

Opening Oration — Water Is a Shapeshifter

9:30 · read aloud, ~3 minutes · also printed standalone as *Opening Oration.pdf*

Prop: A tray with an ice cube on a small plate, a clear jar of water, and an “empty” lidded jar (full of nothing but air), covered with a cloth until the marked moment. (*Freeze the cube overnight; pull it out just before you sit down.*)

Before we start, I want to tell you about a shapeshifter. A real one. It is in this room right now.

A shapeshifter is something that can change its disguise — the same thing, wearing different costumes. And the greatest shapeshifter in the whole world is something you drink every single day.

Water.

(Pull the cloth off the tray.)

Look at these three things. This cold, hard cube — you could stack it, you could hold it, it keeps its corners all by itself. This jar of water — try to stack THAT! It slides, it flows, it lies down flat in its jar. And this jar here... what’s in this one?

Nothing? Are you sure? It’s not nothing. It is full to the very top — with air. Air you can’t see, pressing out to fill every corner of its jar, the way it fills every corner of this room.

Here is the secret: **everything you will ever touch is one of these three.** A thing that keeps its shape by itself — we call that a **solid**. A thing that flows and takes the shape of its container — a **liquid**. A thing that spreads out to fill all the space it can find — a **gas**. Every toy, every drink, every breath. Rocks are solid. Milk is liquid. The wind is a gas. Today, nothing in the world is safe from our sorting.

And water? Water can be **all three**. This ice cube is water in its solid costume. This jar is water in its liquid costume. And floating in the air of this very room — invisible — there is water in its gas costume, too.

So what is the magic word that changes the costume? It isn’t *abracadabra*. It is **temperature**. Warm the ice cube and it melts into water. Warm the water enough and it flies off into the air as gas. Cool it back down... and it comes all the way back, drop by drop, all the way to ice. The shapeshifter never loses itself. It only changes its state.

Today we are going to melt things you have never seen melt. We will read the secret numbers where the changes happen. We will melt a real metal in the palm of your hand. And at the very end, I will show you a solid so strange it skips being a liquid altogether and vanishes straight into fog.

But first — the whole world is waiting to be sorted. Solid, liquid, or gas: let's find out where everything belongs.

Games & Activities (kids do)

G1 · Three Buckets Sort — game, no card (components in game-components/)

10:00 · 25 min · the book's own game (pp. 51–53), played with our illustrated deck

Materials: the 18 illustrated sort cards (sheets 1–2, cut + laminated) · three buckets/boxes or taped floor zones wearing the printed zone labels (*03 Zone Labels.pdf*).

1. Set out the three labeled zones. Seed each yourself first, saying the sentence as you place: “*Water is a liquid.*” “*A rock is a solid.*” “*Air is a gas*” — blow on a hand as you say it.
2. Deal the cards. Each child in turn places one and **must say the sentence**: “A ___ is a ___.” Group votes thumbs up/down; wrong placements get discussed, never silently corrected — mistakes are the curriculum. **No Venn, no overlap zone** — a thing is usually in ONE definite state.
3. The test, said out loud every time: **does it keep its shape by itself? does it flow and take its container's shape? does it spread out to fill everything?**
4. Challenge cards last (marked on the answer key): **sugar jar** and **cereal bowl** pour like liquids — but spilled sugar sweeps into a pile that **KEEPS** its shape, while a pushed “pile” of water instantly flattens; granular things are still solids. **Balloon** and **bubbles** are combinations — a solid skin around trapped gas. **Kettle**: the white puff is tiny liquid drops; the invisible gas is in the clear gap. **Perfume**: every smell is something in gas form — safety moment: strange bad smell = fresh air + tell an adult.
5. Extend to the room — but be careful with your questioning (book p. 53): pointing at a bottle of juice, say whether you mean the juice (liquid) or the bottle (solid). Finish with bodies: solid bones and teeth, liquid blood and spit (urine gets the biggest laugh, the book promises), gas in the lungs — puff your cheeks.

Answer key with challenge-card talk tracks: game-components/Answer Key.md.

Failure modes: arguments about combination cards are the GOAL — let them run. A younger child parking everything in one bucket gets the three questions as a script, one at a time. Laminate the deck to survive the year.

G2 · Bar-Chart Line-Up — game, no card

10:25 · 15 min · straight from G1 · worksheet FRONT

1. Lay each zone's cards end to end in three parallel floor rows from one taped baseline. **The longest row wins.**
2. Say the new words while pointing: this is a **bar chart** — the *taller* the bar, the *more* we found. “*Which state did we find the most of? The least?*”
3. To the table: kids cut minis from the paste strip (*04 Paste Strip.pdf*, one per child), glue each into its worksheet column, then **shade one bar square per card** to copy the floor chart onto paper.

Failure modes: rows get shuffled — tape the baseline, appoint a “chart inspector.” Gluing runs long — pre-cut strips for the youngest two.

G3 • Solid-Liquid-Gas Acting Game — no card (play-act)

10:50 • 15 min • field-proven — reuse verbatim

Kids ARE the particles. Caller shouts a state; the group becomes it: **SOLID** — huddle tight, packed shoulder to shoulder, hold the shape • **LIQUID** — hold hands loosely and slide around each other, flowing into a corner (“your container”) • **GAS** — let go and spread to every corner, no touching.

Then narrate temperature: “*I’m turning up the heat...*” (huddle loosens to liquid, liquid breaks into gas) — “*now the cold comes...*” (gas drifts together, freezes into a block). Call each transition by name: melting, boiling, condensing, freezing.

Failure modes: it becomes tag — the caller’s hand on a shoulder is the only “heat,” so only touched particles change. If they ask, yes — it’s the same game from the A-4 day, because states of matter ARE particle behavior (A-4 forward hook).

A1 • My Own Ice Shape — no card (background race)

11:05 set-out • checks all day • winner declared 1:50 • Number Log section 2

Each child picks one of the fun-shaped ice blocks frozen overnight (one distinct silicone-mold shape per child + one plain cube as control), each on its own named plate on the windowsill.

