Closing the Gap

Use temperature data to trace heat transfer.

PHY.3.5 "Investigate, collect data, and summarize the principles of thermodynamics by exploring how heat energy is transferred from higher temperature to lower temperature until equilibrium is reached."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Circle the two temperatures recorded at each time. Then number the table rows 1 to 5 from greatest to smallest temperature difference to track how the materials approach equilibrium.

Two Temperatures, One Cup

1. On a sunny afternoon, pavement can be warmer than the air above it. Thermal energy moves from the warmer pavement toward the cooler air. This transfer is called heat. As a temperature difference shrinks, the rate of transfer usually slows. At equal temperatures, energy still moves microscopically, but there is no net heat transfer.

2. To investigate another temperature change, a class places an aluminum block into water inside an insulated cup and starts a timer. A probe records each material's temperature at the same moments. The cup reduces heat exchange with the room, but does not eliminate it. The table reports one trial; all temperatures were rounded to the nearest degree Celsius.

TEMPERATURES IN AN INSULATED CUP

Time (min)	Block (°C)	Water (°C)
0	80	20
1	62	27
2	49	33
4	39	38
6	38	38

3. Temperature indicates the direction of net heat flow, not an object's total thermal energy. To track changes, compare each material's readings across the trial. Rounding can hide small differences, and the cup cannot perfectly isolate its contents. A matching pair of readings suggests that the materials are near equilibrium, but further measurements could test whether their temperatures remain equal.

2 ANSWER WITH EVIDENCE

Use the passage

1. At the start of the trial, which way does net heat flow between the block and the water? Use both starting temperatures to explain.

2. From 0 to 2 minutes, how much does each material's temperature change? State whether each change is an increase or a decrease.

3. Compare the temperature difference at 2 minutes with the difference at 4 minutes. What do these differences show?

4. Which reading gives the strongest evidence that the materials are near equilibrium? Use the numbers, and explain why one reading cannot prove they will stay at the same temperature.

3 YOUR TURN

Your own words

Design a new insulated-cup test using two materials other than aluminum and water. In 4 or 5 sentences, give starting temperatures, explain what and when you would measure, predict the initial direction of net heat flow, and describe the readings that would support equilibrium.

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PART 1 · READ AND MARK

Circle the two temperatures recorded at each time. Then number the table rows 1 to 5 from greatest to smallest temperature difference to track how the materials approach equilibrium. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	At the start of the trial, which way does net heat flow between the block and the water? Use both starting temperatures to explain.	**Net heat flows from the 80 °C block to the 20 °C water because heat moves from higher to lower temperature.**
2	From 0 to 2 minutes, how much does each material's temperature change? State whether each change is an increase or a decrease.	**The block decreases by 31 °C, from 80 °C to 49 °C. The water increases by 13 °C, from 20 °C to 33 °C.**
3	Compare the temperature difference at 2 minutes with the difference at 4 minutes. What do these differences show?	**The difference shrinks from 16 °C to 1 °C, showing that the materials are approaching thermal equilibrium.**
4	Which reading gives the strongest evidence that the materials are near equilibrium? Use the numbers, and explain why one reading cannot prove they will stay at the same temperature.	**At 6 minutes, both readings are 38 °C. The values were rounded, and later readings would be needed to check whether they remain equal.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

I would place a copper piece at 65 °C in a cup of oil at 22 °C. I would record both temperatures every minute with separate probes while keeping the cup covered. Initially, net heat would flow from the copper to the oil because the copper is hotter. Nearly equal readings that stay steady during two later measurements would support the conclusion that the materials are near thermal equilibrium.

Accept any valid pair of materials with different starting temperatures and net heat flow predicted from warmer to cooler. Evidence of equilibrium should involve temperatures becoming nearly equal, ideally across repeated measurements.