East Penn School District
Curriculum and Instruction

Curriculum for: Physics 2, College Preparatory

Course(s): CP Physics 2

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

Developed by: Edward Anthony

ADOPTED: 2018

Enduring Understandings & Essential Questions	Knowledge	Skills	Standards
Enduring Understandings: ● Energy can be transferred by waves without the transfer of mass. ● That specific wave frequencies are seen as a specific colors by people. ● How waves interact with the surroundings and other waves. ● Electromagnetic waves are all similar, the energy (frequency) they carry determines how they can be used. Essential Questions: ● How do waves transfer energy from one place to another? ● How do waves interact with one another? ● What is different about one color vs another, and one wave type vs another	● Electromagnetic waves ● Frequency ● Period ● Wavelength ● Wave speed ● Wave energy ● Amplitude ● Superposition ● Interference ● Reflection types and mirrors ● Refraction and lenses ● Index of refraction ● Convex ● Concave ● Focal length ● Real and virtual images ● Ray diagram ● Diffraction and diffraction gratings ● Polarization ● Interference ● Coherent light and lasers ● Primary colors ● si units for wavelength and speed, and frequency	● Compare and contrast light waves to water and sound waves. ● Explain the electromagnetic spectrum. ● Explain the difference between the primary colors of light and pigments with color addition/ subtraction. ● Explain how electromagnetic waves relate to polarizers. ● Describe the motion of electromagnetic waves and of the effect of a medium. ● Identify and describe electromagnetic wave characteristics including energy, amplitude, wavelength (λ), and frequency (f). ● Cite examples of the transportation of energy in waveform and describe how wave energy can be	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. ● HS-PS4-5. Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy. ● 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 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

(ie microwaves vs x-rays)? ● How do optical devices manipulate light?	● Color of light and vision	converted to other forms of energy. ● Solve problems using the wave equation ($c = f\lambda$). ● Sketch and describe how wave fronts reflect off of plane and concave boundaries. ● 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	model is useful for explaining many features of electromagnetic radiation, and the particle model explains other features. ● PS4.C: Information Technologies and Instrumentation - Multiple technologies based on the understanding of waves and their interactions with matter are part of everyday experiences in the modern world (e.g., medical imaging, communications, scanners) and in scientific research. They are essential tools for producing, transmitting, and capturing signals and for storing and interpreting the information contained in them.

		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)	
Enduring Understandings: ● Energy can be transferred by fluid flowing, and energy is conserved. ● That pressure, volume, and temperature of a material are all needed to determine its behavior. ● That as a fluid flows, its area of flow determines its speed, and its speed determines its pressure. ● That materials with lower density will have greater buoyancy.	● Elasticity ● Fluid ● Density ● Buoyant force ● Viscosity ● Surface tension ● Conservation of energy ● Pressure ● Depth, gage, and atmospheric pressure ● Fluid dynamics ● Pascal's principle ● Bernoulli's principle ● Continuity ● Drag ● Ideal gas law ● Kinetic theory of gases ● Pneumatic ● Hydraulic	● Explain the relationships of a moving ideal fluid and viscous fluid. ● Explain fluid flow in Bernoulli's Principle. ● Analyze examples that vary the buoyant force and determines whether an object will float. ● Explain the relationship of pressure, temperature, and volume for gases. ● Explain and apply the relationship between the Force, Area, and pressure and their relation to Pascal's principle.	NGSS Standards: ● 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-PS3-2. Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects). ● 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. ● HS-PS4-1. Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media. ● PS3.A: Definitions of Energy - Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's

Essential Questions: ● What is the difference between solids, liquids, and gases? ● What determines if something floats or sinks? ● What determines how much pressure there is? ● How does the speed of a fluid affect its pressure? ● How does conservation of Energy tie in with fluid flow?			total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. (HSPS3-1),(HS-PS3-2) - At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy . (HSPS3-2)(HS-PS3-3) - These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space. (HS-PS3-2) ● PS3.B: Conservation of Energy and Energy Transfer - Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. (HS-PS3-1) - Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PS3-1),(HS-PS3-4) - Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior. (HS-PS3-1) - The availability of energy limits what can occur in any system. (HS-PS3-1)

			- Uncontrolled systems always evolve toward more stable states—that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down). (HS-PS3-4)
Enduring Understandings: ● Energy can be transferred by heat without the transfer of mass. ● That temperature is not heat, it is a measurement of the quantity of internal energy. ● That heat can be generated from any other form of Energy and follows the conservation of energy. ● Thermodynamic laws describe how heat behaves ● That processes using heat can not be 100% efficient. Essential Questions: ● How does something get hotter or colder?	● Temperature ● Heat ● Thermal equilibrium ● Conduction ● Convection ● Radiation ● Specific heat ● Pressure ● Absolute zero ● Latent heat ● Phase change ● Calorimeter ● Coefficient of expansion ● Efficiency ● Entropy ● Energy conservation ● Thermodynamic laws	● Distinguish between conduction, convection, and radiation with real life examples. ● Explain the differences in specific heats and latent heats. ● Explain kinetic theory as it relates to gases and internal energy. ● Distinguish the relationships between energy transfer and temperature. ● Apply the three laws of thermodynamics to an ideal gas. ● Explain the four processes of thermodynamics. ● Explain heat engines and their efficiency. ● Explain how the conservation of Energy is reflected in Heat theory and Thermodynamics.	NGSS Standards: ● 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-PS3-2. Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects). ● 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. ● HS-PS3-4. Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics). ● PS3.A: Definitions of Energy - Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. (HSPS3-1),(HS-PS3-2)

