EAST PENN SCHOOL DISTRICT

**Physics 2**
July 14, 2025

# Physics 2 Unit 1 - Waves and Sound

## STAGE 1 | DESIRED RESULTS

### Standards

3.2.9-12.T Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.

3.2.9-12.V 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.

### Transfer

*Students will be able to independently use their learning to...*

- ☐ Waves transfer energy without transferring matter.
- ☐ Vibrations and oscillations produce waves.
- ☐ Waves can interfere with each other.
- ☐ Resonance produces large energy waves.
- ☐ Longitudinal waves in the audible frequency range are known as sound waves.

### Meaning

UNDERSTANDINGS

*Students will understand that...*

- ☐ Energy can be transferred by waves without the transfer of mass.
- ☐ Vibrations cause sound.
- ☐ Only certain wave frequencies are heard by people.
- ☐ Under certain conditions, waves can transfer a large amount of energy.

ESSENTIAL QUESTIONS

*Students will keep considering...*

- ☐ How can periodic motion cause waves?
- ☐ How do waves transfer energy from one place to another?
- ☐ How do waves interact with the surroundings and other waves?
- ☐ How can we interpret periodic motion as sound?

### Acquisition(need to align with above and standards)

*Students will know...*

**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

*Students will be skilled at...*

- ☐ *Develop and use models to compare how particles in transverse and longitudinal waves move relative to wave direction.*
- ☐ *Analyze and interpret data from oscillating systems or wave simulations to measure and describe amplitude, wavelength (λ), and frequency (f). Explain how changes in these properties affect the energy and behavior of the wave.*

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| | 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.)<br><br>**PS4.B: Electromagnetic Radiation**<br>☐ 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.<br><br>Other knowledge:<br>☐ *Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models.*<br>☐ *Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.*<br>☐ *Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.*<br><br>Key vocabulary: 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 | ☐ *Use mathematical and computational thinking to solve problems using the wave equation ($v = f\lambda$).*<br>☐ *Construct explanations and cite examples of the transportation of energy in waveform and describe that wave energy can be converted to other forms of energy.*<br>☐ *Construct explanations to 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.*<br>☐ *Develop and use models to 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).*<br>☐ *Construct an explanation to describe the motion of the wave and of the wave medium for transverse and longitudinal waves.*<br>☐ *Through modeling, sketch and describe:*<br>  ☐ *how wave fronts reflect off of plane barriers.*<br>  ☐ *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.*<br>  ☐ *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.*<br>  ☐ *how wave fronts are diffracted when traveling through small apertures, and explain how diffraction varies with wavelength.* |

# Physics 2 Unit 2 - Light Waves

## STAGE 1 | DESIRED RESULTS

### Standards

3.2.9-12.T. Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.

3.2.9-12.V. 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.

3.2.9-12.X. 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.

### Transfer

*Students will be able to independently use their learning to...*

- ☐ Light can behave as a wave.
- ☐ Electromagnetic waves include light and a spectrum of related waves.
- ☐ Waves transfer energy without transferring matter, which is determined by frequency.
- ☐ Waves can interfere with each other.
- ☐ Light with a different wavelength/frequency is a different color of light, white light is made up of many wavelengths/frequencies which sum to make white.
- ☐ Light can be manipulated with reflection, refraction, and diffraction.

### Meaning

UNDERSTANDINGS

*Students will understand that...*

- ☐ Energy can be transferred by waves without the transfer of mass.
- ☐ Specific wave frequencies are seen as a specific color by people.
- ☐ Electromagnetic waves are all similar, the energy (frequency) they carry determines how they can be used.
- ☐ Optical instruments such as lenses and mirrors are used to better view and understand nature.

ESSENTIAL QUESTIONS

*Students will keep considering...*

- ☐ 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 (ie microwaves vs x-rays)?
- ☐ How do optical devices manipulate light?

### Acquisition(need to align with above and standards)

*Students will know...*

**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

*Students will be skilled at...*

- ☐ *Develop and use models to compare and contrast light waves to water and sound waves.*
- ☐ *Construct an explanation for the electromagnetic spectrum and the difference between the primary colors of light and pigments with color addition/subtraction.*
- ☐ *Construct an explanation to explain how electromagnetic waves relate to polarizers*
- ☐ *Construct explanations and computational models to describe the motion of*

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| | 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.)<br><br>**PS4.B: Electromagnetic Radiation**<br>☐ 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.<br><br>**PS4.C: Information Technologies and Instrumentation**<br>☐ 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. | *electromagnetic waves and of the effect of a medium.*<br>☐ *Use data collection tools (simulations or sensors) to Identify and describe electromagnetic wave characteristics including energy, amplitude, wavelength (λ), and frequency (f).*<br>☐ *Use models to illustrate the transportation of energy in waveform and describe how wave energy can be converted to other forms of energy.*<br>☐ *Use mathematical and computational thinking to solve problems using the wave equation (c = fλ).*<br>☐ *Use mathematical and computational thinking to solve problems involving the curved mirror/thin lens equation.*<br>☐ *Develop and use models to 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).*<br>☐ *Construct an explanation to describe the motion of the wave and of the wave medium for transverse and longitudinal waves.*<br>☐ *Through modeling, sketch and describe:*<br>☐ *how wave fronts reflect off of plane barriers.*<br>☐ *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.*<br>☐ *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.*<br>☐ *how wave fronts are diffracted when traveling through small apertures, and explain how diffraction varies with wavelength.* |

# Physics 2 Unit 3 - Introduction to Electricity and Circuits

## STAGE 1 | DESIRED RESULTS

### Standards

3.2.9-12.L Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.

