ENERGY TRANSFER: Heat and Light

Background Information

Energy is the ability to do work. Energy can be thought of as a currency which is universally accepted as the way to make things happen. Energy can be stored in many ways and transferred from place to place in many ways.

Some of the most frequently recognized types of energy are heat and light. These, along with others, can be classified as a phenomenon known as electromagnetic radiation (EM). Radiation is energy that travels and spreads out as it goes. The visible light that comes from a lamp in your house and the radio waves that come from a radio station are two types of electromagnetic radiation. The other types of EM radiation that make up the electromagnetic spectrum are microwaves, infrared light, ultraviolet light, X-rays and gamma-rays.

Moving objects have energy and will transfer it into anything with which they interact. A bowling ball carries energy down the lane and transfers it to knock down the pins. As the bowling ball strikes the pins, some of the energy is transferred into sound waves which travel back to cause vibrations in the bowler’s ears. Heat is a form of energy and it carries energy. Heat flows from wherever the temperature is high to everywhere the temperature is lower. The heat from a stove will flow into a cooler pot of water, perhaps causing the water to boil. Temperature is a measure of thermal energy contained in the object. It is contained in the movement and interactions of molecules in the object. The molecules of hotter bodies move faster than the molecules in colder bodies.

The solar energy reaching Earth's surface includes visible light, ultraviolet and infrared radiation.
Ultraviolet (UV) light is high energy and causes damage including sunburn. It causes fading in fabrics, plastic and rubber. UV is invisible to human eyes and the effects on skin are not immediate, so the consequences of overexposure can very easily sneak up on someone.

There are many ways to protect against UV radiation such as using sunglasses, wearing protective clothing and putting sunscreen on the skin.

Electric currents carry energy. An electric current is a stream of electrons moving in a closed path. Those electrons may pick up energy at a battery and deposit it in a light bulb, causing it to glow. Some materials conduct electricity well such as copper wire and aluminum foil.

**Performance Expectation 4-PS3-2:** Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.  
[https://www.nextgenscience.org/pe/4- ps3-2-energy](https://www.nextgenscience.org/pe/4- ps3-2-energy)

**Disciplinary Core Idea**

PS3.A: Definitions of Energy: Energy can be moved from place to place by moving objects or through sound, light, or electric currents.

PS3.B: Conservation of Energy and Energy Transfer: Energy is present whenever there are moving objects, sound, light, or heat. Light also transfers energy from place to place. Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light.

**Science and Engineering Practices**

Planning and carrying out an investigation: Make observations to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.

Asking Questions: Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.

**Crosscutting Concepts**

Energy and matter: Energy can be transferred in various ways and between objects.

Systems and system models: A system can be described in terms of its components and their interactions.

**Materials**

- Student Pages
- 1 Bracer Maze per group
- Transparent tape
- Aluminum Foil
- Liquid Crystal Sheets
- Scissors
- 1 Button Cell Battery (3 volt) per group
- 1 LED (rated for 3 volts) per group
- UV Sensitive Beads
- Pony Beads (optional)
- Chenille Stem or Ribbon
- Items for UV Bead Testing (Water, Sunscreen, Sunglasses, Fabric, Plastic, Waxed Paper)
- Large Clear Drinking Glass
- Ice cubes
- Plastic and Paper Squares
- Pieces of Foam, Quilt batting, Fabric
- Colored Markers, Crayons, or Pencils

**Resources**

**Advanced Preparation**
- You may wish to cut two strips of aluminum foil about 1 cm wide and about 30 cm long for each student group.
- Cut plastic and paper squares, pieces of foam, quilt batting, fabric for the liquid crystal activity into 4” squares.
- Determine where and how supplies will be distributed.

**Suggested Implementation**

**Part 1: Super**

Provide students with a clear plastic cup. Next they will pour some room temperature water into their cup and add some ice cubes. As the cups are sitting in front of students, host a discussion with questions such as:

- The water was warm before you added the ice cubes. What is happening to the ice cubes after you put them in the water?
- What is happening to the temperature of the water after you added the ice cubes?
- What do you think is melting the ice cubes?
- Both the water and ice cubes have energy. Do you think the ice cubes or the warm water had more energy? Explain your idea.
- Which way do you think the energy moving? What evidence do you have?

