Waves

Missouri Grade-Level Expectations (or other standards)

NGSS-HS-PS:
4-1:Use mathematical representations to support a claim regarding relationships among the frequency, wavelength,and speed of waves traveling in various media.
4-2: Evaluate questions about the advantages of using a digital transmission and storage of information.
4-3: 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.
4-4:Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.
4-5: 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.*

Learning Goal	**Proficiency Scales**
Students will be able to deduce the function and purpose of a wave based on its physical characteristics and behavior.	4: Student demonstrates an in-depth inference or advanced application or innovates with the learning goal. 3: Student demonstrates mastery with the learning goal as evidenced by: ● Representing waves mathematically ($v=f\lambda$) and explaining the relationship of the variables. ● Relating the frequency to the wavelength on the electromagnetic spectrum. ● Describing the process by which energy (digital information) is

	transferred from source to receiver. 2: Student demonstrates he/she is nearing proficiency by: ● Recognizing and recalling specific vocabulary, such as: *reflection, refraction, diffraction, interference, crest, trough, medium, frequency, period, velocity, hertz, Doppler shift, electromagnetic, spectrum, wavelength, wave speed, longitudinal, tranverse, stationary, and amplitude.* ● Performing processes such as: ○ Labeling and defining all parts of a wave. ○ Describing the order of EM spectrum. 1: Student demonstrates a limited understanding or skill with the learning goal.

Learning Targets

- Describe the characteristics and properties of waves
- Describe how to calculate the speed of a wave
- Distinguish between the two types of waves
- Discriminate between sound waves and electromagnetic waves
- Explain the Doppler Effect
- Manipulate the electromagnetic spectrum based on frequency and wavelength
- Investigate waves as a means of digital storage and transmission and contrast with other means
- Summarize various types of interference

Learning Design

Forces and Interaction

Missouri Grade-Level Expectations (or other standards)
NGSS-HS-PS: 2-1. 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. 2-2. 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. 2-3. Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.* 2-4 Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.

Learning Goal	Proficiency Scales
Students will be able to model the motion of an object.	4: Student demonstrates an in-depth inference or advanced application or innovates with the learning goal. 3: Student demonstrates mastery with the learning goal as evidenced by:

	● Describing and manipulating mathematically the relationships among acceleration, mass, velocity, and force using ○ $v=d/t$ ○ $d=1/2at^2$ ○ $a= v_i-v_f/t$ ○ $F=ma$ ○ $p=mv$ ○ Conservation of momentum, and ○ Law of Gravitation. ● Designing, evaluating, and refining a model that minimizes the force of a collision between objects. 2: Student demonstrates he/she is nearing proficiency by: ● Recognizing or recalling specific vocabulary, such as: *velocity*, *inertia, mass, newton, weight, force, acceleration, origin, equilibrium, conservation, momentum, impulse, change in momentum.* ● Performing processes such as: ● Exhibiting an understanding of Newton's 3 laws of motion. ● Constructing free-body diagrams. ● Conceptualizing and categorizing collisions including conservation of momentum but are unsuccessful at analyzing the success or failure of the model. 1: Student demonstrates a limited understanding or skill with the learning goal.

Learning Targets

- Describe the relationship between mass and inertia
- Explain how the law of inertia applies to objects in motion
- State the relationship between acceleration and net force and mass in terms of Newton's 2nd law
- List the factors that affect the movement of an object, such as friction and air resistance
- Analyze the role of mass and force along with velocity in momentum through collisions
- Explain why an impulse is greater when an object bounces than when the same object comes to a sudden stop
- Describe and calculate how the conservation of momentum applies to collisions

Learning Design

WGSD Curriculum -- Physics-Conceptual

Energy

Missouri Grade-Level Expectations (or other standards)

NGSS-HS-PS:

3-1: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.

3-2: 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).

