

Particle Panic at Polar Station

Particle Model of Matter & States of Matter: 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. (Enrichment: this topic is not in the 2023 Indiana Grade 6 science standards.)

Learning target: I can use the particle model to explain the states of matter and changes of state.

Success looks like: Students use the vocabulary correctly, complete the escape room, and score 80% or higher on the evidence-based exit ticket.

Materials: Student devices, the printed lesson worksheet (one per student), projector for the mini-lesson presenter.

LESSON AT A GLANCE

60 minutes

Time	Part	Teacher does	Students do
0:00-0:08	Warm-up	Project the warm-up. Circulate, then call on 2-3 students. Save question 3 for the debrief.	Answer Part 2 of the lesson worksheet; share with a partner.
0:08-0:20	Mini-lesson	Teach with the 4-step presenter. Run each quick check with the whole class.	Complete worksheet Parts 4-11 as each slide appears; answer checks with fingers.
0:20-0:48	Escape Room	Launch Particle Panic at Polar Station. Assign mission levels; circulate with the answer key.	Play solo or in pairs; record code pieces; complete any written evidence task.
0:48-0:52	Debrief	Ask 2 debrief questions and revisit warm-up question 3.	Finish worksheet Part 13 (prediction check + one thing learned).
0:52-1:00	Exit ticket	Hand out the exit ticket. Collect and sort with the mastery guide.	Answer with evidence independently.

Key vocabulary

Word	Student-friendly definition
Particle	A tiny piece of matter (atom or molecule) too small to see.
Thermal energy	The total energy of moving particles in a substance.
Temperature	A measure of the average motion (kinetic energy) of particles.
Melting / freezing	Solid to liquid / liquid to solid.
Evaporation / condensation	Liquid to gas / gas to liquid.
Sublimation	Solid directly to gas (dry ice).

1. WARM-UP

0:00–0:08 · 8 min

Warm-up expectations (post these): Answer in Part 2 of the lesson worksheet (or on this sheet). Number each answer to match the question. Answer in complete sentences. For math, show your work. Work silently for 5 minutes, then share with a partner for 2 minutes. Be ready to share one answer with the class.

#	Question	Look for
1	Name the three common states of matter and one example of each.	Solid (ice), liquid (water), gas (water vapor/air).
2	What happens to a puddle on a hot, sunny day? What is that process called?	The water evaporates: it changes from liquid to gas.
3	Why does a cold soda can get wet on the outside on a warm day?	Water vapor in the air cools on the can and condenses into liquid.

2. MINI-LESSON

0:08–0:20 · 12 min

Project the Lesson presenter from the room page. It runs the whole hour: target and agenda, warm-up with timer, hook vote, 4 teaching steps (key idea, interactive tool, turn and talk, check for understanding), I do / we do / you do, a work-time screen with a timer and expectations, debrief, and the exit ticket. Press N for teacher notes, T to pause the timer, and P to pick a student.

Hook (1 min): Which particles are moving right now: the ones in your desk, your water bottle, or the air?
Class vote: Only the air / The water and the air / All three

Step 1 (3 min): Particles are always moving

Teach	All matter is made of tiny particles that never stop moving. Temperature measures how fast they move on average.
Interactive tool	Simulation: Heat and cool the water particles
Students do	Describe how the particles move at -20 °C in 5 words or fewer.
Turn and talk	A spoon feels solid and still. Are its particles moving? How do you know?
Worksheet Part 5A	All matter is made of PARTICLES that are always MOVING. TEMPERATURE measures their average speed.
Check for understanding	What happens to particles when temperature rises? Answer: (A) They move faster

Step 2 (3 min): Solids, liquids, gases

Teach	Solids: packed tight, vibrate in place, definite shape. Liquids: close but slide past each other, take the container's shape. Gases: far apart, fast, fill the container.
Interactive tool	Flip cards: Solid, Liquid, Gas
Students do	Draw three boxes labeled solid, liquid, gas. Draw the particles in each.
Turn and talk	Why can you pour water but not a block of ice? Explain with particles.
Worksheet Part 6A	In a SOLID, particles vibrate in place. In a LIQUID, they slide past each other. In a GAS, they spread far apart.
Check for understanding	Which state has a definite volume but takes the shape of its container? Answer: (B) Liquid

Step 3 (3 min): Adding and removing energy

Teach	Adding thermal energy speeds particles up until they break free: melting, then boiling/evaporation. Removing energy slows them: condensation, freezing.
Interactive tool	Visual: Heating curve: flat parts are melting (0 °C) and boiling (100 °C)
Students do	Explain why the heating curve is flat at 0 °C and at 100 °C.
Turn and talk	Why does the thermometer stop rising while water is boiling, even though the stove is still on?
Worksheet Part 7A	Adding THERMAL ENERGY causes melting and evaporation. Removing it causes CONDENSATION and freezing.
Check for understanding	On the heating curve, why is the line flat at 0 °C? Answer: (D) Energy is breaking particles free to melt the ice

Step 4 (3 min): Evaporation, condensation, sublimation

Teach	Evaporation: liquid to gas. Condensation: gas to liquid. Sublimation: solid straight to gas (dry ice).
Interactive tool	Board and notes
Students do	Name each change: steam on a mirror, frost disappearing, a puddle drying.
Turn and talk	Frost disappears on a cold, sunny morning without melting. What happened to the particles?
Worksheet Part 8A	CONDENSATION is gas turning into liquid. SUBLIMATION is solid turning straight into gas.
Check for understanding	Water droplets form on a cold mirror after a shower. This is: Answer: (B) Condensation

I do: worked example (shown one step at a time)

1. Problem: Explain what happens to ice particles as the ice is heated.
2. Step 1: At -10°C , particles are packed tightly and vibrate in place: solid.
3. Step 2: Adding thermal energy makes them vibrate faster.
4. Step 3: At 0°C they break out of fixed positions and slide past each other: liquid.
5. Step 4: At 100°C they spread far apart and move fast: gas.

