Teacher Note: Students will observe kinetic energy being transformed into heat, or thermal energy.

**Subject Area:** Physical Science  
**Grade:** 8

**Standards (Content and Characteristics):**

**S8P2. Students will be familiar with the forms and transformations of energy.**  
- d. Describe how heat can be transferred through matter by the collisions of atoms (conduction) or through space (radiation). In a liquid or gas, currents will facilitate the transfer of heat (convection).

**S8CS2. Students will use standard safety practices for all classroom laboratory and field investigations.**  
- a. Follow correct procedures for use of scientific apparatus.  
- b. Demonstrate appropriate techniques in all laboratory situations.  
- c. Follow correct protocol for identifying and reporting safety problems and violations.

**S8CS8. Students will be familiar with the characteristics of scientific knowledge and how it is achieved.**  
Students will apply the following to scientific concepts:  
- a. When similar investigations give different results, the scientific challenge is to judge whether the differences are trivial or significant, which often requires further study. Even with similar results, scientists may wait until an investigation has been repeated many times before accepting the results as meaningful.
Georgia Performance Standards Framework for Physical Science – GRADE 8

Enduring Understandings:
- Energy cannot be created or destroyed, but is only changed from one form into another.
- Transformations of energy usually release some energy typically in the form of heat.
- Heat energy results due to the disorderly motion of molecules.
- Temperature changes as heat gets transferred.

Essential Questions:
- Where do toys/machines get their energy, and what do they do with it?
- How do toys/machines gain potential energy and turn it into kinetic energy?

ADMINISTRATION PROCEDURES

Pre-Assessment:
True and False Survey – Each student is given two different colored strips of paper (example: blue and yellow). They hold up one color to answer “true” and the other to answer “false”. Use student responses to guide instruction and clarify any misconceptions they may have.

1. When you touch a cold object, the cold travels from the cold surface to your hand.
2. Heat is produced when two objects rub against each other.
3. A bicycle tire gets hot due to friction.
4. A penny gets warmer when struck by a hammer.
Students do not commonly think about thermal energy with collisions and friction such as the point where a bicycle tire contacts the road. During this task, students will measure change in temperature on surfaces due to transfer of heat. They will experience the transformation of different forms of energy into thermal energy in toys and other items that they experience in everyday life.

The hands-on demo will be performed by the teacher for safety purposes. The teacher will follow safety procedures as discussed within the demo description. There are a variety of ways to help students understand that thermal energy is produced when two objects collide (kinetic energy converts to thermal energy) and rub against each other (kinetic energy to thermal energy).

**Demo – Thermite Reaction**

Get two RUSTED iron spheres. Cover one with aluminum foil. Use goggles and gloves (the rust will stain your hands). Move one sphere up and the other down so that they barely scrape against each other. This will take some practice, but the collision will produce a reaction forming a spark. In 8th grade the students may not understand the chemical reaction, but they should understand that energy was transformed from kinetic to chemical to thermal. Watch your knuckles. Do not collide the spheres near your face. Do not have the students do this. Have students observe and identify the energies that exist during the entire demo. They will write their observations and conclusions in their science journals. Kinetic and thermal energy should be obvious, but chemical energy may not be obvious for the students to grasp. So, prompt this during the demo by taking two aluminum sheets and hitting them together which...
will not result in a spark. Also, demonstrate that hitting two iron shots together will not produce a spark.

Teacher notes: If you do not have rusted iron spheres, get iron spheres and allow them to rust prior to doing this task. Rust will not appear instantaneously. This process provides an opportunity to demonstrate physical and chemical changes to the class. If your school does not have access to colliding spheres or iron spheres, check at your high school or a local college. If you cannot get the spheres, the videos may be substituted for the actual demo. Have students make their predictions prior to watching the video. See the video http://tinyurl.com/2rqjsc. A “hot spark fire starter” can be used if the above materials are not readily available. They can be purchased from any Boy Scout retailer for approximately $3.

Teacher note: it may be helpful to review conduction, convection and radiation as methods of heat transfer prior to these activities

Activity 1  To show that energy cannot be created nor destroyed only transferred from one form to another, burn paper by colliding two UNRUSTED iron or steel spheres against the paper.

Colliding Spheres Burn Paper

• Ask students if they believe you can burn paper by colliding the two spheres.
• Students should record their predictions in their science journals.  
• Watch the video http://tinyurl.com/2rqjsc.
• A student’s partner holds up a piece of paper by one edge.
• The student hits the spheres together hard with the paper between them.
• They record their observations and conclude how the holes were produced.
Teacher note: The harder the hit, the bigger the holes. The paper will not catch on fire, but the smell of smoke will be apparent

- Students should discuss their observations with lab partners and describe the activity in their journals in terms of energy. While reading their journals, look for misconceptions in phrases such as “loss of energy”. Students should focus on the "transfer" of energy.

Activity 2

- Measure temperatures using Celsius thermometers or temperature probeware where temperature change can be measured; thus kinetic energy has been converted to thermal energy

Before – Still hands, After – Rub hands together (hold temperature probe in hands)

Before – Tire of a bike at rest, After – Tire after bike has been ridden for several minutes (can measure it after going different speeds)

Before – Engine of model train or motorized car at rest, After – Model train or car after it has run around the track

Before – Light bulbs while off, After – Light bulbs while on (CAUTION-use low wattage bulbs)

(Let students offer other ideas for objects to measure temperature change.)

