Fundamentals of PHYSICS

DREYFOUS

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Series 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 Physics” course provides an introduction to the study of physics, its important concepts and their application to everyday life. This course was developed to broaden the students' experience in this area of science. It is aimed at studying the concepts of energy, force, motion, among others.

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.

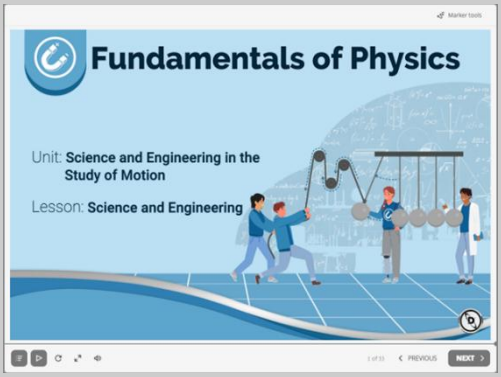
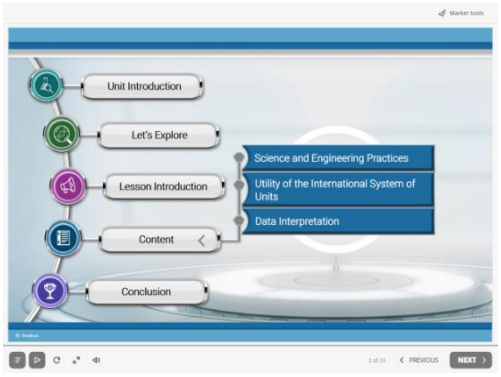
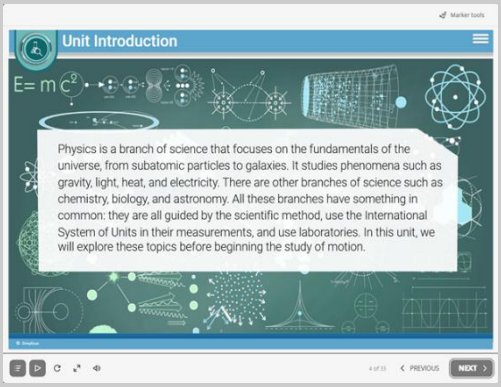
Thematic Focus

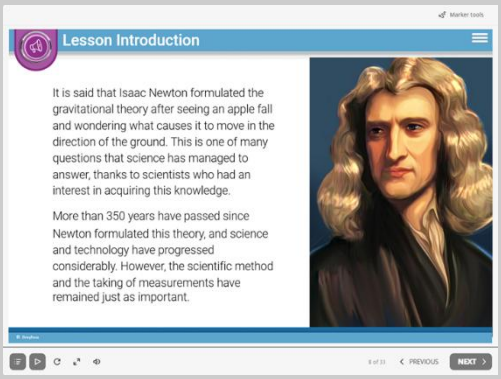
The content of the “Fundamentals” series was designed with a constructivist perspective, where the student will assess prior knowledge and build upon it by exploring new concepts. Each lesson has an exploration section that will allow the student to assess prior knowledge while expanding their learning 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.

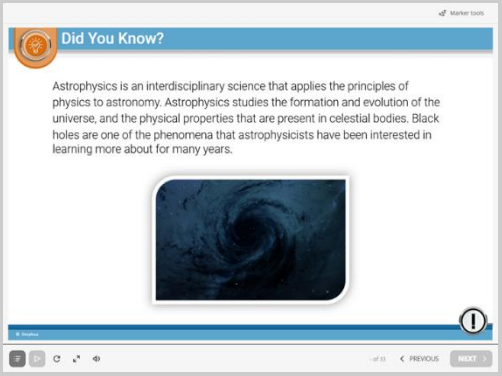
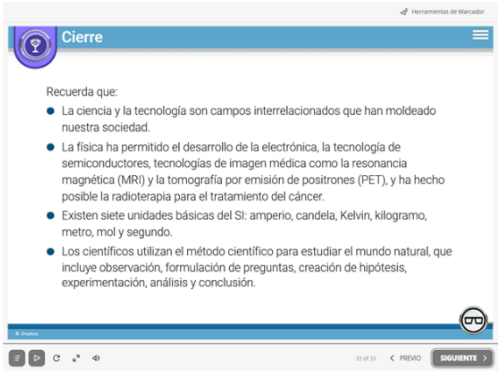
Puerto Rico Core Standards