1. Predict out loud: “*Which shape will melt away first? Why?*” Steer toward size and thinness — a skinny shape has more of itself touching the warm air.
2. Check on the way to lunch and between afternoon blocks; at 1:50 declare the winner and argue why (small/thin/spread-out melts first — surface beats bulk).

Failure modes: cool room = slow race — use a sunny windowsill, all shapes in the SAME sun or it isn’t a fair race (A-B-1 callback). No poking — finger heat cheats.

Experiments (teacher runs, kids predict → watch → explain)

E1 • Three States Trio — Card 1

9:45 · 15 min · field-proven — reuse verbatim · card: 01-three-states-trio.pdf

The oration tray grows into the proven trio: **ice cubes** (solid), a **bowl of water** (liquid), and the **humidifier** breathing visible mist. Kids apply the three test questions and name each state of the SAME substance. Precision moment: the mist is tiny liquid droplets — watch single wisps **vanish mid-air**; where a wisp disappears the water is still there, now invisible **water vapor**, the true gas.

Say: “Same stuff — three disguises. The only difference between them is how much heat energy it has.”

E2 • Reading Real Temperatures — Card 2

11:15 · 20 min · kids hands-on · card: 02-reading-real-temperatures.pdf · Number Log

Stick thermometers in ice water (watch the line fall) and warm water (watch it climb); the IR gun goes around the circle — each child points and reads one thing. Numbers land in the binder **Number Log**. Say the two magic water numbers out loud, pointing at the log’s boxes: **32 °F** freeze-and-melt line, **212 °F** boil line. Tease the afternoon: after lunch the gun points at the hot plate and water crosses both lines.

Say: “Hot and cold aren’t magic — they’re a NUMBER. And water keeps its promises: it always melts at the same number and boils at the same number.”

E3 • Metal That Melts in Your Hand — Card 3

11:35 · 20 min · kids hands-on · card: 03-metal-that-melts-in-your-hand.pdf

A fridge-cold gallium piece in each waiting palm (over a ceramic plate) turns into a bright silver puddle from body heat alone — a real metal whose melting number (≈ 86 °F) is lower than a person (≈ 98 °F, from Card 2). Tip the puddles back into the vial — liquid metal beads and flows like fast silver water. Vial into the fridge over lunch; show it solid again after: **freeze is melt run backwards**. Wash hands. **Never near aluminum**; never for mouths.

Say: “You are warmer than this metal’s melting point. To gallium, your hand is what the stove is to butter.”

E4 • One Ice Cube, All Three States — Card 4 — THE CENTREPIECE

12:40 · 25 min · adult-only heat, kids behind the tape line · card: 04-one-ice-cube-all-three-states.pdf

One single cube climbs the whole ladder: **SOLID** in the cold pan →  **worksheet BACK §1 prediction circled NOW** → heat on, it slumps and **MELTS** (32 °F) to **LIQUID** → keeps heating to a roaring **BOIL** (212 °F) — point at the **clear gap** just above the water: THAT is water vapor, the invisible gas; the white puff above it is already-condensed droplets → boil it **bone dry** and show the empty pan: the cube is now in the room’s air as invisible **GAS**. IR-gun the pan as it climbs; kids call the numbers crossing 32 and 212. Close the loop: cool it back down and it would be drops, then ice, again — A-8 will do exactly that later this year.

Say: "Nothing is gone. Every bit of that ice cube is flying around this room right now, invisible. Temperature ran it up the ladder — and temperature could run it all the way back down."

Failure modes: impatience — a single cube takes ~15 minutes to dry; narrate the thresholds rather than rushing the dial. Steam scalds silently: mitt mandatory, kids seated, hot plate off at dry.

E5 • The Melt Race — Card 5

1:05 · 25 min · kids predict & time · card: 05-the-melt-race.pdf · worksheet BACK §2

Six equal pea-size racers in a ring on the lowest-heat griddle: **ice cube** · **coconut oil** · **chocolate** · **butter** · **gummy bear** · **crayon**. Ordinal predictions (1st–6th) written BEFORE the heat goes on; kids call each racer the moment it runs like a liquid; a timekeeper reads the stopwatch and the group records order + seconds. Expected order ≈ ice (32 °F) → coconut oil (~76) → chocolate (~88) → butter (~95) → gummy bear (~100+, it slumps) → crayon (~130) — but narrate the order you SEE. Then the **cheese spoiler** goes on last: it softens, bubbles, scorches — and never runs. **Not everything melts.**

Say: "Same griddle, same heat — different finish times. Every material carries its own secret melting number, and the race just read those numbers out loud."

Failure modes: unequal pieces ruin the race — pre-cut matched pea-size pieces the night before. Too-hot griddle melts everything at once — start at the lowest setting and creep up. Scorching cheese smokes — crack a window, pull it before it blackens.

E6 • The Disappearing Spoon — Card 6

1:30 · 10 min · teacher demo · card: 06-the-disappearing-spoon.pdf

Pass a Field's-metal spoon and a steel spoon cold — they clink the same. IR-gun the mug of hot (NOT boiling, ~170 °F) water; above or below 144? Stir with steel: nothing. Swap in the Field's spoon and mid-stir it folds and **melts away**, pooling silver at the bottom of the clear mug. The spoon went nowhere — there it is, in its liquid costume; cooled, it is a solid lump again (recast it in its mold for next year). Metal obeys the same rule as butter — it just has its own number.

Say: "Steel and Field's metal are both metal — but each has its own melting number. This water is hot enough for one and nowhere near the other."

E7 • Dry Ice: Solid Straight to Gas — Card 7 — THE FINALE

1:40 · 10 min · teacher demo, ventilated room · card: 07-dry-ice-solid-straight-to-gas.pdf

Side by side: the ordinary cube already puddling on its plate (melting — solid to liquid), and a chunk of **dry ice** lifted with tongs — smoking faintly, never dripping. Into the warm-water bowl: it roars into thick fog that spills over the rim and **pours DOWN** off the table — and the table under it stays dry. No puddle, ever. Solid straight to gas: **sublimation** — say the big word together. Precision: the visible fog is water droplets from the air chilled by the escaping gas; the gas itself is invisible and pours down because cold gas is heavy. Leftovers sublime outdoors on a plate.

