

7thGrade Physical Science: Energy Transformations, Electricity, and Magnetism

Teacher Background Information

Energy appears in many forms, including radiation, the motion of bodies, excited states of atoms and strain within and between molecules. Most of what goes on in the universe involves energy changing from one form to another. Whenever the amount of energy in one place or form diminishes it increases by the same amount in another place or form. Transformations of energy usually produce some energy in the form of heat which spreads around to cooler places. The conversions lead from more concentrated (i.e. more useful) forms of energy to less concentrated (i. e. less useful) forms. Four laws of nature, Maxwell's equations, summarize what we know about the phenomena of electricity and magnetism. They state, among other things, that electricity and magnetism are two aspects of the same force. Every time an electric charge moves a magnetic force is created and moving magnets produce electrical forces. The forces that hold the nucleus of an atom together are much stronger than the electromagnetic force; that is why such great amounts of energy are released from nuclear reactions. Science Matters, Chapters 2 and 3

Science for All Americans, Chapter 4, p 49-52, 55-57
Benchmarks for Science Literacy, Pages 81-86, 93-97
National Science Education Standards, Page 149,154-5

Instructional Implications

In grades 5-8, students begin to see the connections among light, heat, sound, electricity, magnetism, and the motion of objects and to become familiar with the idea that energy is an important property of substances and that most change involves energy transfer.

At this level, students should be introduced to energy primarily through energy transformations. Students should trace where energy comes from (and goes next) in examples that involve several different forms of energy along the way: heat, light, motion of objects, chemical, and elastically distorted materials. To change something's speed, to bend or stretch things, to heat or cool them, to push things together or tear them apart all require transfers (and some transformations) of energy.

Where energy comes from is usually much more evident than where it goes, because some usually diffuses away as radiation and random molecular motion. A slightly more sophisticated proposition is the one that whenever some energy seems to show up in one place, some will be found to disappear from another.

Students should make devices to observe the magnetic effects of current and the electric effects of moving magnets. At first, the devices can be simple electromagnets; later, more complex devices, such as motor kits, can be introduced.

Big Idea

Energy can be transferred and transformed, but never created or lost.

Essential Question:

What is energy and how does it change?

How are electricity and magnetism related?

AAAS Benchmarks/National and Science Education Standards

Energy Transformations

Energy can be transferred from one system to another (or from a system to its environment) in different ways: 1) thermally 2) mechanically 3) electrically,; or 4) by electromagnetic waves. 4E/M2

Energy appears in different forms [motion, thermal, gravitational, elastic, chemical, electrical, and light] and can be transformed within a system...4E/M4

Transformations and transfers of energy within a system usually result in some energy escaping into its surrounding environment. Some systems transfer less energy to their environment than others during these transformations and transfers. 8C/M1

Whenever energy appears in one place, it must have disappeared from another. Whenever energy is lost from somewhere, it must have gone somewhere else...4E/M1

Thermal energy is transferred through a material by the collisions of atoms within the material. Over time, the thermal energy tends to spread out through a material and from one material to another if they are in contact. ... In addition, some thermal energy in all materials is transformed into light energy and radiated into the environment by electromagnetic waves; that light energy can be transformed back into thermal energy when the electromagnetic waves strike another material... E/M3

Forces that Shape the Earth: Electromagnetic Force

*A charged object can be either positively charged or negatively charged... [Similarly charged objects exert a] force of repulsion on each other, while oppositely charged objects exert a force of attraction on each other. 4G/M5(BSL)

*Electric currents and magnets can exert a force on each other. 4G/M3

Materials vary in how they respond to electric currents, magnetic forces, and visible light or other electromagnetic waves. 4D/M9

*Electrical circuits require a complete loop through which an electrical current can pass. 4G/M4** (NSES)

Energy Resources

*Electrical energy can be generated from a variety of energy resources and can be transformed into almost any other form of energy. Electric circuits are used to distribute energy quickly and conveniently to distant locations. 8C/M4

Energy from the sun (and the wind and water energy derived from it) is available indefinitely....8C/M5

By burning fuels, people are releasing large amounts of carbon dioxide into the atmosphere and transforming chemical energy into thermal energy which spreads throughout the environment. 8C/M11

Some resources are not renewable or renew very slowly. Fuels already accumulated in the earth, for instance, will become more difficult to obtain as the most readily available resources run out.. 8C/M10

Materials/Resources

STC: Electrical Energy and Circuit Design

[Science Explorer Electricity and Magnetism](#)

KidWind website

Amerref Energy curriculum

<http://id.mind.net/~zona/mstm/physics/mechanics/energy/heatAndTemperature/heatAndTemperature.html>

<http://environment.nationalgeographic.com/environment/global-warming/wind-power-interactive.html>

Assessments

Science Notebooks

[Uncovering Student Ideas in Science](#)

Volume 1 Probe 14: The Mitten Problem

Volume 1 Probe 15 Objects and Temperature

Volume 2 Probe 7: Batteries, Bulbs, and Wires

Student Difficulties and Misconceptions

There may be some confusion in students' minds between energy and energy sources. Focusing on energy transformations may get around this somewhat. Food, gasoline, and batteries obviously get used up. But the energy they contain does not disappear; it is changed into other forms of energy. Students rarely think energy is measurable and quantifiable. Although students may develop some skill in identifying different forms of energy, in most cases their descriptions focus on forms that have perceivable effects. The transformation of motion to heat seems to be difficult for students to accept, especially in cases with no obvious temperature increase. It may not be clear to students that some forms of energy, such as light, sound, and chemical energy, can be used to make things happen.

Students do not distinguish well between heat and temperature when they explain thermal phenomena. Some students think that "cold" is being transferred from a colder to a warmer object. Students often think objects cool down or release heat spontaneously—that is, without being in contact with a cooler object. Some students believe that some substances (for example, flour, sugar, or air) 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 have different temperatures if they feel different (for example, metal feels colder than wood) and do not recognize the universal tendency to temperature equalization.

Some students interpret the idea that "energy is not created or destroyed" to mean that energy is stored up in the system and can even be released again in its original form.

Some middle-school students do not have a notion of light as something that travels from one place to another and reject the idea that ordinary objects reflect light.

Local Connections

Connect to Earth's magnetic pole- relevant to compass declination and to aurora.

AELP - possibly tour Salmon Creek dam

Local residents with wind turbine, water turbine, solar cell systems... south Douglas

Science Olympiad

Building design and insulation

Alaska GLE's

The student demonstrates an understanding of how energy can be transformed, transferred, and conserved by

[6] **SB2.1** recognizing that energy can exist in many forms (i.e., heat, light, chemical, electrical, mechanical)

[7] **SB2.1** explaining that energy (i.e., heat, light, chemical, electrical, mechanical) can change form

[8] **SB2.1** identifying the initial source and resulting change in forms of energy in common phenomena (e.g., sun to tree to wood to stove to cabin heat)

The student demonstrates an understanding of the interactions between matter and energy and the effects of these interactions on systems by

[8] **SB3.1** exploring changes of state with increase or decrease of particles speed associated with heat transfer (L)

The student demonstrates an understanding of motions, forces, their characteristics, relationships, and effects by

[7] **SB4.2** recognizing that electric currents and magnets can exert a force on each other

[8] **SB4.2** describing the interactions between charges

The student demonstrates an understanding of cycles influenced by energy from the sun and by Earth's position and motion in our solar system by

Connections to other content areas

Heat energy- connects to states of matter, also to weather and climate, and geology

-Biology-Some animals ability to detect and use magnetic fields and to generate electrical currents

Magnetic imaging