility and describe the factors that affect it;
- calculate the concentration of a solution.

Topics

- Properties of solutions
- Solubility
- Concentration
- Molarity

Concepts

- concentration
- dilution
- homogeneous mixture
- hydration
- immiscible substances
- insoluble

- miscible substances
- molality
- molarity or molar concentration
- mole fraction of a solute
- saturated solution
- solubility
- soluble
- solute
- solvation
- solvent
- supersaturated solution
- unsaturated solution

Lesson 3. Colligative Properties

Code: C431G0SU07L03

Objectives

By the end of this lesson, students will:

- create a table to compare and contrast the colligative properties of substances.

Topics

- Electrolytes
- Vapor pressure
- Boiling point
- Freezing point
- Osmotic pressure

Concepts

- boiling point elevation
- colligative property
- freezing point
- molal boiling point elevation constant
- molal freezing point depression constant
- nonelectrolyte
- nonvolatile substance
- osmosis
- osmotic pressure
- strong electrolyte
- volatile substance
- weak electrolyte

Lesson 4. Water and its properties

Code: C431G0SU07L04

Objectives

By the end of this lesson, students will:

- create a water molecule model;
- describe the properties of water that make it a unique substance.

Topics

- Properties of water
- Water as a solvent

Concepts

- boiling point
- dipole
- electronegativity
- freezing point
- polar covalent bond
- specific heat

Unit 8. Acids, Bases, and Redox

At the end of this unit, the students will have accomplished the objectives established in the following lessons.

Lesson 1. Introductions to Acids and Bases

Code: C431G0SU08L01

Objectives

By the end of this lesson, students will:

- distinguish acids from bases, based on their properties.

Topics

- The properties of acids and bases
- Theories of acids and bases

Concepts

- acid
- amphoteric
- Arrhenius acid
- Arrhenius base
- autoionization of water
- basic or alkaline solution
- Brønsted-Lowry acid
- Brønsted-Lowry base
- conjugate acid
- conjugate base
- Lewis acid
- Lewis base
- monoprotic acid
- neutral solution
- polyprotic acid

Lesson 2. Acid and Base Strength

Code: C431G0SU08L02

Objectives

By the end of this lesson, students will:

- establish the relationship between the electrical conductivities of different acidic and basic solutions and their degree of dissociation or ionization;
- distinguish between strong and weak acids and bases, based on their degree of dissociation or ionization;
- compare and contrast the composition of weak and strong acid or base solutions.

Topics

- Strong acids and bases
- Weak acids and bases

Concepts

- acid dissociation constant
- base dissociation constant
- strong acid
- strong base
- weak acid
- weak base

Lesson 3. pH

Code: C431G0SU08L03

Objectives

By the end of this lesson, students will:

- explain what the pH of a substance and the pH scale is, as well as methods for determining pH;
- relate pH to the strength of acids and bases.

Topics

- Ion concentrations in Solution
- pH
- How to determine pH

Concepts

- acid-base indicators
- endpoint
- equivalence point
- pH
- pH meter
- pOH
- standard or titration solution
- titration

Lesson 4. Acid-Base Reactions

Code: C431G0SU08L04

Objectives

By the end of this lesson, students will:

- predict and explain the final results of an acid-base reaction;
- evaluate and describe the importance of a buffer to determine pH;
- design strategies to perform acid-base titrations and calculate the results from the data;

- identify acid-base reactions that occur in everyday life.

Topics

- Neutralization reaction
- Buffer solutions
- Salt hydrolysis

Concepts

- buffer capacity
- buffer solution
- neutralization reaction
- salt

Lesson 5. Redox Reactions

Code: C431G0SU08L05

Objectives

By the end of this lesson, students will:

- describe the characteristics of a redox (reduction–oxidation) reaction;
- identify the substances that become oxidized and those that become reduced in a redox reaction;
- differentiate between oxidizing and reducing agents in redox reactions;
- balance redox reaction equations;
- identify redox reactions that are useful for industrial purposes.

Topics

- What is oxidation?
- Reduction and electron transfer
- What is a redox reaction?
- Oxidizing agents and reducing agents
- Balancing redox equations

Concepts

- half reaction
- oxidation number or oxidation state
- oxidation-reduction reaction (redox)
- oxidizing agent
- reducing agent
- reduction

Lesson 6. Applications of Redox Reactions

Code: C431G0SU08L06

Objectives

By the end of this lesson, students will:

- identify the oxidizing agent and the reducing agent in ordinary redox reactions;
- identify and describe some redox reactions that take place in organism cells.

