Particle Energy Story

Model how heating and cooling change particles and states of matter.

MS-PS1-4 "Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed..."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline every sentence that tells how thermal energy changes particle motion or temperature. Circle each phrase that names a change of state or a stage where two states are present.

Water on a Hot Plate

1. Imagine an open beaker of pure water on a hot plate at constant air pressure. A model can show water particles as identical circles. In solid ice, the circles stay in an orderly arrangement and only vibrate in place. When thermal energy is added, the particles vibrate faster. The ice temperature rises because the particles have greater average kinetic energy. Heat is energy transferred because of a temperature difference. This transfer changes the substance's internal energy, represented through particle motion and arrangement in the model.

2. At the melting point, added thermal energy does not make the temperature rise right away. Instead, it helps loosen the attractions that hold particles in the solid arrangement. The sample contains both solid and liquid while it melts. A useful model shows some particles still ordered and close together, while others remain close but can move past one another. After all the ice becomes liquid, adding more thermal energy again increases particle motion and raises the liquid's temperature.

③ Continue heating the open beaker at the same constant pressure. In liquid water, particles remain close together but move around each other. Their average kinetic energy and the temperature increase until the boiling point. During boiling, added thermal energy separates particles into gas instead of increasing temperature. The model must show liquid water and water vapor together at this stage. In a model that continues heating the vapor at constant pressure, added energy makes the far-apart gas particles move faster and raises the gas temperature. Removing thermal energy reverses these patterns: particles move more slowly, and temperature falls except during a change of state.

2 ANSWER WITH EVIDENCE

Use the passage

1. Why does the temperature of solid ice rise when thermal energy is added before the ice reaches its melting point?

2. What should a particle model show while pure water is melting?

3. What must a model show during boiling, and why does the temperature stay constant at that stage?

4. According to the passage, what happens to particle motion and temperature when thermal energy is removed?

3 YOUR TURN

Your own words

Draw a four-panel particle model for pure water in an open container at constant pressure as it is heated from solid ice through boiling. In each panel, label the state or states, particle spacing and motion, thermal energy being added, and whether temperature rises or stays constant.

ANSWER KEY

Particle Energy Story

GRADES 6-8 · MS-PS1-4

PART 1 · READ AND MARK

Underline every sentence that tells how thermal energy changes particle motion or temperature. Circle each phrase that names a change of state or a stage where two states are present. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Why does the temperature of solid ice rise when thermal energy is added before the ice reaches its melting point?	**The particles vibrate faster and have greater average kinetic energy.**
2	What should a particle model show while pure water is melting?	**It should show both solid and liquid. Some particles are ordered and close together, while others are close together but can move past one another.**
3	What must a model show during boiling, and why does the temperature stay constant at that stage?	**It must show both liquid water and water vapor. Added thermal energy separates particles into gas rather than increasing temperature.**
4	According to the passage, what happens to particle motion and temperature when thermal energy is removed?	**Particles move more slowly, and temperature falls except during a change of state.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Panel 1: Solid ice has particles close together in an orderly pattern. Thermal energy is added, particles vibrate faster, and temperature rises. Panel 2: Melting water has both ordered solid particles and close liquid particles that move past one another. Thermal energy is added, and temperature stays constant. Panel 3: Liquid water has close particles moving around one another. Thermal energy is added, particles move faster, and temperature rises. Panel 4: Boiling water has close moving liquid particles and far-apart water vapor particles. Thermal energy is added, and temperature stays constant.

Accept clear drawings, labels, or written particle descriptions that match the required states, spacing, motion, energy change, and temperature change. During melting and boiling at constant pressure, students must show two states present and a constant temperature. Distinguish energy stored in the substance from heat, which is energy transfer due to a temperature difference. The vapor-heating extension is a model; vapor can escape from an open beaker. Reference: OpenStax University Physics Volume 2, 1.4 Heat Transfer, Specific Heat, and Calorimetry.