

# CAN AN OBJECT PRODUCE MORE THAN ONE TYPE OF ENERGY?

## **BIG IDEA 11: ENERGY TRANSFER AND TRANSFORMATIONS**

### **BENCHMARKS AND TASK ANALYSES**

**SC.3.P.11.1** Investigate, observe, and explain that things that give off light often also give off heat.

**SC.3.N.1.1** Raise questions about the natural world, investigate them individually and in teams through free exploration and systematic investigations, and generate appropriate explanations based on those explorations.

The student:

- poses and investigates questions individually and collaboratively through free exploration and systematic investigations.
- draws conclusions based on the results of the explorations

**SC.3.N.1.6** Infer based on observation.

**SC.3.N.1.7** Explain that empirical evidence is information, such as observations or measurements, that is used to help validate explanations of natural phenomena.

### **KEY QUESTION**

Can an object produce more than one type of energy?

### **TEACHER BACKGROUND INFORMATION**

Heat is a form of energy that moves from one object to another as a result of a difference in temperature. It usually moves from a hot object to a cooler object. The cooler object absorbs this energy and becomes warmer.

Heat moves in three different ways—conduction, convection, and radiation. Conduction moves heat from one object directly to another object. For example, the heat from a rock warmed by the Sun will warm the animal sitting on top of it. Convection transfers heat by the movement of a liquid or gas. The boiling of water in a tea kettle is an example of convection. As the water molecules are heated, they rise and spread heat through the liquid. Radiation is the movement of heat through space in the form of waves. It allows heat to be transferred between objects that are not in direct contact. The Sun radiates heat, as do living human bodies.

Radiation from the Sun provides the Earth with most of its heat. In fuels such as coal, oil, gas, and wood, heat from the Sun is stored, sometimes for millions of years. These fuels can be burned as direct sources of heat. They can also be used to generate electricity, a source of heat that can be carried long distances through wires. The Earth's interior and nuclear reactions are other sources of heat.

### **MATERIALS**

#### **Per group**

Battery  
Battery holders if available  
Flashlight light bulbs  
8-10 inches of coated wire  
Science Notebooks

#### **Teacher**

100 watt bulb  
4 thermometers  
Lamp  
Wire stripper



## **SAFETY**

- Always follow OCPS science safety guidelines.
- Be sure to use extreme caution when dealing with any heat source.
- If you are not able to use battery holders the wires touching the battery will get hot.
- Student can place the wire down on a desk and then place the battery on top using the desk to hold the battery against the wire.
- Have student use caution when constructing the battery and bulb set up.

## **TEACHING TIPS**

1. For the lamp activity in Day 1, choose a lamp with a short base. Be sure to keep the bulb close to the table. A ceramic bulb holder could be used if available.
2. The main focus of this lab is not electricity and circuits. Students might not have prior experience setting up a battery and bulb configuration. The focus of this lab is to understand how the electricity flows through connections that are needed to light a bulb.
3. The wire will need to be cut and the ends stripped prior to the lab. Strip off 2-3 inches so students have enough exposed wire to wrap around the bases of the light bulbs.

## **ENGAGE**

Begin by turning the lights off in the class. Ask: *What are we missing? (Lights)* Explain light is a source of energy. We can refer to it as light energy. When a light bulb is turned on it gives off light energy and another source of energy we are going to explore today.

## **EXPLORE Day 1**

1. Tell students you are going to be recording temperatures today and review the proper use and reading of thermometers.
2. Set up an un-lit lamp with a 100 watt bulb at an observation station. Inform student they will be sent at various times to record temperatures, but they should not touch the lamp.
3. Place a meter stick down at the base of the lamp and place thermometer at 1 cm, 10 cm, 20 cm, and 30 cm.
4. Record beginning temperatures for all the thermometers on class chart. Ask: *Are all of the starting temperatures the same? Do you think any thermometers will change?*
5. Turn on the lamp. Tell students that they will continue to go back and record temperatures in 5 min. intervals and record results on chart.
6. The temperature should rise for the thermometers closest to the light source Ask: *What might cause a change in temperature?*

## **EXPLORE Day 2**

1. Tell the students they are going to create a light source for this investigation.
2. Give each group a battery, battery holder if available, light bulb, and a piece of wire.
3. Draw a diagram of the battery set up on the board and allow students time to construct their own light source.
4. Have each student in the group feel the un-lit light bulb and record their observations in their science notebooks.

Have the group light the bulb after 5 min. Have each group member touch the bulb and record their observations. Ask: *How does the lit bulb compare to the un-lit bulb? What can we say caused the change in temperature we are experiencing?*





### **EXPLAIN**

Students need to make the connections that things that give off light energy also give off heat energy. In the discussion, remember to focus on using the words heat energy and light energy so student can make the connections to the forms of energy explored.