Topics

- Everyday applications
- Biological applications

Concepts

- oxidation

Unit 9. Energy and Chemical Changes

At the end of this unit, the students will have accomplished the objectives established in the following lessons.

Lesson 1. Energy and Heat

Code: C431G0SU09L01

Objectives

By the end of this lesson, students will:

- define the concept of *energy* and distinguish between the different types of energy;
- explain how heat in chemical reactions is related to chemical potential energy;
- explain how energy manifests itself and changes from one form to another;
- create a model that illustrates energy absorption or energy release in a chemical reaction;
- distinguish between the concepts of *enthalpy*, *entropy*, and *free energy*, and describe how they determine the spontaneity of chemical reactions.

Topics

- The nature of energy
- Heat
- Endothermic and exothermic reactions
- Activation energy
- The direction of reactions

Concepts

- activation energy
- chemical energy
- endothermic reaction
- energy
- exothermic reaction
- heat
- irreversible reaction
- kinetic energy
- law of conservation of energy
- potential energy
- radiant energy
- reversible energy
- thermal energy
- thermochemistry

Lesson 2. Measuring Energy Changes

Code: C431G0SU09L02

Objectives

By the end of this lesson, students will:

- explain what the enthalpy change is in chemical reactions;
- describe the calorimetry technique.

Topics

- Enthalpy of reaction

- Calorimetry
- Hess's law
- Second law of thermodynamics

Concepts

- calorimetry
- enthalpy
- enthalpy change
- entropy
- first law of thermodynamics
- free energy
- heat capacity
- Hess's law
- second law of thermodynamics
- specific heat
- standard enthalpy of formation
- standard enthalpy of reaction
- thermochemical equation
- thermochemistry
- thermodynamics
- third law of thermodynamics
- work

Lesson 3. Cells and Batteries

Code: C431G0SU09L03

Objectives

By the end of this lesson, students will:

- relate the movement of charges through an electrical cell to the chemical reactions that occur there;
- compare and contrast primary and secondary batteries;
- create a model of a dry cell battery.

Topics

- Electrochemistry
- Electrochemical cell
- Batteries

Concepts

- anode
- battery
- cathode
- electrochemical cell
- electrochemistry
- oxidation
- oxidizing agent
- redox
- redox equation
- reducing agent
- reduction
- spectator ion

Lesson 4. Electrolysis

Code: C431G0SU09L04

Objectives

By the end of this lesson, students will:

- explain how to cause a nonspontaneous redox reaction during electrolysis;

- explain the principles of electrolysis in its different uses, such as chemical synthesis, refining, lamination, and cleaning.

Topics

- Process of electrolysis
- Applications of electrolysis

Concepts

- electrolytic cell
- electrolysis
- electrometallurgy

Unit 10. Organic Chemistry

At the end of this unit, the students will have accomplished the objectives established in the following lessons.

Lesson 1. Hydrocarbons

Code: C431G0SU10L01

Objectives

By the end of this lesson, students will:

- create a model of an alkane, an alkene, and an alkyne, and describe their structures;
- compare and contrast the properties of alkanes, alkenes, and alkynes;
- distinguish between the isomers of a given hydrocarbon.

Topics

- Alkanes, alkenes, and alkynes
- Sources of organic compounds

Concepts

- aliphatic hydrocarbon
- alkane
- alkene
- alkyne
- aromatic hydrocarbon
- concatenation
- conformation
- cycloalkane
- geometric isomer
- hydrocarbon
- isomer
- organic chemistry
- saturated hydrocarbon
- structural isomer
- unsaturated hydrocarbon

Lesson 2. Substituted Hydrocarbons

Code: C431G0SU10L02

Objectives

By the end of this lesson, students will:

- explain what a functional group is;
- describe the structures of the main types of substituted hydrocarbons;
- describe the properties and uses of each type of substituted hydrocarbon.

