Curriculum Development
In the Fairfield Public Schools

Fairfield Public Schools
Fairfield, Connecticut

PHYSICS 41 CURRICULUM

APPROVED 2/28/2006

PHYSICS 41

Statement of Purpose

Physics is the study of matter and energy, and their interactions. As one of the fundamental sciences, physics describes the processes that involve everything from atoms to the universe. The laws that govern the interactions of matter and energy are the laws that govern the everyday occurrences such as those we experience as we drive a car or listen to a CD. In this course, students will investigate the fundamentals of physics and learn how they relate to their everyday lives. Emphasis will be placed on laboratory experiments and students will be well prepared to take Advanced Placement Physics if they so choose.

Audience

Physics 41 is a full-year, two-credit course designed for academically motivated, high achieving grade 11 or 12 students with excellent problem-solving ability and a keen interest in science.

Prerequisites

Chemistry 31, “B” or better in Algebra I and Geometry

Design and 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 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.
- 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.
- 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.
- 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.
- 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.
- use SI units and conversions
- apply Dimensional Analysis to solve problems
- apply $\sin\theta$, $\cos\theta$, and $\tan\theta$ functions to solve related problems.
- differentiate between Scalar and Vector quantities.
- 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) to solve two dimensional motion problems.
- choose proper sign conventions for direction of motion (+,-).
- solve problems involving Relative Motion (Frames of Reference, Vectors)
- 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.
- 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.
- 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.
- 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.
- 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.
- describe the concept of Electromotive Force (E, emf), and show 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 (W).
- 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.
- 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 $F=qvB\sin\theta$.
- 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.

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.
- draw ray diagrams for refracted rays.
- draw ray diagrams for lens systems to locate images. Identify the “cases” for lenses.
- draw superposed waves through constructive/destructive interference.
- conduct Ripple Tank experiments to show wave behavior.
- 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.
- perform Vector mathematics:
    - Addition (head-to-tail, parallelogram)
    - Determine Components
    - Add/Subtract Components
    - Resolution of Vectors
- draw a Free Body Diagram to solve problems.
- show that Frictional Forces oppose motion.
- 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.
- 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.

Science Standards

Scientific Inquiry (used in all units)

- Scientific inquiry is a thoughtful and coordinated attempt to search out, describe, explain and predict natural phenomena.
- Scientific inquiry progresses through a continuous process of questioning, data collection, analysis and interpretation.
- Scientific inquiry requires the sharing of findings and ideas for critical review by colleagues and other scientists.

Scientific Literacy (used in all units)

- Scientific literacy includes the ability to read, write, discuss and present coherent ideas about science.
- Scientific literacy also includes the ability to search for and assess the relevance and credibility of scientific information found in various print and electronic media.

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.

Students will use mathematical operations to analyze and interpret data, and present relationships between variables in appropriate forms.

Students will articulate conclusions and explanations based on research data, and assess results based on the design of the investigation.

Waves

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

Motion and Forces

Newton's laws predict the motion of most objects.

Conservation of Energy and Momentum

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

Heat and Thermodynamics

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

Electric and Magnetic Phenomena

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

Information and Technology Standards (to be added)

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?

Focus Questions

- How does light behave and what are its properties?
- How are images formed by mirrors?
- How does light behave as it passes from one medium into another?
- How are images formed by lenses?
- How do waves interact with one another?
- 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 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 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 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?
- What is the nature of the electric force?
- What is the relationship among current, voltage, and resistance?
- What is the nature of the magnetic force?
- What is the relationship between electricity and magnetism?

UNITS of STUDY

1. Light – Electromagnetic Radiation
Nature and Behavior of Light

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.

Students will use mathematical operations to analyze and interpret data, and present relationships between variables in appropriate forms.

Students will articulate conclusions and explanations based on research data, and assess results based on the design of the investigation.

Waves

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

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?

Core Topics

- Electromagnetic spectrum (c, λ, ν)
- Reflection (plane and curved mirrors) images.

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.

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.

Sample Assessment
Locating images in plane mirrors
Locating images in curved mirrors

Pacing
3 weeks

2. Light – Electromagnetic Radiation
Refraction

Science Standard

Waves

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

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?

Core Topics

- Snell's Law
- Lenses
- 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.
- 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.

Skill Objectives

Students will:

- draw ray diagrams for refracted rays.

Sample Assessment

Determining the index of refraction (Snell's law)

Pacing

4 weeks

3. Light – Electromagnetic Radiation
Interference

Science Standard

Waves

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

Essential Question

- What is the role of energy in our world?