3.2.9-12.M 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.

### Transfer

*Students will be able to independently use their learning to...*

- ☐ Electric charges can either attract or repel.
- ☐ Flow of charge is known as electric current.
- ☐ Current can transfer energy in a circuit.
- ☐ Ohm's law is the relationship of current, voltage, and resistance in a circuit.
- ☐ Resistors in series increase the overall resistance of the circuit.
- ☐ Resistors in parallel decrease the overall resistance of the circuit.

### Meaning

UNDERSTANDINGS

*Students will understand that...*

- ☐ Unlike charges attract and like charges repel causing electric forces 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

*Students will keep considering...*

- ☐ 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?

### Acquisition(need to align with above and standards)

*Students will know...*

**PS2.B: Types of Interactions**

- ☐ Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields.

**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.
- ☐ Energy cannot be created or destroyed, but it can be

*Students will be skilled at...*

- ☐ Develop and use a model to explain why an electrically charged object can attract an electrically neutral object.
- ☐ Analyze and interpret resistance and current data to differentiate between conducting and insulating materials in terms of the ease that electrons flow in them.
- ☐ Use mathematical representations and graphical analysis to identify and apply the proportional relationships involved in Coulomb's law of electric force

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| | transported from one place to another and transferred between systems.<br>☐ 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.<br>☐ The availability of energy limits what can occur in any system.<br>☐ 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).<br><br>**PS3.C: Relationship Between Energy and Forces**<br>☐ When two objects interacting through a field change relative position, the energy stored in the field is changed.<br><br>*Other knowledge:*<br>☐ Concepts in an electrical circuit including electric potential energy, electric potential, voltage, current, and resistance.<br>☐ 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.<br>☐ Power is the amount of energy transferred (work) divided by the elapsed time.<br>☐ Electrical power is the product of voltage and current and apply this to simple circuits.<br><br>**Key Vocabulary:** Coulomb's Law, Electric force, Attraction, Repulsion, Potential, Difference, Voltage, Current, Resistance, Ammeter, Voltmeter, Multimeter, Circuit, Ohm's Law, Series, Parallel | ☐ Develop and use a model to explain the flow of charge through a simple circuit and to illustrate the electric circuit/water analogy.<br>☐ Use mathematical and computational thinking and Ohm's law (V = IR) to calculate circuit variables.<br>☐ Construct an explanation for why houses are wired in parallel and describe short circuits and the function of circuit breakers.<br><br>Other skills:<br>☐ 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.<br>☐ Identify two kinds of electric charges and describe the interaction of like and unlike charges.<br>☐ Describe the acquisition of net charge in terms of the gain or loss of electrons by friction, conduction, and induction, and explain that connecting objects to the ground discharges them. |

# Physics 2 Unit 4 - Magnetism & Induction

## STAGE 1 | DESIRED RESULTS

### Standards

3.2.9-12.O 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.

3.2.9-12.P 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 positions of particles (objects).

3.2.9-12.Q Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

3.2.9-12.S 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.

3.2.9-12.M Plan and conduct an investigation to provide evidence that an electric current can

### Transfer

*Students will be able to independently use their learning to...*

- ☐ Magnetism is a result of alignment of atoms in a material, which always have two poles.
- ☐ Electromagnetism means magnetism and electricity are part of the same larger idea.
- ☐ Electric current in a conductor makes a magnetic field and causes a force.
- ☐ Placing a conductor in a changing magnetic field causes an electric current.
- ☐ Motors and Generators use the same theory but swap the input and output.
- ☐ Transformers are used to change the magnitude and/or the direction of voltage and current

### Meaning

UNDERSTANDINGS

*Students will understand that...*

- ☐ Energy can be transferred by current.
- ☐ Opposite poles of magnets attract, like repel.
- ☐ Current makes a magnetic field.
- ☐ A changing magnetic field makes current.
- ☐ Transformers are used to change voltage and current, and their direction.

ESSENTIAL QUESTIONS

*Students will keep considering...*

- ☐ 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?

### Acquisition(need to align with above and standards)

*Students will know...*

**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.
- ☐ At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy .
- ☐ These relationships are better understood at the microscopic scale, at which all of the different

*Students will be skilled at...*

- ☐ Develop and use models to describe the connection between electric and magnetic effects and the relation of particle charge and Identify two kinds of magnetic poles and describe the interaction of like and unlike poles.
- ☐ Design and conduct an investigation to collect data to show 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.
- ☐ Apply engineering practices to design, build, and make a motor or generate electricity.

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| produce a magnetic field and that a changing magnetic field can produce an electric current. | 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.<br><br>**PS3.B: Conservation of Energy and Energy Transfer**<br>☐ 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.<br>☐ Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems.<br>☐ Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions<br>☐ 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.<br>☐ The availability of energy limits what can occur in any system.<br>☐ 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).<br><br>**PS3.A: Definitions of Energy**<br>☐ "Electrical energy" may mean energy stored in a battery or energy transmitted by electric currents.<br><br>**PS3.C: Relationship Between Energy and Forces**<br>☐ When two objects interacting through a field change relative position, the energy stored in the field is changed. | ☐ Use graphical and computational tools to compare, contrast, and analyze current flow over time for AC and DC sources<br>☐ Develop and use models to connect electromagnetic theory to conservation of energy. |

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| | **Key Vocabulary:**<br>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 | |