4-PS3.A-2: Forms of Energy Movement

**Target Grade: 4th**

**DCI:**

**4-PS3.A – 2**

[Energy can be moved from place to place by moving objects or through sound, light, or electric currents.](https://www.nextgenscience.org/sites/default/files/evidence_statement/black_white/4-PS3-2%20Evidence%20Statements%20June%202015%20asterisks.pdf)

**Increase Teacher Interest by including the following (find ideas at NGSS Evidence Statement:**[**4-PS3-2**](https://www.nextgenscience.org/pe/4-ps3-2-energy)

* **Science and Engineering Practices**
* **Cross Cutting Concepts**

**Clarification Statement:**

* Does not include quantitative measures of energy.

**MAIN CONCEPTS**

| **concept** | **weight** |
| --- | --- |
| Electrical current transmits energy through moving electric charges. | Core |
| Motion is the change in position of an object. | Peripheral |
| Energy can be moved from place to place by sound. | Core |
| Sound transmits energy through vibrations in materials. | Core |
| Light transmits energy through electromagnetic waves. | Core |
| Energy can be moved from place to place by light. | Core |
| Energy can be moved from place to place by electric currents. | Core |
| Energy can be moved from place to place by moving objects. | Core |
| The energy transmitted by mechanical processes, light, sound, and electrical current can be used in many common applications. | Core |
| Moving objects contain energy. | Peripheral |
| The energy of motion is a kind of mechanical energy. | Peripheral |
| Waves transmit energy from one location to another, but they do not transmit matter. | Peripheral |
| The energy of motion is called kinetic energy. | Peripheral |

**BACKGROUND INFORMATION:**

**(Note: Do not copy and paste content from this section into games, as it is not grade-appropriate)**

**NGSS Framework:**

[PS3.A: Definitions of Energy](https://ngss.sdcoe.net/Disciplinary-Core-Ideas/DCI-Physical-Sciences/PS3A-Definitions-of-Energy)

*What is energy?*

That there is a single quantity called energy is due to the remarkable fact that a system’s total energy is conserved. Regardless of the quantities of energy transferred between subsystems and stored in various ways within the system, the total energy of a system changes only by the amount of energy transferred into and out of the system.   
  
At the macroscopic scale, energy manifests itself in multiple phenomena, such as motion, light, sound, electrical and magnetic fields, and thermal energy. Historically, different units were introduced for the energy present in these different phenomena, and it took some time before the relationships among them were recognized. Energy is best understood at the microscopic scale, at which it can be modeled as either motions of particles or as stored in force fields (electric, magnetic, gravitational) that mediate interactions between particles. This last concept includes electromagnetic radiation, a phenomenon in which energy stored in fields moves across space (light, radio waves) with no supporting matter medium.  
   
Motion energy is also called kinetic energy; defined in a given reference frame, it is proportional to the mass of the moving object and grows with the square of its speed. Matter at any temperature above absolute zero contains thermal energy. Thermal energy is the random motion of particles (whether vibrations in solid matter or molecules or free motion in a gas), this energy is distributed among all the particles in a system through collisions and interactions at a distance. In contrast, a sound wave is a moving pattern of particle vibrations that transmits energy through a medium.   
  
Electric and magnetic fields also contain energy; any change in the relative positions of charged objects (or in the positions or orientations of magnets) changes the fields between them and thus the amount of energy stored in those fields. When a particle in a molecule of solid matter vibrates, energy is continually being transformed back and forth between the energy of motion and the energy stored in the electric and magnetic fields within the matter. Matter in a stable form minimizes the stored energy in the electric and magnetic fields within it; this defines the equilibrium positions and spacing of the atomic nuclei in a molecule or an extended solid and the form of their combined electron charge distributions (e.g., chemical bonds, metals).   
  
Energy stored in fields within a system can also be described as potential energy. For any system where the stored energy depends only on the spatial configuration of the system and not on its history, potential energy is a useful concept (e.g., a massive object above Earth’s surface, a compressed or stretched spring). It is defined as a difference in energy compared to some arbitrary reference configuration of a system. For example, lifting an object increases the stored energy in the gravitational field between that object and Earth (gravitational potential energy) compared to that for the object at Earth’s surface; when the object falls, the stored energy decreases and the object’s kinetic energy increases. When a pendulum swings, some stored energy is transformed into kinetic energy and back again into stored energy during each swing. (In both examples energy is transferred out of the system due to collisions with air and for the pendulum also by friction in its support.) Any change in potential energy is accompanied by changes in other forms of energy within the system, or by energy transfers into or out of the system.   
  