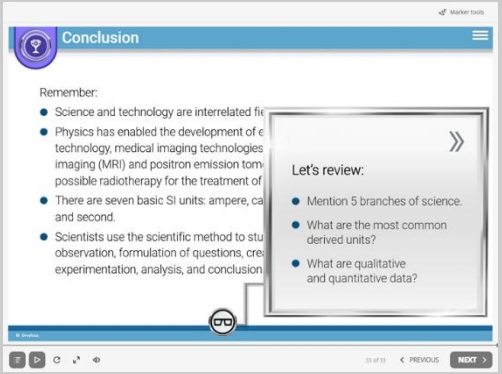
- **Engineering and Technology.** Study and apply science and engineering practices in the design and construction of prototypes to solve problems based on scientific evidence.
- **Physical Science - Physics**. Study the relationship between velocity, motion and force in matter; as well as the properties of waves, which explain the interactions with energy and the transformations of this energy.

Course Structure: Curricular Components

Lesson Content	
Cover 	The cover page is the lesson presentation that includes the following components: - "Fundamentals of Physics" (title of the course); - "Science and Engineering in the Study of Motion" (unit title); - "Science and Engineering" (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.

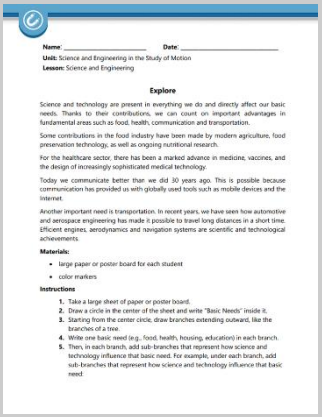
Let's Explore 	"Let's Explore" is an exploratory exercise that exposes the student to a first impression of the topics to be discussed in the lesson.
Lesson Introduction 	The lesson introduction presents the topics to be covered in the lesson, either by means of an example from everyday life or a historical 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.

Worksheets

Explore



Name: _____ Date: _____
Unit: Science and Engineering in the Study of Motion
Lesson: Science and Engineering

Explore

Science and technology are present in everything we do and directly affect our basic needs. Thanks to their contributions, we can count on important advantages in fundamental areas such as food, health, communication and transportation.

Some contributions in the food industry have been made by modern agriculture, food preservation technology, as well as ongoing nutritional research.

For the healthcare sector, there has been a marked advance in medicine, vaccines, and the design of increasingly sophisticated medical technology.

Today we communicate better than we did 30 years ago. This is possible because communication has provided us with globally used tools such as mobile devices and the Internet.

Another important need is transportation. In recent years, we have seen how automotive and aerospace engineering has made it possible to travel long distances in a short time. Efficient engines, aerodynamics and navigation systems are scientific and technological achievements.

Materials:

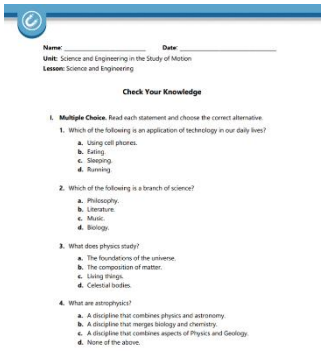
- large paper or poster board for each student
- color markers

Instructions

1. Take a large sheet of paper or poster board.
2. Draw a circle in the center of the sheet and write "Basic Needs" inside it.
3. Starting from the center circle, draw branches extending outward, like the branches of a tree.
4. Write one basic need (e.g., food, health, housing, education) in each branch.
5. Then, in each branch, add sub-branches that represent how science and technology influence that basic need. For example, under each branch, add sub-branches that represent how science and technology influence that basic need.

