



Particle Box

Mission: The lab's molecular microscope zooms in 100 million times. Heat and cool water, oxygen, and iron and build a particle model that explains solids, liquids, and gases.

Big question: How does adding or removing thermal energy change particle motion and state?

★ Warm-up: Draw a model

Draw 6 circles for particles in each box: solid, liquid, gas. Then answer.

How are particles arranged in a solid? ✓ **Tightly packed in a pattern, vibrating in place.**

What is different about a gas? ✓ **Particles are far apart and move fast in all directions.**

Key vocabulary

Particle	A tiny piece of matter (atom or molecule).
Thermal energy	The total energy of moving particles.
Temperature	A measure of the average speed (kinetic energy) of particles.
Melting point	The temperature where a solid becomes a liquid.
Boiling point	The temperature where a liquid becomes a gas.

1 Box 1

Predict

PREDICTION As you keep heating, what will happen to the temperature when the ice reaches 0 °C?

- ☐ It keeps rising steadily ☐ It pauses at 0 °C while the ice melts ☐ It drops

Melt the ice

In the simulator: Heat the water until it is a liquid.

You predicted: _____. What did the thermometer do at 0 °C?

- ☐ It paused at 0 °C while particles broke free ☐ It jumped to 100 °C ☐ It kept rising the whole time

✓ **It paused at 0 °C while particles broke free**

2 Box 2

Boil it

In the simulator: Keep heating until the water becomes a gas.

Compare the gas to the liquid. Choose all that are true.

Choose all that apply.

- ☐ Particles move faster ☐ Particles are farther apart ☐ Particles fill the whole box ☐ The particles got bigger

✓ **Particles move faster; Particles are farther apart; Particles fill the whole box**

3 Box 3

Particle data

Record the state and describe the particle motion.

Temperature	State
-20 °C	solid
50 °C	liquid
120 °C	gas

4 Box 4

Remove energy

In the simulator: Cool the water back into ice.

What happened to the particles as you removed thermal energy?

- ☐ They slowed down and locked into place ☐ They sped up ☐ They disappeared ☐ They shrank
✓ They slowed down and locked into place

5 Box 5

Oxygen

In the simulator: Switch to **Oxygen** and find its state change temperatures.

At what temperature does oxygen boil?

Answer: _____ °C **✓ -183**

Same model, different numbers

Water, oxygen, and iron all follow the same particle model. What is different?

- ☐ The temperatures where they melt and boil ☐ Iron particles never move ☐ Oxygen has no particles
☐ Only water can be a gas
✓ The temperatures where they melt and boil

6 Box 6

Legend: iron Legend only

In the simulator: Melt iron.

Why does iron need so much more thermal energy to melt than ice?

- ☐ Iron particles are held together much more strongly ☐ Iron particles are bigger ☐ Iron has fewer particles
✓ Iron particles are held together much more strongly

7 Box 7

Particle model (CER)

How does adding thermal energy change particles and state?

Claim

Look for: Particles move faster; at least 6 words

Evidence

Look for: Uses observations of the states; Uses the melting/boiling point data; a number from the simulator; at least 12 words

Reasoning

Look for: Explains with energy; Explains how particles separate; at least 12 words

Exit ticket: answer the big question in your own words

How does adding or removing thermal energy change particle motion and state?

Look for: All matter is made of particles in constant motion. Adding thermal energy makes particles move faster, raising temperature; at the melting and boiling points, the energy breaks particles free instead of raising the temperature. Removing energy slows particles until they lock into a solid.

Completion codes

Students see a code like **ABC-I3** when they finish. The first part must match below. The letter is the level (E = Explorer, I = Investigator, L = Legend), and the number at the end is how many stars they earned.

Level	Code starts with
 Explorer	S20-E
 Investigator	AF0-I
 Legend	1XV-L

Watch for these misconceptions

- "Particles in a solid do not move." They vibrate in place.
- "The bubbles in boiling water are air." They are water vapor (gas).
- "Particles expand when heated." Particles themselves do not grow; the spaces between them get larger.