Advanced Placement Physics

Curriculum

Vineland Public Schools
Vineland, NJ
2004

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Advanced Placement Physics
Overview and Goals

Course Description:

The Advance Placement Physics Course Curriculum must comply with the AP Physics course guidelines presented by The College Board and The Advance Placement Program Committee. Following these guidelines, the AP Physics Course Curriculum includes topics in both, classical and modern physics. A knowledge of Algebra, Trigonometry and basic Geometry is required for the course. Calculus is seldom used and it is not a requirement for the successful completion of the course. Students that are considering AP Physics should have completed a year of College Physics, with a teacher's recommendation, or Honors Physics. The best candidates are students interested in life sciences, medicine, all areas of engineering, geology, physical science and related subjects.

The acquisitions of a clear understanding of physics principles, the abilities to apply these principles in the solution of problems and advance experimentation are the major goals of the course. The AP Physics curriculum seeks to be representative of topics covered in a Physics entry-level course in a university setting. Accordingly, five general areas of study will be covered, such as, Newtonian Mechanics, Fluid and Thermal Physics, Electricity and Magnetism, Waves and Optics and Atomic and Nuclear Physics. Revising and in-depth study of each area will depend on the student's background and the time available to cover each topic.

The AP Physics course has been design to help students learn and enjoy the research of one of the most fascinating subjects, "Physics." Students will get practical experience in Physics by the creation and development of laboratory experiments and projects, as well as, their participation in field trips and state competitions. Students will have access to several textbooks, the Problem Solver Physics Guide and any other mean which will be beneficial to them in the comprehension and solution of physics problems.

Students will be encouraged to register for the National Advance Placement Test, it is a great experience and some universities grant credit or exemptions for entry level courses if the student has a three or a better passing grade. In addition, The AP Physics Course is part of the dual credit program in connection with Cumberland County College. Students can earn eight college credits, equivalent to two semesters of Physics, with all the benefits and responsibilities of a registered CCC student.

Goals:

Following the College Board standards, students in the AP Physics course should be able to**:**

- Read, understand, and interpret physical information, verbally, mathematically and graphically.
- Describe and explain the sequence of steps in the analysis of a particular physical phenomenon or problem.
- Use technology to describe the idealized model and to represent the analysis and interpretation of data that will support the assumptions made in a given situation.
- State the principles and definitions that are applicable to a given problem and specify relevant limitations to the application of these principles by drawing conclusions, including discussion of particular cases.
- Use basic mathematical reasoning, arithmetic, algebraic, geometric, trigonometric where appropriate, to solve a physical situation or problem.
- Perform experiments and interpret results of observations, including making an assessment of experimental uncertainties.
- Follow all safety rules when performing experiments or creating original projects.
- Participate in collective research or projects with a clear understanding of the responsibilities and significant contributions of each member of the group.
- Develop and maintain good study habits as well as time management to keep up with the demands of the course.

Framework
New Jersey Core Curriculum Content Standards for Science

5.1 All students will develop problem-solving, decision-making and inquiry skills reflected by formulating usable questions, hypotheses, planning experiments, conducting systematic observations, interpreting and analyzing data, drawing conclusions, and communicating results.

5.2 All students will develop an understanding of how people of various cultures have contributed to the advancement of science and technology.

5.3 All students will integrate mathematics as a tool for problem-solving in science, and as a means of expressing and/or modeling scientific theories.

5.4 All students will understand the interrelationships between science and technology and develop a conceptual understanding of the nature and process of technology.

5.5 All students will gain an understanding of the structure, characteristics, and basic needs of organisms and will investigate the diversity of life.

5.6 All students will gain an understanding of the structure and behavior of matter.

5.7 All students will gain an understanding of natural laws as they apply to motion, forces, and energy transformations.

5.8 All students will gain an understanding of the structure, dynamics, and geophysical system of the earth.

5.9 All students will gain an understanding of the origin, evolution, and structure of the universe.

5.10 All students will develop an understanding of the environment as a system of interdependent components affected by human activity and natural phenomena.

New Jersey Cross-Content Workplace Readiness Standards

Standard 1. All students will develop career planning and workplace readiness skills.

Standard 2. All students will use information technology and other tools.

Standard 3. All students will use critical thinking decision-making, and problem -solving skills.

Standard 4. All students will demonstrate self-management skills.

Standard 5. All students will apply safety principles.

Course Content Outline

I. Newtonian Mechanics

A. Kinematics: Vectors, Coordinate Systems, Displacement, Velocity, Acceleration.
- Motion in One Dimension
- Motion in Two Dimensions (Projectile Motion).

