Grade 8 Science - Unit 4 - Invisible Energy: From Vibrations to Voltage

Unit Focus

Students will explore how energy and information move through waves and fields. They model wave behavior and learn how wave amplitude relates to energy. Students will investigate how waves reflect, absorb, or transmit through materials and compare analog and digital signals to see why digital is more reliable for communication.

The unit also connects to life science as students learn how sensory receptors detect stimuli and send messages to the brain. Finally, students explore electric and magnetic forces, conducting investigations to see how these invisible fields work and how their strength can be changed.

By the end of the unit, students will understand how waves and forces shape both natural phenomena and human-made technologies.

Stage 1: Desired Results - Key Understandings

Standard(s)

Next Generation Science Standards
Performance Expectations: Middle School Life Sciences

- Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories. (MS-LS1-8)

Performance Expectations: Middle School Physical Sciences

- Ask questions about data to determine the factors that affect the strength of electric and magnetic forces. (MS-PS2-3)
- Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact. (MS-PS2-5)
- Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave. (MS-PS4-1)

Transfer

Students will be able to independently use their learning to...
T1 Analyze qualitative and quantitative data to interpret patterns, draw conclusions, and/or make predictions.
T2 Create models to explore complex systems, show mastery of key science concepts, and/or develop solutions through creation of a product open to testing and redesign.

Meaning

Understanding(s)

Students will understand that...
U1 Pushes and pulls have different strengths and directions.
U2 Electric and magnetic fields* act as forces on objects, even when not in contact directly.
U3 Energy can be transferred from place to place by sound waves, light waves, heat, and electric current or from object to object through collision.
U4 The faster a given object is moving, the more energy it possesses.
U5 Energy, in everyday life, typically refers to the conversion of stored energy into a desired form for practical use.
U6 Sound can make matter vibrate, and vibrating matter can make sound.
U7 People use light and sound to communicate.
U8 Waves can be observed as patterns of motion and measured (frequency, amplitude, and wavelength) from which predictions can be made.
U9 Digitized information (data) can be transmitted over long distances.
U10 Electric and magnetic forces can be attractive or repulsive and are dependent on the strength of the charge or magnetic strengths and the distance between them.
U11 Some waves (sound) require a medium to travel through. Other waves (light or electromagnetic) do not require a medium.

Essential Question(s)

Students will keep considering...
Q1 How can we use models understand how waves carry energy and what occurs when waves encounter different materials?
Q2 How does the brain receive and respond to sensory stimuli from the world around us?
Q3 Why are digital signals often more reliable than analog signals for communication?
Q4 How can invisible forces like magnetism and electricity affect objects without touching them?
Q5 What factors can change the strength of an electric or magnetic force?

Stage 1: Desired Results - Key Understandings

- Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials. (MS-PS4-2)
- Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals. (MS-PS4-3)

Madison Public Schools Profile of a Graduate
Product Creation: Effectively use a medium to communicate important information. (POG.3.2)

U12 Wavelength, frequency, and amplitude are properties of a wave that determine its characteristics such as pitch, color, sound and energy.
U13 When light shines on an object, it is reflected, absorbed, or transmitted (refracted) through the object, depending on the object's material and the frequency (color) of the light.
U14 Light travels in straight lines unless it travels through different mediums.
U15 a wave model of light is useful for explaining brightness, color and refraction.
U16 Information can be converted into a digital form so that it can be stored or transmitted through waves.
U17 Electric and magnetic forces can be attractive or repulsive and are dependent on the strength of the charge or magnetic strengths and the distance between them.
U18 Wavelength, frequency, and amplitude are properties of a wave that determine its characteristics such as pitch, color, sound and energy.
U19 Information can be converted into a digital form so that it can be stored or transmitted through waves.
U20 Waves are used in scientific applications and everyday purposes.
U21 Each sense receptor responds to different inputs, transmitting them as signals that travel along nerve cells to the brain; The signals are then processed in the brain, resulting in immediate behavior or memories.
U22 Scientists examine evidence to formulate interesting questions and solve problems.