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: Science and Engineering in the Study of Motion
Lesson: Science and Engineering

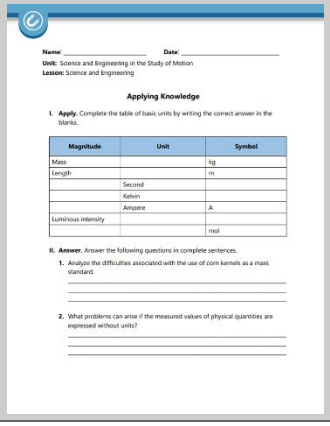
Check Your Knowledge

I. **Multiple Choice.** Read each statement and choose the correct alternative.

1. Which of the following is an application of technology in our daily lives?
   a. Using cell phones.
   b. Eating.
   c. Sleeping.
   d. Running.
2. Which of the following is a branch of science?
   a. Philosophy.
   b. Literature.
   c. Music.
   d. Biology.
3. What does physics study?
   a. The foundations of the universe.
   b. The composition of matter.
   c. Living things.
   d. Celestial bodies.
4. What are astrophysics?
   a. A discipline that combines physics and astronomy.
   b. A discipline that merges biology and chemistry.
   c. A discipline that combines aspects of Physics and Geology.
   d. None of the above.

The worksheet "Check Your Knowledge" 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.

Applying Knowledge



Name: _____ Date: _____
Unit: Science and Engineering in the Study of Motion
Lesson: Science and Engineering

Applying Knowledge

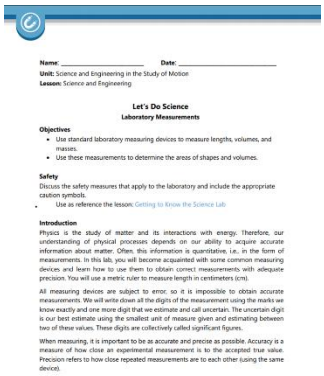
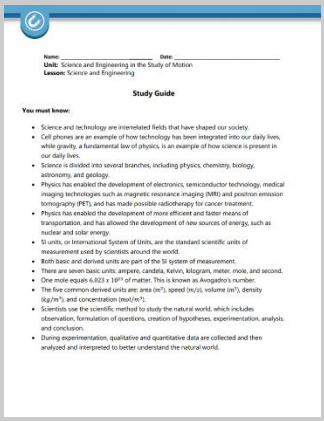
I. **Apply.** Complete the table of basic units by writing the correct answer in the blanks.

Magnitude	Unit	Symbol
Mass		kg
Length		m
	Second	
	Kelvin	
	Ampere	A
Luminous intensity		
		mol

II. **Answer.** Answer the following questions in complete sentences.

1. Analyze the difficulties associated with the use of corn kernels as a mass standard.
2. What problems can arise if the measured values of physical quantities are expressed without units?

