Activity Description & Estimated Class Time

This sequence of activities requires three 50-minute blocks. The first lesson introduces a working definition of energy using a series of energy-related stations with task cards. In the second activity, students revisit the stations and identify the different forms of energy at each one, as well as changes and motion that result from the energy. The third activity introduces energy converting from one form to another.

Objectives

Students will demonstrate knowledge and understanding of the following ideas and content:

- energy exists in many forms,
- energy can cause things to move or change, and
- energy can be converted from one form to another.

Students demonstrate this knowledge and understanding by describing the energy sources and the changes or motions they cause in a variety of situations.

Correlations to North Carolina Science Standards

4.P.3.1 – *Recognize the basic forms of energy (light, sound, heat, electrical, and magnetic) as the ability to cause motion or create change.*

Other common forms of energy (chemical, mechanical, wind, and water) are also included in these activity.

Brief Science Background

A simple way to think about energy is that it is required to make anything change or move. If something moves or changes, energy is involved. Similarly, in physics, energy is defined as “the capacity to do work.” An important characteristic of energy is that it can’t be created or destroyed. It is always “conserved.” Anything that has energy can only get rid of it by transferring it. If another object is involved, the transfer somehow moves or changes the object receiving the energy. Often, energy moves objects, for example, a baseball flying through the air. Energy can also change an object, such as by increasing its temperature or changing its shape (a window when the ball hits it). Energy can also change forms. For example, electrical energy can become heat energy in a light bulb or motion in an electric motor.

Part 1 — Exploration Stations – 50 minutes

Materials

Materials for the Whole Class

- "Exploration Station" materials: ice cube (supplied by teacher), 9-oz cup; hand-powered flashlight; battery holder, switch, electromagnet core and coil, wires, paper clips; wind-up toy; Skittles candy, 1-oz cups with lids; clamp light with bulb, photovoltaic cell and motor with rotating disk; two tall 9-oz plastic cups, two balloons, packet of salt
- set of **BLM 1** Exploration Station Task Cards, one each of seven different cards Materials for groups of 2 students.

Materials for groups of 3 to 4 students

- science notebook (supplied by teacher), one per student

Preparation

Set up seven different Exploration Stations as described below, spread around the room as far apart as possible.

Copy and cut out **BLM 1, Exploration Station Task Cards,** and place the appropriate card at each station.

- Station 1 – an ice cube in a squat 9-oz cup
- Station 2 – hand-powered flashlight

  Set the small switch on the bottom of the flashlight so that light is only produced when the lever is moving.
- Station 3 – battery, battery holder, switch, electromagnet core and coil, wires

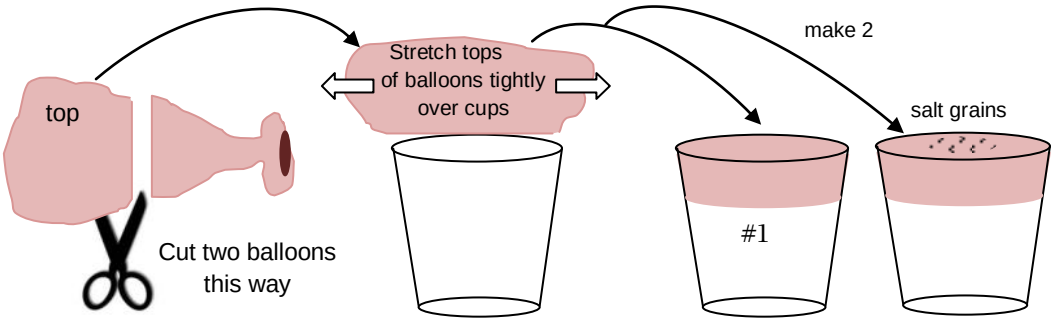
  Place the battery in the battery holder, and connect the wires to make the circuit shown below. The circuit is complete, and the electromagnet is working only when the switch is closed.

Connect the wires by depressing the clip, slipping the wire under the small hook, and releasing the clip.

Preparation (cont.)

- Station 4 – wind-up toy;
- Station 5 – seven 1-oz cups with lids, Skittles candy;
- For each of seven 1-oz cups, put in enough Skittles so that each team member gets one Skittle. Put a lid on each cup;
- Station 6 – clamp light (switched off but plugged in) just above a photovoltaic cell with attached motor and disk such that the motor rotates the disk when the light is turned on;
- Station 7 – two tall 9-oz plastic cups, two balloons, salt packet;

  Cut off the necks of the balloons. Discard the necks and stretch the tops over the cups as shown. Label one balloon-covered cup ' #1'. Pour salt crystals on the stretched balloon of the other cup.



