

### Materials Needed

- 4 to 6-ounce jar with water-tight removable lid
- Tap water
- Thermometer that can be put into a liquid, (a submersible thermometer can be ordered from <https://bit.ly/2NM85re>)
- Stopwatch
- Paper
- Pencil or pen

### Grade Range

3-5  
6-8

### Topics/Skills

Science: Properties of Matter; Measurement; Energy

### Learning Standards

NGSS: [Physical Science](#); [Energy](#)  
CCSS: [Measurement and Data](#)

### Duration

30 minutes

### Prep Time

5 minutes

## Shaking Up to Heat Up

### Temperature Changes in a Shaken, not Stirred, Liquid

In this activity students will vigorously shake a container of water, converting some of the **potential chemical energy** stored in their bodies into **kinetic energy**, which is the energy of motion. This kinetic energy is transferred to the water. What will happen to the temperature (a measure of the **thermal energy** present) when kinetic energy is added?

### Activity Challenge

How much thermal energy, as measured by a rise in temperature, can be added to a liquid by adding kinetic energy by shaking the container of liquid?

### Preparation

1. Review the Materials Needed list and gather materials.
2. Allow time for the tap water to become room temperature.
3. Make a table (example on next page) to record the water temperatures.

### To Do

1. Fill the jar about halfway with room temperature water.
2. Place the thermometer in the water for about 30 seconds.
3. Read the thermometer and record the temperature of the water in the table (like the one on the next page). Remove the thermometer.
4. Securely tighten the lid onto the container.
5. Predict whether, and by how much, the temperature of the water will change after shaking and write down your prediction in the table.
6. Hold the jar securely at the top and bottom between your thumb and forefinger, or in such a way as to not warm the jar with your hands.
7. Shake the jar vigorously for 5 minutes. Take turns with someone if needed. Shaking the jar can get tiring!
8. After 5 minutes, remove the lid and measure the temperature of the water again. Record the new water temperature in the table.
9. Repeat steps 5 to 8 two more times.

### Observations

What kind of energy did you use to shake the water? What happens to the temperature of the water after shaking it? Will it go up, down, or stay the same, and by how much?

### Extensions

- Repeat this activity using liquids with different properties, like liquid dish detergent, rubbing alcohol, or cooking oil. Does type of liquid affect the results? If yes, why could that happen?

- Try starting with water at different temperatures, like refrigerated water or hot tap water. Do different starting temperatures affect the results?
  - If the water in the jar is not at room temperature, it will eventually reach room temperature without shaking. How can a second unshaken jar of liquid (a **control**) be used to determine how much of the temperature change is only due to the shaking?
- Explore energy transfer further with RAFT’s learning activity sheet **Homemade Butter**.

**The Science behind the Activity**

When you rub your hands together quickly your palms become warm due to the **friction** of skin rubbing against skin. This is an example of some of the stored food energy (**chemical energy**) in your body being converted into muscle motion (**kinetic energy**) and then into heat (**thermal energy**).

In this activity, some potential chemical energy gets converted into kinetic energy as your muscles move and when the jar is shaken. The kinetic energy is transferred to the liquid as the liquid molecules get moved about. Shaking the jar causes the liquid’s molecules to hit or rub against each other, as well as to rub against the sides of the jar. This causes the temperature of the liquid to rise. Stirring or swirling the water around in a circle takes less energy to do and creates much less friction and thus less warming of the water.

In this experiment the system is your body, the air around you, the jar, and the water. Your stored food energy is transformed into muscle movement. That muscle movement warms the muscles and that warmth can spread to other parts of your body and the air. You may become so warm while shaking that your body will sweat to help cool off!

The moving muscles shake the jar and cause the water to move and slosh around. The increased motion of the water molecules can be measured as an increased in the temperature of the water. The warmer water will warm the air in the jar, the jar and whatever is in contact with the jar. The heat transfer continues until room temperature is reached by the water in the jar.

The thermal energy (heat) of the liquid is increased by the transferring of the energy used in the muscles that are used to shake the container. The energy is transferred, not created.

Room Temperature Water	Predicted Temperature after 5 minutes of shaking	Actual Temperature after 5 minutes of shaking	Predicted Temperature after 10 minutes of shaking	Actual Temperature after 10 minutes of shaking	Predicted Temperature after 15 minutes of shaking	Actual Temperature after 15 minutes of shaking
68 degrees Fahrenheit	78 degrees Fahrenheit +10 degrees					