PHYSICS 41

Description

This course is an advanced sequence course for students wishing to take an Advanced Placement science course in the 12th grade. Some of the areas studied include: light and waves; mechanics; and electricity and magnetism. The emphasis is on basic concepts, analysis of laboratory data and problem solving. Students in Physics 41 are self-directed learners with demonstrated mathematical and problem-solving ability. Students wishing to prepare for the AP Physics B or C examination should take Physics 41 and AP Physics 51.

Course Overview

Course Objectives

Students should:

Essential Questions

- What is the role of energy in our world?
- What makes objects move the way they do?
- How do we describe the motion of an object?

Assessments

Common Assessments

Skill Assessments

Content Outline

I. Unit 1 - Light – Electromagnetic Radiation - Nature and Behavior of Light
II. Unit 2 - Light – Electromagnetic Radiation - Refraction
III. Unit 3 - Light – Electromagnetic Radiation - Interference
IV. Unit 4 - Light – Electromagnetic Radiation - Diffraction
V. Unit 5 - Mechanics - The Motion of Objects Kinematics
VI. Unit 6 - Mechanics - The Motion of Objects Vectors
VII. Unit 7 - Mechanics - The Motion of Objects Motion in Two Dimensions
VIII. Unit 8 - Mechanics - The Motion of Objects Dynamics
IX. Unit 9 - Mechanics - The Motion of Objects Circular Motion and Gravitation
X. Unit 10 - Mechanics - The Motion of Objects Conservation of Momentum

Standards

State of Connecticut Science Curriculum Frameworks

Connecticut State Standards are met in the following areas:

Core Science Standards

- ***Scientific Numeracy***

Physics Enrichment Standards

- ***Motion and Forces***
- ***Conservation of Energy and Momentum***
- ***Heat and Thermodynamics***
- ***Waves***
- ***Electric and Magnetic Phenomena***

Grade Level Skills

Students will:

- Skills Matrix

XI. Unit 11 - Mechanics - The Motion of Objects Work and Energy XII. Unit 12 - Electricity and Magnetism - Static Electricity XIII. Unit 13 - Electricity and Magnetism - Current Electricity XIV. Unit 14 - Electricity and Magnetism - Magnetism		

Pacing Guide					
1st Marking Period			2nd Marking Period		
September	October	November	December	January	
Unit 1 **Light – Electromagnetic Radiation - Nature and Behavior of Light** 3 weeks	Unit 2 **Light – Electromagnetic Radiation - Refraction** 4 weeks	Unit 3 **Light – Electromagnetic Radiation – Interference** 3 weeks	Unit 4 **Light – Electromagnetic Radiation - Diffraction** 3 weeks	Unit 5 **Mechanics - The Motion of Objects Kinematics** 4 weeks	Unit 6 **Mechanics - The Motion of Objects Vectors** 3 weeks

Pacing Guide							
3rd Marking Period				4th Marking Period			
February	March		April	May		June	
Unit 7 **Mechanics - The Motion of Objects Motion in Two Dimensions** 1.5 weeks	Unit 8 **Mechanics - The Motion of Objects Dynamics** 2.5 weeks	Unit 9 **Mechanics - The Motion of Objects Circular Motion and Gravitation** 2 weeks	Unit 10 **Mechanics - The Motion of Objects Conservation of Momentum** 1.5 weeks	Unit 11 **Mechanics - The Motion of Objects Work and Energy** 1.5 weeks	Unit 12 **Electricity and Magnetism Static Electricity** 2 weeks	Unit 13 **Electricity and Magnetism Current Electricity** 3 weeks	Unit 14 **Electricity and Magnetism - Magnetism** 1 week

Unit 1 - Light – Electromagnetic Radiation - Nature and Behavior of Light, 3 weeks top

Core Science Standards

Scientific Numeracy

Scientific numeracy includes the ability to use mathematical operations and procedures to calculate, analyze and present scientific data and ideas.

Students will:

- use appropriate tools and techniques to make observations and gather data.
- use mathematical operations to analyze and interpret data, and present relationships between variables in appropriate forms.
- articulate conclusions and explanations based on research data, and assess results based on the design of the investigation.

Physics Enrichment Standards

Waves

Waves have characteristic properties that do not depend on the type of wave.

Unit Objectives

Students will be able to:

- discuss specular vs. diffuse reflection.
- distinguish between real and virtual images.
- apply the Mirror Equation and Magnification Equation to solve related problems and locate images.

Essential Question

- What is the role of energy in our world?

Focus Questions

- How does light behave and what are its properties?
- How are images formed by mirrors?