Topics

- Functional groups
- Structure and function of hydrocarbons
- Sources of hydrocarbons

Concepts

- alcohol
- aldehyde
- amine
- carboxylic acid
- ester
- ether
- functional group
- ketone

Lesson 3. Polymers

Code: C431G0SU10L03

Objectives

By the end of this lesson, students will:

- identify the monomers that form specific polymers;
- draw the structural formula of the polymers that form with a determined monomer;
- differentiate between the polymer reactions by condensation and by addition;
- summarize the relationship between the structure and the properties of polymers.

Topics

- Synthetic and natural polymers
- The structure of polymers
- Polymerization reactions
- Materials made from polymers

Concepts

- addition polymerization
- amino acid
- condensation polymerization
- copolymer
- homopolymer
- monomer
- monosaccharide
- natural polymer
- nucleic acid
- nucleotide
- polymer
- polymerization
- polysaccharide
- protein
- synthetic polymer

Lesson 4. Macromolecules

Code: C431G0SU10L04

Objectives

By the end of this lesson, students will:

- describe the structures and functions of proteins, carbohydrates, lipids, and nucleic acids.

Topics

- Proteins
- Carbohydrates
- Lipids
- Nucleic acids

Concepts

- carbohydrates
- DNA
- fatty acid
- lipids
- macromolecules
- nucleic acid
- nucleotide
- peptides
- proteins
- RNA

Lesson 5. Chemical Reactions in Organisms

Code: C431G0SU10L05

Objectives

By the end of this lesson, students will:

- distinguish between anabolic reactions and catabolic reactions;
- explain the importance of ATP in metabolism;
- compare and contrast the chemical processes of respiration, fermentation, and photosynthesis.

Topics

- Metabolism
- Cellular respiration
- Fermentation
- Photosynthesis

Concepts

- alcoholic fermentation
- anabolic reaction (anabolism)
- ATP
- Calvin cycle
- catabolic reaction (catabolism)
- cellular respiration
- chemiosmosis
- electron transport chain
- fermentation
- glycolysis
- Krebs cycle
- lactic acid fermentation
- light-dependent reactions
- light-independent reactions
- metabolic pathway
- metabolism
- oxidative phosphorylation
- photosynthesis
- pyruvate oxidation

Unit 11. Nuclear Chemistry

At the end of this unit, the students will have accomplished the objectives established in the following lessons.

Lesson 1. Radiation

Code: C431G0SU10L01

Objectives

By the end of this lesson, students will:

- describe the studies that led to the discovery of radiation;
- describe the common sources of background radiation;
- compare and contrast the composition and properties of alpha, beta, and gamma radiation;
- explain the concept of half-life of a radioactive element;
- explain how matter transforms into energy, and vice versa, during a nuclear reaction.

Topics

- The discovery of radiation
- Types of radiation
- Detecting radiation

Concepts

- alpha particles
- artificial radioactivity
- beta particles
- gamma particles
- half-life
- radiation
- radioactive elements
- radioactivity

Lesson 2. Nuclear Reactions and Energy

Code: C431G0SU11L02

Objectives

By the end of this lesson, students will:

- distinguish between nuclear fusion and nuclear fission;
- create models representing the changes in the composition of an atom's nucleus and the energy released during the processes of fusion, fission, and radioactive decay;
- create a diagram and explain the process of generating electricity in a nuclear reactor.

Topics

- Nuclear reactions
- Nuclear fission and nuclear fusion
- Nuclear reactors

Concepts

- moderator
- nuclear binding energy
- nuclear chain reaction
- nuclear fission
- nuclear fusion
- nuclear reaction
- nuclear reactor
- nuclear transmutation
- radioactive decay
- thermonuclear reaction

Lesson 3. Uses and Problems of Radiation

Code: C431G0SU11L03

Objectives

By the end of this lesson, students will:

- identify the biological effects of radiation;
- identify the units used to measure radiation exposure levels;
- present and describe examples of medical and non-medical uses for radiation;
- evaluate and argue in favor or against the different uses of radiation in terms of cost, benefits, safety, reliability, and aesthetic considerations, as well as possible social, cultural, and environmental impacts.

Topics

- Medical uses of radiation
- Non-medical uses of radiation
- Disposal of radioactive waste

Concepts

- biological radiation
- ionizing radiation
- level of exposure
- radioactive isotope
- radioactive waste

Unit 12. Environmental Chemistry

At the end of this unit, the students will have accomplished the objectives established in the following lessons.

