

PHYSICS 40

Description

This course will provide students with a fundamental knowledge of physics. Some of the areas studied include: motion and forces, conservation of energy and momentum, waves, heat and thermodynamics, and electricity and magnetism. The emphasis is on basic concepts, analysis of laboratory data and problem solving. Students in Physics 40 will develop problem-solving abilities. Students will investigate these topics through a variety of classroom activities which include: pre-written and open-ended laboratory experiments; small group discussions; lectures and note taking; viewing videos; learning and applying problem-solving techniques; and relating physics principles to daily experience. Students will understand the role of physics in explaining natural phenomena and in seeking solutions to scientific and technological problems that citizens of the 21st century will face.

Course Overview

Course Objectives

Students should:

Essential Question

- What is the role of energy in our world?

Assessments

Common Assessments

Skill Assessments

Content Outline

- I. [Unit 1](#) - Waves and Optics - Reflection
- II. [Unit 2](#) - Waves and Optics - Refraction
- III. [Unit 3](#) - Waves and Optics - Interference
- IV. [Unit 4](#) - Mechanics - Motion and Forces – Kinematics
- V. [Unit 5](#) - Mechanics - Motion and Forces - Dynamics, Circular Motion and Gravitation
- VI. [Unit 6](#) - Mechanics - Motion and Forces - Conservation Laws
- VII. [Unit 7](#) - Electricity and Magnetism - Static Electricity
- VIII. [Unit 8](#) - Electricity and Magnetism - Current Electricity
- IX. [Unit 9](#) - Electricity and Magnetism – Magnetism

Standards

[State of Connecticut Science Curriculum Frameworks](#)

Connecticut State Standards are met in the following areas:

Physics Enrichment Standards

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

Grade Level Skills

Students will:

-

Pacing Guide

Pacing Guide									
1st Marking Period			2nd Marking Period			3rd Marking Period			4th Marking Period
September	October	November	December	January	February	March	April	May	June
Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	
<u>Waves and Optics - Reflection</u>	<u>Waves and Optics – Refraction</u>	<u>Waves and Optics - Interference</u>	<u>Mechanics - Motion and Forces – Kinematics</u>	<u>Mechanics - Motion and Forces - Dynamics, Circular Motion and Gravitation</u>	<u>Mechanics - Motion and Forces - Conservation Laws</u>	<u>Electricity and Magnetism - Static Electricity</u>	<u>Electricity and Magnetism - Current Electricity</u>	<u>Electricity and Magnetism – Magnetism</u>	
3 weeks	2.5 weeks	2.5 weeks	3.5 weeks	4.5 weeks	4.5 weeks	3.5 weeks	4 weeks	4 weeks	

Unit 1 - Waves and Optics - Reflection, 3 weeks [top](#)

Physics Enrichment Standards

Waves

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

- Waves carry energy from one place to another.
- Transverse and longitudinal waves exist in mechanical media, such as springs and ropes, and in the earth as seismic waves.
- Wavelength, frequency, and wave speed are related.
- Radio waves, light, and X-rays are different wavelength bands in the spectrum of electromagnetic waves whose speed in a vacuum is approximately 3×10^8 m/s, and less when passing through other media.

Unit Objectives

Students will be able to:

- discuss specular vs. diffuse reflection.
- distinguish between real and virtual images.
- explain wave behaviors such as Reflection, Refraction, Diffraction, and Interference.

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:

- 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.
- 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.

Unit 2 – Waves and Optics - Refraction, 2.5 weeks [top](#)

Physics Enrichment Standards

Waves

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

- Waves have characteristic behaviors such as interference, diffraction, refraction and polarization.

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.
- describe causes and practical applications of phenomena such as Dispersion and Total Internal Reflection.

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 Objectives

Students will:

- draw ray diagrams for refracted rays.
- apply the Thin Lens Equation and Magnification Equation to solve related problems and locate images.

