Soup to Spoon

Trace heat flow through particle motion

CHE.10.1 "Enrichment: Construct explanations to explain how temperature and heat flow in terms of the motion of molecules (or atoms)."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline two statements that link temperature to particle motion, and circle the words that show where energy moves.

Why Does the Handle Warm Up?

1. A cook leaves a room-temperature stainless-steel spoon in a bowl of hot soup. The soup's moving molecules collide with the spoon's submerged end. Temperature is linked to the average kinetic energy of particles: hotter soup has molecules with greater average motion energy than the atoms in the cooler spoon. Individual particles in either material move at different speeds, so temperature does not tell us the speed of every particle. Before contact, the soup and spoon have different temperatures. Once they touch, energy can pass between them because of that difference.

2. At the spoon's submerged end, collisions with soup molecules transfer energy to the metal. The metal atoms stay near fixed positions, but they vibrate more vigorously as their energy rises. Energy travels toward the handle through vibrating atoms and mobile electrons in the steel. The handle can become warmer even though no soup molecules reach it and the spoon's atoms do not march from one end to the other. Heat is the name for energy transferred because of a temperature difference, not a substance stored inside an object. Its net flow begins in the hotter soup and moves into the cooler spoon.

3. Imagine the bowl and spoon are perfectly insulated from the room. As the soup gives up energy, its molecules have less average kinetic energy, and the soup's temperature falls. The spoon gains energy, its atoms vibrate more vigorously, and its temperature rises. Over time, the soup and the entire spoon can reach the same temperature. Particles still move and exchange energy at their shared boundary, but neither side gains energy overall from the other. That is why there is no net heat flow between them at thermal equilibrium. In a real kitchen, energy also escapes to the air.

2 ANSWER WITH EVIDENCE

Use the passage

1. Why does energy begin to flow from the soup to the submerged end of the spoon when they touch? Use temperature and particle motion in your answer.

2. How can the handle warm up without soup molecules traveling up the spoon? Explain what happens inside the steel.

3. In the insulated setup, why does the soup's temperature fall while the spoon's temperature rises? Describe the change in particle motion in each.

4. At thermal equilibrium, particles still move. Why is there no net heat flow between the soup and spoon?

3 YOUR TURN

Your own words

A warm clay tile touches a cool clay tile inside an insulated container. In four or five sentences, explain the motion of atoms in both tiles before contact, the direction of heat flow, how their temperatures change, and what happens when they reach the same temperature.

ANSWER KEY

Soup to Spoon

PART 1 · READ AND MARK

Underline two statements that link temperature to particle motion, and circle the words that show where energy moves. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Why does energy begin to flow from the soup to the submerged end of the spoon when they touch? Use temperature and particle motion in your answer.	**The soup is hotter, so its molecules have greater average kinetic energy than the spoon's atoms. Collisions transfer energy from the soup to the cooler metal.**
2	How can the handle warm up without soup molecules traveling up the spoon? Explain what happens inside the steel.	**Energy travels through the steel by vibrating atoms and mobile electrons. The atoms in the handle vibrate more vigorously as they gain energy.**
3	In the insulated setup, why does the soup's temperature fall while the spoon's temperature rises? Describe the change in particle motion in each.	**Energy moves from the soup to the spoon. The soup molecules have less average kinetic energy, while the spoon's atoms vibrate more vigorously.**
4	At thermal equilibrium, particles still move. Why is there no net heat flow between the soup and spoon?	**The soup and spoon are at the same temperature. Particles still exchange energy, but neither side gains energy overall.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Before contact, atoms in the warm tile vibrate more vigorously on average than atoms in the cool tile. When the tiles touch, heat flows from the warm tile to the cool tile. The warm tile loses energy, so its atoms vibrate less vigorously and its temperature falls. The cool tile gains energy, so its atoms vibrate more vigorously and its temperature rises. Once both tiles reach the same temperature, their atoms still vibrate, but there is no net heat flow between the tiles.

Accept explanations that connect temperature to average particle motion and net heat flow to a temperature difference. Students may mention vibrating atoms without mentioning mobile electrons when explaining the steel spoon.