

Fixing Jamal's Lab Notebook: Six Mistakes About Properties

Learning target: I can find the error in a mistaken statement about substances and their properties, explain the thinking that caused it, and rewrite the statement correctly.

Error analysis

About 35 min

Individual

MS-PS1-2 · practice

writing

independent practice

Standards connections

MS-PS1-2 (practice): Students who confuse mass with density, dissolving with melting, or sample size with melting point will misread property data later in the unit. Diagnosing those confusions directly builds the interpretation skill the PE requires.

Purpose: practice · **Time:** about 35 minutes · **Format:** individual

Answers with reasoning

Jamal's notebook (copied exactly) — **1.** The big iron bolt (48 g) is denser than the small iron nail (6 g) because the bolt is so much heavier. **2.** We stirred flour into water and the water turned cloudy and the flour spread everywhere, so flour dissolves in water. **3.** We stirred sugar into warm tea and it disappeared, so the sugar melted. **4.** The aluminum bar melts at 660 °C. We sawed it in half, so each half should melt at about 330 °C. **5.** Both unknown bars are shiny, gray and exactly the same size, so they must be the same substance. **6.** Boiling point is an identifying property, so water boils at 100 °C no matter where on Earth you are.

Part A: Diagnose

1. For each entry, name the property or idea that is being confused (for example, 'mass versus density') and confirm that the conclusion is incorrect.

Answer: Entry 1: mass versus density; incorrect. Entry 2: dissolving versus making a suspension (cloudy mixture); incorrect. Entry 3: dissolving versus melting; incorrect. Entry 4: melting point versus sample size (amount); incorrect. Entry 5: appearance and size versus identifying properties; incorrect. Entry 6: boiling point versus conditions (air pressure); incorrect.

Why: Every entry is wrong; the diagnosis is the name of the confusion.

Also acceptable: Accept 'heavy versus dense' for 1, 'cloudy is not dissolved' for 2, 'color and size do not identify' for 5, 'pressure changes boiling point' for 6.

Part B: Explain and rewrite

For each entry write (a) **What went wrong:** the mistaken idea behind the sentence, in one or two sentences; and (b) **Corrected entry:** a new sentence that keeps Jamal's observation and states the correct conclusion. Include a number or a specific observation wherever one is available.

2. Entry 1: the bolt and the nail.

Answer: (a) What went wrong: Jamal treated mass as if it were density. Mass depends on how much iron there is; density is mass per cubic centimeter and is the same for every piece of iron. (b) Corrected entry: 'The bolt (48 g) has eight times the mass of the nail (6 g) because it has about eight times the volume, but both are iron, so both have the same density, about 7.9 g/cm^3 .'

Why: The correction must keep the masses and state that density is shared by all iron samples.

Also acceptable: The 7.9 g/cm^3 value is a bonus; 'the same density' is sufficient.

- Names the mass-density confusion
- Corrected sentence keeps the 48 g and 6 g observation
- States that the two have the same density

3. Entry 2: flour in water.

Answer: (a) What went wrong: Jamal took 'spread out and cloudy' as dissolving. A dissolved substance spreads out so completely that the mixture is clear, and it does not settle; flour makes a cloudy suspension whose particles settle to the bottom over time. (b) Corrected entry: 'Flour stirred into water made a cloudy mixture that settled when left alone, so flour does not dissolve in water; it only mixes in temporarily.'

Why: The clear-versus-cloudy and settles-versus-stays tests are the observable difference.

Also acceptable: Accept 'if it were dissolved you could see through it' as the explanation.

- Explains that cloudy and settling means not dissolved
- Corrected sentence says flour does not dissolve in water

4. Entry 3: sugar in tea.

Answer: (a) What went wrong: Jamal confused dissolving with melting. Melting is a solid turning into a liquid when heated to its melting point, with no second substance involved; dissolving is a substance spreading out among the particles of a liquid. Sugar's melting point is far above the temperature of warm tea. (b) Corrected entry: 'The sugar disappeared in the warm tea because it dissolved in the water; it did not melt, since sugar only melts at well over 150°C and the tea was much cooler than that.'

Why: Students should name both processes and give the temperature argument or the 'needs a second substance' argument.

Also acceptable: Accept 'sugar needs water to dissolve but needs only heat to melt' as the key distinction; the exact melting temperature is not required (sucrose begins to melt and break down around 186°C).

- Distinguishes melting from dissolving
- Corrected sentence says the sugar dissolved

5. Entry 4: the sawed aluminum bar.

Answer: (a) What went wrong: Jamal treated melting point as if it were shared out among pieces, like mass. Melting point is an identifying property of aluminum; it does not depend on the amount. Each half still melts at 660°C ; each half simply needs less thermal energy and less time to get there. (b) Corrected entry: 'We sawed the aluminum bar in half; each half still melts at 660°C , but a half needs about half as much energy to melt completely.'

