Grade 5 Science, Quarter 2, Unit 2.1
Energy Transfer

Overview

Number of instructional days: 15
(1 day = 45 minutes)

Content to be learned
• Describe sound as a transfer of energy through various materials (solids, liquids, gases).
• Investigate how vibrations set up wavelike disturbances that move away from the source.
• Identify real-world applications where heat energy is transferred and show the direction that heat energy flows.

Science processes to be integrated
• Conduct investigations in order to make and record observations, analyze data, and draw conclusions.
• Identify the transfer of energy in systems.

Essential questions
• How is sound energy transferred?
• What effect do various media have on the transfer of sound?
• How is heat energy transferred? Give examples.
Written Curriculum

Grade-Span Expectations

PS 2 - Energy is necessary for change to occur in matter. Energy can be stored, transferred, and transformed, but cannot be destroyed.

**PS2 (5-8) SAE+POC-6**

Given a real-world example, show that within a system, energy transforms from one form to another (i.e., chemical, heat, electrical, gravitational, light, sound, mechanical).

**PS2 (5-6) - 6**

Students demonstrate an understanding of energy by…

*6c* describing sound as the transfer of energy through various materials (e.g., solids, liquids, gases).

PS 3 - The motion of an object is affected by forces.

**PS3 (5-8) SAE+INQ – Local Assessment Only**

Experiment, observe, or predict how energy might be transferred by means of waves.

**PS3 (5-6) – LA**

Students demonstrate an understanding of waves by …

*LAa* investigate how vibrations in materials (e.g., pebble in a pond, jump rope, slinky) set up wavelike disturbances that spread away from the source.

PS 2 - Energy is necessary for change to occur in matter. Energy can be stored, transferred, and transformed, but cannot be destroyed.

**PS2 (5-8) INQ+SAE+POC – 7**

Use data to draw conclusions about how heat can be transferred (convection, conduction, radiation).

**PS2 (5-6) – 7**

Students demonstrate an understanding of heat energy by…

*7a* identifying real world applications where heat energy is transferred and showing the direction that the heat energy flows.

Clarifying the Standards

**Prior Learning**

In kindergarten through grade 2, students identified the sun as a source of heat energy. They described that the sun warms the land and water, and described that objects change in temperature by adding or subtracting heat. Students experimented and described how vibrating objects make sound. They described observable effects of light using a variety of light sources, and demonstrated when a shadow is created using sunny versus cloudy days.
In grades 3–4, students showed that heat moves from one object to another causing temperature change, and described how heat moves from warm objects to cold objects until both objects are the same temperature. Students drew, diagrammed, built, and explained a complete electrical circuit. They described or showed that heat can be produced in many ways, and used experimental data to classify a variety of materials as conductors or insulators. Students experimented to identify and classify different pitches and volumes of sounds produced by different objects, and they used data to explain what causes sound to have different pitch or volume. They investigated observable effects of light using a variety of light sources, and predicted, described, and investigated how light rays are reflected, refracted, or absorbed.

**Current Learning**

In grade 5, students describe sound as the transfer of energy through various materials (solids, liquids, or gases). They investigate how vibrations (e.g., pebble in a pond, jump rope, slinky) in materials set up wavelike disturbances that spread away from the source. Students also identify real world applications where heat energy is transferred and show the direction that the heat energy flows. These concepts are all extensions of prior learning. The transfer of sound energy is new, and should be taught at the developmental level to reinforcement level of instruction. Using models to develop a conceptual understanding of waves is also new, and is taught at the developmental to reinforcement level of instruction. Identifying real world applications of the transfer of heat energy is an extension of prior learning, and is taught at the reinforcement level of instruction.

In the classroom, students need multiple opportunities to investigate the transfer of sound through various mediums. Students should notice that sound travels through matter, and that sound actually transfers better through solids than liquids or gases. Students also should have time to explore/investigate wavelike disturbances, which is foundational for concepts that will be addressed in upper middle school and high school. In addition, several investigations can be devised to show heat transfer using various materials. For example, the rate of heat transfer is not the same for different types of metals. If students use equal-sized strips of metal with their ends dipped in wax, these strips can be heated at their opposite end and timed to see how long it takes for the heat to travel the length of the metal to melt the wax.

Again, the focus in this unit is to give students many opportunities to conduct hands-on investigations in order to develop a conceptual understanding of the transfer of energy.

