

Phoenixville Area School District Understanding by Design (UbD) Science Template

Grade Level &/or HS Subject: Physics

Unit Name: Light and Optics

Plain English Summary: This unit is about light, the nature of light and how it interacts with matter. The focus will be on how we use our understanding of light to improve society or our understanding of nature. This includes things like how lenses work to improve vision, how non-magnetic imaging technology works, how digital information is transmitted, how we measure temperature (IR) and how we can determine properties of the universe like the Big Bang theory or how fast a rainstorm is approaching by using the Doppler Effect. Literature reviews will play a major role in developing an understanding of how light affects society.

Stage 1 Desired Results		
Overarching NGSS & PA 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-PS4-2 Evaluate questions about the advantages of using a digital transmission	Transfer	
	<i>Students will be able to independently use their learning to...</i> Ask questions and define problems Develop and use models Plan and carry out experiments Analyze and interpret data using computational thinking Obtain, evaluate, and communicate information (supported by evidence) Construct explanations and design solutions (Choose the appropriate content-specific transfer goals)	
	Meaning-Making	
	<i>Students will understand that...</i> Mathematical representations can support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media. There are advantages to using a digital transmission and storage of information. There is evidence to support electromagnetic radiation being described either by a wave model or a particle model, and that for some situations one model is more useful than the other Different frequencies of electromagnetic radiation have different effects when absorbed by various matter. Some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.	ESSENTIAL QUESTIONS <i>Students will keep considering...</i> How do we decide what to believe about a scientific claim? How are waves used to transfer energy and information? What is light? How can one explain the varied effects that involve light? What other

<p>and storage of information.</p> <p>HS-PS4-3</p> <p>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</p>	<p>The Big Bang theory is based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe.</p>	<p>forms of electromagnetic radiation are there?</p> <p>How are instruments that transmit and detect waves used to expand human senses?</p>
<p><i>Knowledge and Skills Acquisition</i></p>		
<p>HS-PS4-4</p> <p>Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have</p>	<p>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.</p> <p>Information can be digitized (e.g., a picture stored as the values of an array of pixels); in this form, it can be stored reliably in computer memory and sent over long distances as a series of wave pulses.</p> <p>Modern civilization depends on major technological systems</p> <p>Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks.</p> <p>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.</p> <p>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.</p> <p>Models (e.g., physical, mathematical, and computer models) can be used to simulate systems and interactions — including energy, matter and information flows — within and between systems at different scales.</p> <p>A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment. The science community validates each theory before it is accepted. If new evidence is</p>	<p><i>Students will be skilled at...</i></p> <p>Design, evaluate, and/or refine a solution to a complex real-world problem based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.</p> <p>Use mathematical representations of phenomena to describe explanations.</p> <p>Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.</p> <p>Evaluate the validity and reliability of multiple claims that appear in scientific and technical texts or media</p>

<p>when absorbed by matter.</p> <p>HS-PS4-5</p> <p>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.</p> <p>HS-ESS1-2</p> <p>Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe.</p>	<p>discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence.</p> <p>When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). Shorter wavelength electromagnetic radiation (ultraviolet, X-rays, gamma rays) can ionize atoms and cause damage to living cells.</p> <p>Solar cells are human-made devices that likewise capture the sun's energy and produce electrical energy</p> <p>Photoelectric materials emit electrons when they absorb light of a high-enough frequency.</p> <p>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.</p> <p>The Big Bang theory is supported by observations of distant galaxies receding from our own, of the measured composition of stars and nonstellar gases, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe.</p> <p>Atoms of each element emit and absorb characteristic frequencies of light. These characteristics allow identification of the presence of an element, even in microscopic quantities.</p> <p>The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth.</p>	<p>reports, verifying the data when possible.</p> <p>Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments.</p> <p>Evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set or the suitability of a design.</p> <p>Communicate technical information or ideas (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).</p>
<p>KEY VOCABULARY</p> <p>Electromagnetic Radiation</p> <p>EM Wave</p> <p>Types of Light (Visible, UV, IR, Microwave, etc)</p> <p>Amplitude</p> <p>Frequency</p> <p>Period</p> <p>Electrons</p> <p>Photoelectric</p>		

<p>Which branch(es) of science apply:</p> <p>PS ESS</p>	<p>Heat</p> <p>Photons</p> <p>Wavelength</p> <p>Big Bang</p> <p>Emission Spectra</p> <p>Absorption Spectra</p> <p>Reflection</p> <p>Refraction</p> <p>Doppler Effect</p>	
Stage 2 – Evidence		
Evaluative Criteria	Assessment Evidence	
<p>Good process skills (rubric);</p> <p>Device meets requirements;</p> <p>Device</p>	<p>PERFORMANCE TASK(S):</p> <p>Renewable Energy Designer</p> <p>Goal: Design a solar cell or wind turbine setup to lift a mass, move a vehicle, or accomplish some other tasks that is measurable in terms of energy output. Optimize the results (maximize efficiency).</p> <p>Role: An engineer</p> <p>Audience: A company related to your product that you are trying to convince to buy/invest in it</p> <p>Situation: Students will work in groups. They are trying to design the most efficient device. Materials will also cost money, so there will be a trade-off between efficiency, maximum power/energy, and cost that the students will need to balance.</p> <p>Product: They will need to present their device and try to convince the buyers (other students) that they have optimized their device. This will involve explaining how their device works and how it balances all the requirements.</p> <p>Standards: See Left Column</p>	<p>Differentiation Considerations:</p> <p>Students have the choice in the powering method as well as the task. They can present in a variety of ways. The task can also vary in terms of difficulty.</p>

<p>Accuracy of answers and explanations; lab/inquiry process skills</p>	<p>OTHER EVIDENCE:</p> <ul style="list-style-type: none"> • HW – these will consist of a range of questioning goals, from basic things like vocab understanding to conceptual understanding to application • Lab – a refraction lab • Literature Reviews <ul style="list-style-type: none"> ○ Effects of radiation on matter, including on humans ○ Big Bang Explanation -- provide a short explanation involving visuals (could be written or recorded) using one piece of evidence (light spectra, motion of galaxies, etc.) to support Big Bang in terms that middle school students could understand • Quizzes – MC or FR where work is required; similar to HW, could be fact recall, conceptual understanding or application being assessed. • Test – 1 for the unit, will contain a mix of recall and application focused on the understandings and knowledge from Stage 1 <p>(What evidence will be collected to determine whether Stage 1 goals were achieved?)</p>	<p>Differentiation Considerations:</p> <ul style="list-style-type: none"> • Notes allowed on some assessments • Partial credit + test corrections • Difficulty of literature • Specific topics researched
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