8th Grade Science

UNIT 1 ENERGY CONSERVATION AND TRANSFER:

From the Sun Through Us All

ESSENTIAL QUESTION	BIG IDEAS
Where does energy come from? **How can energy be transferred from one object or system to another?**	• Students can define energy and trace its path through various systems. • Students understand the law of conservation of energy. • Students can distinguish between energy, temperature, and heat. • Students begin to understand the nature of all energy as a mixture of only three forms: kinetic, potential, and radiation. • Students understand how energy manifests itself in multiple phenomena, like motion, light, sound, electrical and magnetic fields, and thermal energy. • Students can design and build a solution to solve a problem that requires either minimizing or maximizing thermal energy transfer. • Students begin to construct and interpret graphical displays of data to identify linear and nonlinear relationships. • Students begin to understand that time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small to easily observe.

GUIDING QUESTIONS

- Content:
  - What is energy?
  - How is energy transferred from one object/system to another, especially from the sun through various earth systems?
  - How is energy conserved within a(n) object/system?
  - How can kinetic energy be distinguished from the various forms of potential energy?
  - How can energy changes to and from each type (kinetic, potential, and radiation – especially infrared) be tracked?
  - What is the difference between energy, temperature, and heat?
  - How can properties of matter (e.g., thickness, heat conductivity, reflectivity) minimize or maximize thermal energy transfer?

- Process
  - How can we design and build a solution to a problem requiring minimizing or maximizing thermal energy transfer?
  - Can you describe the given criteria and constraints that will be taken into account in thermal energy design solution?
  - How can we test the designs to determine its ability to maximize or minimize the flow of thermal energy, using the rate of temperature change as a measure of success?
  - How can energy be modeled and tracked with graphs, diagrams, and mathematical equations?
  - How can results of the design testing be used to evaluate the design systematically against the

criteria and constraints?

- Reflective
  - If the sun's heat is constantly hitting the earth, why aren't we constantly getting warmer?
  - How can wave energy be harvested and stored to provide power for communities?
  - How does fusion produce such life-giving and life-taking energy?
  - How can the sun and other stars' energy move such vast distances to the earth and beyond?
  - Why is the core of the earth so hot?
  - Can you trace the energy in a handheld electronic device back to an origin?
  - Why do more thunderstorms and tornadoes form in Florida and here in "Tornado Alley" than most anywhere on earth?
  - How can structures stay comfortably cool in summer and warm in winter?
  - Why do basements and other underground structures tend to stay at a fairly constant temperature, even in the dead of winter or scorching heat of summer?

FOCUS STANDARDS

Mastered and Assessed in this Unit:

- MS-PS3-3. Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.

  MS-PS3-3 above integrates the following:
  - ETS1.A: Defining and Delimiting an Engineering Problem
  - ETS1.B: Developing Possible Solutions
  - PS3.A: Definitions of Energy
  - PS3.B: Conservation of Energy and Energy Transfer
  - SEP: Constructing Explanations and Designing Solutions
  - CCC: Energy and Matter- The transfer of energy can be tracked as energy flows through a designed or natural system.

Introduced Only (mastered and assessed in Performance Expectations in later units)

  - PS4.B: Electromagnetic Radiation - When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object's material and the frequency (color) of the light.
  - PS3.C: Relationship Between Energy and Forces
  - SEP: Analyzing and Interpreting Data- Construct and interpret graphical displays of data to identify linear and nonlinear relationships, including distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.
  - SEP: Developing and Using Models- Develop, use, and revise models to describe, test, and predict more unobservable mechanism, abstract phenomena, and design systems.
  - CCC: Scale, Proportion, and Quantity- Proportional relationships among different types of quantities provide information about the magnitude of properties and processes. Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.
  - CCC: Systems and System Models- Models can be used to represent systems and their interactions – such as inputs, processes, and outputs – and energy and matter flows within systems.

Energy Connection to 7th Grade

  - LS1.C: Organization for Matter and Energy Flow in Organisms

- PS3.D: Energy in Chemical Processes and Everyday Life

Energy Connections to 6th Grade

- ESS1: Earth's Place in the Universe
- ESS2: Earth's Systems

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UNIT 2 MATTER AND ITS INTERACTIONS:

Structure & Properties of Matter and Chemical Reactions

ESSENTIAL QUESTION	BIG IDEAS
How do matter and energy interact within a system to form the variety of matter we observe?	• Students begin to understand that energy and matter are two sides of the same coin ($E=mc^2$). • Students apply understanding that pure substances have characteristic physical and chemical properties and are made from a single type of atom or molecule. • Students model and explain states and changes between states of matter at the molecular level. • Students model and explain chemical reactions and the regrouping of atoms to form new substances. • Students apply an understanding of the processes of design and design optimization in engineering to chemical reaction systems. • Students develop and use models, analyze and interpret data, design solutions, and obtain, evaluate, and communicate information.