Say: "Watch the table under each one. The ice cube leaves a puddle — solid to liquid. The dry ice leaves nothing at all — solid straight to gas. That skip has its own name: sublimation."

Failure modes: fog weakens as the water chills — refresh with warm water for a second roar. Bought too early = arriving with nothing (it sublimates in storage): buy the morning of. **Safety is absolute:** tongs + insulated gloves, never bare skin; ventilate; never seal in any airtight container.

STRETCH (ranch, adult-run — NOT part of the core day): melting aluminum is feasible but genuinely hazardous (660 °C; a proper mini propane foundry with graphite crucible, never a handheld torch; kids seated well back behind a barrier; every scrap can bone-dry — trapped moisture spatters molten metal). The outline's own recommendation: gallium + Field's metal + dry ice already deliver the same payoff with essentially no risk. No student sheet references this.

Prompts, Send-Home & Prep

PROMPTS & QUESTIONS (USE ALL DAY; BOOK PP. 54–56)

- What is the one word that includes all solids, liquids, and gases? (Matter.)
- It takes the shape of its container but doesn't fill it — which is it? It fills the whole container no matter the size? It has weight — which is it? (All of them!)
- Is the bottle a liquid? Careful — the juice is the liquid; the bottle is a solid.
- Sugar pours — so is it a liquid? What happens when you sweep a spill into a pile?
- What are we really observing when ice melts? Is water “really” a solid or a liquid?
- If nothing is heated and nothing is cooled, will anything change state? (No.)
- What about a pillow? A sponge full of water? Your own body? (Combinations!)
- Is a flame matter? Can you weigh light? Can heat fill a jar? (Energy — C-1 ahead.)
- Look at the whole Earth: land, oceans, atmosphere — solid, liquid, gas.
- If matter did not exist, what would the world be like?
- Could a living thing be made entirely of one state of matter? What would it be like?

WHAT TO WATCH FOR IN DAILY LIFE (SEND HOME — FROM THE BOOK'S “TO PARENTS”)

- Kitchen, bathroom, grocery store: point out solids, liquids, gases — with the reason. (Any smell is a gas!)
- Butter melting in the pan; a crayon left in a hot car; an ice cube shrinking in a summer drink — what is heat doing?
- The freezer turning water to ice; a puddle skimmed with ice on a cold morning — what is cold doing?
- Body parts: solid bones and teeth, liquid blood and spit, air in the lungs. (Urine is a liquid — guaranteed laugh, p. 56.)
- On outings or with a globe: the whole world is land (solid), water (liquid), atmosphere (gas).
- Play “20 Questions” starting with: is it solid, liquid, gas — or a combination?

PREP-AHEAD CHECKLIST

Order ahead (a week out)

- ☐ Gallium + Field's-metal spoon (ship slowly — order first), hot plate/griddle, IR gun, stick thermometers, silicone molds, humidifier — see Supply List.md. IR gun may already be owned from A-8; check before buying twice.
- ☐ Print + cut + laminate sort-card sheets and zone labels (game-components/, color); one paste strip per child.
- ☐ **Locate the dry-ice source now** (grocery chest / welding-gas supplier); plan to buy on lesson morning.

The night before

- Freeze the silicone-mold shapes (one distinct shape per child + a plain control cube) AND ordinary cube trays (oration, E1, E4, E7 comparison).
- Pre-cut melt-race pieces to matched pea size into a labeled muffin tin; fridge (butter and coconut oil must start cold and solid). Peel the crayon.
- Gallium vial into the fridge (fully solid at go time).
- Fill and test-puff the humidifier; check the hot plate at its spot; tape the kid line.
- Batteries: IR gun, digital thermometers; stage the stopwatch.
- Print worksheets/copywork if binder stock is low (student-binder/ PDFs).

The morning of — DRY ICE (it cannot be bought early)

- Buy 2–4 lb of dry ice that morning — it sublimates ~5–10 lb/day even in a cooler; buying the day before can mean arriving with nothing.
- Transport in a hard cooler, **lid resting loose — NEVER latched airtight**, car windows cracked; store ventilated, away from the kids, until 1:40.
- Pull the oration cube and shaped ice only at go time; stage buckets + card deck for G1; kettle ready by 1:25 for E6.

REVIEW HOOKS

- **Back:** A-B-1 — this whole lesson is that sorting game, played on everything that exists.
- **Forward:** A-3 (air is a substance — today’s gas bucket gets weighed and squeezed); A-4 (WHY the states behave as they do — particles holding tight, sliding, flying free; the acting game becomes the particle model); A-8 (evaporation/condensation — where the boiled-away water went and how it comes back); C-1 (light and heat, the not-matter things, get their name: energy).
- The A-6 kit borrows this lesson’s IR thermometer — keep it findable.

Opening Oration — Water Is a Shapeshifter

Solids, Liquids, and Gases — and Change with Temperature • read aloud, ~3 minutes

Prop: A tray with three things side by side: an **ice cube on a small plate**, a **clear jar of water**, and an **“empty” lidded jar** (full of nothing but air). Keep the tray covered with a cloth until the marked moment. (*Prep: freeze the cube the night before and pull it out just before you sit down, so it is still sharp-cornered when the cloth comes off.*)

Before we start, I want to tell you about a shapeshifter. A real one. It is in this room right now. A shapeshifter is something that can change its disguise — the same thing, wearing different costumes. And the greatest shapeshifter in the whole world is something you drink every single day.

Water.

(Pull the cloth off the tray.)

Look at these three things. This cold, hard cube — you could stack it, you could hold it, it keeps its corners all by itself. This jar of water — try to stack THAT! It slides, it flows, it lies down flat in its jar. And this jar here... what’s in this one?

