

Lighter Cup, Heavier Pad: Where Did the Mass Go?

Learning target: I can observe two reactions whose balance readings change in opposite directions, record what I notice and wonder, and write a first explanation that says where mass could have come from or gone.

Phenomenon exploration

About 25 min

Individual

MS-PS1-5 · practice

MS-PS1-2 · supports

discussion

writing

Standards connections

MS-PS1-5 (practice): Students meet the puzzle the PE resolves: a balance reading that falls and one that rises during a reaction. Their first explanation starts the model of atoms moving in or out of an open container that they will build and use across the chapter.

MS-PS1-2 (supports): Fizzing and a color change are the evidence that a reaction happened at all. That prior idea from the previous lesson is background here; the new question is what happens to the atoms and the mass.

Purpose: activate · **Time:** about 25 minutes · **Format:** individual

Answers with reasoning

Two demonstrations, two balances

Demonstration 1: chalk in vinegar. A plastic cup of vinegar sits on a balance that reads to 0.01 g. The cup and vinegar together read 86.40 g. A 2.00 g piece of white chalk made of calcium carbonate, broken into small lumps, is dropped in, so the balance should read 88.40 g. The chalk fizzes at once. Tiny bubbles stream up and pop at the surface for about twenty minutes. When the fizzing stops, no chalk is left and the balance reads 87.52 g. The cup is open to the air the whole time.

Demonstration 2: a copper pad in the heat. A new copper scouring pad is shiny and orange-pink. On the balance it reads 2.40 g. The teacher sets it on a very hot plate for ten minutes, using tongs. The pad slowly turns dull, then black. After it cools, it is placed back on the balance: 2.58 g. Nothing was added to the pad by hand. It sat in ordinary air the whole time.

Before and after on the balance

Demonstration 1: chalk in an open cup of vinegar

Before: $86.40\text{ g} + 2.00\text{ g} = 88.40\text{ g}$

During: steady fizzing, bubbles leave the surface

After: 87.52 g

Change: reading went DOWN by 0.88 g

Demonstration 2: copper pad heated in open air

Before: 2.40 g, shiny orange-pink

During: pad turns dull, then black

After: 2.58 g

Change: reading went UP by 0.18 g

Teaching data: the readings are invented to be realistic for a 2.00 g piece of chalk and a small copper pad. They are not measurements from a real classroom.

Part A: Notice and wonder

1. Write three things you **notice** in the demonstrations or the figure. Stick to observations: things you could see or read on the balance, not explanations.

Answer: Any three observations, for example: the chalk fizzed and disappeared; bubbles left the surface of the vinegar; the cup reading fell from 88.40 g to 87.52 g; the copper pad changed from shiny orange-pink to black; the pad reading rose from 2.40 g to 2.58 g; nothing was added to the pad by hand.

Why: Observations are things seen or read, not reasons. 'The chalk dissolved' is a mix of observation and interpretation; accept it but note the difference.

Also acceptable: Accept observations about the time (twenty minutes, ten minutes) or the open cup.

- Three distinct observations
- No explanations mixed in

2. Write two things you **wonder**. Start each one with 'I wonder' and make it something an experiment could answer.

Answer: Examples: I wonder what is inside the bubbles. I wonder whether the reading would change if the cup had a lid. I wonder where the extra mass on the copper pad came from. I wonder whether the black coating can be scraped off and weighed by itself.

Why: A testable wonder names something that could be measured or observed in a follow-up experiment.

Also acceptable: Accept any wonder that is testable, even if it is not about mass.

- Two questions beginning 'I wonder'
- Each could be answered by an experiment or measurement

Part B: What you already know

3. From the last lesson, what evidence tells you that a chemical reaction (not just a melt or a mix) happened in each demonstration? Name one piece of evidence for each.

Answer: Demonstration 1: the fizzing (a gas was produced that was not there before) and the chalk disappearing. Demonstration 2: a new color (shiny orange-pink to black) that stayed after the pad cooled, so it was not just a hot glow.

Why: Gas production and a lasting color change are both signs of a new substance with new properties, the previous lesson's evidence for a reaction.

Also acceptable: Accept 'the chalk got used up' for Demonstration 1 if paired with the fizzing.

- One sign of a reaction for each demonstration
- Signs are about new substances or properties, not just 'something happened'

4. Calculate the change in reading for each demonstration and write it with a sign (+ or –). Then write one sentence saying why the two changes are surprising when you put them side by side.

Answer: Demonstration 1: $87.52\text{ g} - 88.40\text{ g} = -0.88\text{ g}$. Demonstration 2: $2.58\text{ g} - 2.40\text{ g} = +0.18\text{ g}$.

