Heating and Cooling Curves of Water

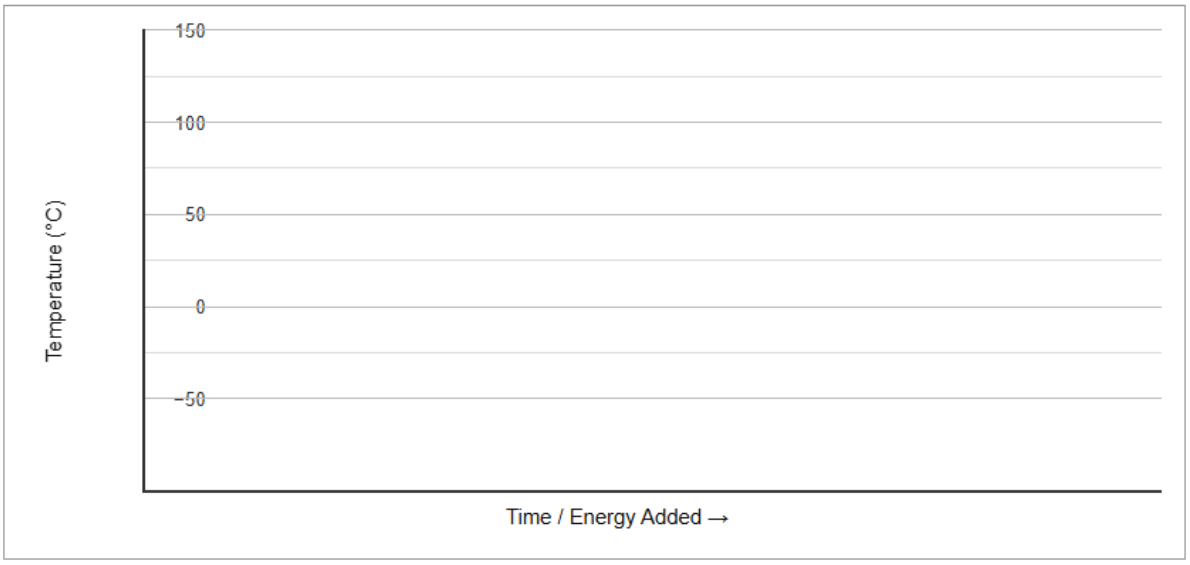
A worksheet on states of matter and phase changes

Name: Class: Date:

Instructions: Use the interactive simulation to complete this worksheet. Heat the substance from −50°C to 150°C, then cool it back down. Observe the graph and particle arrangement at each stage.

Section 1 — Sketch the Heating Curve

Using the simulation, sketch the heating curve of water in the grid below. Label the axes and mark the melting point and boiling point.



On your sketch, label: Solid, Melting, Liquid, Boiling, Gas | Mark the Melting Point (0°C) and Boiling Point (100°C)

Section 2 — Recording Observations

Complete the table as you heat the substance from −50°C to 150°C.

Stage	Temperature range / plateau	What do you observe on the graph?	What are the particles doing?
Solid	−50°C to 0°C	Temperature rises steadily.	Particles vibrate about fixed positions. They are very closely packed in an orderly arrangement.
Melting	0°C (plateau)	Temperature stays constant at 0°C.	Energy is absorbed to overcome forces of attraction between particles. Particles break free from fixed positions.
Liquid			

Boiling			
Gas			

Section 3 — Energy Changes

Complete the table by classifying each process and explaining the energy change. Details for boiling and freezing are provided for you.

Process	Endothermic or Exothermic?	What happens to the energy and why does temperature stay constant?
Melting		
Boiling	**Endothermic**	Energy is absorbed to overcome forces of attraction between particles. All energy goes into separating particles, so temperature stays constant.
Condensation		
Freezing	**Exothermic**	Energy is released as particles attract one another and settle into fixed positions. Temperature stays constant as energy is released to the surroundings.

Section 4 — Macroscopic, Microscopic & Symbolic

For the process of **melting**, the following information is provided:

Level	Description
Macroscopic What we observe	Ice turns into liquid water. Temperature stays constant at 0°C. The substance changes from a solid (fixed shape and volume) to a liquid (no fixed shape, fixed volume).
Microscopic What particles do	Particles absorb energy and overcome forces of attraction. They break free from their fixed positions and begin to slide past one another. Spacing between particles increases slightly.
Symbolic Representations	H_2O (s) → H_2O (l) | Melting point: 0°C | Endothermic process | Plateau on heating curve at 0°C

Now do the same for **boiling**.

Level	Description
Macroscopic What we observe	
Microscopic What particles do	
Symbolic Representations	

Section 5 — Short Answer Questions

1. Why does the temperature remain constant during melting, even though energy is still being added?
2. How does the particle arrangement differ between the liquid state and the gas state?
3. A student says: *"Freezing releases energy, so the surroundings get colder."* Do you agree? Explain.
4. Compare the heating curve and cooling curve of water. What is the same and what is different?
5. State one piece of evidence from the simulation that supports the kinetic particle model.

Choose two questions to answer:

Question number: My answer:
Question number: My answer:

Section 6 — True or False

Circle **True** or **False** for each statement. If false, write the correct statement on the line below.

Statement	**True / False**	**Correction (if false)**
During melting, the temperature of a substance remains constant.	T / F	
Boiling is an exothermic process.	T / F	
Gas particles are very far apart and move rapidly in random directions.	T / F	
Freezing is an endothermic process.	T / F	
During condensation, the kinetic energy of particles increases.	T / F	