Ask the students to draw an outline of their thumb or several fingers on the first data table. Read and discuss the data table as a class. Clarify any questions regarding the remaining steps in the procedure. Provide each group with a piece of the liquid crystal paper. (Note: The pieces may need to sit on student desks for a moment to return to their starting color.) Have one of them put their hand on the liquid crystal square, hold it, and take it off. Students record their observations noting the colors in the data table. Assist groups as needed while they work through the rest of the steps. After student have answered the three questions, host a class discussion. If needed use the following prompts:

- What similarities did you observe among the different tests?
- What differences did you observe among the different tests?
- What did you do to cause these changes?
- Why do you think the colors changed?
Where might this type of technology be useful?

Part 2: Power

Advanced Preparation

- Decide which beads you will use. Only UV detector beads? Both UV detector and plain pony beads?
- Based on your decision, modify the procedure as needed.
- Make sure that UV detector beads are their original color.

The UV beads will stay white when inside or not exposed to UV. They will only turn bright colors when exposed to UV, usually from the Sun or a UV (“black”) light. The darker the color of the beads, the more UV rays they are detecting.

Distribute a cup of beads to each group. (Note: If using both types of beads, put a mixture of pony beads and UV detector beads in the cup.) Ask students to string 5 beads (10 if using both) on their ribbon or chenille stem. If possible, have students take their beads outside and make observations. Alternately, beads may be placed in windows. Encourage student discussions regarding their observations, what caused color changes, and the trade-offs of UV light.

Have students share with the class why UV protection is needed. Students will now work in small groups to determine what items they would like to test. Point out the items that you have provided as potential test items. Groups will then devise a plan for testing, carry out the investigations, and record results on the table provided. Once they have completed their tests, the class can compare their results.

Part 3: Bracers of Power

Ask the class:

- Does anyone have a favorite superhero?
- Which superhero needs the most energy? Explain why you think so.
- What is energy?
- List some ways that energy moves from one place to another. How does that happen?

Help students find partners and pass out Student Pages. Ask for volunteers to read aloud the superhero’s speech bubble text and the Problem statement. Allow students to complete Escape from the Maze! You may let each student be responsible for finding one path through the maze. Partners may even race, although the maze is so easy it will be a short race.

Each group will need two strips of aluminum foil about 1 cm wide and about 30 cm long. You can save time by pre-cutting these before you begin the activity.

Allow students to complete Bracers of Power!

Students complete a circuit by adding an LED and battery to the foil strips. The long lead of the LED must
connect to the + side of the battery, but let students figure that out for themselves. Encourage them to keep trying to get the LED to illuminate.

At no point do the Student Pages ever use the word “electricity” or “electric”. This is by intent. Try to avoid introducing this term yourself. Allow students to explain what carries the energy from the battery to the LED.

Allow students to complete Sending Energy Through Space section. Students will direct the LED toward a target on their paper to illuminate it. The fact that they can see color on the white paper indicates that energy from the LED has bounced from the paper into their eyes.

At no point do the Student Pages ever use the word “light”. This is by intent. Try to avoid introducing this term yourself. Allow students to explain what carries the energy from the LED to the target.

Finally, students are asked to consider other things that might carry energy from one place to another. This could be a simple discussion or lead into further experimentation with sound, heat, or moving objects.

**Assessment**

The following single point rubric can be used to assess student understanding. For each of the four criteria listed below, either circle the proficient description or add notes to a box indicating why the student’s performance was either lacking or exceptional.

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<thead>
<tr>
<th>Areas that need improvement.</th>
<th>Criteria for Proficient Performance</th>
<th>Evidence of exceeding standards.</th>
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<tbody>
<tr>
<td>Developing Performance</td>
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<td>Advanced Performance</td>
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<td></td>
<td>Explained that energy was carried</td>
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<td>Explained that energy was carried</td>
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<td>from LED to paper or eyes by light.</td>
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<td>students referenced observations</td>
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<td>additional way in which energy</td>
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**Accommodations**

Next Generation Science Standards
Constructing the foil path requires **fine motor skills**. Students with difficulty can be paired with an appropriate partner.
Reading aloud instructions with students can help those still developing **grade-level reading** skills.

**Extensions**

Have students use the liquid crystal sheets to test the heat given off by different types of light bulbs. Most LED bulbs will remain much cooler than the old style incandescent bulbs making them more efficient. They also use much less electricity. **SAFETY: DO NOT ALLOW LIQUIFD CRYSTAL SHEETS TO COME IN CONTACT WITH LIGHT BULBS.**