3-3:Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.*

Learning Goal	Proficiency Scales
Students will be able to categorize energy sources and demonstrate an understanding of the Law of Conservation of Energy	4: Student demonstrates an in-depth inference or advanced application or innovates with the learning goal. 3: Student demonstrates mastery with the learning goal as evidenced by: ● Modeling multiple sources of energy. ● Modeling the Law of Conservation of Energy. ● Calculating the conservation of potential and kinetic energy in a given system. ● Demonstrating energy transfer. 2: Student demonstrates he/she is nearing proficiency by: ● Recognizing or recalling specific vocabulary, such as: *conservation, potential, kinetic, height, mechanical, nonmechanical, gravitational, efficiency, work, heat, sound, friction, static, and power.* ● Performing processes such as:

	○ Listing and describing sources and transfers of energy. ○ Describing Law of Conservation of Energy with teacher supplying terms. ○ Planning and building a device that demonstrates some energy transfer with some success. 1. Student demonstrates a limited understanding or skill with the learning goal.

Learning Targets

- Define and describe work
- Define and describe power
- State the two forms of mechanical energy and explain how energy is changed in a closed system
- State three forms of potential energy
- Describe how work and potential and kinetic energy are related verbally and mathematically
- State the law of conservation of energy and describe the transfer of energy in a system
- Build a model that demonstrates energy transfer

Learning Design

Electricity and Magnetism

Missouri Grade-Level Expectations (or other standards)

NGSS-HS-PS:
2-4:Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.
2-5: 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.
3-5: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.

Learning Goal	Proficiency Scales
Students will be able to analyze the interaction of electrical and magnetic forces.	4: Student demonstrates an in-depth inference or advanced application or innovates with the learning goal. 3: Student demonstrates mastery with the learning goal as evidenced by: ● Using Coulomb's law to mathematically demonstrate electrostatic forces between particles. ● Using Ohm's law to explain the relationship between voltage, resistance, and current. ● Discriminating among the types of charges, ways to charge materials, and factors that affect charges, such as resistance etc. ● Demonstrating the essential relationship between electric current and magnetic fields ● Demonstrating that an electric current can produce an electric field and a changing magnetic field can produce an electric current. 2: Student demonstrates he/she is nearing proficiency by: ● Recognizing or recalling specific vocabulary, such as *domains,*

	poles, charge, conservation, excess, field, Coulomb's Law, inverse square, attraction, repulsion, electrons, protons, neutrons, nucleus, Ohm's Law, resistance, current, voltage, electric potential energy, power, circuit, conductor, insulator, generator, compass, induction, and mass.
	
	● Performing processes such as:
	  ● Explaining the essentials of the effects of the inverse square law on two charged particles.
	  ● Representing electric and magnetic fields using field lines.
	  ● Explaining how electrons flow through a circuit and how series and parallel circuit differ.
	  ● Describing magnetic and electric fields.
	
	1: Student demonstrates a limited understanding or skill with the learning goal.

Learning Targets

- Describe the fundamental rule at the base of all electrical phenomena
- Explain how an object becomes electrically charged
- Use Coulomb's law to understand the relationship among force, charge and distance
- Describe two ways electric charges can be transferred
- Describe what happens when a charged object is placed near a conducting surface
- Describe how to measure the strength of an electric field at different points
- Illustrate electric fields with vectors and by electric field lines
- Describe the flow of electric charge, magnetic field, and a current-carrying wire
- Give examples of voltage sources

- Analyze the relationship among the factors that affect the resistance of a wire
- Describe Ohm's law
- Distinguish between DC and AC and how AC is converted to DC
- Explain how current can be turned on or off in a circuit, and how electrical devices can be connected in a circuit
- Describe the characteristics of a series and parallel circuit
- Explain how magnetic poles affect each other
- Describe the magnetic field in the space around a magnet
- Describe how a magnetic field exerts a force on a charged particle in the field
- Describe how current is affected by a magnetic field
- Create a motor

Learning Design