The "Applying Knowledge" 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: Science and Engineering in the Study of Motion Lesson: Science and Engineering **Let's Do Science** **Laboratory Measurements** **Objectives** • Use standard laboratory measuring devices to measure lengths, volumes, and masses. • Use these measurements to determine the areas of shapes and volumes. **Safety** Discuss the safety measures that apply to the laboratory and include the appropriate caution symbols. • Use as reference the lesson: Getting to Know the Science Lab **Introduction** Physics is the study of matter and its interactions with energy. Therefore, our understanding of physical processes depends on our ability to acquire accurate information about matter. Often, this information is quantitative, i.e., in the form of measurements. In this lab, you will become acquainted with some common measuring devices and learn how to use them to obtain correct measurements with adequate precision. You will use a metric ruler to measure length in centimeters (cm). All measuring devices are subject to error, so it is impossible to obtain accurate measurements. We will write down all the digits of the measurement using the marks we know exactly and one more digit that we estimate and call uncertain. The uncertain digit is our best estimate using the smallest unit of measure given and estimating between two of these values. These digits are collectively called significant figures. When measuring, it is important to be as accurate and precise as possible. Accuracy is a measure of how close an experimental measurement is to the accepted true value. Precision refers to how close repeated measurements are to each other (using the same device).	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: Science and Engineering in the Study of Motion Lesson: Science and Engineering **Study Guide** **You must know:** • Science and technology are interrelated fields that have shaped our society. • Cell phones are an example of how technology has been integrated into our daily lives, while gravity, a fundamental law of physics, is an example of how science is present in our daily lives. • Science is divided into several branches, including physics, chemistry, biology, astronomy, and geology. • Physics has enabled the development of electronics, semiconductor technology, medical imaging technologies such as magnetic resonance imaging (MRI) and positron emission tomography (PET), and has made possible radiotherapy for cancer treatment. • Physics has enabled the development of more efficient and faster means of transportation, and has allowed the development of new sources of energy, such as nuclear and solar energy. • SI units, or International System of Units, are the standard scientific units of measurement used by scientists around the world. • Both basic and derived units are part of the SI system of measurement. • There are seven basic units: ampere, candela, Kelvin, kilogram, meter, mole, and second. • One mole equals 6.023×10^{23} of matter. This is known as Avogadro's number. • The five common derived units are: area (m^2), speed (m/s), volume (m^3), density (kg/m^3), and concentration (mol/m^3). • Scientists use the scientific method to study the natural world, which includes observation, formulation of questions, creation of hypotheses, experimentation, analysis, and conclusion. • During experimentation, qualitative and quantitative data are collected and then analyzed and interpreted to better understand the natural world.	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: Science and Engineering in the Study of Motion

Physics is a branch of science, just like biology and chemistry. Physics is responsible for studying phenomena such as gravity, light, heat, electricity, among others. Like the other branches of science, physics is governed by the scientific method.

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

Lesson 1: Science and Engineering
Code: C468G0SU01L01

Objectives:
At the end of this lesson, the student will:

- describe the branches of science associated with physics and the contributions of scientists to the knowledge of physics;
- apply the processes of observation, measurement, inference, prediction, classification, data interpretation, hypothesis formulation, experimentation, and communication in the development of research.

Topics

- Science and Engineering Practices
- Utility of the International System of Units
- Data Interpretation

Keywords
astrophysics, astronomy, biology, biochemistry, science, qualitative data, quantitative data, physics, geophysics, geology, data interpretation, scientific method, chemistry, System of Units (SI), technology, basic units, derived units, derived units

Lesson 2: Mathematics: The Language of Science

Code: C468G0SU01L02

Objectives:

At the end of this lesson, the student will:

- explain the importance of the international system of units;
- mention the units of the international system of units and describe them;
- convert measurements to scientific notation;
- distinguish between accuracy and precision in measurements;
- use significant figures in measurements and calculations;
- determine the appropriate units for certain measurements.

Topics

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

Keywords

standard deviation, percent error, accuracy, scientific notation, precision, SI prefixes, International System of Units (SI), unit of measurement, base and derived units

Lesson 3: Getting to Know the Science Lab

Code: C468G0SU01L03

Objectives:

At the end of this lesson, the student will:

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

Topics

- Safety in the Lab
- Laboratory Equipment and Uses

Keywords

droppers and pipettes, Personal Protective Equipment (PPE), laboratory safety equipment, specialized equipment, laboratories, Erlenmeyer flask, Bunsen burner, tweezers, scalpels and dissecting scissors, hot plate, laboratory safety, test tubes

Lesson 4: The Study of Motion

Code: C468G0SU01L04

Objectives:

At the end of this lesson, the student will:

- describe motion through the concepts of distance, displacement, speed, velocity, acceleration, and deceleration;
- explain the conditions under which an object can change its motion;
- compare and contrast the concepts of distance with displacement, and speed with displacement, and speed with velocity.