B. Newton's Laws of Motion: Friction, Centripetal force.
- Static Equilibrium
- Dynamics of a Single Particle
- System of Two or More Bodies

C. Work, Energy, Power
- Work and Work-Energy Theorem
- Conservative Forces and Potential Energy
- Conservation of Energy
- Power

D. System of Particles and Linear Momentum
- Impulse and Momentum
- Conservation of Momentum in a Collision

E. Circular Motion and Rotation
- Uniform Circular Motion
- Torque and Rotational Statics

F. Oscillations and Gravitation
- Simple Harmonic Motion
- Mass on a Spring
- Pendulum
- Newton's Law of Gravity
- Circular Orbits

II. Fluid Mechanics and Thermal Physics

A. Fluid Mechanics
- Hydrostatic Pressure
- Buoyancy
- Fluid Flow Continuity
- Bernoulli's Equation

B. Temperature and Heat
- Mechanical Equivalent of Heat
- Specific and Latent Heat
- Heat Transfer and Thermal Expansion

C. Kinetic Theory and Thermodynamics
- Ideal Gas Law and Kinetic Model
- Laws of Thermodynamics

III. Electricity and Magnetism

A. Electrostatics
- Charge, Field and Potential
- Coulomb's Law, Potential of Point Charges
- Fields and Potentials of Planar Charge Distributions

B. Conductors, Capacitors, Dielectrics
- Electrostatics with Conductors
- Parallel Plate Capacitors

C. Electric Circuits
- Current, Resistance, Power
- Direct Current Circuits with Batteries and Resistors
- Capacitors in Circuits - Steady State

D. Magnetostatics
- Forces on Moving Charges in Magnetic Fields
- Forces on Current-Carrying Wires in Magnetic Fields
- Fields on Long Current-Carrying Wires

E. Electromagnetism
- Electromagnetic Induction. Faraday's Law and Lenz's Law

IV. Waves and Optics

A. Wave Motion
- Properties of Traveling Waves
- Properties of Standing Waves
- Doppler Effect
- Superposition

B. Physical Optics
- Interference and Diffraction
- Dispersion of Light. The Electromagnetic Spectrum

C. Geometric Optics
- Reflection and Refraction

Mirrors
Lenses

V. Atomic and Nuclear Physics
A. Atomic Physics and Quantum Effects
Photons and the Photoelectric Effect
Atomic Energy Levels
Wave-Particle Duality
B. Nuclear Physics
Nuclear Reactions. Conservation of Mass Number and Charge
Mass-Energy Equivalence

AP Physics Laboratory Guide. Contents

I. Mechanics
Lab one: Velocity and Acceleration during Free Fall
Lab two: Forces at Angles.
Lab three: Friction and Air Resistance
Lab four: Elastic Collisions
Lab five: Rotational Motion
Lab six: Torque
Lab seven: Hooke’s Law and Harmonic Motion

II. Fluid Mechanics and Thermal Physics
Lab eight: Calorimetry
Students will present demonstrations and original experiments to cover these topics.

III. Electricity and Magnetism
Lab nine: Ohm’s Law
Lab ten: Electrical Power and Batteries
Lab eleven: Resistors and Capacitors
Lab twelve: Magnetic Fields

IV. Optics
Lab thirteen: Geometrical Optics. The Index of Refraction
Lab fourteen: The Diffraction Grating

V. Modern Physics

Lab fifteen: Planck's Constant
Lab sixteen: The Photoelectric Effect

Student Proficiencies/ Outcomes/ Objectives

The AP Physics Course Objectives are carefully selected by The College Board and serve as a guide to the instructor teaching the course. It is reasonable to expect that limitations in instructional time may force the teacher to review and select the most important sections from the list of given objectives. Therefore, great efforts should be made to try to follow the list of objectives in its entirety.

Objectives

Safety:

Students should be able to,

1. identify the location of safety equipment in the classroom and know how to use it in case of an emergency.
2. know the proper use of lab equipment and the safety rules of the classroom in order to avoid accidents.
3. maintain proper discipline and follow directions given by the instructor at all times.

(5.1-12. C-1, WRS:3,5)

Course Objectives:

I. Newtonian Mechanics (5.1-12:A,B 5.2-12:A-1, B-1,2,3 5.3-12:A,B,C,D 5.4-12:A-1,C-1 5.6-12:A-1,3,6 5.7-12:A-1-8, B-1-4 5.9-12:A,B,C WRS: 2,3,4,5)

A. Kinematics

1. Motion in One Dimension

Students should understand the general relationships among position, velocity, and acceleration for a motion of a particle along a straight line, so that given a graph of one of the kinematic quantities, position, velocity, or acceleration, as a function of time, they can recognize in what time intervals the other two are positive, negative, or zero, and can identify or sketch a graph of each as a function of time.

Students should understand the special case of motion with a constant acceleration so they can:

a) Write down expressions for velocity and position as functions of time, and identify or sketch graphs of these quantities.

b) Use the equations generated to solve problems involving one-dimensional motion with constant acceleration.