**Future Learning**

The concepts in this unit of study are not addressed in Grade 6.

In grades 7–8, students will use a real-world example to explain the transfer of potential energy to kinetic energy, and will construct a model to explain the transformation of energy from one form to another. They will explain that while energy may be stored, transferred, or transformed, the total amount of energy is conserved, and will describe the effect of changing voltage in an electric circuit. Students will demonstrate an understanding of heat energy by designing a diagram, model, or analogy to show or describe the motion of molecules for a material in a warmer and cooler state. They will also explain the difference among conduction, convection, and radiation and create a diagram to explain how heat energy travels in different directions and through different materials by each of these methods.

**Additional Findings**

To overcome the many challenges presented by the concepts in this unit, students need multiple opportunities to conduct hands-on investigations that involve the transfer of energy.
In grades 5-8, the understanding of energy will build on the K-4 experiences with light, heat, sound, electricity, magnetism, and the motion of objects. In 5-8, students begin to see the connections among those phenomena and to become familiar with the idea that energy is an important property of substances and that most change involves energy transfer. Students might have some of the same views of energy as they do of force—that it is associated with animate objects and is linked to motion. In addition, students view energy as a fuel or something that is stored, ready to use, and gets used up. The intent at this level is for students to improve their understanding of energy by experiencing many kinds of energy transfer. Some fundamental concepts include that heat moves in predictable ways, flowing from warmer objects to cooler ones, until both reach the same temperature. Electrical circuits provide a means of transferring electrical energy when heat, light, sound, and chemical changes are produced. In most chemical reactions, energy is transferred into or out of a system. Heat, light, mechanical motion, or electricity might all be involved in such transfers. The sun is a major source of energy for changes on the surface of the earth. The sun loses energy by emitting light. A tiny fraction of that light reaches the earth, transferring energy from the sun to the earth. The sun’s energy arrives as light with a range of wavelengths, consisting of visible light, infrared, and ultraviolet radiation (National Science Education Standards, pp. 154-155).

Investing much time and effort in developing formal energy concepts can wait. The importance of energy, after all, is that it is a useful idea. It helps make sense out of a very large number of things that go on in the physical and biological and engineering worlds. The one aspect in which students in grades 3-5 can make some headway is heat, which is produced almost everywhere. In their science and technology activities, students should be alerted to look for things and processes that give off heat, and then for those that seem not to give off heat. Also, the time is appropriate to explore how heat spreads from one place to another and what can be done to contain it or shield things from it (Benchmarks for Science Literacy, p. 83).

Students’ ideas of heat may have many wrinkles. In some situations, cold is thought to be transferred rather than heat. Some materials may be thought to be intrinsically warm (blankets) or cold (metals). Objects that keep things warm—such as a sweater or mittens—may be thought to be sources of heat. Only a continuing mix of experiment and discussion is likely to dispel these ideas. By the end of grade 5, students should know that when warmer things are put with cooler ones, the warm ones lose heat and the cools ones gain it until they are all at the same temperature. A warmer object can warm a cooler one by contact or at a distance. Some materials conduct heat much better than others. Poor conductors can reduce heat loss (Benchmarks, pp. 83, 84)

Middle school students do not always explain the process of heating and cooling in terms of heat being transferred. Some students think that “cold” is being transferred from a colder to a warmer object, while others think that both “heat” and “cold” are transferred at the same time. Students do not always explain heat-exchange phenomena as interactions. For example, students often think objects cool down or release heat spontaneously—that is without being in contact with a cooler object. Even after instruction, students don’t always give up their naïve notion that some substances cannot heat up or that metals get hot quickly because “they attract heat,” “suck heat in,” or “hold heat well.” Middle school students believe different materials in the same surroundings have different temperatures if they feel different (for example, metal feels colder than wood). As a result they do not recognize the universal tendency to temperature equalization. Few middle and high school students understand the molecular basis of heat transfer even after instruction. Although specially designed instruction appears to give students a better understanding about heat transfer than traditional instruction, some difficulties often remain (Benchmarks, pp. 337-338).

According to Making Sense of Secondary Science, students tend to mistakenly believe that sound needs an unobstructed pathway in order to travel. Children may envision sound as an invisible object with dimensions that needs room to move. The idea that air is needed for sound transmission is not understood. Students rarely suggest a mechanism for sound at any age (p. 135).