Clues in the Heat

Use temperature and particle motion to predict phase changes.

PS.5.b "Analyze and interpret data to predict changes in the phase of a material based on changes in particle motion, temperature, pressure, or thermal energy."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Circle temperatures in the table where two phases coexist, then underline sentences in the passage that help explain why temperature can stay steady while energy enters.

Heating a Water Sample

1. A research team warms a small sample of pure water in a vented container at normal atmospheric pressure. They add thermal energy at a steady rate and record the sample every two minutes. The table pairs each temperature with what the team sees. Use both columns: temperature alone cannot show how much of a phase change is complete.

WATER HEATED AT NORMAL ATMOSPHERIC PRESSURE

Time (min)	Temperature (°C)	Observed phases
0	-5	Ice
2	0	Ice and liquid water
4	0	Ice and liquid water
6	20	Liquid water
8	100	Liquid water and water vapor

2. In a solid, water molecules vibrate around fixed positions. As energy enters, their motion increases until melting begins. During melting, added energy loosens the arrangement of molecules instead of raising temperature, so ice and liquid water can exist together. Once all the ice melts, added energy raises the liquid's temperature again.

3. At normal atmospheric pressure, liquid water boils at about 100 °C. During boiling, added energy separates molecules into gas while temperature stays near that value. At lower pressure, boiling begins at a lower temperature. Pressure shifts the boiling point, but a flat temperature reading during heating, alongside both liquid and gas, signals a phase change.

2 ANSWER WITH EVIDENCE

Use the passage

1. Between minutes 2 and 4, the temperature stays at 0 °C even though energy enters. What phase change is taking place, and where is that energy going?

2. Between minutes 4 and 6, the temperature rises and only liquid water remains. What does this pattern show about the ice and the motion of the liquid molecules?

3. If heating continues just after minute 8 at the same pressure, predict how the amounts of liquid water and water vapor will change. What will happen to the temperature while both phases remain?

4. If the team repeats the test at a lower pressure, would boiling begin above or below 100 °C? Use the passage to explain your prediction.

3 YOUR TURN

Your own words

A different pure substance starts as a liquid at 12 °C. As thermal energy is removed at a steady rate, its temperature reaches 5 °C and stays there while solid and liquid are both present; then the temperature falls again. In three sentences, predict its phase after the temperature starts falling again and explain the pattern using particle motion and thermal energy.

ANSWER KEY

Clues in the Heat

PART 1 · READ AND MARK

Circle temperatures in the table where two phases coexist, then underline sentences in the passage that help explain why temperature can stay steady while energy enters. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Between minutes 2 and 4, the temperature stays at 0 °C even though energy enters. What phase change is taking place, and where is that energy going?	**The ice is melting. Added energy loosens the molecules' solid arrangement rather than raising the temperature.**
2	Between minutes 4 and 6, the temperature rises and only liquid water remains. What does this pattern show about the ice and the motion of the liquid molecules?	**All the ice has melted. Added energy now increases the motion of the liquid molecules, so the temperature rises.**
3	If heating continues just after minute 8 at the same pressure, predict how the amounts of liquid water and water vapor will change. What will happen to the temperature while both phases remain?	**The amount of liquid will decrease and the amount of vapor will increase. The temperature will stay near 100 °C while boiling continues.**
4	If the team repeats the test at a lower pressure, would boiling begin above or below 100 °C? Use the passage to explain your prediction.	**Boiling would begin below 100 °C because lower surrounding pressure lowers water's boiling point.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

After the temperature starts falling again, the substance is solid. At 5 °C, removing thermal energy changes liquid into solid while both phases are present, so the temperature stays steady. Once the change is complete, further energy loss reduces particle motion and the solid's temperature falls.

Accept explanations that describe energy changing particle arrangement during a phase change rather than raising or lowering temperature. For Your Turn, the response must identify the final phase as solid and account for both the steady temperature and the later drop.