Procedure

1. Inform students that they will visit seven different stations. At each station, they will have three minutes to accomplish a task. Advise students that the three minutes include writing an answer to a question at each station.
2. Divide the class into seven groups, and assign each group a starting station and corresponding team number (1 to 7). Inform them of the rotation direction from station to station (e.g. clockwise around the room). Send each team to its first station, and start the clock. **Inform students when half the time has passed so they can put down the materials and begin writing in their notebooks.**
3. After all groups have been to all stations call them back to their seats.
4. Ask the students for some of their ideas about what happened at the stations. Accept all answers. Ask the class to think of a common theme for all of the stations they visited. Again, accept all answers.

Part 2 — Energy Explorations – 50 minutes

Materials

Materials for the whole class

- to project for the class: BLM 2 "Forms of Energy"
- "Exploration Station" materials: ice cube (supplied by teacher), 9-oz cup; hand-powered flashlight; battery, battery holder, switch, electromagnet core and coil, wires, paper clips; wind-up toy; Skittles candy, 1-oz cups with lids; clamp light and bulb, photovoltaic cell and motor with rotating disk; two tall plastic cups, two balloons, packet of salt
- seven copies of BLM 3 "Energy, Motion, and Change"
- rubber band car

Materials for groups of 3 to 4 students

- sticky dots
- sticky (Post-it®) notes
- science notebook

Preparation

1. Set up the "Exploration Stations" used in Part 1.
2. Place a copy of **BLM 3** the "Energy, Motion, and Change" sheet at each station. Write the number of the station on each sheet, and turn the sheet face down.
3. Place sticky dots and blank Post-it® notes at each station.
4. Clear a table for the rubber band car to move across. Place books at one end to keep the car from going off the edge.

Procedure

1. Review students' ideas about a unifying theme for all of the stations in the previous activity. Point out that all the stations involved forms of energy, so "Energy" is the theme. Ask students to give possible definitions of "energy" based on what they observed at the stations. Discuss their ideas.
2. Explain that the easiest "scientific" definition of energy is that energy can make things move or change. In fact, energy is necessary to make anything change its movement or change in any way. Ask students for examples of energy making something move or change. **Students may talk about gas making their cars move, energy to throw a ball, electricity to run a computer, etc. Ask them to focus on the energy and the change or motion that resulted from it.**
3. Point out that energy comes in many forms and ask them to think of different forms of energy that they have heard of. **Accept all answers.**
4. Give each team **BLM 2** the "Forms of Energy" sheet, and explain that the sheet lists common forms of energy that they will refer to during the activity. Ask students to read the sheet and rank the energy forms in order from what they think is the most important type to the least important type. Discuss their rankings with emphasis on why they think one type is more important than another. **There is no correct ranking. The assignment is intended to**

Part 2 (cont.)

get students to read the descriptions and talk about them. Do not spend time defining terms now. Instead, let the students work within their understanding of each form.

5. Hold up the rubber band car and ask students to observe carefully as you wind it up and release it to move across the table until it runs into a book. **To wind up the rubber band car:**

   - **press the car down on a surface and roll it backwards for several feet,**
   - **where you stop it, hold the wheels to keep them from moving,**
   - **with wheels held, place the car at a starting point and release.**

6. Ask students to describe the movement or changes they observed. **Students might say the car moved and ran into the book. If students begin with this, ask where the energy that caused the movement came from. If they say muscle energy turned the wheel and twisted the rubber band, ask where the energy came from that allowed your hand to turn the wheel. Push students to think about the chain of energy forms going as far back as possible.**

7. Preview the activity. Tell students that they will revisit the stations from the previous activity, and will again have three minutes at each station. At each station, teams will use **BLM 2** "Forms of Energy" to identify kinds of energy experienced and note all motion and changes that they observe. After a few minutes observing and discussing among themselves, students will turn **BLM 3** "Energy Forms, Motion, and Changes" face up and do the following:

   - put a sticky dot labeled with their team number in any space on the sheet that names a form of energy they observed at that station.
   - write what movement or change the energy caused on a sticky note and place that note on the Change/Motion area at the bottom of the sheet.
   - turn the sheet face down before they leave the station.