• What does temperature tell us about an object? • What happens when a material has a phase change? • How is heat energy converted to mechanical energy?			- At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy . (HSPS3-2)(HS-PS3-3) - These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space. (HS-PS3-2) • PS3.B: Conservation of Energy and Energy Transfer - Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. (HS-PS3-1) Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PS3-1),(HS-PS3-4) - Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior. (HS-PS3-1) - The availability of energy limits what can occur in any system. (HS-PS3-1) - Uncontrolled systems always evolve toward more stable states—that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down). (HS-PS3-4)

Enduring Understandings: ● Energy can be transferred by current. ● That opposite poles of magnets attract, like repel. ● That current makes a magnetic field. ● That a changing magnetic field makes current. ● That transformers are used to change voltage and current, and their direction. Essential Questions: ● How does electricity get produced? ● What is the relationship between electricity and magnetism? ● What is the difference between AC & DC electricity? ● What is the difference between motors and generators?	● Electromagnetism ● Magnetic poles ● Magnetic field ● Magnetic force ● Induction ● Motors ● Generators ● EMF (electromotive force), potential difference, & voltage ● Lenz's law and Faraday's law of emf ● Transformers ● AC & DC ● Root mean square (rms) ● Electromagnetic flux ● Energy conservation	● Identify two kinds of magnetic poles and describe the interaction of like and unlike poles. ● Describe the connection between electric and magnetic effects and the relation of particle charge. ● Describe the acquisition of net charge in terms of the gain or loss of electrons by induction, and how this can be caused by magnetism or how moving charge causes magnetism. ● Explain and demonstrate how these concepts can be used to both make a motor or generate electricity. ● Compare and contrast AC and DC electric current. ● Explain and calculate AC current and rms values. ● Describe the connection of electromagnetic	NGSS Standards: ● 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-PS3-2. Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects). ● 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. ● HS-PS3-5. Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction. ● 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. [Assessment Boundary: Assessment is limited to designing and conducting investigations with provided materials and tools. ● PS3.A: Definitions of Energy - Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. (HSPS3-1),(HS-PS3-2)

		theory to conservation of energy.	- At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy . (HSPS3-2)(HS-PS3-3) - These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space. (HS-PS3-2) ● PS3.B: Conservation of Energy and Energy Transfer - Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. (HS-PS3-1) - Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PS3-1),(HS-PS3-4) - Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior. (HS-PS3-1) - The availability of energy limits what can occur in any system. (HS-PS3-1) Uncontrolled systems always evolve toward more stable states—that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down). (HS-PS3-4)

			● PS3.A: Definitions of Energy - "Electrical energy" may mean energy stored in a battery or energy transmitted by electric currents. ● PS3.C: Relationship Between Energy and Forces - When two objects interacting through a field change relative position, the energy stored in the field is changed. (HS-PS3-5)
Enduring Understandings: ● Energy can be transferred only in specific quantities, and mass and energy are equivalent. ● That elements will absorb or radiate specific wave frequencies, or quantities of light. ● That light sometimes behaves as a wave and sometimes as a particle but not both at the same time. ● There is uncertainty about the location and momentum of particles. ● There are 4 fundamental forces. Essential Questions: ● How is light both a wave and a particle?	● Quantum ● Spectra ● Wavelength ● Frequency ● Photon ● Duality ● Uncertainty ● Emission and absorption ● Photoelectric effect ● Atomic models ● Fusion ● Fission ● $E = mc^2$	● Describe atomic energy level transitions due to the absorption and emission of photons. ● Calculate the wavelength and energy of a photon emitted or absorbed in an atomic transition. ● Describe the current atomic and particle model of matter. ● Explain the uncertainty principle as it relates to particles. ● Describe the photoelectric effect and how it is used in society. ● Explain the duality of light.	● NGSS Standards: ● HS-PS1-1. Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms. ● HS-PS1-3. Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles. Examples of particles could include ions, atoms, molecules, and networked materials (such as graphite). ● HS-PS1-5. Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs. ● HS-PS1-8. Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay. ● 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. ● PS1.A: Structure and Properties of Matter - Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. (HS-PS1-1)

● How is quantization apply to matter and Energy? ● How can we identify composition of distant or small objects with light? ● How does uncertainty relate to matter?			- The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states. (HS-PS1-1),(HS-PS1-2) - The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. (HS-PS1-3),(secondary to HS-PS2-6) - A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart. (HS-PS1-4) ● PS1.C: Nuclear Processes - Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy. The total number of neutrons plus protons does not change in any nuclear process. (HSPS1-8) ● PS3.A: Definitions of Energy - Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. (HSPS3-1),(HS-PS3-2) - At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy . (HSPS3-2)(HS-PS3-3) - These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases the relative position energy can be thought of as stored in

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Materials and Resources:
"Holt Physics"   2012 edition
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