Students should be able to make connections to items in their life that give off heat and light energy such as televisions.

### **EXTEND/APPLY**

1. Place battery bulb and wires in a science center for further exploration. Students can test different strengths of batteries.
2. Have students explore different types of bulbs for heat level, such as incandescent and florescent bulbs.

### **ASSESSMENT**

After students have completed the activity, ask students to respond to the following questions in their science notebook.

1. *Are all light energy sources also heat energy sources?*
2. *How did our experiments help you know?*

# HOW IS HEAT PRODUCED?

## **BIG IDEA 11: ENERGY TRANSFER AND TRANSFORMATIONS**

### **BENCHMARKS AND TASK ANALYSES**

**SC.3.P.11.1** Investigate, observe, and explain that things that give off light often also give off heat.

**SC.3.P.11.2** Investigate, observe, and explain that heat is produced when one object rubs against another, such as rubbing one's hands together.

The student:

- investigates, observes, and explains that heat is produced when one object rubs against another (e.g., rubbing one's hands together, sanding wood, filing fingernails).

**SC.3.P.10.1** Identify some basic forms of energy such as light, heat, sound, electrical, and mechanical.

The student:

- recognizes that energy comes in many different forms.
- identifies forms of energy, such as light, heat, sound, electrical, and mechanical.

**SC.3.N.1.2** Compare the observations made by different groups using the same tools and seek reasons to explain the differences across groups.

The student:

- works in a group using the same tools as other groups to gather common data.
- compares groups' data and explains differences.

**SC.3.N.1.3** Keep records as appropriate, such as pictorial, written, or simple charts and graphs, of investigations conducted.

The student:

- records in a science notebook, pictorial or written information or simple charts and graphs of investigations conducted.

**SC.3.N.1.5** Recognize that scientists question, discuss, and check each other's evidence and explanations.

The student:

- understands that scientists question, discuss, and check each other's evidence and explanations.

### **KEY QUESTION**

How is heat produced from various activities?

### **BACKGROUND INFORMATION**

At this grade level, students do not need to develop formal concepts of energy. However, heat energy, which is produced almost everywhere, is a type of energy which students at this age can begin to explore. By this time in their lives, students should have noticed some things and processes give off heat—lights, radios, television sets, the sun, sawing wood, polishing surfaces, bending things, running motors, people, animals, etc.—and some seem not to give off heat.

It is important to keep in mind that students' ideas about heat are inexact. In some situations, cold is thought to be transferred (e.g., ice cools drinks) rather than heat. Some materials may be thought to be intrinsically warm (blankets) or cold (metals). Students frequently think objects that keep things warm—such as a sweater or mittens—are sources of heat. Use a continuing mix of experiment and discussion to dispel these ideas.

While teaching, it is also important to be aware of the many misconceptions that students at this level have about heat energy and energy transformation. For example, even after instruction, students don't



always give up their naive notion that some substances (e.g., flour, sugar, or air) cannot heat up or that metals get hot quickly because *they attract heat, suck heat in, or hold heat well*. In addition, the transformation of motion to heat seems to be difficult for students to accept, especially in cases with no obvious temperature increase.

## **MATERIALS**

### **Per class**

suggested items (you may make substitutions):

activity-based items – pencil erasers (sandpaper and wood, cloths, crayons, paper clips)

mechanical items – mechanical pencil sharpener, toy car (roller skates)

electrical items – electric pencil sharpener, computer (radio, clock)

light-producing items – flashlight, lamp, television (computer monitor, sunny window)

non-heat producing items – book, plant (cardboard box, toy without moving parts)

### **Per student**

copy of activity sheet *How is Heat Produced?*

## **SAFETY**

Always follow OCPS science safety guidelines.

Remind students to be careful moving around the room.

## **TEACHING TIPS**

1. Activities may vary depending on the availability of items and stations for each activity that will need to be set up throughout the classroom. The activity sheet may need to be edited accordingly.
2. Elicit students' thoughts on heat by using *Uncovering Student Ideas in Science Vol. 1, The Mitten Problem*. Have students complete the probe. Using mittens and thermometers, investigate whether the thermometer in the mitten does record a different temperature than the thermometer not in the mitten.

## **ENGAGE**

Begin by having the class stand up to perform a number of physical activities that produce heat, such as jog in place, stomp their feet, wave their arms up and down, or bend down to touch their hands to their feet again and again. After a few minutes, have students stop the activity to discuss their similar heat-based reactions. You may wish to give them the impression that they are "little heat producers" when they are physically active. Ask: How do you feel right now? Why? In what kinds of situations would you do something like this? Why? Accept all answers, but ask students to support their views with explanations.

Lead the class in a discussion of heat in general terms. Questions may include: Why do people need heat? In what kinds of specific everyday situations do we need heat? What are some of the major sources of heat that we rely on? What kinds of machines produce heat when being used?