Topics

- Description of Motion
- Newton's Laws of Motion
- Motion Analysis

Keywords

average acceleration, acceleration, kinematics, displacement, dynamics, distance, scalar, force, inertia, Newton's Laws of Motion, frame of reference, mass, motion, Newton (N), average speed, speed, vector, average velocity, velocity

Unit 2: Gravitational Force and Space

For centuries, humans have studied space, which contains all existing matter. However, because we do not yet have the required technology, we have only been able to explore a small part of it. In this unit, the study of the force of gravity and celestial bodies will predominate as some of the space-related topics.

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

Lesson 1: Gravitational Force

Code: C468G0SU02L01

Objectives:

At the end of this lesson, the student will:

- define the force of gravity;
- describe how the Earth's gravitational force acts on objects;
- demonstrate that the gravitational interactions between celestial bodies are of attraction;
- describe the physical properties, location, and motion of the components of the solar system that are supported by gravitational force.

Topics

- Force of Gravity
- Law of Universal Gravitation
- Gravitational Fields

Keywords

accretion, radial gravitational attraction, gravitational field, Galileo Galilei, gravity, law of universal gravitation, mass, Nicolas Copernicus, weight

Lesson 2: Planetary Motion

Code: C468G0SU02L02

Objectives:

At the end of this lesson, the student will:

- describe the properties and motion of the solar system components by means of the laws of planetary motion;
- explain how gravitational interactions between celestial bodies occur;

- establish the relationship between mass and distance with the energy from the Sun that is received by the Earth.

Topics

- Components of the Solar System
- Laws of Planetry Motion
- Satellites

Keywords

accretion, aphelion, asteroids, asteroid belt, Kuiper belt, protoplanetary disk, Kepler's laws of planetary motion, moons, solar nebula, elliptical orbit trajectory, geosynchronous orbit or Clarke orbit, high Earth orbit (HEO) or geosynchronous orbit, low earth orbit (LEO), medium earth orbit (MEO), perihelion, orbital period, inner and outer planets, planets, planetesimals, protoplanets, satellite, artificial satellites, natural satellites, solar system, telescopes

Lesson 3: Space Travel and Exploration

Code: C468G0SU02L03

Objectives:

At the end of this lesson, the student will:

- describe the beginnings of space exploration;
- describe the types of orbits;
- explain the operation of rockets and space vehicles;
- justify the need for space exploration.

Topics

- Rockets
- Spaceflights
- Spacecraft
- Space Stations

Keywords

Amerika Bomber, lander, rocket, International Space Station (ISS), rover, total rocket mass, orbiter, Apollo Program, NASA space shuttle program, Saturn V, Skylab, flyby, space shuttle Enterprise, Voyager 1 and Voyager 2, Wernher von Braun

Unit 3: Work, Power, and Machines

Work and power are two concepts studied in physics. How much energy do we have to apply to move an object? Do we use more energy when pulling or pushing an object? In this unit we will answer these two questions.

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

Lesson 1: Work and Power

Code: C468G0SU03L01

Objectives:

At the end of this lesson, the student will:

- define the concept of work according to its application in physics;
- identify the units of measurement to represent the work done in a system;
- describe the conditions under which a system carries out work;
- calculate the work done on a system;
- define the concept of power and contrast it with the concept of work;
- use mathematical equations to calculate the power generated by doing a work;
- distinguish between the units of power and work.

Topics

- What is Work?
- What is Power?

Keywords

energy, constant force, variable force, force, Joule (J), power, work, Watt (W)

Lesson 2: Machines

Code: C468G0SU03L02

Objectives:

At the end of this lesson, the student will:

- identify the different types of simple machines and their function;
- classify between the different types of machines;
- explain the operation of a compound machine;
- calculate the mechanical advantage of a machine;
- create a solution to an everyday problem using a simple or compound machine.

Topics

- Wht are Machines?
- Types of Machines

Keywords

bicycle, wheelbarrow, wedge, car jack, stapler, complex machine, simple machine, lever, inclined plane, pulley, wheel and axle, screw, mechanical advantage

Unit 4: Energy and Its Transformations

Energy is a concept that relates to our lives every day. It is vital to both physics and the functioning of many systopics that we see in biology and chemistry. Energy is necessary for the systopics of the human body to function.

