East Penn School District
Curriculum and Instruction

Curriculum for: Physics 1, College Preparatory

Course(s): CP Physics 1

Grades: 10-12

Department: Science | **Length of Period (average minutes): 42**

Periods per cycle: 8 | **Length of Course (yrs): 1**

Type of offering: elective | **Credit(s) awarded: 1.4 4.0/4.0**

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ADOPTED: 2018

Enduring Understandings & Essential Questions	**Knowledge**	**Skills**	**Standards**
Enduring Understandings: ● Motion is relative. ● Motion can be described using position, velocity, acceleration and time. ● Mathematical and graphical models can be used to describe and predict motion. ● Force and net force are not the same. ● Net force affects the motion of a mass. ● The state of motion cannot change when there is no net force on a mass. ● The types of forces they encounter. Essential Questions: ● How we describe and predict the motion of an object? ● What causes objects to move the way they do?	● The meaning of frame of reference, position, displacement, distance, speed, velocity and acceleration. ● The kinematic equations both linear and two dimensional (including freefall and projectile motion). ● The difference between scalar quantities and vector quantities ● The SI units for distance, time, velocity and acceleration ● The two types of forces, contact and field. ● Newton's laws of motion ● The meaning of net force ● The difference between mass and weight	● Identify trends and sources of error using experimental data. ● Predict and explain everyday phenomena using equations and graphs derived from data. ● Define position as a signed number relative to an origin. ● Calculate displacement (Δx) as the change in position of an object. ● Identify the frame of reference used in any problem. ● Calculate speed as the distance traveled divided by the elapsed time. ● Calculate velocity as the change in position divided by the elapsed time. ● Identify cases where average speed does not equal average velocity. ● Describe a situation when the velocity is negative. ● Define and calculate acceleration as the change in velocity divided by the elapsed time. ● Describe how the physics definition of acceleration differs from the everyday definition of acceleration. ● Interpret position versus time and velocity versus time graphs for motion at constant velocity and for motion at constant acceleration. ● Solve and interpret situations of constant acceleration. ● Identify a projectile as an object which has been launched and whose motion is affected only by gravity (ignoring air resistance).	NGSS Standards: ● HS-PS2-1. Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.

● What causes objects to change the way they are moving?	● The names of forces they encounter ● SI units for force, mass and weight	● Analyze the motion of a projectile by breaking its velocity and acceleration vectors into components. ● Identify scalar and vector quantities. ● Perform vector addition geometrically. ● Determine the components of a vector using a geometric method. ● Apply vector concepts to physical situations involving forces, projectile motion ● Explain that objects change their motion only when a net force is applied. ● Apply the relationship, a = F/m, to physical situations in order to explain qualitatively and quantitatively how any one variable is affected by a change in another. ● Explain that force is not something that an object "has", but is characteristic of the action between objects. ● Explain that when one object applies a force to a second object, the second object simultaneously applies an equal and opposite force to the first object.	
Enduring Understandings: ● There are different forms of energy. ● Energy is conserved. ● Energy is converted from one form to another. Essential Questions:	● Work ● Energy ● Forms of energy ● Power ● SI units for work, energy and power ● System	● Define energy in terms of work. ● Calculate work and illustrate that simple machines do not decrease work, rather, they decrease application force by increasing the distance that the force is applied. ● Define and calculate kinetic energy, and gravitational potential energy. ● State and apply the relationship that work done with no opposing force equals the change in kinetic energy. ● State and apply the relationship that work done against gravity equals the change in gravitational potential energy.	NGSS Standards: ● HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. ● HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and

• How energy is converted from one form to another. • How we describe and predict the motion of an object? • What causes objects to move the way they do? • What causes objects to change the way they are moving?		• Define and calculate mechanical energy as the sum of the kinetic and potential energy. • Identify the different forms of energy in simple systems such as a swinging pendulum or a car on a frictionless roller coaster. • Describe the law of conservation of energy for a system and apply it to problems where friction and air resistance are ignored.	trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. • HS-ETS1-4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem. • HS-PS3-1. Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. • HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.
Enduring Understandings: • How mass and velocity affect momentum.	• Momentum • Impulse • Conservation of momentum • Elastic collision	• Calculate the momentum of an object. • Define and calculate impulse and apply it to the change in momentum of an object.	NGSS Standards: • HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down