## **EXPLORE**

1. Allow the heat-based discussion to lead into an orientation and warm up about the different ways that heat can be produced (by humans, mechanical objects, electrical objects, light). You may want to write the categories on the board and ask what they think these categories represent and how they might relate to heat. You can have them brainstorm to come up with a number of heat-producing activities or machines and let the students decide which categories they would belong.



2. When the categories have been filled up on the board, finish off the activity by adding the additional category of Non-Heat-Producing Situations, explaining that it is important to be aware that there are many objects in the world that do not produce heat. Have them brainstorm again and fill the category with specific objects or situations. (If appropriate, students may revisit this chart in the Assessment section if they need to modify any of their answers based on what they learned in the lesson.)
3. Explain that students will rotate to different areas or stations to explore whether or not certain activities will produce heat. Hand out the How is heat produced? activity sheet. (Students can glue or tape the sheet into their science notebook when completed.) Read over the chart with the class for general comprehension. The first column describes the activity to be performed. In the second column, students estimate the level of heat produced by the activity. Finally, in the third column, they decide in which of the previously discussed five categories the activity belongs. This last column could also be saved to complete as a class in the Explain section.
4. As indicated in the charts, the ten activities will need to demonstrate how heat is produced or not produced (revise chart if needed):
5. Human-based activity – rubbing a pencil eraser on a table (sandpapering wood, rubbing two cloths, scribbling with crayons, bending paper clips back and forth)
6. Mechanical activity (moving parts that rub together) – using a mechanical pencil sharpener, rolling a toy car back and forth (rolling roller skates)
7. Electrical activity – using an electric pencil sharpener, computer (radio, clock)
8. Light-producing activity – using a flashlight or lamp, watching television (computer monitor, sunny window)
9. Non-heat producing activity – reading a book, watching a plant (cardboard box, toy without moving parts)

### **EXPLAIN**

Between activities, have students take short breaks to discuss their findings (for further guidance, insight, and reinforcement). Students should discuss and compare the observations made by different groups and seek reasons to explain the differences across groups.

Overall, it is important that students come to understand that all of the situations that produce heat involve motion—either observable (activity-based and mechanical) or molecular (electrical and light), and that simple, stationary objects do not produce heat. Students should also note that objects that produce light energy also produce heat energy.

### **EXTEND AND APPLY**

Investigate the following websites:

Energy sources and uses, <http://www.energyquest.ca.gov/story/index.html>

Green buildings, <http://www.rmi.org/sitepages/pid479.php#4KSolar>

### **ASSESSMENT**

Review with students what they have learned about how heat is produced by the activities we undertake and by many of the mechanical and electrical machines around us. To further broaden their understanding, you may ask them to ponder and respond to questions like these: Which of the activities did you find most surprising? Why? What are some of the benefits and dangers of heat being produced in human, mechanical, and electrical situations? What would life be like if we didn't have these kinds of heat-producing situations? In what ways has this lesson changed the way you think about heat? Explain.



Student Scientist: \_\_\_\_\_

### How is Heat Produced?

Directions: Fill in the chart with the best answer or observation based on the activity.

<b>Activity</b>	<b>Level of Heat Produced</b> (circle one)			<b>Heat Category</b>
Rubbing an eraser on the table	1 cold	2 warm	3 hot	
Rubbing your hands together	1 cold	2 warm	3 hot	
Rolling a toy car back and forth rapidly	1 cold	2 warm	3 hot	
Using a mechanical pencil sharpener	1 cold	2 warm	3 hot	
Using an electric pencil sharpener	1 cold	2 warm	3 hot	
Using a computer	1 cold	2 warm	3 hot	
Using a flashlight or lamp	1 cold	2 warm	3 hot	
Watching TV	1 cold	2 warm	3 hot	
Reading a page in a book	1 cold	2 warm	3 hot	
Watching a plant	1 cold	2 warm	3 hot	

What did you discover? \_\_\_\_\_



# CAN WE CHANGE HEAT PRODUCTION?

## **BIG IDEA 11: ENERGY TRANSFER AND TRANSFORMATIONS**

### **BENCHMARKS AND TASK ANALYSES**

**SC.3.P.11.2** Investigate, observe, and explain that heat is produced when one object rubs against another, such as rubbing one's hands together.

The student:

- Investigates, observes, and explains that heat is produced when one object rubs against another (e.g., rubbing one's hands together, sanding wood).

**SC.3.N.1.2** Compare the observations made by different groups using the same tools and seek reasons to explain the differences across groups.

The student:

- works in a group using the same tools as other groups to gather common data.
- compares groups' data and explains differences.

**SC.3.N.1.3** Keep records as appropriate, such as pictorial, written, or simple charts and graphs, of investigations conducted.

