When Particles Shift

Use particle theory to explain phase changes in three substances.

PHS.8.2 "Apply particle theory to phase change and analyze freezing point, melting point, boiling point, vaporization, and condensation of different substances."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Circle each boiling temperature in the table, and underline phrases in the passage that describe what particles do during heating or cooling.

Three Samples, Different Changes

1. Imagine three labeled samples in a computer simulation: pure water, pure ethanol, and pure acetone. Each starts as a liquid, and the surrounding pressure stays at one atmosphere. The table lists temperatures at which each substance changes phase. For a pure substance at the same pressure, its freezing point is also its melting point.

PHASE-CHANGE TEMPERATURES AT ONE ATMOSPHERE

Substance	Freezing / melting point (°C)	Boiling / condensation point (°C)
Water	0	100
Ethanol	-114	78
Acetone	-95	56

2. Heat a liquid slowly. Its particles move faster on average until it reaches its boiling point. Then added energy separates particles into gas instead of raising the temperature during the change. At the same pressure, substances boil at different temperatures because the attractions between their particles differ. Evaporation can also occur below the boiling point.

3. Cooling reverses energy flow. When a gas condenses, it releases energy as particles come closer together. When a liquid freezes, it releases energy while particles settle into more fixed positions; they still vibrate. A melting solid absorbs energy as particles move more freely. During a phase change, a pure substance's temperature stays constant at fixed pressure.

2 ANSWER WITH EVIDENCE

Use the passage

1. At 20 °C, which of the three substances would be liquid at one atmosphere? Explain using both temperature limits.

2. Ethanol cools from 90 °C to 70 °C at one atmosphere. Which phase change occurs? Explain what happens to its particles and where energy goes.

3. At -100 °C, which substances are solid and which is liquid at one atmosphere? Use their freezing points to explain.

4. Pure acetone is boiling at one atmosphere. Why can its temperature stay at 56 °C while heat enters?

3 YOUR TURN

Your own words

Choose two different substances from the table and invent one heating or cooling trip for each, with starting and ending temperatures. For each trip, identify a phase change crossed and explain particle behavior and energy transfer.

When Particles Shift

PART 1 · READ AND MARK

Circle each boiling temperature in the table, and underline phrases in the passage that describe what particles do during heating or cooling. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	At 20 °C, which of the three substances would be liquid at one atmosphere? Explain using both temperature limits.	**All three would be liquid. For each substance, 20 °C is above its freezing point and below its boiling point.**
2	Ethanol cools from 90 °C to 70 °C at one atmosphere. Which phase change occurs? Explain what happens to its particles and where energy goes.	**Ethanol condenses at 78 °C. Its particles come closer together, and energy leaves the ethanol.**
3	At -100 °C, which substances are solid and which is liquid at one atmosphere? Use their freezing points to explain.	**Water and acetone are solid because -100 °C is below their freezing points of 0 °C and -95 °C. Ethanol is liquid because -100 °C is above its freezing point of -114 °C and below its boiling point.**
4	Pure acetone is boiling at one atmosphere. Why can its temperature stay at 56 °C while heat enters?	**The added energy separates acetone particles into gas rather than raising the temperature during boiling.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Water warms from -10 °C to 10 °C, crossing its melting point of 0 °C. As it melts, its particles gain freedom to move past one another, and energy enters the water. Acetone cools from 65 °C to 40 °C, crossing its condensation point of 56 °C. Its particles come closer together during condensation, and energy leaves the acetone.

Accept other starting and ending temperatures if each trip crosses the correct phase-change point at one atmosphere. Particle behavior and energy transfer must match the direction of each change.