● How momentum is transferred during a collision. Essential Questions: ● What affects the force on an object during a collision. ● How energy conservation is related to the type of collision. ● What affects the motion of objects in a collision? ● How can an object be protected in a collision?	● Inelastic collision ● Conservation of kinetic energy ● SI Units for momentum	● Use the concept of impulse to explain and demonstrate mathematically why it is safer in a collision to take a longer time to come to a stop. ● Analyze a problem and choose a system to determine if the forces are internal or external to that system. ● Explain that a conserved quantity is a quantity that remains numerically constant. ● Define and identify situations involving elastic and inelastic collisions and explosions. ● State the law of conservation of momentum and use it to solve one - dimensional explosion and collision problems	into smaller, more manageable problems that can be solved through engineering. ● HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. ● HS-ETS1-4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem. ● HS-PS2-2. Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system. ● HS-PS2-3. Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the

			force on a macroscopic object during a collision.
Enduring Understandings: • Torque depends on force and where it is applied • Net torque causes change in rotation • Centripetal force is required for motion along a curved path Essential Questions: • What is the difference between an object that rotates and one that follows a curved path? • What causes an object to rotate or follow a curved path?	• Centripetal force • Torque • Tangential velocity • Centripetal acceleration • Moment arm/lever arm • SI Units for torque • Universal Gravitation	• Explain the relationship of torque and moment of inertia. • Analyze situations of objects rolling as opposed to sliding down a hill. • Calculate the forces on a system in equilibrium. • Explain the difference between center of mass and gravity. • Explain the relationship between moment of inertia and angular velocity. • Demonstrate the relationship of torque and angular acceleration. • Calculate the centripetal force of a mass traveling in a vertical and horizontal circular path. • Explain the relationship of g-force to speed, radius, and centripetal force. • Mathematically analyze the type of forces applying the centripetal force that acts on any object in uniform circular motion. • Identify a centrifugal force as a fictitious force and explain how it results from an accelerated frame of reference. • Determine the directions of the velocity, acceleration, and net force vectors for an object in uniform circular motion. • Apply the proportional relationship of the law of universal gravitation • Explain why a spaceship in a stable circular orbit is in free fall and why a person in that spaceship experiences weightlessness. • Use Newton's second law and the law of universal gravitation to show why all objects	NGSS Standards: • HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. • HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. • HS-ETS1-4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem. • HS-PS2-4. Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe

		near the surface of the earth fall with the same constant acceleration.	and predict the gravitational and electrostatic forces between objects.
Enduring Understandings: ● Energy can be transferred by waves without the transfer of mass. ● How vibrations cause sound. ● That only certain wave frequencies are heard by people. ● How waves interact with the surroundings and other waves. ● Under certain conditions, waves can transfer a large amount of energy. Essential Questions: ● How can periodic motion cause waves? ● How do waves transfer energy from one place to another? ● How can we interpret periodic motion as sound? ● How do waves interact with one another?	● Simple harmonic motion ● Frequency ● Period ● Wavelength ● Wave speed ● Amplitude ● Medium ● Superposition ● Interference ● Standing waves ● Resonance ● Transverse ● Longitudinal ● SI Units for wavelength and speed, and frequency	● Describe the motion of the wave and of the wave medium for transverse and longitudinal waves. ● Define wave characteristics including amplitude, wavelength (λ), and frequency (f). ● Solve problems using the wave equation ($v = f\lambda$). ● Cite examples of the transportation of energy in waveform and describe that wave energy can be converted to other forms of energy. ● Sketch and describe how wave fronts reflect off of plane barriers. ● Sketch and describe how wave fronts refract when crossing a boundary, how the change in wave speed at the boundary produces refraction, and how refraction is affected by the wavelength of the wave. ● Describe how the crests and troughs of two transverse waves can interfere (add or subtract) while passing through one another, and produce a pattern by two in- phase point sources. ● Sketch and describe how wave fronts are diffracted when traveling through small apertures, and explain how diffraction varies with wavelength. ● Illustrate that the wavelength of an approaching or receding wave source is different from the wavelength of a stationary wave source (i.e., explain the Doppler Effect).	NGSS Standards: ● HS-PS4-1. Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media. ● HS-PS4-3. Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other. ● PS4.A: Wave Properties - The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing. Waves can add or cancel one another as they cross, depending on their relative phase (i.e., relative position of peaks and troughs of the waves), but

