

Heat, Temperature and State Changes: Mastery Check

Learning target: I can show that I can tell heat, temperature and thermal energy apart, predict which way energy moves, name and model all six changes of state, read a heating curve, and explain why substances change state at different temperatures.

Retrieval and mastery check

About 40 min

Individual

MS-PS1-4 · assesses

MS-PS3-4 · supports

independent practice

writing

Name _____

Date _____

Period _____

Directions

Work alone. Part A has eleven items; Part B is one paragraph. Show your work on items that ask for a calculation, and use complete sentences where an item asks you to explain. All temperatures for melting and boiling are at normal sea-level air pressure. Points for each item are shown in the margin.

You will need: This worksheet, Pencil, Calculator (optional)

Part A: Retrieval (items 1-11)

1. Which statement about temperature is correct? 2 pts
 - ☐ A. It measures the total energy of all the particles in a sample.
 - ☐ B. It measures the average kinetic energy of a sample's particles.
 - ☐ C. It measures how much heat an object contains.
 - ☐ D. It is always higher in a larger sample of the same substance.
2. A 2-liter pot of water and a 200-milliliter mug of water are both at 60 °C. Which statement is true? 2 pts
 - ☐ A. The mug has more thermal energy because it is smaller.
 - ☐ B. They have the same temperature, and the pot has more thermal energy.
 - ☐ C. They have the same thermal energy because they have the same temperature.
 - ☐ D. The pot has a higher temperature because it holds more water.
3. A metal spoon at 22 °C is placed in a bowl of soup at 70 °C. Which way does energy move as heat? 3 pts

What happens to the temperature of each object, and when does the overall transfer stop?

4. Name the change of state in each case and say whether thermal energy goes into or out of the substance that changes. 3 pts

Change of state	Thermal energy into or out of the substance?
a. A block of dry ice shrinks and leaves no puddle.	
b. Dew forms on grass early on a cool morning.	
c. Melted chocolate hardens in the refrigerator.	
d. Big bubbles of vapor rise all through a pot of soup.	

Heating an unknown pure solid at a steady rate (teaching dataset)

Simulated teaching dataset: the numbers are invented to be realistic, not measured.

Time (min)	Temperature (°C)
0	20
2	32
4	44
6	54
8	54
10	54
12	54
14	62
16	70

Simulated data for items 5a to 5c. The sample started as a solid.

5. Use the table. (a) What is the melting point of the substance? (b) How fast did its temperature rise from minute 0 to minute 4, in °C per minute? Show the calculation. (c) What state or states were present at minute 9? 3 pts

6. True or false: 'Adding thermal energy to a substance always raises its temperature.' Circle your answer and use the table above to explain. 2 pts

☐ True ☐ False Explain your thinking:

7. Draw two particle boxes: water vapor in the air near a cold window, and the same water after it has condensed on the glass. Show spacing and motion, and draw one arrow showing which way energy moves between the water and the window. 3 pts



8. Helium boils at about -269°C , but water boils at 100°C . What best explains the difference? 2 pts
- ☐ A. Helium atoms are so light that they float away from the liquid.
 - ☐ B. The attractions between helium atoms are much weaker than those between water molecules.
 - ☐ C. Helium is made of bigger particles than water.
 - ☐ D. Water molecules move faster than helium atoms at every temperature.

9. A puddle on the playground disappears on a 15°C day. Which explanation is correct? 2 pts
- ☐ A. The puddle boiled, because all liquids boil in sunlight.
 - ☐ B. The most energetic water molecules at the surface escaped into the air as vapor.
 - ☐ C. The water turned into air.
 - ☐ D. The water must have soaked into the ground, because water cannot become a gas below 100°C .

10. Two identical hot plates heat a 150 g block and a 300 g block of ice, both already at 0°C . The 150 g block takes 6 minutes to melt completely. How long should the 300 g block take? What does the thermometer read in each block while it melts? Explain briefly. 3 pts

11. A cold can of juice gets covered in drops on a humid day but stays nearly dry in a room with very dry air. Explain where the drops come from and why the amount of water vapor in the air matters. 3 pts

Part B: Synthesis (item 12)

- 12.** Ethanol melts at about -114°C and boils at about 78°C . A sample of solid ethanol at -130°C is heated at a steady rate until it is a gas at 90°C . In one paragraph, tell what happens to the particles' motion, the temperature and the state at each stage, including both level stretches and why the temperature holds steady in each. End by explaining why ethanol's melting and boiling points are lower than water's. 4 pts

Optional supports for this check

Students who need it may use a one-page reference with the six-change map (solid, liquid and gas joined by arrows marked energy in or energy out) and the sentence frame 'Temperature is the ___ ; thermal energy is the ___ ; heat is ___.' Items may be read aloud. For item 12, offer a five-box organizer: solid warming, melting, liquid warming, boiling, gas warming.

Write a question that would catch a misconception

Choose one misconception from this chapter (for example, cold flowing, temperature always rising when energy is added, or the white cloud being water vapor). Write a multiple-choice question with four options in which each wrong option matches a specific mistaken idea. Write a one-line note for each wrong option explaining which misconception it catches, and trade with a classmate to test it.