

Tracing Heat Flow

Follow heat as temperatures change and become equal.

SC.7.P.11.4 "Observe and describe that heat flows in predictable ways, moving from warmer objects to cooler ones until they reach the same temperature."

NAME _____

DATE _____

1 READ AND MARK _____ Read it twice

YOUR JOB Underline every phrase that tells which object is warmer or cooler, and number each heat-flow direction in the order you find it.

When Temperatures Meet

- ① During a lab, Maya pours warm water into a ceramic mug. The mug begins at room temperature, much cooler than the water. Energy transfers as heat from the warmer water to the cooler mug. The water's temperature decreases, while the mug's temperature increases. The air around the mug is also cooler than the water, so heat moves from the water to the nearby air. Each transfer continues while a temperature difference exists. Heat does not move from a cooler object to a warmer object on its own.
- ② In a second test, students place a 70°C metal block against a 20°C metal block inside an insulated container. The blocks are identical in size and material. Heat flows from the 70°C block to the 20°C block. As energy leaves the warmer block, its temperature falls. As energy enters the cooler block, its temperature rises. After enough time, both blocks measure 45°C. They have reached thermal equilibrium, which means they have the same temperature. At that point, no net heat flows between the blocks, even though their particles still move.
- ③ Thermal cameras can show changing temperatures with colors, but a thermometer gives number measurements. Imagine checking the two blocks every few minutes. At first, one reading would drop and the other would rise. The readings would get closer together because heat transfer reduces the temperature difference. Equal temperature is not the same as zero energy. In both blocks, particles continue moving. Thermal equilibrium means the energy exchanged in each direction balances, so there is no net transfer of heat from one block to the other.

2

ANSWER WITH EVIDENCE

Use the passage

1

In the mug situation, which two cooler things receive heat from the warm water?

2

What happens to the water's temperature and the mug's temperature as heat moves from the water to the mug?

3

For the two metal blocks, what is the direction of heat flow at the start? Use the temperatures in your answer.

4

What evidence shows that the metal blocks have reached thermal equilibrium, and what happens to net heat flow then?

3

YOUR TURN

Your own words

First observe heat transfer with your teacher. An adult puts a small thin-walled metal cup containing cool water inside a larger insulated container of comfortably warm water, keeping the waters separate. Two non-glass probes measure the inner and outer water. Record both starting readings in degrees Celsius; then record them each minute for at least ten minutes and continue until the difference is within the probes' resolution. On extra paper make Time / Inner water / Outer water rows. Describe the temperature changes, initial net heat-flow direction and evidence of approaching the same temperature. If readings are still different, report that equilibrium has not yet been observed. Then complete the two-row model below: invent two new two-object situations, name warmer/cooler objects, show heat-flow direction and describe the final temperature condition.

OBJECTS AND STARTING TEMPERATURES	HEAT-FLOW DIRECTION	FINAL CONDITION

PART 1 • READ AND MARK

Underline every phrase that tells which object is warmer or cooler, and number each heat-flow direction in the order you find it. Accept any marking that follows this job and points at the right text.

PART 2 • ANSWERS

#	QUESTION	ANSWER
1	In the mug situation, which two cooler things receive heat from the warm water?	The ceramic mug and the nearby air receive heat from the warm water.
2	What happens to the water's temperature and the mug's temperature as heat moves from the water to the mug?	The water's temperature decreases, and the mug's temperature increases.
3	For the two metal blocks, what is the direction of heat flow at the start? Use the temperatures in your answer.	Heat flows from the 70°C block to the 20°C block.
4	What evidence shows that the metal blocks have reached thermal equilibrium, and what happens to net heat flow then?	Both blocks measure 45°C, so they have the same temperature. No net heat flows between them.

PART 3 • YOUR TURN (SAMPLE ANSWER)

OBJECTS AND STARTING TEMPERATURES	HEAT-FLOW DIRECTION	FINAL CONDITION
Two identical sealed water bottles, one at 60°C and one at 20°C, touching in an insulated cooler	From the 60°C bottle to the 20°C bottle	Both bottles reach 40°C, so no net heat flows between them.
Two identical ceramic tiles, one at 50°C and one at 30°C, touching in an insulated container	From the 50°C tile to the 30°C tile	Both tiles reach 40°C, so no net heat flows between them.

Accept equivalent descriptions that identify heat moving from the warmer object to the cooler object. For the open task, accept reasonable examples that state the objects eventually reach the same temperature and have no net heat flow between them. Teacher supplies a stable nested-cup setup, comfortably warm water no hotter than 40°C, cool room-temperature water, two safe temperature probes, timer and tray. Adult handles pouring and probe placement; keep inner water separate, immerse enough of the inner cup for thermal contact, do not touch probe tips to metal. Pretest convergence and extend observations if needed; no stove or 70°C blocks for children. Check actual paired time readings and warmer-to-cooler explanation, accepting measured disagreement or no change with investigation of limitations. Ambient losses also occur, so do not force an exact average temperature. Treat the retained 40°C model examples as idealized equal-heat-capacity insulated cases with negligible container heat capacity, not observed predictions. ACS Heat, Temperature, and Conduction supports paired warming/cooling observations and notes short tests may not reach equilibrium; this nested-water setup is an adaptation: <https://www.acs.org/middleschoolchemistry/lessonplans/chapter2/lesson1.html> .