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

Lesson 1: Energy

Code: C468G0SU04L01

Objectives:

At the end of this lesson, the student will:

- define the concept of energy;
- identify the different types of energy;
- explain the relationship between energy and work;
- compare energy and work;
- describe the different forms of energy;
- describe everyday situations in which the different types of energy are manifested;
- experiment with energy to observe the changes it produces in objects.

Topics

- Energy and Work
- Forms of Energy
- Energy Preservation
- Energy Resources

Keywords

acoustic energy, elastic energy, electrical energy, resting energy, wind energy, gravitational energy, hydroelectric energy, mechanical energy, nuclear energy, chemical energy, radiant energy, solar energy, thermal energy, electromagnetic radiation, energy resources, energy reserves

Lesson 2: Energy Transformations

Code: C468G0SU04L02

Objectives:

At the end of this lesson, the student will:

- describe the transformations of energy;
- provide examples of energy transformations into different forms of energy;
- explain how energy transformations allow energy to be useful;
- explain the role of machines in energy transformations.

Topics

- Chemical Energy Transformations
- Energy Transformation in Plants
- Electrical Energy Transformations
- Machines as Power Transformers

Keywords

food, batteries, static electricity, endothermic, electrical energy, chemical energy, exothermic, photosynthesis, petroleum, propane

Lesson 3: Conservation of Energy

Code: C468G0SU04L03

Objectives:

At the end of this lesson, the student will:

- explain how energy is conserved;
- describe the law of conservation of energy;
- explain the impossibility of perpetual motion.

Topics

- Where Does Energy Go?
- Law of Conservation of Energy
- Perpetual Motion

Keywords

conduction, convection, dissipation, mechanical energy, thermal energy, friction, conservative force, law of conservation of mechanical energy, perpetual motion machine, perpetual motion, first law of thermodynamics, radiation, closed system, energy transfer

Lesson 4: Energy Resources

Code: C468G0SU04L04

Objectives:

At the end of this lesson, the student will:

- name different energy resources;
- explain why the Sun is the main source of energy in the solar system;
- evaluate the advantages and disadvantages of various energy resources.

Topics

- Nonrenewable Resources
- Renewable Resources
- Advantages and Disadvantages of Energy Resources

Keywords

fossil fuels, biomass energy, geothermal energy, nuclear fission, organic matter, minerals, nonrenewable, natural resources, renewables

Unit 5: Electricity and Magnetism

The concepts of electricity and electric charge are closely related. Both are important for our daily life, as they are relevant in the use of electronic items. In this unit we will learn about electric charge, the relationship between electricity and magnetism and how electronic devices interact with electric charges.

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

Lesson 1: Electric Charges

Code: C468G0SU05L01

Objectives:

At the end of this lesson, the student will:

- explaining the electrical nature of matter;
- define the concepts of electric charge and static electricity;
- describe how an object acquires electric charge.

Topics

- Electric Charge
- How are Objects Charged?
- Static Electricity

Keywords

atom, static electric charge, electric charge, elementary charge, conduction, electron, induction, ion, law of conservation of charge, neutron, pyroelectricity, proton, thermoelectricity, charge transfer

Lesson 2: Electrical Energy and Current

Code: C468G0SU05L02

Objectives:

At the end of this lesson, the student will:

- describe the electric current and explain how it is produced;
- describe how electric charges flow in the form of electric current;
- describe the voltage;
- explaining the behavior of the two types of currents;
- describe resistance and its relationship to electric current;
- compare and contrast the properties of electrically conductive materials and electrically insulating materials;
- explain how the cells generate electrical energy.