- Record the data in a table in your science journals.
- Analyze the change in temperatures, and draw a conclusion from your observations. Collect enough data per situation to accurately measure the change in temperature.
Explain how the heat energy was transferred in these activities. Was the heat transferred by conduction? Convection? Radiation? Give a rationale for your explanations.

**Activity 3**

How can you demonstrate heat transfer?

You were able demonstrate heat transfer through collisions of molecules (conduction) in *Activity 2*. You will now explore how currents facilitate the transfer of heat through convection.

**Safety note:** You will be using glass bottles, hot water and food coloring that can stain clothing and skin. Aprons and goggles are required for this activity!

- Take two small empty glass bottles (the same size) and fill one to the very top with cold water.
- Add several drops of food coloring to the other bottle and fill to the top with hot (not boiling) water.
- Place a piece of plastic or index card on top of the hot water.
- Carefully turn the bottle of hot water over and place the bottle on top of the bottle of cold water.
- Holding both bottles, quickly “snap” the card or plastic out and observe the movement of the water for several minutes.
- Record your observations.
- Empty both bottles and refill as above.
- Place the piece of plastic or index card on top of the cold water.
- Carefully turn the bottle of cold water over and place the bottle on top of the bottle of hot water.
- Holding both bottles, quickly “snap” the card or plastic out and observe the movement of the water for several minutes.
- Record your observations.
Compare your observations for the two trials. In a paragraph, explain which water molecules (hot or cold) had the greatest energy. Describe how that energy affected the motion of the molecules. How would you describe the circulation of the currents from one area to another? What method of heat transfer is demonstrated here?

| Materials Needed: | 2 rusted-covered iron spheres and 2 (non-rusted) iron or steel spheres - Available from science supply vendors
Unbreakable Celsius thermometers or temperature probeware and supporting hardware iron- Available from science supply vendors
Aluminum foil
Assorted materials for temperature change experiments. (May include, but are not limited to light bulbs and lamp, motorized model cars or trains, bicycles)
2 empty glass bottles, same size (small olive or bacon-bits jars work especially well). Food coloring, index card or thin plastic sheet (write-on transparency sheets are good), cold and hot (not boiling) water. |

| Safety Precautions: | Wear goggles when using the spheres.
Watch knuckles and toes.
Wear aprons and goggles when handling glass bottles filled with hot water. |

| Task with Student Directions: | Task for demo:
Write predictions and observations that are made and conclusions on what was occurring. Identify as many forms of energy that you observed as you can. Explain why you identified each as an energy source. |
Task for Activities:

Activity 1
- Record observations and conclusions
- Discuss your observations with lab partners and describe them in your journal in terms of energy.

Activity 2
- Measure temperatures for objects at rest and after moving.
- Record data in a table of your own design.
- Analyze the data to determine if there is a temperature change due to energy transformation.
- If a temperature change occurs, explain what energy transformations took place to generate/absorb the energy that caused the temperature change.

Activity 3
- Describe each set-up and record your observations in your science journal.
- Compare your observations for the two trials. In a paragraph, explain which water molecules (hot or cold) had the greatest energy. Describe how that energy affected the motion of the molecules. How would you describe the circulation of the currents from one area to another? What method of heat transfer is demonstrated here?

Resources:

Unitedstreaming Videos
- Heat, Temperature, and Energy – Radiation and The Sun
- Heat, Temperature, and Energy – Calories, Measuring Heat
Georgia Performance Standards Framework for Physical Science – GRADE 8


http://tinyurl.com/39y188 temperature inversion video
http://tinyurl.com/356tof friction fire video
http://tinyurl.com/2kkwgo Physics Solar Toy Workshop - A great demonstration to be performed by the teacher for heat formed during collisions:
http://tinyurl.com/2rqjsc
http://www.arborsci.com/CoolStuff/cool26.htm Thermodynamics Newsletter

Homework / Extension: Have students create a flip-chart for the methods of heat transfer. Fold a piece of paper in half, vertically (long ways). Cut the top half only into thirds. Write “conduction”, “convection” or “radiation” on each of the three divisions. Lift the flap and underneath write the definition and an activity/example of this type of heat transfer. Have students discuss ways that temperature sensors could be used in real-life applications to measure temperature changes that reflect transformation of energy. Students may use internet research, personal interviews, experience, or any other source. They should prepare a one-minute presentation for the class that describes how the device works and what energy transformations are made.

Note to teacher: IR sensors are used by a variety of people from firefighters, police officers, NASCAR engineers, AC repair-men, military, etc.
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<tr>
<th>Instructional Task Accommodations for ELL Students:</th>
<th>The ELL students may need a word bank (with basic definitions) along with specific writing prompts in their science journals in order to complete observations and conclusions. The word bank should include the names of the materials/equipment used in the demos and the activity. The ELL student may also benefit from a table placed in their journals and clearly labeled for data collection.</th>
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<td>Instructional Task Accommodations for Students with Specific Disabilities:</td>
<td>Students with organizational deficits may need specific writing prompts written in advance and placed in their science journals for the demo and the activities. In the prompts, the teacher may need to include specific vocabulary to be covered in the observations/conclusions. The student may also need a table prepared in advance for the activity. Be sure that students who have focusing difficulties are completing and recording data collection in the activity involving the thermometers or temperature probes. Students may need limits set as to how many repetitions are allowed for a measurement.</td>
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<td>Instructional Task Accommodations for Gifted Students:</td>
<td>Gifted students might explore the use of infrared sensors and their applications, such as “night vision goggles”, and report their findings to the class in a poster presentation.</td>
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