Why: The amount changes the energy and time required, not the temperature.

Also acceptable: Accept 'it would melt faster but at the same temperature.'

- States that melting point does not depend on amount
- Corrected sentence keeps 660°C for each half
- Optionally notes the energy or time difference

6. Entry 5: the two gray bars.

Answer: (a) What went wrong: Jamal used appearance and size as if they identified the substance. Many metals are shiny and gray (aluminum, zinc, silver, iron, tin), and size is a property of the object, chosen by whoever cut the bar. (b) Corrected entry: 'Both bars are shiny, gray and the same size, which fits many metals; to find out whether they are the same substance we need to measure identifying properties such as density or melting point and compare them.'

Why: The correction must call for an identifying-property test rather than asserting the answer either way.

Also acceptable: A student who adds 'the two bars had different masses, so they cannot be the same' has invented a measurement; mass alone would in fact be strong evidence here only because the sizes are equal.

Accept if the student says equal volume makes the mass difference a density difference.

- Explains that color and size are not identifying
- Corrected sentence proposes a test using an identifying property

7. Entry 6: boiling point everywhere on Earth.

Answer: (a) What went wrong: Jamal assumed 'identifying property' means 'never changes under any conditions.' Boiling point depends on air pressure; reference tables give it at normal sea-level pressure. At high elevations the air pressure is lower and water boils at a lower temperature, around 90 °C in a mountain town about 3,000 m up. (b) Corrected entry: 'Water boils at 100 °C at normal sea-level air pressure; at high elevations, where the pressure is lower, it boils at a lower temperature, so boiling points are compared under the same conditions.'

Why: This is the textbook's 'never change' simplification corrected.

Also acceptable: Accept any realistic mountain example; the exact temperature is not required.

- Explains that boiling point depends on air pressure
- Corrected sentence states the sea-level condition

Part C: Step back

8. Entries 1 and 4 share the same underlying mistake. Describe it in one sentence that does not mention bolts or aluminum.

Answer: He assumed that a property of the substance would change when the amount of the sample changed, or the reverse: he treated an amount-dependent quantity (mass) and an amount-independent property (density, melting point) as if they behaved the same way.

Why: Both entries confuse object properties with substance properties.

Also acceptable: Accept 'he thought size changes identifying properties.'

- Names the object-property versus substance-property confusion without using the specific examples

9. Jamal's observations were all correct; only his conclusions were wrong. Suggest one habit he could add to his notebook so that this happens less often.

Answer: Any one: after every observation, write 'Would this be the same for a bigger sample?' before writing a conclusion; keep observations and conclusions in separate columns; compare every measured value with a reference table before naming a substance; write the conditions (temperature, pressure) next to every boiling or melting point; never name a substance from one property alone.

Why: The habit should target the conclusion step, since the observations were fine.

Also acceptable: Accept 'ask a partner to check each conclusion' if the student says what the partner should check.

- Proposes a specific habit that checks the conclusion against the observation

Teacher notes

The six entries target the most common confusions in this lesson: mass versus density (1), suspension versus solution (2), dissolving versus melting (3), amount versus melting point (4), appearance versus identifying properties (5), and 'never changes' versus 'same under the same conditions' (6). Entry 6 corrects a simplification in the textbook, which says identifying properties never change; the accurate version is that they are the same for every sample under the same conditions. Reference values used in the key: iron about 7.9 g/cm^3 ; aluminum melting point 660°C ; sucrose begins to melt and decompose at about 186°C ; water boils near 90°C at about 3,000 m elevation. In entry 1 the bolt-to-nail mass ratio is 8:1, so the corrected entry can say the bolt has about eight times the volume. Expect some students to 'correct' entry 5 by declaring the bars different; push them toward proposing a test instead.

Scaffold offered to students: Three questions to ask each entry

For every entry, ask: (1) Would this still be true if the sample were twice as big? If the answer changes, Jamal has confused an object property with a substance property. (2) Did the substance stay the same substance? If yes, the change was physical (melting, dissolving), not a new substance. (3) Were the conditions the same? If the air pressure or temperature could differ, the property's value could differ too.

Extension: Write entry 7

Write a seventh notebook entry in Jamal's voice that contains a mistake about **flammability** or about **mixtures**, then swap with a partner and diagnose each other's entry using the three questions in the scaffold. Your entry must include a true observation and a wrong conclusion, just like the originals. Discuss which of the six original mistakes is easiest to make and why.