GUIDING QUESTIONS

- Content
    - What is the relationship between matter and energy?
    - How do atomic and molecular interactions explain the properties of matter that we see and feel?
    - How does energy create the structure of an atom (electromagnetic & strong/weak forces) and simple molecules and extended structures (interaction of electrons as electromagnetic forces)?
    - How does energy change matter and its state? (heat transfer and phase changes)
    - How does atomic structure determine the organization of the periodic table?
    - How can we use the periodic table to understand and/or predict properties of pure substances and their interactions?

- Process
    - How can we develop models to describe the atomic composition of simple molecules and extended structures?
    - How can we analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred?
    - How can we gather and make sense of information to describe that synthetic materials come from natural resources and impact society?
    - How can we develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed?

- How can we develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved?
- How can we design, construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes?

- Reflective
  - How does energy from the sun affect various matter here on earth and across the solar system?
  - How does energy burn us in various ways and which is most severe?
  - How does the interaction of energy and matter affect our perception of hot and cold (e.g. feeling cold after getting out of the swimming pool or shower)?
  - Why do snowflakes come in so many shapes and sizes?
  - Which elements are considered “dangerous” and why?
  - If nuclear fusion, like in the sun, is so powerful, why do nuclear power reactors use nuclear fission instead?
  - Are recycling programs (paper, plastic, glass, aluminum, etc.) really worthwhile for long-term sustainability?

FOCUS STANDARDS

- MS-PS1-1. Develop models to describe the atomic composition of simple molecules and extended structures.
- MS-PS1-2. Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.
- MS-PS1-3. Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.
- MS-PS1-4. Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.
- MS-PS1-5. Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.
- MS-PS1-6. Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.

  PS1-1 through PS1-6 above integrate the following:
  - ETS1.B: Developing Possible Solutions (MS-PS1-6)
  - ETS1.C: Optimizing the Design Solution (MS-PS1-6)
  - PS1.A: Structure and Properties of Matter (MS-PS1-1) (MS-PS1-2) (MS-PS1-3) (MS-PS1-4)
  - PS1.B: Chemical Reactions (MS-PS1-2) (MS-PS1-3)(MS-PS1-5) (MS-PS1-6)
  - ƒ(MS-PS1-3)

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UNIT 3 MOTION AND STABILITY:

Forces, Motion, and Types of Interactions

ESSENTIAL QUESTION	BIG IDEAS
Why do things move? **What happens when objects interact?**	• Students can apply Newton's Third Law of Motion to relate forces to explain the motion of objects. • Students can apply ideas about gravitational, electrical, and magnetic forces to explain a variety of phenomena. • Students will develop understanding that gravitational interactions are always attractive but electrical and magnetic forces can both attract and repel. • Students develop ideas that objects can exert forces on each other even though the objects are not in contact, through fields. • Students solve a problem caused when objects collide by applying engineering practices and crosscutting science concepts of cause and effect; system and system models; and stability and change. • Students demonstrate proficiency in asking questions, planning and carrying out investigations, and designing solutions, and engaging in argument.

GUIDING QUESTIONS

- Content
  - How can collisions be predicted and analyzed using Newton's Third Law of Motion?
  - How can the mass of an object and the forces acting upon it determine its motion?
  - What relationships exist between mass and force?
  - What factors affect the strength of electric and magnetic forces?
  - Can you convincingly support the claim that gravitational interactions are attractive and depend on the masses of interacting objects?
  - What attractive/repelling effects do gravitational and electromagnetic forces have on objects?
  - How can force fields explain/predict interactions of objects at a distance?
  - How does movement & the mass of an object predict its stability?
  - How do inputs, outputs, and feedback mechanisms explain/predict the stability of a system?

- Process
  - How can we investigate to provide evidence of the relationship between the change in an object's motion, forces on the object, and the mass of the object?
  - How can we conduct an investigation to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact?
  - How can we construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object?
  - How can we conduct an investigation to provide evidence that fields exist between objects

exerting forces on each other even though the objects are not in contact?

- Reflective
  - Are seat belts really safe? How about air bags? How do Newton's Laws of Motion help us stay safe as we learn to drive a car?
  - Are football and cheerleading safe sports?
  - How do amusement park engineers use motion and stability to make the rides more thrilling?
  - Do all cannons recoil when fired? How are fire hoses like cannons?
  - Why are spacewalk maneuvers so difficult for humans compared to walking and climbing on earth? They should be easier in microgravity, right?
  - How is it possible to lay on a bed of nails unscathed?
  - Can you invent a perpetual motion machine that works?

FOCUS STANDARDS

- MS-PS2-1. Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.
- MS-PS2-2. Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.
- MS-PS2-3. Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.
- MS-PS2-4. Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.
- MS-PS2-5. 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-PS3-1. Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.
- MS-PS3-2. Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.
- MS-PS3-5. Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.

