ENERGY

Everything that happens in the world requires energy

INTRODUCTION

As described in earlier sections, energy is the ability to do work and make things change, grow, or move. Everything that happens in the world takes energy. This section includes the following energy-related topics:

- energy sources
- sound
- light
- electricity and magnetism
- gravity, friction, and inertia

ENERGY SOURCES

Background Information

Energy is the ability to do work. It is what makes things change, grow, and move. Everything that happens in the world takes energy.

Energy exists in one of two states. **Potential energy** is stored energy. Potential energy is present in a stretched-out elastic band, a rock held above the ground, a **battery** (a source of electricity) that is not in use, and food before it is eaten. **Kinetic energy** is the energy of motion or work. It is present in a rebounding elastic band, a

falling rock, a battery that is sending a current to a device, and food that is being used to provide chemical energy to move muscles. In each case, potential energy is turned into kinetic energy.

The potential energy was there in each of these objects — the elastic band, rock, battery, and food — in that the object had the energy within it necessary to do work, but until that energy was released and actually did the work, the energy remained potential energy. When it was released, the potential energy was transformed into kinetic energy.

However, the motion of kinetic energy is not always visible. Sometimes it involves the invisible movement of atoms, molecules, or electrons, such as when heat energy is added to water. The water definitely gains energy, and the motion of the molecules definitely increases, but these changes are visible only as the water's rise in temperature and its expansion.

Scientists classify energy into six types, most of which can exist as kinetic and potential energy:

- **Thermal energy**, also called heat, is the energy carried in the movement of molecules.
- **Radiant energy**, also called sound and light, is the energy carried through the movement of sound waves through air and the movement of light particles/waves through anything, even a **vacuum**, a region without matter.
- **Mechanical energy** is the energy in moving, stretched, or compressed objects, such as a train, an elastic band, and a spring, respectively, and in objects held above the ground.
- **Electrical energy** is the energy of electrons flowing in electric currents.
- **Chemical energy** is the energy in food, fuel, batteries, and other chemicals.
- **Atomic energy** is the energy in the nucleus of an atom.

Energy cannot be created or destroyed, but it can change states or forms. Such a change is called an **energy transformation**. For example, radiant kinetic energy from the sun is stored as chemical potential energy in apples on a tree. This chemical energy remains as potential energy until someone eats the apple. The person's body transforms the apple's chemical potential energy into mechanical energy when it is used by the body to produce movement and heat.

When things grow, change, or move — indeed, when they do anything, it is by means of an energy transformation. The following list gives examples of some common transformations.

Some common energy transformations

- A car uses chemical potential energy stored in fuel to create the mechanical kinetic energy of the motion of the car.
- A telephone transforms radiant kinetic energy of sound waves from a voice into electrical kinetic energy that travels along telephone lines to another telephone, where it is transformed back into sound waves.
- Most power plants turn the potential chemical energy from coal, oil, or nuclear fuel, into the radiant kinetic energy of heat to generate electricity. The exception is a hydroelectric plant that uses the mechanical kinetic energy of falling water to generate the electrical kinetic energy of electricity.
- Hands being rubbed together turn mechanical kinetic energy into the radiant kinetic energy of heat through friction.
- A campfire takes the chemical potential energy contained in wood and turns it into the radiant kinetic energy of heat and light.
- A weightlifter's body turns the chemical potential energy stored in food into the mechanical kinetic energy of moving muscles.
- Plants turn radiant kinetic energy from the sun into the potential chemical energy in fruit and seeds.
- Electrical appliances turn electrical kinetic energy into mechanical kinetic energy for uses such as vacuuming or drilling.

Apart from food, the most important sources of energy for humanity are **fossil fuels**. These are fuels made from the carbon-rich remains of prehistoric plants and animals. The most abundant fossil fuel is **coal**, a dark brown or black rock-like substance that contains at least 50 percent carbon and burns well. Coal has been used as fuel for thousands of years. Today, it is burned mainly to melt iron in steel mills and to generate electrical power.

The other main fossil fuels are **oil** and **natural gas**, two carbon-rich substances formed from processes similar to that which produced coal, so that they also burn easily. Oil, sometimes called petroleum, is a brownish liquid that is pumped from oil wells in the ground. It is used to make many types of fuel, including gasoline, diesel oil, and heating oil. It is also used to make plastic, fertilizer, and pesticides.

ACTIVITY 1

Transforming Energy

Purpose

To learn how energy can be transformed from one state or form to another.

Material

Chart, Some common energy transformations.

Photo such as the illustration, Everything that happens in the world requires energy.

Two beanbags, or similar heavy but soft objects.

A small board with a roller or block, set up like a teeter-totter (seesaw).

Electric toaster, Year 6.

Slice of bread, Year 6.

Plate, Year 6.

Dinner knife, Year 6.