2. Motion in Two Dimensions

Students should know how to deal with vectors and scalars so they can:

a) Relate velocity, displacement, and time for motion with constant velocity.

b) Calculate the components of a vector along a given axis, or resolve a vector into components along the x and y-axis.

c) Add vectors in order and find the resultant of successive straight-line displacements.

d) Subtract displacement vectors and find the location of one particle relative to another, or the average velocity of a particle.

e) Add or subtract velocity vectors in order to calculate the change in velocity or average acceleration of a particle.

Students should understand the motion of projectiles in a uniform gravitational field to be able to:

a) Write down the equations for the horizontal and vertical components of velocity and position as a function of time, and develop a graph of these components.

b) Use these equations to analyze the motion of a projectile fired at an angle with the ground and with a given initial velocity, and solve problems related to this motion.

Students should understand uniform circular motion in order to:

a) Relate the radius of the circle and the tangential velocity of a body to the magnitude of the centripetal acceleration.
b) Describe the direction of the velocity and acceleration vectors at any time during the motion and determine the vector components in order to sketch or graph these quantities.

B. Newton's Laws of Motion
1. Static Equilibrium - First Law
Students should be able to analyze situations in which a body remains at rest or moves with a constant velocity under the effect of several forces.
2. Dynamics of a Single Body - Second Law
Students should be able to understand the relation between the force that acts on a body and the change in the body's motion so they can:
a) Calculate the change in velocity or acceleration of a body moving in one direction under the effects of a constant force over a given time interval.
b) Determine the average force acting on a body moving with a given acceleration in a given time interval.
Students should understand Newton's Second Law, F=ma, applied to a body under the effects of forces such as gravity or some contact forces in order to:
a) Draw a well defined Free Body Diagram, showing all forces acting on the body.
b) Write down the vector equations generated by applying Newton's Second law to the body and brake down the equations into components along the corresponding axes.
Students should be able to analyze situations in which a body moves with a given acceleration under the influence of one or more forces such as:
a) Motion up or down with a constant acceleration (elevator motion).
b) Motion in a horizontal circle (rotational or car rounding a curve).
c) Motion in a vertical circle (roller-coaster or Ferris wheel).
Students should be able to define non-conservatives forces and understand the importance of the coefficient of friction so they can:
a) Write equations that relate the normal and frictional forces on a surface.
b) Analyze the motion of a body that is pushed or pulled across a flat surface or across an inclined plane.
c) Calculate the force of friction or the coefficient of friction of a surface if a body at rest begins to slip across a surface and determine the conditions that caused such motion.
3. System of Two or More Bodies-Third Law.
Students should be able to:

a) Identify action-reaction forces, their magnitude and direction.
b) Analyze the force of contact between two bodies that accelerate together along a horizontal or a vertical line, or between two surfaces that slide across one another.
c) Study the Atwood's Machine, and know that there is a constant tension in a light string that passes over a massless pulley and suspends a system of two or more bodies.

C. Work, Energy, and Power
1. Work and the Work-Energy Theorem
Students should understand the definition of Work to be able to:
a) Calculate the work done by a constant force acting on a body and causing a displacement along a horizontal line.
b) Understand the graph of force as a function of position and realize that work can be calculated by using the area below this graph.
c) Apply the derived scalar product expressions to the solution of problems.
d) Relate the work done on a body to the change in Kinetic Energy or the change in speed of the body.
e) Knowing the change of speed or change in Kinetic Energy on a body, calculate the work done by the net force, or by each of the components of the net force.
f) Define the Work-Energy Theorem, and apply it to determine the force needed to bring a body to rest within a specified distance.
2. Conservative Forces and Potential Energy
Students should be able to:
a) Write the expression for the force exerted by an ideal spring and for the Potential Energy stored in a stretched or compressed spring.
b) Calculate the Potential Energy of a body in a uniform gravitational field.
3. Conservation of Energy
Students should be able to define Mechanical Energy and Total Energy in order to:
a) Identify situations in which Mechanical Energy is or is not conserved.
b) Apply y the Law of Conservation of Energy to the motion of bodies in a gravitational field, held by strings or moving under the influence of springs.

4. Power
Students should be able to:
a) Define Power

b) Calculate the power needed to maintain the motion of a body with a constant acceleration, raising the body vertically or moving it along a level surface, with or without friction.
c) Determine the work done by a force that supplies constant power or the power produce by a force that exerts a specific amount of work.

D. Systems of Particles- Linear Momentum
1. Impulse and Momentum
Students should be able to:
a) Relate the mass, velocity and Linear Momentum for a body in motion, and calculate the Total Linear Momentum of a system of bodies.
b) Define Impulse as the change in Linear Momentum and relate it to the average force acting on the body.
2. Conservation of Linear Momentum- Collisions
Students should be able to:
a) Identify cases in which Linear Momentum or a component of the momentum vector is conserved.
b) Apply the laws of conservation of Momentum and Energy to bodies moving along the same line, or at right angles, that collide and stick together, or separate, after the collision.
c) Analyze collisions in one or two dimensions, and determine unknown masses, velocities and loss of Kinetic Energy during the collision.