Surprising because one reaction seems to lose matter and the other seems to gain it, even though nothing was poured out of the cup or added to the pad.

Why: The signs matter: the question sets up the chapter's idea that mass can move out of or into an open container.

Also acceptable: Accept 'lost 0.88 g' and 'gained 0.18 g' written in words. The surprise sentence can also note that both containers were open to the air.

Part C: Your first explanation

5. Write your first explanation. Where could the 0.88 g that 'left' the cup have gone? Where could the 0.18 g that 'joined' the copper pad have come from? Use the word *atoms* at least once, and say whether you think any matter was created or destroyed.

Answer: A strong first explanation: the bubbles were a gas, and gas is matter with mass; the atoms in that gas came from the chalk and the vinegar and floated out of the open cup, so the reading fell by the mass of the gas that left. The copper pad gained mass because atoms from the air (oxygen) joined the copper and became part of the black coating, so the reading rose by the mass of the air that joined. No matter was created or destroyed; it moved into or out of the open containers.

Why: This is an initial explanation, so credit any coherent idea that locates the missing or extra mass somewhere real. The key accurate ideas are: the gas has mass and left; something from the air joined the pad; matter was moved, not made or destroyed. Students who say matter was destroyed have written a testable claim that the chapter will revise; do not mark it wrong here, but note it for the misconception worksheet.

Also acceptable: A student who says 'the heat added mass' has given a testable but incorrect idea; prompt them with 'what in the room could have touched the pad?'

- Says where the lost mass went (the gas carried it away)
- Says where the gained mass came from (the air)
- Uses the word atoms
- Takes a position on whether matter was created or destroyed

6. Suppose Demonstration 1 were repeated inside a tightly sealed bottle instead of an open cup, with the whole bottle on the balance. Predict the reading after the fizzing stops and explain your prediction in one sentence.

Answer: The reading would stay at 88.40 g (the same as before), because the gas would be trapped inside the sealed bottle and its mass would still be on the balance.

Why: This prediction is the heart of the law of conservation of matter. Students who predict a drop are assuming the gas has no mass or can pass through the bottle.

Also acceptable: Accept 'almost the same' with the trapped-gas explanation.

- Predicts no change (or a change too small to see)
- Explains that the gas is trapped and still weighed

7. Write one question you would need answered to be sure your explanation in q5 is right.

Answer: Examples: Does the gas from the chalk have mass, and is it about 0.88 g? Is the black coating made of copper plus something from the air? Would a sealed version of each demonstration show no change?

Why: The question should target the part of the explanation that is still a guess.

Also acceptable: Any question tied to the student's explanation earns credit.

- One question that would confirm or challenge the student's own q5 explanation

Teacher notes

Both demonstrations are real reactions with simulated numbers. The chalk here is calcium carbonate; with vinegar it releases carbon dioxide, and 2.00 g of calcium carbonate reacting completely releases about 0.88 g of carbon dioxide, which is the loss in the dataset (a real open cup keeps a little gas dissolved, so a real loss would be slightly smaller). Many classroom chalks are gypsum (calcium sulfate) and will not fizz; if you run Demonstration 1 live, test your chalk first or use crushed limestone or a plain calcium carbonate antacid tablet. The copper pad forms black copper oxide on its surface; a gain of 0.18 g on a 2.40 g pad is realistic for partial surface oxidation. If you run Demonstration 2 live, use a pure copper pad (some 'copper' scrubbers are copper-plated steel), tongs, a hot plate rather than an open flame, and let the pad cool fully; copper oxide flakes can stain. Do not reveal the chapter's answer during this sheet: the point is to collect first explanations. Keep students' q5 and q6 responses; W7 (misconceptions) and W6 (the candle CER) revisit them. The textbook's own opener is a rusting car; rust also needs water, so this sheet uses copper oxide, which forms from copper and oxygen alone.

Scaffold offered to students: Sentence starters for the explanation

If q5 is hard to start, use these frames. 'The reading in the cup went down because something ____ the cup. I think it was ____.' 'The reading for the pad went up because something ____ the pad. I think it was ____.' 'I think matter was / was not created or destroyed because ____.' Remember that air is matter even though you cannot see it.

Extension: Design the sealed test

Sketch an experiment that would test your q6 prediction fairly. Name the container, say what goes on the balance, list two things you would keep the same between the open and sealed versions, and state exactly what reading would support your explanation and what reading would force you to change it. Then explain one reason a sealed container could still give a slightly different reading even if your explanation is right.