Assessments

- Locating images in plane mirrors
- Locating images in curved mirrors

Skill Objectives

Students will:

- show that light can be considered an electromagnetic wave with a frequency, wavelength, and speed (c).
- show through ray diagrams the concepts of wave front for spherical and plane waves.
- draw ray diagrams for plane mirrors and find images.
- draw ray diagrams for curved mirrors and locate images. Identify the “cases” for mirrors.

Unit 2 – Light – Electromagnetic Radiation - Refraction, 6 weeks top

Physics Enrichment Standards

Waves

Waves have characteristic properties that do not depend on the type of wave.

Unit Objectives

Students will be able to:

- describe Refraction and what happens to a light ray as it passes from one medium into another.
- use the Index of Refraction to solve related problems.
- apply Snell's Law of refraction to solve related problems.
- calculate the apparent depth of an object.
- explain Total Internal Reflection, its cause and practical applications.
- discuss Polarization and use Brewster's Law to solve related problems.
- describe Dispersion and its cause.
- apply the Thin Lens Equation and Magnification Equation to solve related problems and locate images.

Essential Question

- What is the role of energy in our world?

Focus Questions

- How does light behave as it passes from one medium into another?
- How are images formed by lenses?

Assessment

- Determining the index of refraction (Snell's law)

Skill Objective

Students will:

- draw ray diagrams for refracted rays.

Unit 3 - Light – Electromagnetic Radiation - Interference, 3 weeks top

Physics Enrichment Standards

Waves

Waves have characteristic properties that do not depend on the type of wave.

Unit Objectives

Students will be able to:

- define a wave as a disturbance that carries energy from place to place.
- discuss the difference between a transverse and longitudinal wave.
- define wavelength, period, cycle, phase, amplitude, and frequency.
- articulate the relationship between wavelength, frequency, and speed of a wave.
- discuss the characteristics of sound waves such as: require a medium, speed in medium is temperature dependent, intensity and intensity level, refraction, Doppler effect.
- discuss the concepts of phase and phase difference.
- explain the phenomenon of beats in terms of the superposition of waves.
- describe the relationship between nodes and antinodes, and standing waves.
- explain the concept of resonance.
- explain wave behaviors such as Reflection, Refraction, Diffraction, and Interference for both water waves and light waves.

Essential Question

- What is the role of energy in our world?

Focus Question

- How do waves interact with one another?

Assessment

- Ripple Tank

Skill Objectives

Students will:

- draw superposed waves through constructive/destructive interference.
- conduct Ripple Tank experiments to show wave behavior.

Unit 4 - Light – Electromagnetic Radiation - Diffraction, 3 weeks top

Physics Enrichment Standards

Waves

Waves have characteristic properties that do not depend on the type of wave.

Unit Objectives

Students will be able to:

- apply superposition and interference to light waves.
- define coherence and monochromatic as they pertain to light.
- describe how light can interfere only if it originates from coherent sources.
- describe Young's double slit experiment and its historical significance.
- discuss the uses of diffraction gratings.
- summarize how thin films can cause interference, and the function of phase in the process.
- discuss the applications for interference of light such as in CD's and data storage/retrieval.
- apply interference to other areas of the electromagnetic spectrum.

Essential Question

- What is the role of energy in our world?

Focus Question

- How do waves interact with one another?

Assessments

- Young's Double Slit
- Spectral Analysis

Skill Objectives

Students will:

Unit 5 - Mechanics - The Motion of Objects Kinematics, 6 weeks top

Physics Enrichment Standards
Motion and Forces
Newton's laws predict the motion of most objects.

Unit Objectives
Students will be able to:

- explain the difference between Position, Distance, and Displacement.
- differentiate between Speed and Velocity.
- describe the difference between Constant, Average, and Instantaneous velocity.
- differentiate between Velocity and Acceleration.
- apply acceleration due to Gravity to solve related problems, and describe the motion of objects in free fall.
- use the Kinematics Equations for one dimensional motion with constant acceleration to solve related problems.
- develop and use Problem Solving Strategies to solve kinematics problems in one dimension.

Essential Question

- What makes objects move the way they do?

Focus Questions

- How are displacement, velocity, and acceleration related?
- How do we describe the motion of an object?

Assessment

- Graphical Analysis of linear motion

Skill Objectives
Students will:

- construct displacement-time, velocity-time, and acceleration-time graphs.
- collect, graph, and analyze experimental data.
- apply graphical analysis technology and techniques to understand and solve kinematics problems in one dimension.

Unit 6 – Mechanics - The Motion of Objects Vectors, 3 weeks top

Physics Enrichment Standards
Motion and Forces
Newton's laws predict the motion of most objects.

Unit Objectives
Students will be able to:
- use SI units and conversions.
- apply Dimensional Analysis to solve problems.
- apply sin□, cos□, and tan□ functions to solve related problems.
- differentiate between Scalar and Vector quantities.

Essential Question
- What makes objects move the way they do?