Nothing? Are you sure? It’s not nothing. It is full to the very top — with air. Air you can’t see, pressing out to fill every corner of its jar, the way it fills every corner of this room.

Here is the secret: **everything you will ever touch is one of these three**. A thing that keeps its shape by itself — we call that a **solid**. A thing that flows and takes the shape of its container — a **liquid**. A thing that spreads out to fill all the space it can find — a **gas**. Every toy, every drink, every breath. Rocks are solid. Milk is liquid. The wind is a gas. Today, nothing in the world is safe from our sorting.

And water? Water can be **all three**. This ice cube is water in its solid costume. This jar is water in its liquid costume. And floating in the air of this very room — invisible — there is water in its gas costume, too.

So what is the magic word that changes the costume? It isn’t *abracadabra*. It is **temperature**. Warm the ice cube and it melts into water. Warm the water enough and it flies off into the air as gas. Cool it back down... and it comes all the way back, drop by drop, all the way to ice. The shapeshifter never loses itself. It only changes its state.

Today we are going to melt things you have never seen melt. We will read the secret numbers where the changes happen. We will melt a real metal in the palm of your hand. And at the very end, I will show you a solid so strange it skips being a liquid altogether and vanishes straight into fog.

But first — the whole world is waiting to be sorted. Solid, liquid, or gas: let’s find out where everything belongs.

A-2 Supply List — Solids, Liquids, and Gases

Everything for the full 9:30–2 day. Prices are rough. **Order-ahead flags matter:** gallium and the Field's-metal spoon ship from small suppliers (order a week out), and **dry ice can only be bought the morning of the lesson** — it sublimates away in storage.

ALREADY HAVE (TYPICAL HOUSEHOLD)

☐	ITEM	USED IN
☐	Three buckets / boxes / taped floor zones	G1 sort
☐	Painter's tape + marker	G1 zones, G2 baseline, E4/E5 kid line
☐	Scissors + glue sticks (per kid)	G2 worksheet paste
☐	Ice cube trays — freeze plenty the night before	Oration, E1, E4, E7
☐	Small plates (one per kid + spares)	Oration prop, A1 shapes, E7
☐	Clear jar of water + "empty" lidded jar + tray + cloth	Oration prop
☐	Bowl of water	E1 trio
☐	Saucepan (small, light-colored helps)	E4 centrepiece
☐	Glass mug or heat-proof clear cup	E6 spoon
☐	Kettle / hot tap for hot (not boiling) water	E6
☐	Muffin tin (staging pre-cut melt-race pieces)	E5
☐	Melt-race foods: butter, chocolate, gummy bears, cheese, coconut oil	E5
☐	One crayon (peeled — sacrifice a broken one)	E5
☐	Two clear glasses (ice water / warm water)	E2
☐	Stopwatch or phone timer	A1, E5
☐	Oven mitt	E4, E5
☐	Hard-sided cooler (dry-ice transport, lid loose)	E7
☐	Fridge + freezer	E3 re-solidify, A1, prep

TO BUY

☐	ITEM	QTY	~PRICE	WHY	ORDER AHEAD?
☐	Gallium sample (30–50 g, sealed vial)	1	\$15–25	E3 — a real metal that melts in a child's warm hand (~86 °F); non-toxic, reusable forever	YES — ships slow, order first
☐	Field's-metal "disappearing spoon" (Bi-In-Sn — NOT lead/cadmium Wood's metal)	1	\$25	E6 — a metal spoon that melts away in hot water (144 °F) and re-solidifies to use again	YES — ships slow
☐	Dry ice	2–4 lb	\$3–5/lb	E7 — sublimation showstopper: solid straight to gas, no puddle	Morning-of ONLY — grocery chest or welding-gas supplier; call ahead
☐	Small electric hot plate or griddle	1	\$25	E4 centrepiece + E5 melt race (griddle = best for the race)	Yes
☐	Infrared no-touch thermometer gun	1	\$18	E2 — point-and-read temperatures (see note below: may already be owned)	Yes
☐	Kid stick thermometers	3–4	\$12	E2 — every child reads a real number	Yes
☐	Silicone ice molds, fun shapes	1–2 sets	\$8	A1 — one distinct shape per child for the melt race on the windowsill	Yes
☐	Mini ultrasonic humidifier	1	\$20	E1 — the proven vapor prop (skip if you already own one that works)	Yes
☐	Insulated gloves + kitchen tongs	1 pr + 1	\$15	E7 — dry ice is never touched with bare skin	Yes
☐	Cardstock + lamination for the sort-card sheets	—	~\$5	G1/G2 — print game-components/ in color; laminate to survive the year	Yes

Total new spend: ~\$150–170 ($\approx$ \$135 durable + \$10–20 dry ice + consumables).

CHECK-YOU-OWN-IT NOTES

- **Infrared thermometer** — also on the A-8 supply list (\$18). If A-8's shopping was already done, you own one; buy only once. (A-6 will borrow it from this kit too.)
- **Humidifier** — A-4 uses one; if you already own one that runs, strike it from TO BUY.
- **Gallium safety notes:** non-toxic, but it wets and stains skin faintly gray (washes off) and it **destroys aluminum** — keep it off aluminum foil, pans, and jewelry. Store the re-solidified pellet in its plastic vial, never an aluminum container.
- **Dry-ice handling (E7 card has the full safety box):** tongs + insulated gloves, never bare skin; ventilated room; **never sealed in an airtight container** (gas pressure bursts it); cooler lid rests loose; leftovers sublime away outdoors, never in a sink or closed room.

STRETCH PURCHASES (ONLY IF PURSUING THE RANCH ALUMINUM MELT — SEE TEACHER GUIDE STRETCH)

☐	ITEM	~PRICE	FOR
☐	Mini propane foundry + graphite crucible + PPE	~\$120+	Melting aluminum at 660 °C — adult-only, honestly not recommended; gallium + Field's metal + dry ice already deliver the payoff

Tick the box beside each item as it goes in the box. Anything flagged **order ahead** ships — buy it a week before the lesson.