		● Describe the motion of the wave and of the wave medium for transverse and longitudinal waves. ● Define wave characteristics including amplitude, wavelength (λ), and frequency (f). ● Solve problems using the wave equation ($v = f\lambda$). ● Cite examples of the transportation of energy in waveform and describe that wave energy can be converted to other forms of energy. ● Sketch and describe how wave fronts reflect off of plane barriers. ● Sketch and describe how wave fronts refract when crossing a boundary, how the change in wave speed at the boundary produces refraction, and how refraction is affected by the wavelength of the wave. ● Sketch and describe how the crests and troughs of two transverse waves can interfere (add or subtract) while passing through one another, and produce a pattern by two in- phase point sources. ● Sketch and describe how wave fronts are diffracted when traveling through small apertures, and explain how diffraction varies with wavelength. ● Illustrate that the wavelength of an approaching or receding wave source is different from the wavelength of a stationary wave source (i.e., explain the Doppler Effect).	they emerge unaffected by each other. (Boundary: The discussion at this grade level is qualitative only; it can be based on the fact that two different sounds can pass a location in different directions without getting mixed up.) ● PS4.B: Electromagnetic Radiation - Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining many features of electromagnetic radiation, and the particle model explains other features.
Enduring Understandings: ● Unlike charges attract and like charges repel causing electric forces	● Coulomb's Law ● Electric force ● Attraction ● Repulsion ● Potential Difference	● Identify two kinds of electric charges and describe the interaction of like and unlike charges. ● Describe the acquisition of net charge in terms of the gain or loss of electrons by friction,	NGSS Standards: ● HS-PS2-4. Use mathematical representations of Newton's Law of Gravitation and

between charged objects. ● Moving charges transfer energy as current. ● Resistance in an electric circuit limits and controls the amount of current flowing. ● There are mathematical models that relate current, voltage, and resistance in various circuit configurations. Essential Questions: ● What causes electric charges to move? ● Why does charge move easier in some materials than others? ● How does a circuit allow energy to be transferred?	● Voltage ● Current ● Resistance ● Ammeter ● Voltmeter ● Multimeter ● Circuit ● Ohm's Law ● Series ● Parallel	conduction, and induction, and explain that connecting objects to the ground discharges them. ● Explain why an electrically charged object can attract an electrically neutral object. ● Differentiate between conducting and insulating materials in terms of the ease that electrons flow in them. ● Identify and apply the proportional relationships involved in Coulomb's law of electric force ● Describe the concepts in an electrical circuit including electric potential energy, electric potential, voltage, current, and resistance. ● Use each concept to explain the flow of charge through a simple circuit and to illustrate the electric circuit/water analogy. ● Use Ohm's law (V = IR) to calculate circuit variables. ● Explain that current is not "used up" in an electric circuit, rather, the electric potential energy of a charge is converted to heat energy as the charge flows through a resistor. ● Identify the characteristics of simple series circuits including that the total resistance is equal to the sum of the resistances of the resistors, the current is constant throughout the circuit, and the sum of the voltages across the resistors equals the voltage across the voltage source. ● Identify the characteristics of simple parallel circuits including the inverse of the total resistance is equal to the sum of the inverses of the resistors, the voltage across each resistor is the same as the voltage source, and the sum of the currents in the branches equals the current output by the voltage source.	Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects. ● HS-PS2-5. Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.

		• Explain why houses are wired in parallel and describe short circuits and the function of circuit breakers. • Define power as the amount of energy transferred (work) divided by the elapsed time. • Define electrical power as the product of voltage and current and apply this to simple circuits.	

Materials and Resources:

"Holt Physics"   2012 edition

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