What to say on every slide is in the presenter script PDF.

We do: guided practice

Explain why a balloon shrinks when you put it in the freezer.

1. The balloon is full of gas particles moving quickly and hitting the inside of the balloon.
2. In the freezer, thermal energy leaves the gas.
3. The particles slow down and hit the balloon walls less often and less hard.
4. The gas takes up less space, so the balloon shrinks. The number of particles did not change.

Answer: Slower particles take up less space

You do: independent check (2 min)

Water vapor touches a cold window and forms droplets. Which describes the particles? (A) They turn into new substances (B) They lose energy, slow down, and move closer together (C) They gain energy and spread out (D) They stop moving completely

Answer: (B) They lose energy, slow down, and move closer together. Students who miss it: 3-minute reteach at the teacher table, then start the room at the Explorer level.

Misconception: "Particles in a solid do not move." They vibrate in place.

Misconception: "The bubbles in boiling water are air." They are water vapor (gas).

Misconception: "Particles expand when heated." Particles themselves do not grow; the spaces between them get larger.

3. ESCAPE ROOM: PARTICLE PANIC AT POLAR STATION

0:20–0:48 · 28 min

Launch: project the start screen, read the story aloud, and assign mission levels (Explorer = extra support, Agent = on level, Legend = challenge). Students can open Supports any time for read-aloud, bigger text, a word bank, and a scratch pad.

- Locks open in order, so every student moves through the same sequence. Circulate and listen for which lock is causing a traffic jam.
- Pairs work well: one student reads the clue card aloud, the other controls the device. Switch roles at every lock.
- If a group is stuck for more than 3 minutes, ask "What does the clue card say about this?" before giving the hint.

Students turn in: the completion code plus their copied "turn in your work" block (Canvas Text Entry).

4. DEBRIEF

0:48–0:52 · 4 min

1. Use the word particles to explain why a balloon shrinks in the freezer.

2. Why does the temperature stay the same while ice is melting?
3. Which state of matter was hardest to model? Why?

Close the loop: return to warm-up question 3. Answer: Water vapor in the air cools on the can and condenses into liquid.

5. EXIT TICKET

0:52–1:00 · 8 min

Print the exit ticket PDF (page 2 is the key and mastery guide). Every item requires evidence: Part A asks students to justify each choice, Part B asks for an explanation, and Part C applies the standard to a new situation using Claim-Evidence-Reasoning. Sort results into Mastered, Approaching, and Beginning to plan tomorrow's groups.

LESSON RESOURCES

Resource	How it fits the lesson
Warm-up worksheet (PDF)	Optional standalone warm-up (also Part 2 of the lesson worksheet), with a key.
Mini-lesson presenter	Projectable, step-by-step interactive lesson with tools and quick checks (room page).
Lesson worksheet (PDF + key)	One printable packet students complete during the whole lesson: short fill-ins and quick checks in 13 small parts that match the presenter slides.
Particle Panic at Polar Station (.html)	The escape room for Canvas, with differentiated levels, supports, and a turn-in.
Exit ticket (PDF + key)	Evidence-based check with a rubric and a mastery sorting guide.
PhET: States of Matter (extra)	Watch particles change as you heat and cool them. The single best tool for this standard. https://phet.colorado.edu/
PBS LearningMedia (extra)	Search "particle model states of matter" for videos and interactives. https://www.pbslearningmedia.org/
OpenSciEd (extra)	Free middle school units built on particle models. https://www.openscienced.org/
Khan Academy: Physics (extra)	Videos on states of matter and thermal energy. https://www.khanacademy.org/science

ANSWER KEY: PARTICLE PANIC AT POLAR STATION

Lock 1: Particles Everywhere (code piece: P)

1. True or false: Particles in a solid are completely still. -> False
2. What is between the particles of a gas? -> Mostly empty space
3. Which statement fits the particle model? -> All matter is made of particles that are always moving

Lock 2: Solid, Liquid, Gas (code piece: H)

1. Sort each description to its state of matter. -> Solid: Particles vibrate in fixed positions, Keeps its own shape | Liquid: Particles slide past one another, Takes the shape of its container but keeps its volume | Gas: Particles are far apart and move fast, Spreads out to fill any container
2. Why can a gas be compressed (squeezed) into a smaller space, but a solid cannot? -> Gas particles have lots of

space between them

Lock 3: Adding Energy (code piece: A)

1. What happens to water particles as ice is heated? -> They move faster
2. Snow in the Arctic can turn directly into water vapor without melting. What is this called? -> Sublimation
3. What is the difference between temperature and thermal energy? -> Temperature measures average particle motion; thermal energy is the total energy of all the particles

Lock 4: Removing Energy (code piece: S)

1. Is energy added or removed during each change? -> Energy added: Melting, Boiling, Sublimation | Energy removed: Condensation, Freezing, Deposition
2. Your breath forms a cloud of tiny droplets in the cold air. Which change of state is this? -> Condensation

Lock 5: The Heating Curve (code piece: E)

1. Put the stages of the heating curve in order. -> Ice warms up -> Ice melts at 0 °C -> Water warms up -> Water boils at 100 °C -> Steam warms up
2. Why does the temperature stay the same while ice is melting? -> The energy is being used to break the particles out of their fixed positions
3. At what temperature (in °C) does pure water boil at sea level? -> 100 °C
4. Tap the part of the heating curve where the ice is MELTING. -> Tap Ice melting
5. Now tap the part where the water is BOILING. -> Tap Water boiling

Final code: PHASE