E. Rotation
1. Torque and Rotational Statics
Students should be able to:
a) Define Torque, and calculate the magnitude and direction of the Torque associated with a given force.
b) Determine the Torque on a rigid body due to gravity.
c) State the conditions for Translational and Rotational Equilibrium of a rigid body.
d) Refer to these conditions in the solution of problems associated with the equilibrium of a rigid body under the combined effect of coplanar forces applied at different locations.

2. Angular Momentum and Its Conservation
Students should be able to recognize the conditions under which The Law of Conservation of Momentum is applicable, and relate the law to single or multiple

particle systems such as satellite orbits or atomic structures.

F. Oscillations and Gravitation

1. Oscillation

Students should understand Simple Harmonic Motion so they can:

a) Sketch or recognize a graph of Displacement as a function of Time and, using the graph, determine the Amplitude, Period and Frequency of the motion.

b) Generate an appropriate expression, for the displacement of an oscillator, of the form $A\sin\omega t$ or $A\cos\omega t$ to describe the motion.

c) Identify points in the motion where the velocity, or the acceleration, is zero or has the highest positive or negative value.

d) State qualitatively, and prove the relation between acceleration and displacement.

e) Define and apply the relation between frequency and period.

f) Explain how the total energy of an oscillating system depends on the amplitude of the motion, sketch or identify a graph of Kinetic or Potential Energy as a function of time, and identify points on the graph where the energy is all Potential or all Kinetic.

g) Calculate the Kinetic and Potential energies of an oscillating system as functions of time, and prove that the sum of these energies is constant at all times.

h) Derive the expression for the period of oscillation of a mass on a spring and apply this expression in the solution of problems.

I) Generate the expression for the period of a simple pendulum and apply it to solve problems.

2. Gravitation

Students should know how:

a) State Newton's Law of Universal Gravitation.

b) Determine the force that one spherical body exerts on another.

c) Calculate the strength of the gravitational field at a specified point outside a spherically symmetrical mass.

d) Understand the motion of a body in orbit under the influence of gravitational forces.

e) In a circular orbit, recognize that the motion does not depend on the body's mass, and describe how the velocity, period of revolution and centripetal acceleration depend upon the radius of the orbit. Derive the proper equations for each of those variables.

f) State Kepler's Three Laws of Planetary Motion and relate them to the motion of a body in an elliptic orbit.

g) Apply conservation of Angular Momentum to determine the velocity and radial distance at any point in the orbit.
h) Use Angular Momentum and Energy conservation laws to relate the velocity of a body at the two extremes of an elliptic orbit.

II. Fluid Mechanics and Thermal Physics (5.1-12: A,B,C 5.2-12: B-3 5.3-12: A,B,C,D 5.4-12: A-1 5.6-12: A-1-3-5-7, B-1 5.7-12: A-5,6, B-1-4 WRS 2,3,4,5

A. Fluid Mechanics

Students should be able to state and explain the following concepts:
a) Hydrostatic Pressure
b) Archimedes Principle- Buoyancy
c) The Fluid Flow Continuity Equation
d) The Bernoulli's Equation

B. Temperature and Heat

Students should be able to :
a) Understand the Mechanical Equivalent of Heat, and calculate how much a substance will be heated by a specific quantity of mechanical work.
b) Identify, given a graph of heat added to a substance as a function of temperature, the melting point and boiling point, and calculate the heat of fusion, heat of vaporization and the specific heat of each phase.
c) Determine how much heat must be added to a substance in order to cause it to melt or vaporize.
d) Determine the final temperature of a mixture of substances that come to thermal equilibrium.
e) Calculate how the flow of heat through a slab of material is affected by changes in the thickness or area of the slab, or the temperature difference between the two faces of the slab.
f) Analyze qualitatively what happens to the size and shape of a body when is heated.

C. Kinetic Theory and Thermodynamics

1. Ideal Gases
Students should be able to:
a) Understand The Kinetic Theory Model of an Ideal Gas and state the assumptions of the model

b) Relate temperature and mean Translational Kinetic Energy in order to determine the mean speed of gas molecules as a function of their mass and temperature.
c) State the relationship between Avogadro's number, Boltzmann's constant, and the gas constant R, and express the energy of a mole of monatomic ideal gas as a function of its temperature.
d) Explain how the model describes the pressure of a gas in terms of collisions with the container walls, and predicts that, for a fixed volume, pressure must be proportional to temperature.
e) Relate the pressure and volume of a gas during isothermal expansion or compression.
f) Analyze the pressure and temperature of a gas during constant-volume heating or cooling, or the volume and temperature during constant-pressure heating or cooling.
g) Calculate the work done on or by a gas during an expansion or compression at constant pressure.
h) Understand the process of adiabatic expansion or compression of a gas.
I) Identify or sketch on a PV Diagram the curves that represent each process.
2. Laws of Thermodynamics
Students should be able to:
a) Apply the First Law of Thermodynamics in order to relate the heat absorbed by a gas, the work performed by the gas, and the internal energy change of the gas for any of the given processes.
b) Compare the work performed by a gas in a cyclic process to the area enclosed by a curve on a PV Diagram.
c) State the Second Law of Thermodynamics, and determine whether entropy will decrease, increase or remain the same during a particular situation.
d) Compute the maximum efficiency of a heat engine.
e) Relate the heat exchanged at each thermal reservoir in a Carnot cycle to the temperature of the reservoirs.