Focus Question

- How do waves interact with one another?

Core Topics

- Wave phenomena
- Superposition

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.

Skill Objectives

Students will:

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

Sample Assessment

Ripple Tank

Pacing

3 weeks (end marking period #1)

4. Light – Electromagnetic Radiation
Diffraction

Science Standard

Waves

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

Essential Question

- What is the role of energy in our world?

Focus Question

- How do waves interact with one another?

Core Topics

- Wave phenomena
    - Young's double slit
    - Diffraction grating, spectra
- Thin Films

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.

Sample Assessment

Young's Double Slit
Spectral Analysis

Pacing

3 weeks (Thanksgiving)

5. Mechanics - The Motion of Objects
Kinematics

Science Standard

Motion and Forces

Newton's laws predict the motion of most objects.

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?

Core Topics

- Motion in one dimension (d, v, a)
    - Graphical analysis (data acquisition and analysis)

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.

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.

Sample Assessment

Graphical Analysis of linear motion

Pacing

3 weeks

6. Mechanics - The Motion of Objects
Vectors

Science Standard

Motion and Forces

Newton's laws predict the motion of most objects.

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?

Core Topics

- Vector Addition
- Graphical (scale diagram)
    - Mathematical (trigonometry)
    - Relative Motion

Unit Objectives

Students will be able to:

- use SI units and conversions
- apply Dimensional Analysis to solve problems
- apply sinθ, cosθ, and tanθ functions to solve related problems.
- differentiate between Scalar and Vector quantities.

Skill Objectives

Students will:

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

Sample Assessment

Addition and resolution of vectors

Pacing

3 weeks (Midterm)

7. Mechanics - The Motion of Objects
Motion in two dimensions

Science Standard

Motion and Forces

Newton's laws predict the motion of most objects.

Essential Question

- What makes objects move the way they do?

Focus Question

- How does gravity influence the motion of a projectile?

Core Topics

- Projectiles
    - Relative motion

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)

Sample Assessment

Predicting the range of a projectile

Pacing

1.5 weeks

8. Mechanics - The Motion of Objects
Dynamics

Science Standard
Motion and Forces
Newton's laws predict the motion of most objects.

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

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

Core Topics
- Newton's Laws
- Friction

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.

Skill Objectives
Students will:
- draw a Free Body Diagram to solve problems.
- show that Frictional Forces oppose motion.

Sample Assessment
Inertial balance
Inclined plane and the force of friction

Pacing
2.5 weeks

9. Mechanics - The Motion of Objects
Circular Motion and Gravitation

Science Standard

Motion and Forces

Newton's laws predict the motion of most objects.

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?

Core Topics

- Centripetal force
    - Law of Universal Gravitation
    - Kepler's Laws, orbits

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.

Sample Assessment

Centripetal force

Pacing

2 weeks

10. Mechanics - The Motion of Objects
Conservation of Momentum

Science Standard

Conservation of Energy and Momentum

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

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?

Core Topics

- Conservation
- Collisions
- Explosions

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.

Sample Assessment

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

Pacing

1.5 weeks

11. Mechanics - The Motion of Objects
Work and Energy

Science Standard

Heat and Thermodynamics

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

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?

Core Topics

- Conservation
    - Work-Energy Theorem
    - Kinetic, Potential, Heat
    - Simple Harmonic Motion

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.

Sample Assessment

Determining mechanical equivalent of heat
Hooke's law

Pacing

1.5 weeks (end marking period #3)

12. Electricity and Magnetism
Static Electricity

Science Standard

Electric and Magnetic Phenomena

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

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?

Core Topics

- Charges
- Coulomb's Law
- Fields

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.

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.

Sample Assessment

Electric field mapping

Pacing
2 weeks

13. Electricity and Magnetism
Current Electricity

Science Standard

Electric and Magnetic Phenomena

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

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?

Core Topics

- Potential
    - Voltage, current, resistance
    - Circuits
- Ohm's Law

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.

Sample Assessment

Determining current, voltage, and resistance in a circuit

Pacing

3 weeks

14. Electricity and Magnetism
Magnetism

Science Standard

Electric and Magnetic Phenomena

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

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?

Core Topics

- Poles
    - Fields
- Forces
- Electromagnetism

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 $F=qvB\sin\theta$.
- 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.

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.

Sample Assessment

Measuring the mass of the electron

Pacing

1 week