The student:

- records in science notebook, pictorial or written information or simple charts and graphs of investigations conducted.

**SC.3.N.1.4** Recognize the importance of communication among scientists.

The student:

- understands the importance of communicating results.

**SC.3.N.1.6** Infer based on observations.

### **KEY QUESTION**

Can we change heat production?

### **TEACHER BACKGROUND INFORMATION**

Friction is a force that acts between two objects that are in contact with one another. Friction can produce heat by speeding up the molecules in the objects rubbing together. Friction occurs between all types of matter—liquids, gases, and solids. For example, air resistance is a type of friction that occurs between a moving object and air. It slows down the movement of the object, but it can be reduced by changing the design of the object. This is called streamlining. Cars, trains, and airplanes, for example, are given smooth, curved surfaces to aid the flow of air around them.

Some substances cause more friction than others. Surfaces that slow movement down most are described as high friction, while those that allow more movement are described as low friction. Rough surfaces cause more friction than smooth ones. Friction can be useful. The rubber brakes on a bicycle slow down the wheels when they are applied, and friction between shoe soles and the ground prevent slipping. Friction also causes heat to be created, such as when you rub your hands together. Friction can also cause problems. When two parts of a machine rub against each other they can cause damage, and they lose energy in the form of heat. Using lubricants, such as oil, can reduce friction. Lubricants are substances that help surfaces move against one another more smoothly.

### **Materials**

#### **Per Teacher**

Circle Map



### **Per student**

science notebook  
2 balloons (or per group)  
marker  
safety goggles  
hand lotion

### **SAFETY**

- Always follow OCPS science safety guidelines.
- We aware of any allergies students may have to smells or perfumes before giving them hand lotion.
- Safety goggles should be worn during balloon activity.

### **TEACHING TIPS**

The balloon activity can be done as a teacher demonstration or individual student activity. You may want pre-blow up balloons so they are all approximately the same size. Small in-expensive balloons will work the best.

### **ENGAGE**

1. Have students place hands on their face and notice temperature of their hands.
2. Ask: *Have you ever seen people rubbing their hands or arms when they are cold? Why do they do this? What happens when you rub your hands together?*
3. Direct students to rub their hands together while you count to 30. Have the student again place their hands on their face and discuss the change. Ask: *What caused your hands to feel warm?*
4. Discuss their responses and explain that some of the energy used to rub their hands together changed into heat energy. Tell them that rubbing their hands together is an example of friction.
5. Add the word friction to a Circle Map and ask students for other examples of friction. (Example: brakes on your bike, sliding down a slide etc.)
6. Tell students that they are going to rub their hands together again with lotion on them. Ask: *How do you think it will be different when we rub our hands together now?*
7. Squirt a small amount of hand lotion in the students' hands and tell them to rub their hands together while you count to 30. Have student place hands back on their face.
8. Ask: *Are your hands as warm as last time? Why do you think there is a difference?*
9. Explain to students that the lotion allowed their hands to slide more easily; reducing the friction; when there is less friction, there is less heat energy.
10. Have students draw a Tree Map in their science notebook and record the results of rubbing their hands with and without lotion.

### **EXPLORE**

1. Pass out 2 balloons to each student/group. Have students blow up balloons so they are the same size or pass out pre-blow balloons.
2. Ask: *What will happen if we rub the balloons together? How will it compare to when we rubbed our hands together?*
3. Have the student's record predictions in their science notebooks.
4. Have students put on safety goggles.



5. Have students draw a circle on each balloon with a marker. Tell the students they will line up the circles and rub them together keeping the circle touching at all times. Explain it is important to keep the circle areas of the balloons together to concentrate the heat energy.
6. One balloon will eventually pop. Ask: *Why did rubbing the balloons cause one to pop? Do you think we could reduce the friction between the balloons?*

### **EXPLAIN**

Students should make connections to the hand rubbing experience and recognize the balloons rubbing together created heat energy. The rubber surface of the balloons created enough heat energy to melt the surface of the balloon and cause it to pop. Students' predictions about the effects of rubbing the objects should reflect understanding of the earlier group activity.

### **EXTEND/APPLY**

1. Have students test rubbing their hands as before on a variety of smooth and ruff surfaces in the class (jeans, top of desk, carpet on floor etc).
2. Create a chart of the surfaces that create the most heat.
3. Leave the Circle Map displayed so student can continue to add examples of friction to continue to add to the Circle Map.
4. Have student test a variety of materials (rubbing two pieces of sand paper, blocks of wood, smooth cloth etc).
5. Have students find ways in which friction is used in our daily lives (brakes, rubber keeping your shoes from slipping etc).

### **ASSESSMENT**

After students have completed the activity, ask students to respond to the following questions in their science notebook:

- What is it called when we rub two objects together?
- What does that rubbing produce and how could you prove this to someone?