Three States Trio

TEACHER DEMO

RUN AT 9:45

15 MIN

The point

The SAME substance — water — sits on the table in all three states at once. State words describe how a thing is **right now**, and the same stuff can wear all three costumes.

Materials

- Bowl of ice cubes (frozen overnight)
- Bowl or clear jar of liquid water
- Mini ultrasonic humidifier, filled and running
- The oration tray (cube · water jar · air jar) stays in view

Steps

- 1 Set the trio in a row. Ask: **“What are these three things made of?”** (All water!)
- 2 For each one, kids answer the three test questions: **does it keep its shape? does it flow? does it spread out?**
- 3 Kids **name each state**: ice — solid. Water — liquid. And the humidifier’s breath…?
- 4 Precision moment: **watch one wisp of mist until it vanishes mid-air**. The white mist is tiny liquid droplets; where a wisp disappears, the water is still there — it has become invisible **water vapor**, the true gas.
- 5 Pass an ice cube; let it start melting in a warm hand. **“What is your hand’s heat doing?”** — the afternoon is coming.

Say: “Same stuff — three disguises. The only difference between them is how much heat energy the water has.”



Fig. 1 — one substance, three states, one table

TEACHER PREP

Freeze plenty of cubes the night before. Fill and test-puff the humidifier. Good light behind the mist makes the vanishing wisps easy to see.

What to watch for

- Kids applying the three test questions without help
- The mist visibly **vanishing** a few inches up — liquid drops becoming invisible gas
- Someone asking whether the air jar is really empty (it isn’t — A-3 hook)

EXPECTED RESULT

Kids sort all three correctly and say the sentence “ice, water, and vapor are the same water.” **State depends on heat, not on what the stuff is.**

Reading Real Temperatures

KIDS HANDS-ON

RUN AT 11:15

20 MIN

The point

Temperature stops being a feeling and becomes a **number a child reads for themselves** — and water's two magic numbers (32 °F and 212 °F) are where its state changes happen.

Materials

- Kid stick thermometers (3–4)
- Infrared no-touch thermometer gun
- Clear glass of ice water · clear glass of warm tap water
- Binder **Number Log** sheets + pencils

Steps

- 1 Hand out stick thermometers. Kids **hold the tip in ice water**, watch the line fall, and read the number out loud.
- 2 Same in **warm water** — watch the line climb. Read it.
- 3 IR gun goes around the circle: each kid **points and reads one thing** — room air (a wall), the window, their own palm.
- 4 Everyone writes their numbers in the **Number Log** (a grown-up writes first for copying).
- 5 Announce the two magic numbers, pointing at the log's boxes: **32 °F** — freeze-and-melt line; **212 °F** — boil line.
- 6 Tease the afternoon: **“After lunch we’ll point the gun at the hot plate and watch water cross BOTH lines.”**

Say: “Hot and cold aren’t magic — they’re a NUMBER. And water keeps its promises: it always melts at the same number, and always boils at the same number.”



Fig. 2 — two waters, two very different numbers

TEACHER PREP

Battery-check the IR gun and any digital thermometers. Stage ice water just before — it should read close to 32 °F while the kids watch. Warm tap water only; no kettle here.

What to watch for

- Ice water reading lands near **32** — right ON the melt line (the ice is holding it there)
- Kids discovering their own hand is about 98 — warmer than gallium's melting point (next card!)
- Stick thermometers need a slow count to ten before reading

EXPECTED RESULT

Ice water $\approx$ 32–35 °F, room air $\approx$ 70 °F, warm water $\approx$ 100–110 °F. **Different heat = different number, and the state-change lines sit at fixed numbers.**

Metal That Melts in Your Hand

KIDS HANDS-ON

RUN AT 11:35

20 MIN

The point

Metals melt too — each at its own temperature. Gallium's melting point ($\approx 86^\circ\text{F}$) is **lower than a person**, so body heat alone turns a solid metal into a bright silver puddle. And it's reversible, just like ice.

Materials

- Gallium sample (30–50 g), fridge-cold and solid
- One small ceramic plate per child (never aluminum)
- Paper towels · soap and water for after
- Fridge (re-solidify over lunch)

Steps

- 1 Pass the cold vial. “Is this metal solid or liquid?” Solid — it keeps its shape, it clinks.
- 2 Recall Card 2: your hand is about 98°F . Gallium's melting number is about 86. “Who is hotter — you, or the metal's melting point?”
- 3 Each child **cups the piece in a bare palm over a plate** and holds still. Watch it slump, gleam, and pool — a real liquid metal.
- 4 Tip each puddle back into the vial (it beads like fast silver water — a liquid taking its container's shape).
- 5 Vial goes **into the fridge**: after lunch, show it solid again. Freeze is just melt run backwards.
- 6 Everyone **washes hands**.

Say: “You are warmer than this metal's melting point. To gallium, your hand is what the stove is to butter.”



Fig. 3 — body heat crosses gallium's melting line

SAFETY

Gallium is **non-toxic but never for mouths** — teacher hands it out and collects it. It can leave a faint gray smudge (washes off with soap). **Keep it far from anything aluminum** — foil, pans, jewelry — it destroys aluminum on contact.

TEACHER PREP

Park the vial in the fridge overnight so it is fully solid at go time. Cold hands melt it slowly — run this **AFTER** thermometer play, when hands are warm.

What to watch for

- It melts from the outside in — where it touches the warm skin
- The puddle is shiny, heavy, and **flows** — every liquid rule applies
- After the fridge: solid again — nothing was used up

EXPECTED RESULT

Solid metal → liquid metal in 2–4 minutes of patient holding, back to solid in the fridge. **Melting isn't a water trick — it's what matter does when heat crosses its own melting number.**

One Ice Cube, All Three States

TEACHER DEMO · THE CENTREPIECE

RUN AT 12:40

25 MIN

The point

One single ice cube climbs the whole ladder while the kids watch: **SOLID** → **LIQUID** → **GAS**. The same water, narrated across each threshold — and at the end the pan is dry because the water is **in the room's air**, not gone.