8. Before starting, point out **BLM 3** and demonstrate how to use it. Restate that teams must first analyze the energy forms, motion, and changes, and discuss these among themselves. When you tell them to turn the sheet face up, they will add their dots and sticky notes, then turn sheet face down again when they leave the station.

Wrap-Up

1. After students have gone to all of the stations, call them back to their seats and ask them which station used energy in forms that were easiest to identify. Discuss their answers.

2. Ask which station had the most forms of energy. Discuss answers.

3. Last, ask which station had the most motion or changes. Discuss answers. **Answers will vary, but students will probably find the first station the easiest to identify as an example of heat energy causing a change (melting) in the ice. The fact that this a familiar experience contributes to their understanding. Even though eating candy is also familiar, the idea of chemical energy is a new concept to many students, so students may be less inclined to identify the Skittles station as the "easiest." All students should be able to recognize that the other stations involved several energy forms and changes or motions.**

Part 3 — Energy Moving and Changing

Materials

Materials for the whole class

- a lit candle
- the "Energy, Motion, and Changes" sheets completed by students in the previous activity

Preparation

- Sort the completed "Energy, Motion, and Changes" sheets into the order you want to discuss them.
- Set up and light the candle.

Procedure

1. Display the lit candle. Ask students to name the forms of energy they can observe. **Heat, light, sound (sputtering), and motion of the flame.** Ask students what they think would happen if you let it burn for an hour? **The candle will get shorter.** Ask students where the energy to keep the candle flame burning might come from? **The chemical energy stored in the wax of the candle is released when the candle burns.** This is the time to point out that not only can energy cause motion or change, but it can be changed from one form of energy to another. Point out that they are watching that happen in the candle: stored chemical energy is being changed into light, heat, sound and motion.

2. Go through the charts that the groups filled in with dots and notes during Part 2, and trace with the students the types of energy involved at each station and the changes that occurred.

   - Station 1 – Heat energy in the air warmed the ice and caused it to melt.
   - Station 2 - Chemical energy from food was converted to the mechanical muscle energy to squeeze the flashlight. That squeeze turned a small generator, which converted mechanical energy to electrical energy. The electrical energy converted to light energy in the bulb.
   - Station 3 – Chemical energy in the battery produced electrical energy in the wires. The special arrangement of wires converted the electrical energy to magnetic energy. The magnetized nails picked up the paper clips.
   - Station 4 – Chemical energy from food was converted to the mechanical muscle energy needed to wind up the toy. The winding action compressed, a spring inside the toy, and the spring stored mechanical energy. When the winder was released, the stored energy was released as the spring expanded and pushed on other parts inside the toy, causing it to move.
   - Station 5 – Skittles have stored chemical energy that is converted to muscle energy after the students eat them.
   - Station 6 – The photovoltaic cell converted light energy to electrical energy. The motor converted electrical energy to mechanical energy.
   - Station 7 – Chemical energy from food became the mechanical muscle energy that pulled up the balloon. Releasing the balloon converted the energy to sound energy. The sound energy moved through the air as waves. The waves traveled to the other stretched balloon, where they made the balloon vibrate enough to move the salt (mechanical energy).

Guided Practice

Guided Practices are similar to typical tests, but require students to reveal their thinking about content. They serve as a practice before a test and should not be graded. They are intended to expose misconceptions *before* an assessment and to provide opportunities for discussion, re-teaching, and for students to justify answers. They are best given as individual assignments without the manipulatives used in the activity. In that context, pose the following "test items" to the class. Ask them to write responses in notebooks.

1. Tell students about Rube Goldberg, who was a cartoonist, sculptor, engineer, author, and inventor born in 1883. He is most famous for "Rube Goldberg Inventions" cartoons, which are long series of whimsical gadgets that work together to do a simple task. Explain that these "inventions" can be thought of as "energy changing machines." With students, watch the OK GO music video, "This Too Shall Pass – Rube Goldberg Machine Version" http://www.youtube.com/watch?v=3CBDOYPL_xA. Ask students to look for different kinds of energy used, changes, and motions.

2. Discuss the students' observations.

3. Project the image of the boy on the sofa, **BLM 4** *without the caption.* To do this, use a document camera and cover the caption. Ask student groups to figure out what would to happen, and how it would work. After a few minutes, ask for their ideas and read the official explanation.

4. Challenge students to sketch a "Rube Goldberg " device in words and pictures. Their device must use at least four different types of energy to accomplish a task. Tasks should be simple, such as waking a person up in the morning or feeding a pet.