Topics

- Electric Current
- Types of Electric Current
- Voltage
- Resistance and Conductors
- Cells and their Components

Keywords

insulator, ampere, photovoltaic cell, conductor, alternating current, direct current, electric current, photovoltaic effect, generator, resistance, semiconductor, voltage, depletion zone

Lesson 3: Ohm's Law

Code: C468G0SU05L03

Objectives:

At the end of this lesson, the student will:

- use Ohms' law to calculate voltage, current, and resistance;
- calculate the electrical power;
- determine the electrical energy consumed in a system.

Topics

- Ohm's Law
- Electric Power
- Energy Consumption

Keywords

International Energy Agency (IEA), climate change, electric circuit, current (II), electric power, electric energy, nuclear energy, greenhouse gases, Ohm's law, ohm (Ω), electric power (P), power, resistance (R), voltage (V), watts (W)

Lesson 4: Electrical Circuits

Code: C468G0SU05L04

Objectives:

At the end of this lesson, the student will:

- describe the components of an electrical circuit;
- compare series circuits with parallel circuits;
- analyze and explain the safe ways to work with electricity.

Topics

- What is an Electrical Circuit?
- Types of Electrical Circuits
- Electrical Circuit Diagrams
- Safety When Working with Electrical Circuits

Keywords

open circuit, complete circuit, series circuit, parallel circuit, circuit, short circuit, circuit diagram, electrocution, fuse, digital switch, circuit breaker, circuit symbols

Lesson 5: Electromagnetism

Code: C468G0SU05L05

Objectives:

At the end of this lesson, the student will:

- describe what a magnet is and its properties;
- explaining the origin of magnetism;
- explain the origin of the Earth's magnetic field;
- identify the relationship between electric current and a magnetic field;
- explain how an electric current can form a magnetic field and vice versa;
- explain the use of electromagnetic induction in a generator.

Topics

- Magnets and Magnetic Forces
- Origin of Magnetism
- Types of Magnets
- Earth as a Magnet
- Magnetism and Electricity
- Electromagnetism Applications

Keywords

anti-ferromagnetism, aurora borealis, compass, geomagnetic field, magnetic field, diamagnetism, dipole, electromagnetism, electromagnetic spectrum, spin, ferromagnetism, ferromagnetic, magnet, magnetism, magnetosphere, magnetic moment, monopole, paleomagnetism, paramagnetism, polarization, solar radiation, superparamagnetism, maglev trains, solar winds

Lesson 6: Electronic Devices

Code: C468G0SU05L06

Objectives:

At the end of this lesson, the student will:

- identify the function of the components of a circuit board;
- describe semiconductors, diodes, and transistors;
- explain the importance of integrated circuits in communication technology.

Topics

- Inside an Electronic Device
- Semiconductors and Their Function
- Diodes and Transistors
- Communication Technology

Keywords

diode, electronic device, electronics, fiber optics, internet, microchip, semiconductor, analog signal, digital signal, silicon, transformer, transistor

Unit 6: Waves

Waves are a disturbance that is transmitted in space and carry energy, but do not carry matter. An example of a wave is sound. In this unit we will study the nature of waves, as well as their components and interactions.

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

Lesson 1: The Nature of Waves

Code: C468G0SU06L01

Objectives:

At the end of this lesson, the student will:

- describe how waves transmit energy without transferring matter;
- understand the difference between mechanical waves and electromagnetic waves;
- classifying waves as transverse waves or longitudinal waves.

Topics

- What is a Wave?
- Types of Waves

Keywords

radio waves, stationary waves, longitudinal waves, mechanical waves, seismic waves, sound waves, transverse waves, traveling waves, tsunamis

Lesson 2: Wave Properties

Code: C468G0SU06L02

Objectives:

At the end of this lesson, the student will:

- describe the properties of waves;
- explain the relationship between frequency and wavelength with wave speed;
- calculate the frequency, wavelength and velocity of a wave by means of diagrams.