  PEs above integrate the following:
  - PS2.A: Forces and Motion (MS-PS2-1), (MS-PS2-2)
  - PS2.B: Types of Interactions (MS-PS2-3), (MS-PS2-4), (MS-PS2-5)
  - PS3.A: Definitions of Energy (MS-PS3-1), (MS-PS3-2)
  - PS3.B: Conservation of Energy and Energy Transfer (MS-PS3-5)
  - PS3.C: Relationship Between Energy and Forces (MS-PS3-2)
  - SEP: Asking Questions and Defining Problems- Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles. (MS-PS2-3)
  - SEP: Planning and Carrying Out Investigations- Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how

many data are needed to support a claim. (MS-PS2-2) Conduct an investigation and evaluate the experimental design to produce data to serve as the basis for evidence that can meet the goals of the investigation. (MS-PS2-5)

- SEP: Constructing Explanations and Designing Solutions- Apply scientific ideas or principles to design an object, tool, process or system. (MS-PS2-1)
- SEP: Engaging in Argument from Evidence- Construct and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-PS2-4)
- SEP: Developing and Using Models- Develop a model to describe unobservable mechanisms. (MS-PS3-2)
- CCC: Cause and Effect- Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-PS2-3), (MS-PS2-5)
- CCC: Systems and System Models- Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy and matter flows within systems. (MS-PS2-1), (MS-PS2-4) (MS-PS3-2)
- CCC: Stability and Change- Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales. (MS-PS2-2)
- CCC: Scale, Proportion, and Quantity- Proportional relationships (e.g. speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes. (MS-PS3-1)
- CCC: Energy and Matter- Energy may take different forms (e.g. energy in fields, thermal energy, energy of motion). (MS-PS3-5)

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UNIT 4 WAVES AND THEIR APPLICATIONS:

Properties, Electromagnetic Radiation, and Information Transfer

ESSENTIAL QUESTION	BIG IDEAS
How are waves used to transfer energy? **How are waves used to transfer information?**	• Students understand that waves are repeating patterns with specific wavelength, frequency, and amplitude that transfer energy. • Students understand that mechanical waves need a medium to be transmitted, yet the particles of matter in the medium return to their fixed position. • Students develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials. • Students explore the claim that digitized signals are more reliable than analog for communication.

GUIDING QUESTIONS

- Content
  - How does energy from the sun relate to information technology and communications?
  - What are the characteristic properties and behaviors of waves and how can they be used?
  - How can wavelength, frequency, and amplitude demonstrate a repeating pattern?
  - How do mediums change the way a wave is transmitted?
  - How does the structure of the wave determine its path through different mediums?
  - Why can light travel through (mostly) empty space, but sound and water waves need a medium?
  - Why can some waves travel thru a human body while others cannot?
  - Why do some waves damage human cells while others do not?
  - How can waves send encoded information over long distances?
- Process
  - How can we mathematically model how the amplitude of a wave is related to the energy in a wave?
  - How can we model the way waves are reflected, absorbed, or transmitted through various materials?
  - Can you support the claim, with reliable scientific evidence, that digitized signals are a more reliable way to encode and transmit information than analog signals?
- Reflective
  - How do noise canceling headphones work?
  - Why can we only see certain frequencies of light and only hear certain frequencies of sounds, but other organism see and hear more or less?

- How can advances in wave technology be used to keep mosquitos away?
- How do geologists use seismic waves to predict the formation of a tsunami?
- How do moths jam bat sonar? Can technology mimic this effect?
- How does a flute produce specific sound waves? How is this different than a tuba, guitar, violin, or piano?
- What are the differences between 3G, 4G, and 5G? Do they impact our lives?
- How is Bluetooth different from cell phone service?
- How are digital photos different from printed photos (like in our textbook)?
- Could a very large electromagnetic pulse really destroy all digital information on earth? Why or why not?
- How are streaming, radio transmissions, and television transmissions related?
- How does the auto park feature of a car work?
- How do optical illusions work, where you stare at an image then look away and "see" something unusual?

FOCUS STANDARDS

- MS-PS4-1. 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-PS4-2. Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.
- MS-PS4-3. 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.

PS4-1 through PS1-3 above integrate the following:

- PS4.A: Wave Properties (MS-PS4-1) and (MS-PS4-2)
- PS4.B: Electromagnetic Radiation (MS-PS4-2)
- PS4.C: Information Technologies and Instrumentation (MS-PS4-3)
- SEP: Developing and Using Models- Develop a model to describe phenomena. (MS-PS4-2)
- SEP: Using Mathematics and Computational Thinking- Use mathematical representations to describe and/or support scientific conclusions and design solutions. (MS-PS4-1)
- SEP: Obtaining, Evaluating, and Communicating Information- Integrate qualitative scientific and technical information in written text with that contained in media and visual displays to clarify claims and findings. (MS-PS4-3)
- CCC: Patterns- Graphs and charts can be used to identify patterns in data. (MS-PS4-1)
- CCC: Structure and Function- Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used. (MS-PS4-2) Structures can be designed to serve particular functions. (MS-PS4-3)