BLM 1 Exploration Station Task Cards

Station 1-

Observe the ice cube.

Answer in your notebook:

What makes the ice cube melt?

Station 2 –

Squeeze the flashlight and observe what happens.

Answer in your notebook:

What is the result of squeezing the flashlight?

Station 3 –

Open the switch on the circuit and touch the nails wrapped in wire to the paper clips. Close the switch on the circuit and touch the nails to the paper clips again. Leave the station with the switch open.

Answer in your notebook:

If you left the switch closed, what would eventually happen in this set up?

Station 4 –

Gently wind up the toy, turn it loose on the table and observe.

Answer in your notebook:

How is this toy able to move?

BLM 1 Exploration Station Task Cards continued...

Station 5 –

Open one cup of Skittles and pass out one Skittle to each member of your group member. Eat the Skittles.

Answer in your notebook:

What do you think is happening to the Skittle you ate?

Station 6 –

Switch on the clamp light above the solar cell and observe.

Answer in your notebook:

How can light make the motor turn?

Station 7 –

Pick up cup number one and tilt it slightly toward the other cup, about a foot away. On cup number one, gently pinch the center of the balloon with your thumb and forefinger to pull the balloon a short distance out from the cup. Let go with a loud snap. Watch what happens to the salt on the other cup.

Answer in your notebook:

What could explain how the salt moved?

BLM 2 Forms of Energy

Light Energy

The light we can see is only one kind of light energy. Materials that absorb light energy usually change by getting warmer. Some special materials can absorb light and produce electricity.

Sound Energy

Sound energy is created when something vibrates. Sound energy moves as vibrations through air and other materials. Sound energy can vibrate the things that absorb it.

Heat Energy

Heat energy can move from one object or place to another. It warms whatever absorbs that heat energy. Heat energy can also be used to make things move, like making steam in a steam locomotive.

Chemical Energy

Chemical energy is stored until it is released through a chemical reaction. Some examples are burning gasoline in a car engine, a battery in a flashlight, and the food you eat.

Electrical Energy

Electrical energy can move in different ways, but the most common way is moving through wires to produce, light, sound, motion, or magnetic forces.

Magnetic Energy

Magnetic energy works to move magnetic materials that are in the force field of the magnet.

Mechanical Energy

Mechanical energy is energy of movement. It can be stored in a compressed spring that suddenly expands when released, like in the tops of some types of ball-point pens. Moving objects have mechanical energy, such as a bowling ball that knocks down the pins. Mechanical energy can cause motion or change and even generate heat, sound, or electricity.

Wind and Water Energy

Wind and water energy are often used to make things move, such as sailboats and water wheels in old mills. Today wind and water energy are often used to turn large fans, or turbines, that make electricity