III. Electricity and Magnetism (5.1-12: A,B,C 5.2-12: B-2 5.3-12: A,B,C,D 5.4-12: A,C 5.6-12: A,B 5.7-12: A-4,5,6,7,8, B-1,2,3 WRS-2,3,4,5)

A. Electrostatics

1. Charge, Field and Potential
Students should be able to:
a) Define The Electric Field in terms of a force in a test charge.
b) Calculate the magnitude and direction of the force on a positive or negative charge placed in a specific field.
c) Using a diagram of an electric field represented by flux lines, determine the direction of the field at a given point, identify the strength of the field at different locations and where positive or negative charges must be present.
d) Analyze the motion of a charged particle, with a given mass, in a uniform electric field.
e) Understand the concept of Electric Potential, and calculate the electric work done on a charged particle that moves through a given potential difference.
f) Given a diagram of equipotential lines for a charge configuration, determine the direction and magnitude of the electric field at different positions.
g) Using the Law of Conservation of Energy, find the speed of a charged particle that has been accelerated through a potential difference.
h) Calculate the potential difference between two points in a uniform magnetic field and indicate which one represents the higher potential.
2. Coulomb's Law, Field and Potential of two point charges.
Students should be able to:
a) State Coulomb's Law and The Principle of Superposition
b) Calculate the force that acts between two point charges, and explain the field of a single point charge.
c) Use vector addition to obtain the electric field produced by two or more point charges.
d) Determine the electric potential near one or more point charges.
e) Describe the Electric Field created by a set of parallel charged plates.

B. Conductors, Capacitors and Dielectrics
1. Electrostatics with Conductors
Students should be able to:
a) Explain why there is an absence of electric field inside a conductor and all excess charge is found on the surface of the conductor.
b) Understand that a conductor must be an equipotential, and apply this principle in the case when conductors are joined by wires.
c) Indicate the direction of the force on a charged particle brought near an uncharged or grounded conductor.
d) Describe and sketch a graph of the electric field and potential inside and outside

a charged conducting sphere.
e) Demonstrate the process of charging, a neutral body, by Conduction and Induction.
f) Indicate the direction of the force on a charged particle brought near an uncharged or grounded conductor.
2. Capacitors and Dielectrics
Students should be able to:
a) Know the definition of Capacitance, and relate stored charge, stored energy and voltage for a capacitor.
b) Recognize situations in which energy stored in a capacitor is converted to other forms of energy.
c) Describe the electric field inside a Parallel-Plate Capacitor, and relate the strength of this field to the Potential Difference between the plates and the Plate Separation.
d) Determine how changes in the dimensions of the capacitor will affect the value of the Capacitance.

C. Electric Circuits
1. Current, Resistance, Power
Students should be able to:
a) Understand and define Electric Current, and relate the magnitude and direction of a current in a wire to the rate of flow of positive and negative charge.
b) Define conductivity, resistivity and resistance, and relate current and voltage to resistance.
c) Describe how the resistance of a resistor depends on its length and cross-sectional area. ($R \alpha L/A$)
d) Find a relation between the current, voltage and resistance of a resistor to the rate of heat production in a resistor.
2. Direct Current Circuits with Batteries and Resistors.
Students should be able to understand Series and Parallel Circuits so they can:
a) Given a circuit diagram, identify resistors connected in series or in parallel.
b) State Ohm’s Law, and determine the ratio of the voltages across a resistor connected in series or the ratio of the currents through resistors connected in parallel.
c) Calculate the voltage, current, and power dissipation for a resistor in a network of resistors connected to a single battery.
d) Design and draw a diagram for an electric circuit, using conventional symbols, that represents a simple series-parallel combination with the voltage and current

given for one of the components of the circuit.
e) Calculate the terminal voltage of a battery, with a given EMF, and the internal resistance from which a known current is flowing.
f) Apply Ohm's Law and Kirchhoff's Rules to direct-current circuits, and determine an unknown current, voltage, or resistance.
g) Understand the properties of Voltmeters and Ammeters, and explain whether the resistance of each is high or low.
h) Show correct methods of connecting meters into electric circuits to measure voltage and current.
3. Capacitors in Circuits
Students should be able to:
a) Calculate the equivalent capacitance of a series or parallel combination of capacitors.
b) Describe how stored charge is divided between two capacitors connected in parallel.
c) Determine the ratio of voltages for two capacitors connected in series
d) Find the voltage or stored charge, under steady-state conditions, for a capacitor connected to a circuit consisting of a battery and resistors.
e) Analyze the behavior of circuits containing several capacitors and resistors
f) Find values of voltages and currents immediately after a switch has been closed and also after steady-state conditions exist.

