Heat and Energy

In these simple experiments, you can plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system, which is a way to demonstrate the second law of thermodynamics.

The materials you need:

- Two thermometers

For experiment one:

- A pitcher and a cup (or any two containers)
- Milk and hot coffee are one option, but fluids of different temperatures

For experiment two:

- Tap water and ice cubes.
- A bowl to hold ice cubes.
- A container for the tap water.

Experiment one:

1. Take a hot fluid (such as hot coffee) and partly fill a coffee cup (or other container).
2. Take a cooler fluid (such as milk from a refrigerator) and mostly fill another container.
3. Take the temperature of each fluid.
4. Now combine the two—pour some of the cooler fluid into the container with the hotter fluid.
5. Measure the temperature of the combined fluid.

Experiment two:

1. Place the ice cubes in a bowl and partially fill a container with tap water.
2. Measure the temperature of the ice cubes and the tap water. Adjust the temperature of the water you put in the container until the water is above room temperature but not so hot as to be able to burn you.
3. Now place the ice cubes in the water.
4. Measure the temperature of the combination at 5, 10, and 15 minutes. This should allow time enough for the ice cubes to melt. If they have not melted, wait a bit.

Questions:

1. How does the temperature of a substance relate to its thermal energy?
2. When you combine the fluids (or fluid and solid), how does the temperature of the combination relate to the temperature of each substance individually?
3. Explain why the temperatures of the substances change. What is flowing?
4. If you did experiment two, you controlled the temperature of the hotter fluid and used ice cubes, but what third fluid is playing a role in this experiment?
5. Can you reverse these processes—e.g., can you separate the coffee and milk (if you used those substances) so that you have the original situation of hotter coffee and cooler milk? Consider what law of thermodynamics might guide your answer.
6. Explain this experiment in terms of the law of thermodynamics.