Unit 3 - Waves and Optics - Interference, 2.5 weeks [top](#)

Physics Enrichment Standards

Waves

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

- Sound is a longitudinal wave whose speed depends on the properties of the medium in which it propagates.
- Waves have characteristic behaviors such as interference, diffraction, refraction and polarization.
- Beats and the Doppler Effect result from the characteristic behavior of waves.

Unit Objectives

Students will be able to:

- 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.
- apply superposition and interference to waves.
- discuss the uses of diffraction gratings.

Essential Question

- What is the role of energy in our world?

Focus Question

- How do waves interact with one another?

Assessments

- Spring Lab
- Wavelength Analysis

Skill Objectives

Students will:

- draw superposed waves through constructive/destructive interference.

Unit 4 - Mechanics - Motion and Forces – Kinematics, 3.5 weeks [top](#)

Physics Enrichment Standards

Motion and Forces

Newton’s laws predict the motion of most objects.

- When forces are balanced, no acceleration occurs; thus an object continues to move at a constant speed or stays at rest.
- The law $F = ma$ is used to solve motion problems that involve constant forces.
- Applying a force to an object perpendicular to the direction of its motion causes the object to change direction.

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.
- differentiate between Scalar and Vector quantities.
- choose proper sign conventions for direction of motion (+,-).

Essential Question

- What is the role of energy in our world?

Focus Questions

- How are displacement, velocity, and acceleration related?
- How do we describe the motion of an object?
- What is the nature of vectors and how do they differ from scalar quantities?
- How does gravity influence the motion of a projectile?
- How do we describe the motion of an object?

Assessments

- Graphical Analysis of linear motion
- Projectile targeting

Skill Objectives

Students will:

- construct and analyze displacement-time, velocity-time, and acceleration-time graphs.
- collect data and apply graphical analysis techniques to understand and solve kinematics problems in one dimension.
- use the Kinematics Equations for one dimensional motion with constant acceleration to solve related problems.
- use the independence of motion in each direction (x, y) to solve problems in two dimensions.

Unit 5 - Mechanics - Motion and Forces - Dynamics, Circular Motion and Gravitation, 4.5 weeks [top](#)

Physics Enrichment Standards

Motion and Forces

- The law $F = ma$ is used to solve motion problems that involve constant forces.
- When one object exerts a force on a second object, the second object always exerts a force of equal magnitude and in the opposite direction.
- Circular motion requires the application of a constant force directed toward the center of the circle.

Unit Objectives

Students will be able to:

- define Force, Mass, Weight, and Inertia.
- differentiate between Mass and Weight.
- explain Newton's Laws of Motion.
- identify Action-Reaction force pairs.
- identify frictional forces and explain their importance.
- define equilibrium and 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.
- describe the roles of force and inertia in centripetal motion.

Essential Question

- What is the role of energy in our world?

Focus Questions

- How are Newton's Laws used to describe motion?
- How does circular motion differ from linear motion?
- How does the Law of Universal Gravitation govern the interaction of objects in the universe?
- How do we describe the motion of an object?

Assessments

- Inclined plane and the force of friction
- Centripetal motion

Skill Objectives

Students will:

- draw a Free Body Diagram to solve problems.
- solve problems relating force, mass, and acceleration.
- solve related problems and applications involving circular motion.
- use Newton's Law of Universal Gravitation to solve related problems.

Unit 6 – Mechanics - Motion and Forces - Conservation Laws, 4.5 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.

- Kinetic energy can be calculated by using the formula $E = (1/2)mv^2$.
- Changes in gravitational potential energy near Earth can be calculated by using the formula (change in potential energy) = mgh .
- Momentum is calculated as the product mv .
- Momentum is a separately conserved quantity different from energy.
- An unbalanced force on an object produces a change in its momentum.
- The principles of conservation of momentum and energy can be used to solve problems involving elastic and inelastic collisions.