D. Magnetostatics
1. Forces on Moving Charges in Magnetic Fields
Student should be able to:
a) Calculate the magnitude of the force, acting on a charged particle in a magnetic field, in terms of q, **v** and **B**, and explain why the magnetic force does no work.
b) Explain the direction of a Magnetic Field using information from the forces acting on the charged particles moving through the field.
c) Using Newton's Second Law and the Magnetic Force Law, derive and apply the formula for the radius of the circular path of a charge that moves perpendicular to a uniform magnetic field.
d) Describe the motion of a particle that enters a uniform magnetic field with a given initial velocity.
e) Determine under what conditions particles will move with constant velocity through crossed electric and magnetic fields.
2. Forces on Current-carrying Wires in Magnetic Fields
Students should be able to:

a) Calculate the magnitude and direction of the force on a straight segment of a current-carrying wire in a uniform magnetic field.
b) Indicate the direction of magnetic forces on a loop of wire in a magnetic field, and determine how the loop will tend to rotate under the effect of these forces.
c) Understand the magnetic field produced by a long straight current-carrying wire.
d) Calculate the magnitude and direction of the field at a point near a long current-carrying wire.
e) Use superposition to determine the magnetic field produced by two long wires.
f) Find the force of attraction or repulsion between two long current-carrying wires.

E. Electromagnetism
1. Electromagnetic Induction
Students should be able to:
a) Define Magnetic Flux, and calculate the flux of a uniform magnetic field through a loop of wire
b) Understand Faraday's Law and Lenz's Law, and recognize situations in which changing flux through a loop will cause an induced *emf* or current in the loop.
c) Calculate the magnitude and direction of the induced *emf* and current in:
1) A square loop of wire pulled at a constant velocity in and out of a uniform magnetic field.
2) A loop of wire placed in a uniform magnetic field whose magnitude changes at a constant rate.
3) A loop of wire rotating at a constant rate about an axis perpendicular to a uniform magnetic field.
4) A conducting bar moving perpendicular to a uniform magnetic field.

IV. Waves and Optics (5.1-12: A,B,C 5.2-12: B 5.3-12: A,B,C,D 5.4-12: A 5.6-12: A,B 5.7-12: A-1,5,6, B-1,2,4 5.10-12: A,B)

A. Wave Motion and Sound
Students should be able to:
a) Understand the concept of waves, and sketch or identify graphs that represent

traveling waves in order to determine the Amplitude, Wavelength, Frequency and Velocity of the wave.
b) Generate mathematical relationships relating wavelength, frequency and velocity of a wave.
c) Create graphs that describe the reflection of a wave from a fixed or free end of a string, and know what factors determine the speed of a wave on the string and the speed of sound.
d) Sketch standing wave modes for stretched strings, which are fixed at both ends, and calculate the amplitude, wavelength, and frequency of the standing pattern.
e) Describe standing sound waves in a pipe that has either open or closed ends, and determine the wavelength and frequency of such waves.
f) Explain the Doppler Effect for Sound, and the reasons for a frequency shift in both the moving-source and moving-observer situation.
g) Derive and apply the equations for the frequency shift that describe the moving-source and moving-observer Doppler Effect, and create or identify graphs that explain this effect.
h) Understand the Principle of Superposition, and apply it to traveling waves in opposite direction to create a standing wave.

B. Physical Optics
Students should be able to:
a) Understand the Principle of Interference and Diffraction of waves, and apply these principles to coherent sources oscillating in phase.
b) Describe the conditions under which waves undergo constructive or destructive interference.
c) Determine the locations of interference maxima or minima for two sources, or the frequencies or wavelengths that can cause constructive or destructive interference at a given point.
e) Compare the amplitude and intensity of the constructive interference produced by two or more sources to those produced by a single source.
f) Apply the principles of Interference and Diffraction to waves that pass through a single or double slit or through a Diffraction Grating.
g) Draw or identify the Intensity pattern on a screen, that results when monochromatic waves pass through a single slit, and explain how this pattern will change if the wavelength or the width of the slit varies.
h) Using a single slit pattern, calculate the angles or the positions, on a distant screen, where the Intensity is zero.
I) Sketch or identify Interference pattern created by monochromatic waves passing