Focus Question
- What is the nature of vectors and how do they differ from scalar quantities?

Assessment
- Addition and resolution of vectors

Skill Objectives
Students will:
- perform Vector mathematics:
  - Addition (head-to-tail, parallelogram)
  - Determine Components
  - Add/Subtract Components
  - Resolution of Vectors

Unit 7 – Mechanics - The Motion of Objects Motion in Two Dimensions, 1.5 weeks top

Physics Enrichment Standards
Motion and Forces
Newton's laws predict the motion of most objects.

Unit Objectives
Students will be able to:

- explain that motion in two dimensions is similar to that already studied for one dimension.
- use the Equations of Motion for two dimensions to solve related problems. (additionally: Time-of-flight and Range equations)
- use the independence of motion in each direction (x,y) and use this to solve two dimensional motion problems.
- choose proper sign conventions for direction of motion (+,-).
- solve problems involving Relative Motion (Frames of Reference, Vectors).

Essential Question

- What makes objects move the way they do?

Focus Question

- How does gravity influence the motion of a projectile?

Assessment

- Predicting the range of a projectile

Skill Objectives
Students will:

Unit 8 – Mechanics - The Motion of Objects Dynamics, 2.5 weeks top

Physics Enrichment Standards
Motion and Forces
Newton's laws predict the motion of most objects.

Unit Objectives
Students will be able to:

- define Force, Mass, Weight, and Inertia.
- differentiate between Mass and Weight.
- explain Newton's Laws of Motion.
- solve problems relating force, mass, and acceleration.
- identify Action-Reaction force pairs.
- identify Normal Forces and explain their importance.
- differentiate between Static and Kinetic friction, and solve related problems.
- define equilibrium and solve related problems.

Essential Question

- What makes objects move the way they do?

Focus Question

- How are Newton's Laws used to describe motion?

Assessments

- Inertial balance
- Inclined plane and the force of friction

Skill Objectives
Students will:

- draw a Free Body Diagram to solve problems.
- show that Frictional Forces oppose motion.

Unit 9 – Mechanics - The Motion of Objects Circular Motion and Gravitation, 2 weeks top

Physics Enrichment Standards
Motion and Forces
Newton's laws predict the motion of most objects.

Unit Objectives
Students will be able to:

- use Newton's Law of Universal Gravitation to solve related problems.
- explain the connection between gravitational force and weight.
- compare and contrast uniform circular motion, to linear motion.
- describe the concept of centripetal acceleration.
- differentiate between centripetal force and centrifugal force.
- identify connections between Newton's Laws of Motion and centripetal force.
- solve related problems and applications involving circular motion such as: banked curves, satellite orbits, apparent weightlessness, and vertical circular motion.

Essential Question

- How do we describe the motion of an object?

Focus Questions

- How does circular motion differ from linear motion?
- How does the Law of Universal Gravitation govern the interaction of objects in the universe?

Assessment

- Centripetal force

Skill Objectives
Students will:

Unit 10 – Mechanics - The Motion of Objects Conservation of Momentum, 1.5 weeks top

Physics Enrichment Standards

Conservation of Energy and Momentum

The laws of conservation of energy and momentum provide a way to predict and describe the movement of objects.

Unit Objectives

Students will be able to:

- explain that Impulse and Momentum are vector quantities.
- relate the Impluse-Momentum Theorem to Newton's 2nd Law.
- justify the connection between Newton's 3rd law and the impulses exerted during collisions.
- apply the principle of Conservation of Momentum for a system of objects.
- verify that linear momentum is conserved in both elastic and inelastic collisions.
- investigate the conservation of kinetic energy in collisions.
- define the Center of Mass for a system, and how it remains the same before and after collisions if the total linear momentum of the system is constant.

Essential Question

- What makes objects move the way they do?

Focus Questions

- How are impulse and momentum related?
- How does the law of conservation of momentum (in a closed system) apply to collisions and explosions?

Assessment

- Conservation of momentum in a collision, an explosion, and through change of mass

Skill Objectives

Students will:

Unit 11 – Mechanics - The Motion of Objects Work and Energy, 1.5 weeks top

Physics Enrichment Standards

Heat and Thermodynamics

Energy cannot be created or destroyed although, in many processes, energy is transferred to the environment as heat.

Unit Objectives

Students will be able to:

- explain Work as a vector quantity.
- verify that the work done depends only upon the force and displacement, and not the path taken.
- apply the Work-Energy Theorem to solve related problems.
- explain that the work done against gravity changes the Potential Energy of the object and depends upon the vertical displacement.
- explain that work done can also change the Kinetic Energy of an object.
- define Power as the rate at which work is done, and use it to solve related problems.
- apply the principles of Conservation of Energy, and identify other forms of energy (Mechanical, Potential, Kinetic, Elastic...).
- differentiate between conservative and non-conservative Forces.