BLM 3 Energy, Motion and Change

Energy, Motion, and Change

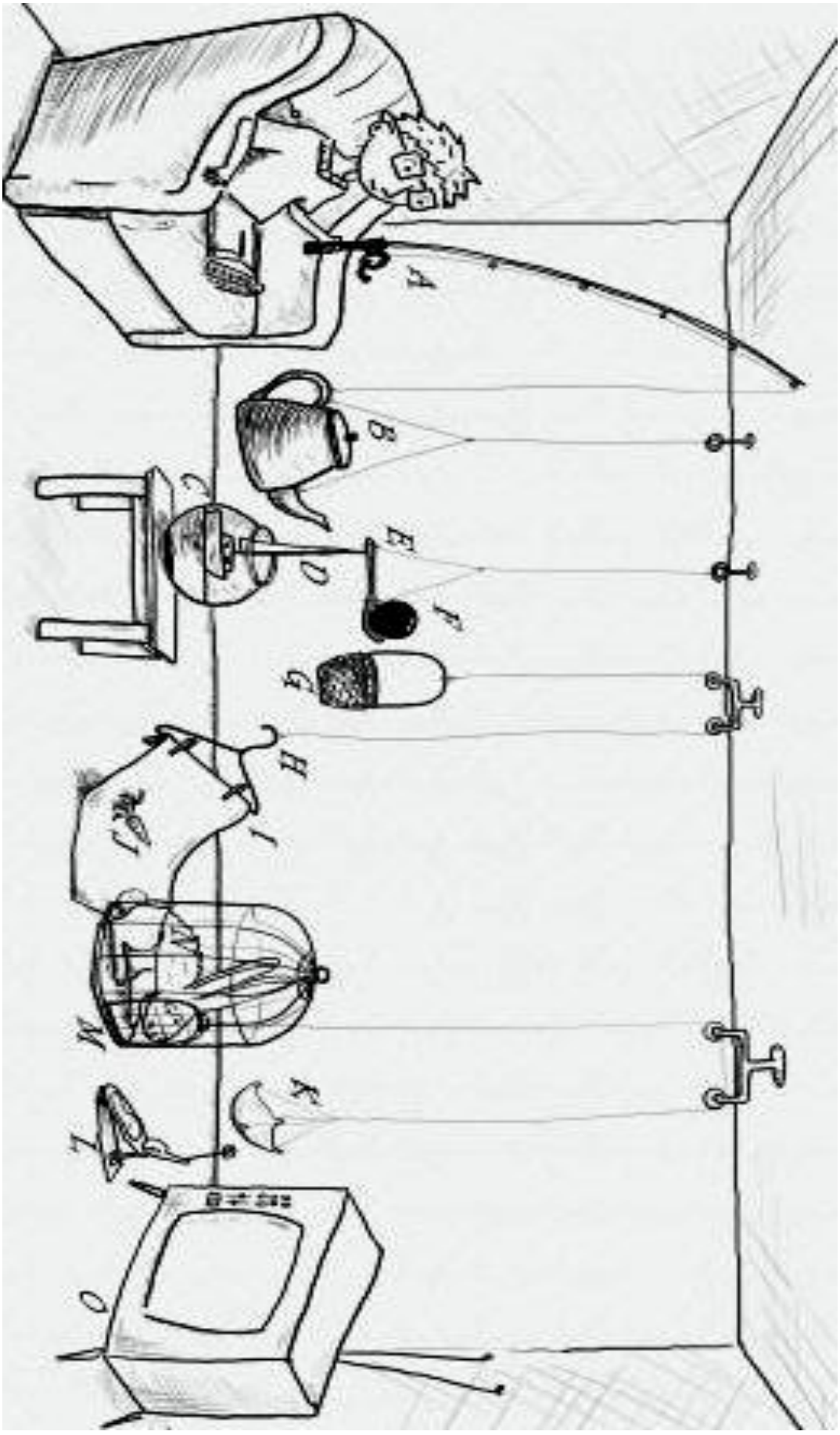
Station Number_____

Light Energy	Sound Energy	Heat Energy	Chemical Energy
Electrical Energy	Magnetic Energy	Mechanical Energy	Wind and Water Energy

Movement and Change

Station Number_____

BLM 4



Boy sitting on couch reels in fishing rod (A) causing kettle (B) to tilt and pour water into fishbowl (C). As water level rises, toy yacht (D) floats higher and tilts spoon (E) causing ball (F) to roll into basket (G). As basket drops to floor, coat hanger (H) rises, making towel (I) stretch tight and baby carrot (J) is launched through the air. As carrot lands in napkin (K), it falls gently onto bass drum pedal (L) and raises door of rabbit cage (M). Rabbit (N) comes out of cage to eat carrot and steps on bass drum pedal, causing pedal to strike the power button on television (O), allowing boy to enjoy the show.

Appendix

Common Student Preconceptions About This Topic

Children's ideas about energy fall into several different types. One view is that energy is something that humans (and perhaps other animals) need in order to live and be active: without energy, people are tired and need to take vitamins, eat food, and/or rest to get more energy. In this view, non-living things are perceived as not needing energy. Another view is that energy is "in" some things but not others, and only things containing energy are able to cause something to move or change in some way. Other students may recognize that some type of energy is needed to make something inanimate "work", as in, "A television works because electricity is put into it when you turn it on." In all these views, energy is seen as something that is consumed, and in many cases it can even run out: a battery dies when its energy is used up, a car stops when it runs out of gas, etc. The idea that energy doesn't run out but instead is converted to another form is an idea that will likely be met with skepticism. It is probably best to avoid introducing it until students are older and have more opportunities to experiment and learn about energy forms and how they are converted from one to another.

Most children recognize a connection between energy and movement. However, for many students movement is an indication of whether or not something has energy, and for others the movement *is* the energy. The concept of potential energy is often particularly problematic for children. For some, potential energy means the potential to have energy. Similarly, children tend to use the words "fuel" and "energy" interchangeably, thinking that fuel *is* energy rather than fuel contains or is a source of energy.