Topics

- Amplitude
- Wavelength
- Frequency
- Wave Velocity

Keywords
mean square amplitude (RMS), peak amplitude, pulse amplitude, amplitude modulation (AM), peak-to-peak amplitude, decibel (dB), frequency (ff), frequency modulation (FM), wavelength, half-wavelength, angular velocity (ω), wave velocity

Lesson 3: Wave Interaction

Code: C468G0SU06L03

Objectives:
At the end of this lesson, the student will:

- describe the reflection, refraction, diffraction, and interference of waves;
- explain the concept of resonance and provide examples of these;
- provide examples on the concept of resonance.

Topics

- Reflection and Refraction
- Diffraction and Interference
- Resonance

Keywords
angle of incidence, angle of refraction, diffraction, resonance frequency, refractive index, law of reflection, reflection of waves, refraction of waves, resonance

Lesson 4: Sound

Code: C468G0SU06L04

Objectives:
At the end of this lesson, the student will:

- describe how vibrations produce sound;
- explain how sound waves propagate through a medium;
- recognize the difference between pitch and intensity of sound waves;
- explain the functioning of the human ear.

Topics

- What is Sound?
- Sound Waves
- Pitch and Volume
- Sound Sources
- Hearing

Keywords
hearing, hair cells, cochlea, compression, decibel (dB), echo, frequency, ossicles, infrasound, rarefaction, sonar, loudness, eardrum, pitch, ultrasound

Lesson 5: Sound Wave Properties

Code: C468G0SU06L05

Objectives:
At the end of this lesson, the student will:

- analyze and compare the speed of sound in different media;
- explain the relationship between the frequency and pitch;
- explain the doppler effect and give examples of it;
- explain the function of an oscilloscope;
- explain how echoes are produced and describe how they can be used to locate objects;
- describe the phenomenon of interference and provide examples.

Topics

- Speed of Sound
- The Doppler Effect
- Volume and Amplitude
- Sound Wave Interactions

Keywords
amplitude, Doppler effect, intensity, constructive interference, destructive interference, dead spot, sound speed, volume

Unit 7: The Nature of Light

Life as we know it exists because of sunlight. Without it, plants could not produce glucose for energy and survival, and other organisms would lose their food without plants. However, visible light is just one of many forms of light waves. You may have already heard of some of them, such as ultraviolet or infrared rays, and X-rays. In this unit, we will look at the properties of light waves and the nature of light as a wave and as a particle.

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

Lesson 1: What is Light?

Code: C468G0SU07L01

Objectives:

At the end of this lesson, the student will:

- describe the dual nature of light;
- calculate the distances traveled by light using the speed of light;
- explain how electromagnetic waves differ from each other;
- mention and explain examples of the uses of electromagnetic waves;
- explain examples of the uses of electromagnetic waves ;
- explain the harmful effects of overexposure to some electromagnetic waves.

Topics

- Light as a Wve
- Speed of Light
- Light as a Paarticle
- The Electromagnetic Spectrum

Keywords

light year, wave-particle duality, electromagnetic spectrum, photon, infrared, visible light, microwaves, radio waves, gamma rays, x-rays, ultraviolet, astronomical unit (AU), speed of light

Lesson 2: Light Wave Interactions

Code: C468G0SU07L02

Objectives:

At the end of this lesson, the student will:

- describe the reflection;

- describe absorption and dispersion;
- explain how refraction separates white light;
- explain the relationship between refraction and wavelength;
- compare the types of interference.

Topics

- Reflection
- Absorption and Dispersion
- Refraction and Diffraction
- Interference

Keywords

absorption, angle of incidence, angle of reflection, diffraction, scattering, index of refraction, interference, Snell's law, absorbing material, diffuse reflection, specular reflection, reflection, refraction

Lesson 3: Light and Color

Code: C468G0SU07L03

Objectives:

At the end of this lesson, the student will:

- describe the three ways in which light interacts with matter;
- explain how the colors of objects are determined;
- establish the differences between colors and pigments;
- explain the theory of color.

Topics

- Light and Matter
- Colors
- Pigments

Keywords

absorption, bicolor, camouflage, emission, spectroscopy, pigment, inorganic pigments, organic pigments, transmission