Electrical outlet, Year 6.

Whiteboard and marker, Year 6.

Matter and Energy journals and pencils.

Presentation

- Most Montessori teachers present this concept in Year 4 and explore it in more detail in Year 6.
- Announce to the students that they will have an opportunity to investigate how to transform energy.

YEAR 4: EXPLORING ENERGY TRANSFORMATIONS

- Present the illustration and chart and invite the students to examine them. Discuss how energy is used in each instance to do work. Clarify that work is anything that makes things different, whether moving an arm, turning the wheels of a car, lighting a room, or making a sound.
- Invite the students to look around the classroom and name different ways that energy changes things through work. (Examples: students are moving their bodies, which requires food, water, and air energy and produces muscle energy; the lights are glowing, which requires electrical energy and produces light and heat energy; music is playing, which requires electrical energy and produces sound energy; a plant is growing, which requires food, water, and air energy and produces plant growth and movement; the heating system is keeping the room warm, which requires electrical, oil, gas,

or coal energy and produces heat energy.)

- Explain that energy comes in two main forms, potential and kinetic. Explain that potential energy is the energy available to do work if the situation changes.
- Place the teeter-totter on the floor. Place a beanbag on one end of the teeter-totter.
- Invite a student to hold the beanbag above the empty end of the teeter-totter. Explain that the beanbag held in the air has potential energy, also called stored energy, because if the beanbag falls, then the beanbag's movement allows it to do work, such as bouncing the other beanbag on the teeter-totter into the air. But because the beanbag is held in the air, it cannot do any work yet, and only has the potential to do work.
- Explain that the second form of energy is kinetic energy, the energy used in actually doing work, such as the beanbag falling, moving the teeter-totter, and lifting the other beanbag into the air.
- Invite the student to drop the beanbag onto the empty end of the teeter-totter. The beanbag will lift the other beanbag into the air.
- Explain that the potential energy of the beanbag held in the air changes into the kinetic energy of movement, first of the beanbag falling, then of the teeter-totter moving, then of the other beanbag moving.
- Ask the students to use their journals to draw a picture showing the beanbag above the ground, falling toward the teeter-totter, and lifting the other beanbag into the air, with labels that say "potential energy" and "kinetic energy" as appropriate.

YEAR 6: USING ENERGY TRANSFORMATIONS

- Review the concepts of energy and energy transformations.
- Using the whiteboard, present the six main types of energy: thermal, radiant, mechanical, electrical, chemical, and atomic.

- Present the illustration and chart of different energy uses, and work with the students to classify the energy uses shown. (Not all of the six types have to be discussed; those not discussed can be dealt with in the extensions.)
- Explain to the students that today they will find out about the types of energy involved in making and eating a slice of toast.
- Invite a student to put a slice of bread in the toaster. Encourage the student to say what kind of energy she/he just used to pick up the bread. (Mechanical energy.) Invite the student to say where that mechanical energy came from. (Chemical energy.)
- Invite another student to turn the toaster on. Invite the student to say what kind of energy he/she used to turn on the toaster (mechanical), and what kind of energy the toaster is using. (Electrical.)
- With the students, discuss how the toaster cooks the bread. (It transforms electrical energy into heat energy. The intense heat toasts the bread by producing a chemical change in the toast.)
- With the students, watch the toast pop up, then describe what has happened in terms of energy. (The mechanical energy used to push the toast down into the toaster was stored as potential energy in the spring, which turned into mechanical energy to push the toast up.)

- Invite a student to put the toast on a plate and cut it into enough pieces for everyone to have a taste. Invite the student to describe what is happening in terms of energy. (This takes mechanical energy from the student.)
- Encourage each of the students to eat a small piece of the toast. Invite the student to describe what is happening in terms of energy. (Chewing takes mechanical energy produced from the chemical energy of food. The toast contains stored chemical energy.)
- Discuss with the students the different things their bodies may do with the toast's stored chemical energy. Invite the students to describe what is happening in terms of energy (e.g., transforms the toast's stored chemical energy into mechanical energy for walking; transforms the toast's stored chemical energy into heat energy to keep their bodies warm; transforms the toast's stored chemical energy into stored energy (fat) if a student has eaten more than she/he needs at that moment).

- Ask the students to use their journals to draw and label a picture about cooking and eating a slice of toast, and to write a paragraph describing the types of energy involved.

Extensions

- Bake a batch of cookies, the write a summary of the energy transformations involved. Examples of questions that could be answered: What is the heat energy in the oven used for? Does it end up in the cookies as extra chemical energy? (No, but the energy is used in changing the chemical structure of the cookie ingredients from a mix of materials into finished cookies.)

- Create and perform a play, poem, or song about energy. Different types of energy could be different characters.
- At home, make a list of ten ways that energy is used in the house and in a family's ordinary life.