Electromagnetic radiation (such as light and X-rays) can be modeled as a wave of changing electric and magnetic fields. At the subatomic scale (i.e., in quantum theory), many phenomena involving electromagnetic radiation (e.g., photoelectric effect) are best modeled as a stream of particles called photons. Electromagnetic radiation from the sun is a major source of energy for life on Earth.  
   
The idea that there are different forms of energy, such as thermal energy, mechanical energy, and chemical energy, is misleading, as it implies that the nature of the energy in each of these manifestations is distinct when in fact they all are ultimately, at the atomic scale, some mixture of kinetic energy, stored energy, and radiation. It is likewise misleading to call sound or light a form of energy; they are phenomena that, among their other properties, transfer energy from place to place and between objects.

**POSSIBLE GAME SCENARIOS**

**Note: Do not discuss how energy changes forms, or collisions between objects. Focus is on the nature of different types of energy and how they can transmit energy from one place to another. AVOID USING THE TERMS “\_\_\_\_\_\_ ENERGY.” NGSS PREFERS TO USE LANGUAGE TO RECOGNIZE THAT ENERGY IS TRANSMITTED BY SOUND, LIGHT ETC, BUT THEY DO NOT WANT TO TALK ABOUT “SOUND ENERGY” AS ITS OWN THING.**

* Have students track the movement of different forms of energy (can do this by treating energy as traveling in straight lines from their sources). For example, sound is emitted from a speaker, it travels through the air and strikes our eardrums; light is emitted from the Sun, it travels through space, bounces off different objects, and travels to our eyes; electric current travels through electrical wires from a power plant to our homes. (Do not discuss energy transformations yet, as this is covered in another topic.)
* Explore the properties and distinguish between how energy is transmitted in different ways, including through mechanical, sound, electrical current, and light. Be sure to discuss how each form moves energy from one place to another, but they do it in different ways (through different media, etc). (Hits TEKS 3.6A and 4.6A)
* Discuss common applications of how energy is transmitted by sound, mechanical, light, and electric currents in everyday life (such as with speakers, computers, a blender, a fan, a car, a musical instrument, flashlights, televisions, etc). (Hits TEKS 5.6A).

**Grade Bands:**

| **K-2**  You can assume that students already know that  . . . | **3-5**  Students need to learn: | **6-8**  DO NOT INCLUDE | **9-12**  DO NOT INCLUDE |
| --- | --- | --- | --- |
| • (nothing at this grade level) | • Energy can be moved from place to place by moving objects or through sound, light, or electric currents. (Boundary: At this grade level, no attempt is made to give a precise or complete definition of energy.) | Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed. A system of objects may also contain stored (potential) energy, depending on their relative positions. For example, energy is stored - in gravitational interaction with Earth — when an object is raised, and energy is released when the object falls or is lowered. Energy is also stored in the electric fields between charged particles and the magnetic fields between magnets, and it changes when these objects are moved relative to one another. Stored energy is decreased in some chemical reactions and increased in others.  The term “heat” as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and energy transfers by convection, conduction, and radiation (particularly infrared and light). In science, heat is used only for this second meaning; it refers to energy transferred when two objects or systems are at different temperatures. Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. | 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. “Mechanical energy” generally refers to some combination of motion and stored energy in an operating machine. “Chemical energy” generally is used to mean the energy that can be released or stored in chemical processes, and “electrical energy” may mean energy stored in a battery or energy transmitted by electric currents. Historically, different units and names were used for the energy present in these different phenomena, and it took some time before the relationships between them were recognized. These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as either motions of particles or energy stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space. |

**Additional Resources:**

Video at the bottom of this page: <https://ngss.sdcoe.net/Disciplinary-Core-Ideas/DCI-Physical-Sciences/PS3A-Definitions-of-Energy>

Energy: <https://www.ck12.org/book/CK-12-Fourth-Grade-Science/section/1.1/>

Forms of energy: <https://www.ck12.org/book/CK-12-Fourth-Grade-Science/section/1.3/>