Materials

- Hot plate + small saucepan
- One ice cube (+ spares)
- Painter's-tape kid line on the floor
- Oven mitt · worksheet BACK + pencils

Steps

- 1 Kids seated behind the tape line. Hold up ONE cube: “**Follow this water. Don't lose it.**” Into the cold pan — **SOLID**.
- 2  **Worksheet moment:** kids circle their guess NOW (back, section 1) — where will the water be when the pan is dry?
- 3 Heat on. Watch it slump and slide — **MELT**, at 32 °F. Now it flows and lies flat: **LIQUID**.
- 4 Keep heating. Bubbles roar — **BOIL**, at 212 °F. Point at the **clear gap** just above the water: **THAT** is water vapor, the invisible gas. The white puff above it is tiny liquid drops.
- 5 IR gun on the pan as it climbs — kids call the numbers crossing 32 and 212.
- 6 Boil it to **bone dry**. Show the empty pan. “**Where is our ice cube?**” — in the air of this room, every bit of it, as invisible **GAS**.
- 7 Close the loop: cool it back down and it would be drops, then ice, again — and A-8 will do exactly that, later this year.

Say: “Nothing is gone. Every bit of that ice cube is flying around this room right now, invisible. Temperature ran it up the ladder — and temperature could run it all the way back down.”



Fig. 4 — one cube: solid, liquid, then invisible gas

SAFETY

Adult-only heat. Steam scalds silently — **kids stay seated behind the tape line**; only the teacher's mittied hand crosses it. Hot plate off and pan parked at the back before anyone stands up.

TEACHER PREP

Tape the kid line before lunch. Check the hot plate at its spot (induction needs a magnetic pan). A dry pan over heat is fine for the minute it takes to finish — but turn it off promptly at dry.

What to watch for

- Every change happens to **one traceable cube** — no swaps, no additions
- The water level falls as it boils — the gas is leaving the pan
- The clear gap vs. the white puff (gas is invisible)

EXPECTED RESULT

Cube → puddle → rolling boil → dry pan in ~15 minutes. **Temperature alone moved one batch of water through all three states.**

The Melt Race

TEACHER DEMO · KIDS PREDICT & TIME

RUN AT 1:05

25 MIN

The point

It isn't only water that changes state. Six materials warm together and melt **in order** — because **every material has its OWN melting temperature**. And the cheese proves not everything melts at all.

Materials

- Hot plate / griddle on its **lowest** setting
- Equal pea-size pieces: **ice cube** · **coconut oil** · **chocolate** · **butter** · **gummy bear** · **crayon** (peeled) + the **cheese spoiler**, staged in a muffin tin
- Stopwatch · worksheet BACK + pencils · oven mitt · tape kid line

Steps

- 1 Show the six racers cold.  **Worksheet moment:** each child writes an **ordinal guess** (1st–6th) for the melting order — before any heat.
- 2 Place the six pieces in a **ring on the cold griddle**, evenly spaced from the middle (fair test — same heat, same size).
- 3 Lowest heat on. Start the **stopwatch**.
- 4 Kids call each one the moment it **runs like a liquid**; a timekeeper reads the stopwatch and the group records order + seconds on the worksheet.
- 5 Creep the heat up only as the race stalls — slow heat stretches the drama and keeps the order honest.
- 6 Last: drop the **cheese** on. It softens, bubbles, browns... but never runs. **Not everything melts** — some things scorch and burn instead.
- 7 Compare guesses to results; star the winner and read the order aloud in ordinal words.

Say: "Same griddle, same heat — different finish times. Every material carries its own secret melting number, and the race just read those numbers out loud."

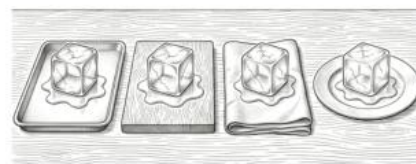


Fig. 5 — six racers, one heat, their own finish times

SAFETY

Hot surface — adult hands only past the tape line; mitt for any repositioning. Nothing from the griddle is eaten (crayon wax shares it). Scorching cheese can smoke — crack a window and pull it off before it burns black.

TEACHER PREP — THE NIGHT BEFORE

Pre-cut all pieces to matched pea size into a labeled muffin tin, fridge overnight (butter and coconut oil must start cold and solid). Unequal pieces ruin the race.

What to watch for

- Expected order $\approx$ ice $\rightarrow$ coconut oil $\rightarrow$ chocolate $\rightarrow$ butter $\rightarrow$ gummy bear $\rightarrow$ crayon — but narrate the order you **SEE**, not the list
- Ice wins from a griddle that barely feels warm — its number (32) is far below all the others
- The gummy slumps slowly — melting can be gradual

EXPECTED RESULT

Six clean finishes in order, one refusal. **Each material changed state at its own temperature; the cheese scorched without melting.**

The Disappearing Spoon

TEACHER DEMO

RUN AT 1:30

10 MIN

The point

A real metal spoon melts away in a mug of hot water — because Field's metal's own melting number (144 °F) sits **below hot-water temperature**. Metal obeys exactly the same rule as butter; it just has a different number.

Materials

- Field's-metal spoon (Bi-In-Sn — confirm it is Field's, never leaded Wood's metal)
- Ordinary steel spoon (the control)
- Clear glass mug of hot water (~170 °F — hot tap + kettle top-up, NOT boiling)
- IR thermometer gun

Steps

- 1 Pass BOTH spoons cold. “Solid or liquid? Same or different?” They look and clink the same.
- 2 IR-gun the mug; kids read the number (~170). Ask: is that above or below 144? Above or below steel's melting number (2500!)?
- 3 Stir with the **steel spoon** first: nothing. Its number is miles higher than the water's.
- 4 Swap in the **Field's-metal spoon** and stir slowly... mid-stir it softens, folds, and **melts away**, pooling as bright silver at the bottom.
- 5 Let kids peer through the glass at the metal puddle. “Where did the spoon go? Nowhere — there it is, in its liquid costume.”
- 6 Cool the mug; show the solid lump after. (Recast it in its mold at home and the spoon returns for next year.)

