Transferring Kinetic Energy to Thermal Energy

Exploration

The law of conservation of energy states that the total energy of an isolated system remains constant. Over time, all energy is conserved. It is neither created nor destroyed-instead it transfers from one form to another. When shaking a jar of sand, what happens to the temperature of the sand? Explore how this relates to the law of conservation of energy.

Materials

- Jar of sand
- Ziplock bag that can be completely sealed
- PocketLab

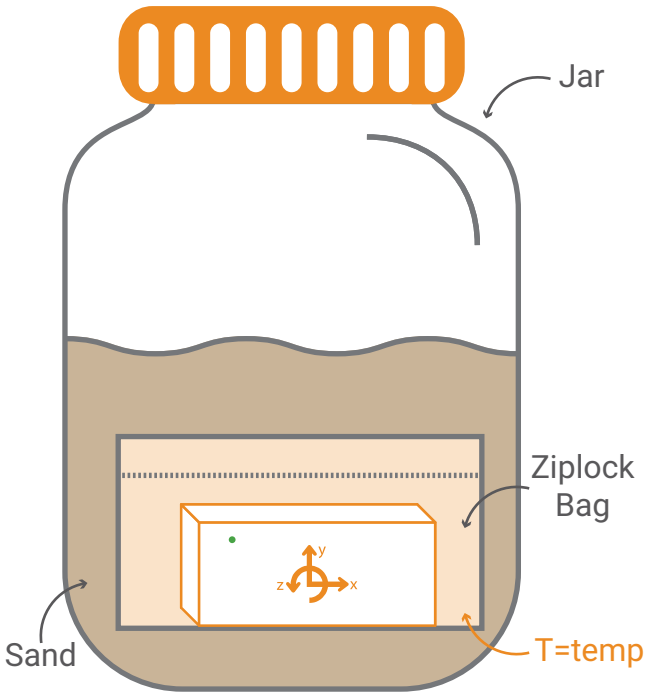
Objective

In this experiment, students will:

1) Observe how kinetic energy transfers to thermal energy.

2) Use observations of heat transfer to better understand the law of conservation of energy.

3) Trace the thermal energy in the sand to energy from sunlight.



Method

1. Seal the PocketLab in a Ziploc bag. Ensure the bag is completely sealed. Use tape if needed. The jar and PocketLab will be shaken vigorously, so test out the seal by shaking the sealed PocketLab in an empty jar. If the seal breaks and sand gets inside the PocketLab it may become damaged.
2. Place the sealed PocketLab into the jar of sand and close the jar. Allow the PocketLab to read the temperature of the sand. Set the jar down and wait for the temperature sensor to settle. Record the temperature of the sand for an additional 30 seconds.
3. Shake the jar at a moderate rate. For 1 minute record both temperature data and acceleration scalar data while shaking the jar. Set the jar down and wait for the temperature sensor to settle. Record the temperature of the sand for an additional 30 seconds.
4. Repeat step 3, but shake the jar more vigorously. Monitor the acceleration scalar data to ensure the shaking is more vigorous.
5. Repeat step 3 and 4 one more time, shaking the jar more vigorously.

Note: The PocketLab's temperature sensor is not a probe. The temperature sensor is just as accurate, but takes a longer time to "settle" on the correct temperature. For best results, make sure the PocketLab has been sitting at room temperature for while before beginning the experiment, and make sure to allow the temperature sensor time to "settle" on the correct temperature before recording data.

Predictions

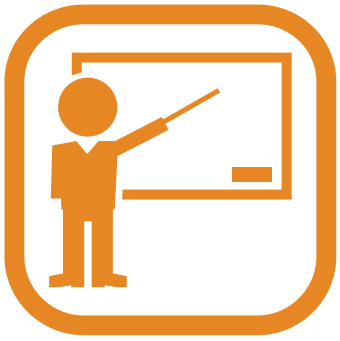
- What type of energy is increased when the jar is shaken with greater and greater acceleration? Explain.
- How will increasing the acceleration caused by shaking the jar affect the temperature of the sand? Explain your prediction in terms of energy.

Data Analysis and Observations

- How did kinetic energy from the shaking affect the thermal energy of the sand? Support your answer with collected data.

Conclusions

- Explain why the thermal energy changed by shaking the jar. Why did it change as the shaking of the jar increased?
- Think about how the jar was shaken. It required energy for you to shake the jar. Did that energy disappear after you used it? If not, where did it go? How did you get the energy to shake the jar in the first place? Trace the energy change in the sand to energy that comes to Earth through sunlight. How does this help explain the law of conservation of energy?



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TEACHER GUIDE

When setting up the experiment, make sure the PocketLab is completely sealed. Don't allow any sand to leak into the bag, otherwise the PocketLab could be damaged. Make sure to test the seal by shaking the PocketLab in the jar without sand to ensure the seal will stay during the experiment. Between each trial, check that the seal is still good.

Push students to connect the shaking of the jar to kinetic energy. As the kinetic energy increases, they should observe the temperature of the sand increasing. This is because the kinetic energy from their shaking is being transferred to thermal energy in the sand. To highlight the relationship between kinetic energy and thermal energy, have students rub their hands together. They should feel the temperature of their hands increase. The faster they move their hands, the greater the increase in temperature. Point out that this is another example of kinetic energy transferring to thermal energy.

Students can then try to trace the increase in thermal energy of the sand to energy that originally came to Earth as sunlight. This will help students understand how energy is continuously conserved and recycled as it transfers from one form to another.