Unit Objectives

Students will be able to:

- explain that Impulse and Momentum are vector quantities.
- relate the Impulse-Momentum Theorem to Newton’s Laws.
- verify that linear momentum is conserved in both elastic and inelastic collisions.
- investigate the conservation of kinetic energy in collisions.
- differentiate among different forms of energy.
- verify that the work done depends only upon the force and displacement, and not the path taken.
- explain that the work done changes the energy of the object.
- define Power as the rate at which work is done.

Essential Question

- What is the role of energy in our world?

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?
- What is the relationship between work and energy?
- How is energy transformed from one type into another?
- What makes objects move the way they do?

Assessment

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

Skill Objectives

Students will:

- apply the Work-Energy Theorem to solve related problems.
- apply the principles of Conservation of Energy to solve related problems.
- apply the principle of Conservation of Momentum for a system of objects to solve problems.

Unit 7 – Electricity and Magnetism - Static Electricity, 3.5 weeks [top](#)

Physics Enrichment Standards

Electric and Magnetic Phenomena

Electric and magnetic phenomena are related and have many practical applications.

- Charged particles are sources of electric fields and are subject to the forces of the electric fields from other charges.

Unit Objectives

Students will be able to:

- explain that charge is conserved and quantized.
- differentiate between electrical Conductors and Insulators.
- demonstrate how objects can be charged by conduction and induction.
- demonstrate that like charges repel and opposites attract.
- apply the concept of an Electric Field created by a point charge to.

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.
- solve problems using Coulomb’s Law.
- calculate the forces experienced by a test charge in an electric field.

Unit 8 – Electricity and Magnetism - Current Electricity, 4 weeks [top](#)

Physics Enrichment Standards

Electric and Magnetic Phenomena

Electric and magnetic phenomena are related and have many practical applications.

- The voltage or current in simple direct current (DC) electric circuits constructed from batteries, wires, resistors, and capacitors can be predicted using Ohm's law.
- Any resistive element in a DC circuit dissipates energy, which heats the resistor.
- The power in any resistive circuit element can be calculated by using the formula $\text{Power} = I^2R$.

Unit Objectives

Students will be able to:

- describe the concept of electromotive force.
- define electric current.
- differentiate between the concepts of voltage, current and resistance.
- explain the process of energy transfer via.
- demonstrate and explain the function of a Voltmeter, Ammeter, Galvanometer, etc.

Essential Question

- What is the role of energy in our world?

Focus Question

- What is the relationship among current, voltage, and resistance?

Assessment

- Determining current, voltage, and resistance in a circuit

Skill Objectives

Students will:

- solve related problems using Ohm's Law.
- apply $P=IV$ to show that energy is transferred at a given rate.
- calculate the equivalent resistance (R_{eq}) electrical circuits.

Unit 9 – Electricity and Magnetism - Magnetism, 4 weeks [top](#)

Physics Enrichment Standards

Electric and Magnetic Phenomena

Electric and magnetic phenomena are related and have many practical applications.

- Magnetic materials and electric currents (moving electric charges) are sources of magnetic fields and are subject to forces arising from the magnetic fields of other sources.
- Changing magnetic fields produce electric fields, thereby inducing currents in nearby conductors.

Unit Objectives

Students will be able to:

- differentiate among the several kinds of magnets: Permanent, Temporary, and Electromagnets.
- compare and contrast Electrical Fields and Magnetic Fields.
- discuss applications of magnetism (recording, maglev, speakers, etc).
- identify applications of magnetism and electromagnetic induction (generators, transformers).
- explain the relationship between current and magnetism.
- conclude that an electromagnetic wave (light) is composed of electric and magnetic fields that oscillate.

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

- Mapping magnetic fields

Skill Objectives

Students will:

- show that opposite poles attract, and like poles repel.
- show the interactions between magnetic fields and currents.
- apply the rules for magnetic fields (i.e. direction of lines, magnitude, never cross, etc).