Say: “Steel and Field's metal are both metal — but each has its own melting number. This water is hot enough for one and nowhere near the other.”



Fig. 6 — the spoon is still there — at the bottom, liquid

SAFETY

Hot water — **teacher's hands only**; kids watch from their seats. Field's metal is the non-toxic bismuth alloy, but like gallium it is **never for mouths**; the mug and lump are washed before kitchen re-use.

TEACHER PREP

Kettle staged by 1:25. Test water with the IR gun: aim for 160–180 °F — hot enough to melt in under a minute, no scalding boil. Keep the spoon's silicone mold for recasting.

What to watch for

- The bowl of the spoon goes first (thinnest part — A1 ice-shape echo)
- The liquid metal **flows to the lowest point** and takes the mug's shape — liquid rules apply to metal
- The steel control never changes — same water, different number

EXPECTED RESULT

Spoon melts in ~30–60 seconds; steel spoon unchanged. **Melting point is a property of the material, not of “being metal.”**

Dry Ice: Solid Straight to Gas

TEACHER DEMO · THE FINALE

RUN AT 1:40

10 MIN

The point

Some solids skip liquid entirely and go **straight to gas**. That is **sublimation** — and dry ice proves it beside a normal ice cube: one leaves a puddle, one leaves **nothing at all**.

Materials

- Dry ice chunk (bought **this morning** — see prep)
- Kitchen tongs + insulated gloves
- Big bowl of warm water · hard cooler (storage, lid loose)
- Plate with a normal ice cube (the comparison), set out early so it is already puddling

Steps

- 1 Point at the comparison plate: the ordinary cube is **melting** — solid to LIQUID; there's the puddle.
- 2 Gloves on. With **tongs**, hold up the dry ice. It smokes faintly and never drips. **"Watch the table under it — where's its puddle?"**
- 3 Lower it into the **warm water**: it roars into thick white fog that spills over the rim and **pours DOWN** off the table edge.
- 4 Precision moment: the fog you see is tiny water droplets from the air, chilled by the escaping gas — **the gas itself is invisible**. It pours down because cold gas is heavy.
- 5 Side-by-side verdict: ice cube → puddle (melting). Dry ice → fog and **no puddle ever** (sublimation). Say the big word together.
- 6 Leftover dry ice goes outdoors on a plate to finish sublimating — never down a sink, never in a closed box.

Say: "Watch the table under each one. The ice cube leaves a puddle — solid to liquid. The dry ice leaves nothing at all — solid straight to gas. That skip has its own name: sublimation."



Fig. 7 — one puddle, one nothing: melt vs. sublimate

SAFETY — READ BEFORE TOUCHING

Never bare skin — dry ice is -109°F and burns like fire; **tongs and insulated gloves only**, teacher's hands only. **Ventilate the room** (open a window; the invisible CO_2 sinks and pools low). **NEVER seal it in any airtight container** — building gas pressure bursts it. Kids stay seated an arm's length back; nobody leans a face into the fog.

TEACHER PREP — MORNING OF ONLY

Buy 2–4 lb the **morning of** (grocery dry-ice chest or welding-gas supplier — call ahead). It sublimates away in storage, so earlier = arriving with nothing. Transport and store in a hard cooler with the **lid resting loose, never latched**, windows cracked.

What to watch for

- Fog pours **down**, hugging the table — cold, heavy gas
- The dry table under the fog — no liquid stage, ever
- The warm water eventually grows a normal ice skin — the dry ice is that cold

EXPECTED RESULT

Roaring fog, no puddle, one unforgettable word. **Sublimation: solid → gas with no liquid in between.**



Everything you can ever touch is a **solid**, a **liquid**, or a **gas** — and all of it together is called **matter**. The only thing that moves matter from one state to another is **temperature**.

 SOLID Keeps its shape all by itself — blocks, rocks, ice, spoons, you can stack it.	 LIQUID Flows and runs, and takes the shape of its container — but doesn't fill it up.	 GAS Spreads out to fill every corner of any space — like the air all around you.
--	--	---

THE SHAPESHIFTER — THE SAME WATER, THREE WAYS

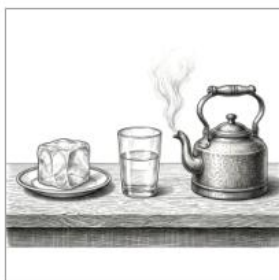
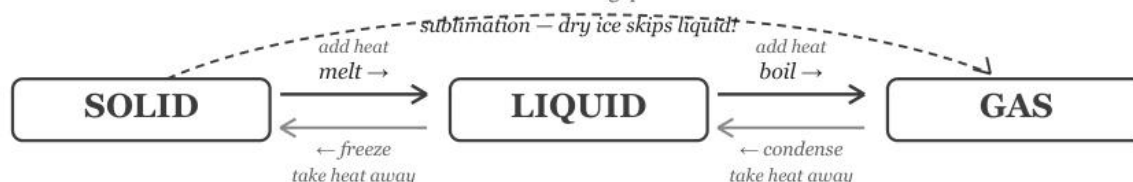


Fig. 1 — one substance, three states: ice (solid), water (liquid), and water vapor (gas) — the white puff is tiny drops; the true gas is invisible, in the clear gap.



