Where Energy Goes

Track energy changes in a heated cup

HS-ICP3-1 "Quantitatively analyze various scenarios to describe how the change of energy in one component in a system responds to the change in energy of the other components and flow of energy into and out of the system are known."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline what crosses the system boundary, circle the parts that store energy, and number the quantities you would use to check whether a trial's energy accounts balance.

The Heated Cup Lab

1. Students use an electric coil to heat water in a steel cup. The system includes the water, cup, and coil. Electrical energy enters through the coil, and energy leaves for the room. Because the coil begins and ends at the same temperature, its net energy change is zero. The remaining energy changes belong to the water and cup.

2. The table shows four trials. In each, the equipment begins at the same temperature, and all energy values are measured in joules (J). "Water gain" and "cup gain" describe increases in stored thermal energy. "Room loss" is energy crossing out of the system, not energy stored in the cup. One entry was erased from the lab notebook.

ENERGY IN FOUR HEATING TRIALS

Trial	Electrical input (J)	Water gain (J)	Cup gain (J)	Room loss (J)
A	500	330	70	100
B	500	290	90	120
C	650	450	80	120
D	650	440	?	100

3. To check a trial, add the gains in the system and the energy that left for the room. That total should match the electrical input. To compare two trials with equal input, track each change, including energy sent to the room. A larger room loss does not, by itself, reveal which system component gained less energy.

2 ANSWER WITH EVIDENCE

Use the passage

1. In trial A, how much energy did the system gain in total? Show how the input and room loss support your answer.

2. Trials A and B have the same electrical input. How do the changes in cup gain and room loss account for the change in water gain?

3. Calculate the missing cup gain in trial D. Show your energy calculation.

4. From trial C to trial D, the room loss decreases. Why does the water gain also decrease? Use all three energy changes in your explanation.

3 YOUR TURN

Your own words

Design two new heating trials with 720 J of electrical input in each. Choose different cup gains and room losses, calculate each water gain, and explain how the changes in cup gain and room loss affect the water.

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PART 1 · READ AND MARK

Underline what crosses the system boundary, circle the parts that store energy, and number the quantities you would use to check whether a trial's energy accounts balance. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	In trial A, how much energy did the system gain in total? Show how the input and room loss support your answer.	**The system gained 400 J: 500 J entered and 100 J left for the room. The water and cup gains also total 330 + 70 = 400 J.**
2	Trials A and B have the same electrical input. How do the changes in cup gain and room loss account for the change in water gain?	**From A to B, cup gain rises by 20 J and room loss rises by 20 J. With the same input, water gain falls by 40 J.**
3	Calculate the missing cup gain in trial D. Show your energy calculation.	**Cup gain = 650 − 440 − 100 = 110 J.**
4	From trial C to trial D, the room loss decreases. Why does the water gain also decrease? Use all three energy changes in your explanation.	**Room loss falls by 20 J, so the system gains 20 J more. Cup gain rises by 30 J, leaving water gain 10 J lower.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

In trial 1, the cup gains 80 J and the room receives 140 J, so the water gains 720 − 80 − 140 = 500 J. In trial 2, the cup gains 110 J and the room receives 170 J, so the water gains 440 J. Both cup gain and room loss rise by 30 J, leaving 60 J less for the water.

Accept any two trials with different nonnegative cup gains and room losses, nonnegative calculated water gains, and an explanation consistent with the changes. For each trial, cup gain, room loss, and water gain must total 720 J.