through a double slit, and point out which features of this pattern represent Single-slit Diffraction and which are due to Two-slit Interference.
j) In a Two-slit Interference pattern, calculate the angles and positions for Intensity Maxima or Minima.
k) Explain the interference pattern formed by a Multiple-slit Diffraction Grating, calculate the location for Intensity Maxima, and describe why a multiple-slit grating is better than a two-slit grating for making an accurate determination of the wavelength.
l) Apply the principles of Interference to light reflected by thin films, and state the conditions for a phase reversal when light is reflected from the interface between two media of different indices of refraction.
m) Relate constructive or destructive interference in thin films to Newton's Rings and similar phenomena, and explain how coated glass minimizes reflection of visible light.
n) Understand Dispersion and the Electromagnetic Spectrum, and connect the variation of index of refraction to frequency and degree of refraction.
o) Know the Electromagnetic Spectrum by increasing order of wavelength.
p) Using the concept of the transverse nature of light waves, explain the polarization of light.
q) Apply the Inverse Square Law to calculate the intensity of light at different given distances from a known power source.

C. Geometric Optics

Students should be able to:
a) Understand the principles of Reflection and Refraction of Light, and show how the speed and wavelength of light change when light passes from one medium into another.
b) Draw a diagram showing the directions of the reflected and refracted rays, and use Snell's Law to predict the direction of the incident ray, the refracted ray, or the indices of refraction of the media.
c) Describe the conditions for Total Internal Reflection, and derive an expression for the Critical Angle.
d) Explain image formation by a plane or spherical mirrors, and know the relation between the focal point and the center of curvature of a spherical mirror.
e) Locate and trace the image of a real object in front of a mirror, and determine whether the image is real or virtual, upright or inverted, larger or smaller than the object.
f) Know image formation by converging or diverging lenses in order to relate the

focal length of the lens to its radius of curvature, index of refraction of the lens's material or the medium in which it is immersed.
g) Locate, by ray tracing, the image of a real object placed inside or outside the focal point of the lens, and state the characteristics of the resulting image.
h) Use the Thin Lens Equation to calculate the object distance, image distance and the focal length of the lens, and determine the magnification of the image.
I) Draw and analyze situations in which the image formed by one lens serves as the object for another lens.

V. Atomic and Nuclear Physics (5.1-12: A,B,C 5.2-12: B-1,2,3 5.3-12: A,B,C,D 5.4-12: A 5.6-12:A-1,3,6, B-2 5.7-12:A-4,5,6,8,B 5.9-12: D)

A. Atomic Physics and Quantum Effect

Students should be able to:
a) Describe the Rutherford Scattering Experiment and explain how it provides evidence for the existence of the atomic nucleus.
b) Know the properties of photons, and relate their energy in joules or electron-volts to their wavelength or frequency.
c) Express the Linear Momentum of a photon in terms of its energy or wavelength, and apply conservation of momentum to processes related to the emission, absorption, or reflection of photons.
d) Calculate the number of photons per second emitted by a monochromatic source of given wavelength and power.
e) Understand the Photoelectric Effect and how it relates to evidence of the photon nature of light.
f) Analyze the Photon Model of Light, and understand that the number of photoelectrons and their maximum Kinetic Energy depend on the wavelength and intensity of the light striking the surface.
g) Compare the maximum Kinetic Energy of photoelectrons ejected by photons with different energies or wavelengths.
h) Using a graph of Stopping Potential versus Frequency from a photoelectric-effect experiment, locate the threshold frequency and work function, and calculate an approximate value of h/e.
I) Understand the concept of energy levels for atoms in order to calculate the energy or wavelength of the photon emitted or absorbed in transition between levels, or the energy or wavelength needed to ionize an atom.
j) Explain the origin of emission or absorption spectra of gases.

k) Given the wavelength or energies of photons emitted or absorbed in a two-step transition between levels, calculate those values for a single-step transition between the same levels.
l) Explain the Bohr Model for the Hydrogen atom, and write the formula for the energy levels of Hydrogen in terms of the ground-state energy, which relates to the Hydrogen Spectrum.
m) Refer to the concept of DeBroglie wavelength, and calculate the wavelength of a particle as a function of its momentum.
n) Describe the Davisson-Germer Experiment, and explain how it provides evidence for the wave nature of electrons.
o) Understand the nature and production of X- Rays, and determine the shortest x-ray wavelength produced by electrons accelerated through a given voltage.
p) Describe the Compton's Experiment and account for the increase of photon wavelength observed, and explain the significance of the Compton wavelength.