Essential Question

- What makes objects move the way they do?

Focus Questions

- What is the relationship between work and energy?
- How is energy transformed from one type into another?

Assessments

- Determining mechanical equivalent of heat
- Hooke's law

Skill Objectives

Students will:

Unit 12 – Electricity and Magnetism Static Electricity, 2 weeks top

Physics Enrichment Standards
Electric and Magnetic Phenomena
Electric and magnetic phenomena are related and have many practical applications.

Unit Objectives
Students will be able to:

- explain that charge is quantized.
- explain that charge is conserved in an isolated system although the charge on objects can change.
- differentiate between electrical Conductors and Insulators.
- demonstrate the process of Separation of Charge and how objects can be charged by Contact and Induction.
- use the force between charges (Coulomb's Law) to solve problems, and demonstrate that like charges repel and opposites attract.
- compare and contrast Coulomb's Law and Newton's Law of Universal Gravitation.
- apply the concept of an Electric Field created by a point charge to calculate the forces experienced by a Test Charge.
- identify and explain the electrostatic processes involved in charging and discharging object such as pith balls, electroscopes, Van de Graff generators, etc.
- discuss the relationship between an Electric Field and Coulomb's Law.
- demonstrate that the work done on a charge in an electric field is path independent.

Essential Question

- What is the role of energy in our world?

Focus Questions

- What is the nature of the electric force?
- How is charge formed/transferred?
- How does Coulomb's Law explain the force between charged particles?
- What are the properties of an electric field?
- How is the electric field similar to the gravitational field?

Assessment

- Electric field mapping

Skill Objectives
Students will:

- sketch Electric Field Lines and Equipotential Lines for an arrangement of charges or devices such as capacitors.
- show that the Electric Field points from a region of high potential to a region of low potential, and that a positive test charge is repelled by the higher potential region.

Unit 13 – Electricity and Magnetism Current Electricity, 3 weeks top

Physics Enrichment Standards
Electric and Magnetic Phenomena
Electric and magnetic phenomena are related and have many practical applications.

Unit Objectives
Students will be able to:

- describe the concept of Electromotive Force (E, emf), and recognize that when a battery is connected to a circuit, an electric field is created within and parallel to the wire that causes free electrons to flow. The unit for emf is the Volt (V).
- define Electric Current (I) as the number of charges passing a point in the circuit per unit time. The unit for current is the Ampere (A).
- differentiate between the concepts of resistance and resistivity. The unit for resistance is the ohm (Ω).
- solve related problems using Ohm's Law.
- justify that as conventional current (positive charge) moves from a region of high potential to a region of low potential, energy is transferred from the battery to any devices connected to it.
- apply P=IV to show that energy is transferred at a given rate.
- compare and contrast A/C and D/C sources and circuits.
- calculate the equivalent resistance (R_{eq}) for both Series and Parallel circuits.
- identify the effects on the body of electricity and safety practices, and how electrical safety devices work.
- demonstrate and explain the function of a Voltmeter, Ammeter, Galvanometer, etc.

Essential Question

- What is the role of energy in our world?

Focus Questions

- What is the nature of the electric force?
- What is the relationship among current, voltage, and resistance?

Assessment

- Determining current, voltage, and resistance in a circuit

Skill Objectives
Students will:

Unit 14 – Electricity and Magnetism, 1 week top

Physics Enrichment Standards
Electric and Magnetic Phenomena
Electric and magnetic phenomena are related and have many practical applications.

Unit Objectives
Students will be able to:

- discuss the two kinds of magnetic poles, North and South, and that magnetic monopoles have not been discovered.
- differentiate among the several kinds of magnets: Permanent, Temporary, and Electromagnets (also ferromagnetism, domains, etc.).
- compare and contrast Electrical Fields and Magnetic Fields.
- apply the rules for magnetic fields(i.e. direction of lines, magnitude, never cross, etc).
- calculate the magnetic field strength, and the magnetic force experienced by a charged particle using F=qvBsin□.
- discuss applications of magnetism (recording, maglev, speakers, etc.)
- discuss applications of e/m induction (generators, transformers).
- conclude that an electromagnetic wave (light) is composed of electric and magnetic fields that oscillate.
- differentiate between the parts of the Electromagnetic Spectrum.
- discuss the dual nature of light, and how the Photoelectric effect has influenced our theories.

Essential Question

- What is the role of energy in our world?

Focus Questions

- What is the nature of the magnetic force?
- What is the relationship between electricity and magnetism?

Assessment

- Measuring the mass of the electron

Skill Objectives
Students will:

- show that opposite poles attract, and like poles repel.
- show the effects of a magnetic field on a current, and explain the relationship between current and magnetism.