Lesson 1. Gases in the Atmosphere

Code: C431G0SU12L01

Objectives

By the end of this lesson, students will:

- create a diagram of the structure of Earth's atmosphere and identify the main gases that make up each layer;
- explain the chemical relationship between atmospheric ozone and CFCs;
- describe the causes leading to the formation of the photochemical smog and identify its main components based on its color;
- describe the connection between human activities and climate change, global warming, and the increase in greenhouse gases;
- propose alternatives to minimize the anthropogenic causes of climate change, both at a local level and worldwide.

Topics

- Structure and composition of the atmosphere
- Ozone
- Photochemical smog
- Human activities and climate change

Concepts

- atmosphere
- chlorofluorocarbons (CFCs)
- climate change
- exosphere
- global warming
- greenhouse effect
- greenhouse gases
- ionosphere
- mesosphere
- ozone
- stratosphere
- thermosphere
- troposphere

Lesson 2. Water

Code: C431G0SU12L02

Objectives

By the end of this lesson, students will:

- describe the chemical processes involved in water desalination and purification;
- identify and describe the parameters used to determine water quality and the chemical tests performed for each one;
- evaluate the possibility of establishing a desalination plant in the country to produce potable water, taking into account cost, benefits, safety, reliability, and aesthetic considerations, as well as possible social, cultural, and environmental impacts.

Topics

- Salinity and desalination
- Water purification treatment
- Water quality

Concepts

- aqueous solution
- desalination
- non-potable water
- potable water
- reverse osmosis
- salinity
- water purification
- water quality

Lesson 3. The Earth's Crust

Code: C431G0SU12L03

Objectives

By the end of this lesson, students will:

- identify and describe the main components of Earth's crust, including its chemical composition.

Topics

- Components of the lithosphere

Concepts

- chemical weathering
- continental crust
- Earth’s crust
- erosion
- geosphere
- lithosphere
- oceanic crust
- tectonic plates

Lesson 4. Biogeochemical Cycles

Code: C431G0SU12L04

Objectives

By the end of this lesson, students will:

- create a diagram of the carbon and nitrogen cycles;
- explain the chemical processes that occur in the carbon and nitrogen cycles;
- determine and describe the importance of the chemical processes that happen in both the carbon and the nitrogen cycles;
- describe how human activity interferes with the carbon and nitrogen cycles and the consequences of such interference on the environment.

Topics

- Biogeochemical cycle
- Carbon cycle
- Nitrogen cycle

Concepts

- biogeochemical cycle
- carbon cycle
- cellular respiration
- denitrification
- fixation
- nitrification
- nitrogen cycle
- phosphorus cycle
- photosynthesis
- sulfur cycle
- water cycle

Lesson 5. Solid Waste Management

Code: C431G0SU12L05

Objectives

By the end of this lesson, students will:

- create a diagram and describe the process of recycling plastics;
- identify the chemical reactions and substances produced in a landfill, as well as their effects on the environment;
- describe the chemical residues that result from the processes of pyrolysis, gasification, and the incineration of solid waste, as well as their effects on the environment;
- using the different waste disposal methods studied as reference, create a model that optimizes the limitations of the existing methods.

Topics

- Recycling
- Landfills
- Incineration
- Pyrolysis and gasification

Concepts

- biodegradable material
- composting
- gasification
- incineration
- landfills
- non-biodegradable material
- pyrolysis
- recycling
- reduce
- reuse
- solid waste

Lesson 6. Energy Generation

Code: C431G0SU12L06

Objectives

By the end of this lesson, students will:

- describe the use of hydrogen to produce energy;
- explain the process of producing ethanol from organic matter;
- compare and contrast the formation, chemical composition, and uses of fossil fuels;
- describe the economic implications, safety, reliability, and aesthetic considerations, as well as possible social, cultural, and environmental impacts, of the use of different types of fuels;
- create a model for an energy generation system that uses renewable energy as its main source.

Topics

- Hydrogen
- Ethanol
- Fossil fuels
- Economic and environmental implications

Concepts

- biomass
- carbon
- ethanol
- fossil fuel
- geothermal energy
- hydroelectric power
- hydrogen
- natural gas
- petroleum
- renewable energy
- solar energy
- wind energy