Where Heat Goes

Read a heating curve through energy and temperature data.

CHE.7.3 "Analyze and interpret heating curve graphs to explain the energy relationship between states of matter (e.g., thermochemistry-water heating from -20oC to 120oC)."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the sentence that explains a rising curve and circle the sentence that explains a flat curve. Write R or F beside each table row to show whether that section rises or stays flat.

Heating Water, Step by Step

1. A 10 g sample of H_2O starts at −20 °C at 1 atm. A heater adds energy while a probe measures temperature. The table shows five consecutive sections of a heating curve. Energy values are cumulative, measured from the start. To graph the data, place energy on the horizontal axis and temperature on the vertical axis.

FIVE SECTIONS OF THE HEATING CURVE

Cumulative energy (kJ)	Temperature (°C)
0 to 0.42	−20 to 0
0.42 to 3.76	0 to 0
3.76 to 7.94	0 to 100
7.94 to 30.54	100 to 100
30.54 to 30.94	100 to 120

2. A rising segment means temperature increases as energy enters the sample. Particles move faster on average, so their average kinetic energy rises. A horizontal segment means energy enters without a temperature increase. During that interval, particles rearrange as the substance changes state, and their potential energy increases. The heater has not stopped working.

3. At this pressure, water melts at 0 °C and boils at 100 °C. On a heating curve, a section at either temperature may show two states present at once. The horizontal distance along the energy axis tells how much energy an interval requires. A wider horizontal segment therefore represents more energy transferred during a phase change.

2 ANSWER WITH EVIDENCE

Use the passage

1. What happens to the water from 0.42 to 3.76 kJ? Explain where the added energy goes.

2. Compare the temperature changes from 3.76 to 7.94 kJ and from 7.94 to 30.54 kJ. What does each change show about the water?

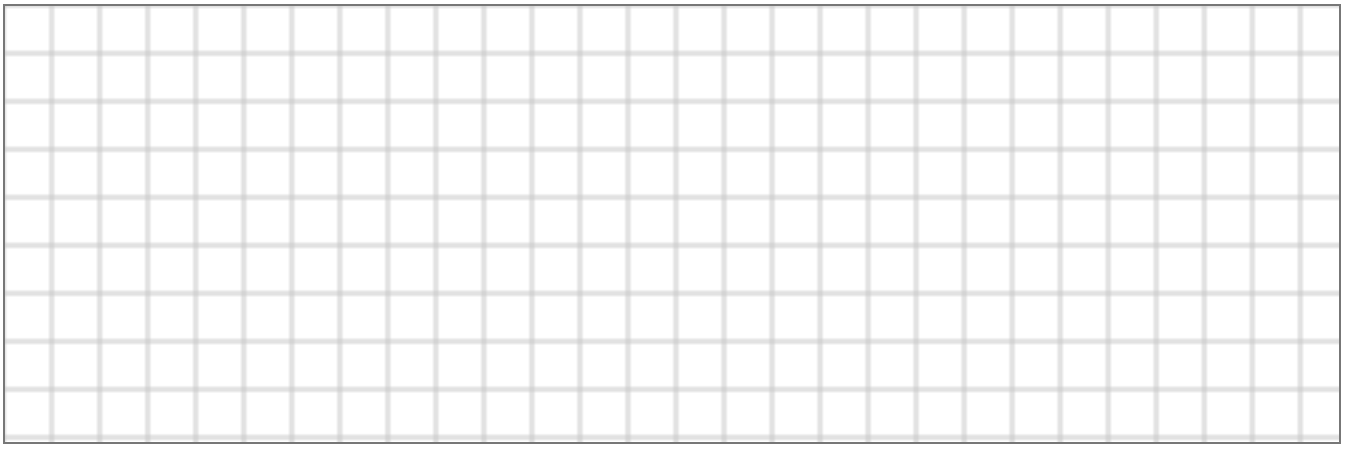
3. How much energy does boiling require compared with melting in this sample? Use the table to support your answer.

4. From 30.54 to 30.94 kJ, which state of water is warming? What happens to its particles' average kinetic energy?

3 YOUR TURN

Your own words

Plot the table's section endpoints on the grid to make a heating curve, and label both axes. Mark the point at 5.00 kJ, then write two sentences estimating the temperature there and explaining the water's state and how its energy is changing.



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PART 1 · READ AND MARK

Underline the sentence that explains a rising curve and circle the sentence that explains a flat curve. Write R or F beside each table row to show whether that section rises or stays flat. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	What happens to the water from 0.42 to 3.76 kJ? Explain where the added energy goes.	**The ice melts at 0 °C. The added energy increases the particles' potential energy as they rearrange, rather than raising the temperature.**
2	Compare the temperature changes from 3.76 to 7.94 kJ and from 7.94 to 30.54 kJ. What does each change show about the water?	**From 3.76 to 7.94 kJ, liquid water warms from 0 °C to 100 °C. From 7.94 to 30.54 kJ, the temperature stays at 100 °C while the water boils.**
3	How much energy does boiling require compared with melting in this sample? Use the table to support your answer.	**Boiling requires 22.60 kJ (30.54 − 7.94), while melting requires 3.34 kJ (3.76 − 0.42). Boiling requires 19.26 kJ more.**
4	From 30.54 to 30.94 kJ, which state of water is warming? What happens to its particles' average kinetic energy?	**Water vapor warms from 100 °C to 120 °C. Its particles' average kinetic energy increases.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Graph: Energy (kJ) on the horizontal axis and temperature (°C) on the vertical axis. Connect (0, −20), (0.42, 0), (3.76, 0), (7.94, 100), (30.54, 100), and (30.94, 120); mark 5.00 kJ at about 30 °C. At 5.00 kJ, the water is liquid at about 30 °C. Its temperature is rising, so its particles' average kinetic energy is increasing.

For the marking job, accept R, F, R, F, R in table order. For the graph, accept a temperature near 30 °C at 5.00 kJ and a reasonable scale that shows both horizontal sections.