Acquisition of Knowledge and Skill

Knowledge	Skill(s)
Students will know... **K1** Electric Forces experience Like charges repel; opposite charges attract. **K2** Magnetic poles behave similarly: like poles repel, opposite poles attract. **K3** The strength of electric and magnetic forces depends on: Distance between objects and the strength of the charge or magnet **K4** Electromagnetic forces can act at a distance. **K5** A field (electric or magnetic) exists around an object and can exert a force on another object without direct contact. **K6** Evidence of a field includes movement of objects when they are near (but not touching) a charged or magnetized object. **K7** Field strength decreases with distance. **K8** Waves have properties including wavelength, frequency, amplitude, and speed.	*Students will be skilled at...* **S1** Asking scientific questions based on patterns in data. **S2** Analyzing data to determine how distance, strength, and polarity affect electric and magnetic forces. **S3** Identifying variables that influence force strength in electric and magnetic systems. **S4** Design and conducting investigations to test the existence and effects of fields (electric or magnetic). **S5** Collecting and interpreting evidence that supports the presence of non-contact forces. **S6** Evaluating experimental design for accuracy and reliability in measuring field effects.

Stage 1: Desired Results - Key Understandings		
	K9 Amplitude is the height of a wave and is related to the wave's energy. **K10** Larger amplitude = more energy; smaller amplitude = less energy. **K11** Waves can be: Reflected (bounce back from a surface) **K12** Waves can be: Absorbed (energy taken in by the material). **K13** Waves can be transmitted through a material. **K14** Refraction occurs at a boundary between two different mediums bending a wave as a result. **K15** Different materials interact with waves in different ways (e.g., glass transmits light; metal reflects it). **K16** Analog signals vary continuously (like a wave). **K17** Digital signals are in binary (on/off), making them more resistant to interference. **K18** Digital signals are more reliable for encoding and transmitting information (e.g., phones, fiber optics). **K19** Sensory receptors (e.g., in eyes, ears, skin) detect stimuli such as light, sound, and touch. **K20** These receptors send signals to the brain via the nervous system. **K21** The brain processes these signals: Some lead to immediate responses and others are stored as memories for future use. **K22** Vocabulary : Attraction, conductor, electric current, electric field, electromagnetic field, electromagnet, frequency, induction, insulator, permanent magnet, polarity, repulsion, resistance, voltage, Conductor, electric charge, electric current, electric force, electromagnetic field, electromagnet, frequency, induction, insulator, magnetic field lines, magnetic force, permanent magnet, polarity, repulsion, resistance, voltage, direction, magnitude, ampere, charged particle, volts, gravity, Speed, force, kinetic energy, proportional, sound wave, wavelength, frequency, resting position, medium, crest, trough, Refracted, medium, transparent, frequency, brightness, color, bending, amplitude, sound wave, light wave, path, propagation, filter, barrier, lens, mirror, mechanical waves, electromagnetic, visible light, ray, prism, wavelength, Computer, machine, communicate, electricity, device, coded, decode, conversion/convert, digitize, encode, radio wave, Memory, perception, transmit, accuracy, immediate, nerve, receptor, sense receptor, sensory, behavioral response to stimuli, electromagnetic, stimulus, short-term memory, long-term memory, salt, sour, sweet, bitter, brain, nervous system, taste, smell, touch, hear, sight (K22)	**S7** Using models to describe wave properties (amplitude, frequency, wavelength). **S8** Quantifying relationships between amplitude and energy in wave systems. **S9** Graphing and interpreting data related to wave characteristics. **S10** Creating and using models (diagrams, simulations, physical models) to explain how waves interact with different materials. **S11** Differentiating between reflection, absorption, and transmission of waves. **S12** Predicting wave behavior based on material properties. **S13** Comparing and contrasting analog and digital signals using qualitative and technical sources. **S14** Citing evidence from text and diagrams to argue why digital signals are more reliable. **S15** Integrating information from multiple sources to support scientific claims about communication technologies. **S16** Gathering information from multiple sources (e.g., diagrams, articles, simulations) about sensory receptors. **S17** Synthesizing evidence to explain how sensory input leads to responses or memory formation. **S18** Explaining the role of the nervous system in processing stimuli and coordinating behavior.