B. Nuclear Physics
Students should be able to:
a) Understand the concept of Half-life in Radioactive Decay.
b) Graph the fraction of radioactive decay of a sample as a function of time and indicate the half-life represented on such graph.
c) Calculate the progression of decay per unit time of an isotope sample of given half-life.
d) Interpret symbols for nuclei such as the atomic number, mass number and charge.
e) Use conservation of mass number and charge to complete nuclear reactions.
f) Determine the mass number and charge of a nucleus after decay, and write the reaction that describes the process of α, β and γ decay.
g) Relate the existence of the neutrino to the β decay and fundamental conservation laws.
h) Compare the nature of the nuclear force to the electromagnetic force in terms of strength and range.
I) Describe a typical neutron-induced fission, explain why a chain reaction is possible and relate the energy released in fission to a decrease in rest mass.
j) Know the postulates of Special Relativity, and apply the basic assumptions about the equivalence of inertial frames and about the speed of light.
k) Explain the significance of the Michelson-Morley Experiment.
l) Understand the kinematic effects predicted by special relativity, and relate the lifetime of a fast-moving particle as timed by two stationary clocks, to the lifetime

of such particle in its rest frame.
m) Calculate the effect of Lorentz contraction on the dimensions of a fast-moving object.
n) Given two objects moving at high speeds along the same line, describe the limits on the speed of one object in the frame of reference where the other is at rest.
o) Sketch or identify a graph of the total energy of a particle as a function of its velocity, and calculate the total energy, kinetic energy, or momentum of a moving particle in terms of its rest mass and speed.
p) Apply the relationship *E=mc* _ in the explanation of physical processes in which kinetic energy is converted to rest energy and rest energy is converted to kinetic energy.
q) Describe the behavior of the velocity, acceleration, linear momentum, and energy of a particle accelerated close to the speed of light by a constant force.

Assessment

Student proficiency (satisfactory achievement) in each of the outcomes/ objectives listed in this guide shall be determined by student attainment of the 70% district passing standard which pertains to all curricula and populations. Such proficiency shall be measured by a multiplicity of evaluation techniques and instruments, which includes, but is not restricted to the following:

1. Teacher-made tests and quizzes
2. Laboratory reports, laboratory projects or lab tests
3. Oral presentations, research projects using computer generated information and creative writing
4. Homework assignments
5. Laboratory notebook
6. Construction of creative designs and models
7. Self-discipline, time management and ability to work with others
8. Ability to solve problems using analytical and creative thinking
9. Participation in group competitions or field trips.
10. Final assessment based on final test and practice AP exam.
11. Proper use of laboratory equipment and safety rules.
12. Cooperation and participation in group projects or assignments.

Marking Period Assessment and Grading System:

Students are evaluated based on three main areas of performance

Unit tests - 1/3 of final grade

Laboratory Activities - 1/3 of final grade

Homework Assignments - 1/3 of final grade

Quizzes are considered to be extra-credit. The quizzes are averaged together and generate a maximum of 5 points, which are added directly to the test grade average.

Since the quizzes do not affect the maximum value of the test grades (100) and are extra-credit, students need to be present the day they are offered. The intension behind this system is to reward students that have perfect attendance while offering a cushion for the test average. Students should consider quizzes as a savings account and they should try their best to accumulate the maximum number of points.

Homework assignments are given every Monday and are due on Friday. Therefore, students have five days to ask questions or seek help if necessary. This system encourages students to develop time management skills. Additional

assignments
are given with longer time frames.

Homework assignments are not accepted late, only 50% credit will be given to homework assignment submitted after the due date. The grade is based on effort and responsibility. Students should attempt all problems given, and research the topics to improve comprehension and seek solutions.

Laboratory work receives a letter grade such as A+, A, A-, B+, B, B-, etc. because some flexibility is needed in order to evaluate the student's performance in this area. The test questions have specific answers so grades are given as numerical averages.

The final grade for the year includes the average of all four marking periods, which counts for 8/9 of the total grade, and the final assessment grade for the last 1/9 of the total grade. The final assessment represents the Final Test and a practice AP test, or a Final Project.

Instructional Resources / Materials

Textbook:

The formal textbook for this course is under revision. The Textbook with Study Guide in use at this time is:

Giancoli, Douglas C. *Physics: Principles with Applications,* 4th edition.

Supplementary Materials:

Beiser, Arthur. *Physics.* 5th edition
Sears, Zemansky and Young. *College Physics*.7th edition
Serway and Faughn. *College Physics.* 4th edition
Halliday, Resnick and Krane. *Physics, Volumes I and II.* 4th edition
Serway, Raymond A. *Physics: for Scientists and Engineers.* 3th edition
Hewitt, Paul G. *Conceptual Physics, The High School Physics Program.* 2nd ed.
Research and Education Association. *The Physics Problem Solver*
The Physics Teacher, published monthly by The American Association of Physics Teachers.

Laboratory Resources:

Haber-Schaim, Dodge, and Walker. *Laboratory Guide to PSSC Physics.*
Robinson, Paul. *Conceptual Physics Laboratory Manual.*
Pasco Scientific Equipment
Teacher-made laboratory experiments and projects.

In addition to these resources, guess speakers, films, and field trips are used to enrich student's background, and increase their interest in science.

Great efforts should be made to teach "Physics" as a fun and exiting field of study.

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