WORDS TO KNOW

solid

liquid

gas

matter

melt

freeze

boil

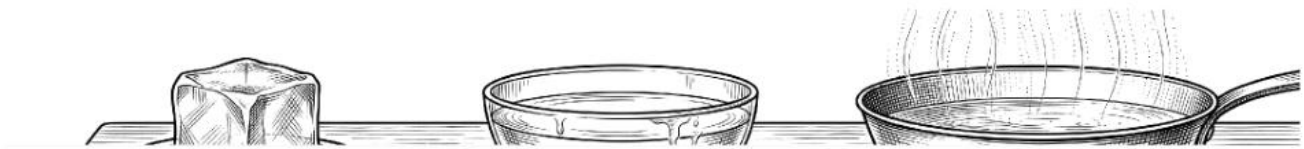
temperature

sublimation

matter — solids, liquids, and gases all together; everything that has weight and takes up space · **melt** — heat turns a solid into a liquid · **freeze** — cold turns a liquid into a solid · **boil** — heat makes a liquid turn into gas fast · **temperature** — the number that tells how hot or cold · **sublimation** — a solid goes straight to gas, skipping liquid

WATCH FOR THIS IN EVERYDAY LIFE

- Butter in a hot pan at dinner. *What is the heat doing to it?*
- An ice cube shrinking in a summer drink. *Which state is it leaving?*
- Water going into the freezer at night. *What will the cold turn it into?*
- Any smell, anywhere — every smell is something in its **gas** state. *What is your nose catching?*
- Look at the whole world: land, ocean, sky. *Solid, liquid, and gas — can you name all three?*



solid

solid

liquid

liquid

gas

gas



1 • GLUE EACH LITTLE PICTURE WHERE IT BELONGS

Cut the little pictures from the paste strip. Ask each one: does it keep its shape? does it flow? does it fill all the space? Then glue it in its column.

 SOLID	 LIQUID	 GAS
<i>keeps its shape by itself</i>	<i>flows — takes its container's shape</i>	<i>spreads out to fill any space</i>

2 • OUR BAR CHART

Shade one box for each card your team put in that bucket in the floor game — start at the bottom. The tallest stack is the state we found the most of. Put a ★ star on the winner.

solid

liquid

gas

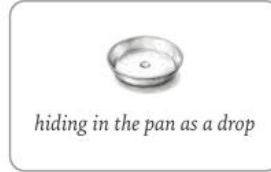
3 • THE SAME WATER, THREE WAYS

SOLID		LIQUID		GAS
<i>draw an ice cube</i>	<i>add</i> → <i>heat</i>	<i>draw water in a glass</i>	<i>add</i> → <i>heat</i>	<i>draw the kettle — the gas above the spout is invisible!</i>



1 • ONE ICE CUBE, ALL THREE STATES — CIRCLE YOUR GUESS FIRST

We will keep heating one ice cube until it melts, boils, and the pan is empty and dry. Where will the water be then?



2 • THE MELT RACE — GUESS THE ORDER, THEN RECORD WHAT HAPPENED

Before the heat goes on: write your guess — 1, 2, 3, 4, 5, 6 (1 = melts first). After the race: write the real order, and how long each took.

WHAT'S RACING	MY GUESS (1ST-6TH)	REAL ORDER	HOW LONG? (SECONDS OR MINUTES)
 ice cube			
 coconut oil			
 chocolate			
 butter			
 gummy bear			
 crayon			

Ordinal words to copy:

first

second

third

fourth

fifth

sixth

3 • THE SPOILER — AND THINKING LIKE A SCIENTIST

The cheese got hot too... did it ever **run like a liquid**? Circle: **YES** / **NO**. Not everything melts! Now put a ★ on the race winner and tell someone why the racers finished in different order. *Hint: every material has its own melting temperature — its own number.*



1 • READING REAL TEMPERATURES

Read the thermometer (or the point-and-read gun) and write the number. A grown-up can write it first for you to copy.

WHERE WE MEASURED	°F	COLDER OR WARMER THAN ME? (I AM ABOUT 98 °F)
 ice water		
 room air		
 warm water		
 hot plate surface (teacher points the gun)		

32 °F

water's freeze-and-melt line — below it water is ice; above it
ice becomes water

212 °F

water's boil line — here liquid water races away into
invisible gas

2 • MY ICE SHAPE RACE

Draw your shape when we set it out. Check it after each experiment — when only a puddle is left, write down how long your shape lasted.

MY SHAPE AT THE START (DRAW IT)	MY SHAPE AFTER LUNCH (DRAW IT)	HOW LONG DID IT LAST?

Which shape in the race melted first — a big fat one or a small skinny one? Tell a grown-up why.

**VERSE 1**

An ice cube keeps its corners, a rock sits on its own,
A teddy keeps his bear shape when you leave him all alone.
Stack it, hold it, tap it — it stays the way it was:
That's a SOLID, that's a solid, that's what a solid does!

CHORUS

Solid keeps its shape! (huddle up tight)
Liquid flows and pours! (hold hands loose)
Gas spreads out to fill the space — out every door!
Solid, liquid, gas — it's all matter, don't you know,
And it's temperature, temperature, that makes the changes go!

VERSE 2

Now water in a pitcher goes wiggle, slide, and slip,
It lies down in its container and it dribbles when you tip.
It never keeps a shape — it takes the shape it's in:
That's a LIQUID, that's a liquid — pour it out and pour it in!

(CHORUS)**VERSE 3**

And what's inside this jar here? You say it's empty air?
It's GAS — it fills the corners, it's spreading everywhere!
You can't see it, can't hold it, but it's real as real can be —
Every smell that finds your nose is a gas that's flying free!

(CHORUS)**BRIDGE (SLOWER, WONDERING)**

Warm it up — it MELTS... (solid turns to liquid, see it run)
Warm it more — it BOILS... (liquid turns to vapor in the sun)
Cool it down — it's drops again, then FREEZES hard and true —
The very same water, coming back to you!
And strange old dry ice skips a step — no puddle on the grass —
SUB-LI-MA-TION! Solid straight to gas!

(CHORUS ×2, SECOND TIME STOMP ON "TEMPERATURE, TEMPERATURE")

Tag (spoken, kids): "Solid!... Liquid!... Gas!...
That's matter — now sort it!"

How to use it. Play the recording once while everyone just listens. Play it again and join in on the chorus only — that is the part carrying the lesson. By the third time most children have the chorus. Then close the binder and ask what the words actually mean; a child who can sing it and explain it has the idea for good.