

Reaction or Not? Mastery Check

Learning target: I can name reactants and products, tell a chemical reaction from a physical change, explain what starts and stops a reaction, and use before-and-after property data to decide whether a new substance formed.

Retrieval and mastery check

About 35 min

Individual

MS-PS1-2 · assesses

independent practice

writing

Standards connections

MS-PS1-2 (assesses, items 5, 6, 12 and 13 ask students to interpret before-and-after property data; the other items check the supporting ideas): The solubility calculation, the melting-point check item, the boiling-versus-fizzing item and the synthesis paragraph each require the student to decide from property data whether a reaction occurred, which is the PE's task inside its assessment boundary. The remaining items retrieve the vocabulary and the conditions ideas that make that analysis possible.

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

Answers with reasoning

Part A: Retrieval

1. Which change is a chemical reaction? 1 pt

Answer: C. A steel pad turning into orange crumbs that a magnet cannot lift.

Why: The crumbs have a different property (not magnetic, crumbly) from the steel, so a new substance formed. Melting, dissolving and boiling leave the same substance behind.

Also acceptable: None.

2. When vinegar is poured onto baking soda, which of these is a **product**? 1 pt

Answer: C. Carbon dioxide.

Why: Sodium bicarbonate (baking soda) and acetic acid (from vinegar) are the reactants; carbon dioxide, water and sodium acetate are the products. 'Vinegar' is the reactant mixture, not a product.

Also acceptable: None.

3. True or false: If a mixture gets warm when two things are combined, a chemical reaction must have happened. Give one example to support your answer. 1 pt

Answer: False. Calcium chloride pellets dissolving in water make the water hot, yet evaporating the water returns the same calcium chloride; a temperature change is a clue, not proof of a reaction.

Why: Any correct example of a warming physical change earns the point; the most familiar from this chapter is calcium chloride dissolving.

Also acceptable: Accept 'hot water poured into cold water warms it with no reaction' or any other accurate example.

4. Name two of the properties scientists compare before and after a change to confirm that a new substance formed, and explain why 'it looks the same' is weak evidence that nothing changed. 2 pts

Answer: Any two of: density, melting point, boiling point, solubility, flammability, odor. 'It looks the same' is weak because thousands of substances share an appearance (many are white powders), and products can match their reactants in color; a product only has to differ in some characteristic properties, which appearance does not test.

Why: The six properties are the ones in the PE's assessment boundary. The second half checks the 'looks the same so it is the same' misconception.

Also acceptable: Accept 'reacts with vinegar' or 'attracted to a magnet' as a property if two of the six are also named; one of the two must be from the list.

- Two of the six properties
- Explains that appearance is shared by many substances or that products can share some properties

5. Before a change, a white solid dissolves 9.6 g per 100 mL of water at 20 °C. After the change, the dry solid left behind dissolves 121 g per 100 mL at 20 °C. Calculate how many grams of each would dissolve in 50 mL of water at 20 °C, and state the difference between the two amounts. 2 pts

Answer: 50 mL is half of 100 mL, so halve each value. Before: $9.6 \text{ g} \div 2 = 4.8 \text{ g}$ in 50 mL. After: $121 \text{ g} \div 2 = 60.5 \text{ g}$ in 50 mL. Difference: $60.5 \text{ g} - 4.8 \text{ g} = 55.7 \text{ g}$.

Why: Scaling by the volume ratio keeps grams as the unit. The difference is far beyond any measurement wobble, which is why solubility settles the question.

Also acceptable: Accept 4.8 g, 60.5 g and 55.7 g; accept 'about 56 g' for the difference.

6. A chemist finds that the powder made in a reaction melts 23 °C lower than the starting powder. Which extra check makes the claim 'a new substance formed' **strongest**? 1 pt

Answer: B. Check that the new powder melts over a narrow range and that a second property, such as solubility at the same temperature, also differs.

Why: A lower melting point can come from an impure sample, which melts lower and over a wider range; a narrow range rules that out, and an agreeing second property makes the claim strong. Color (A) is weak, re-weighing (C) says nothing about identity, and D confuses heating time with melting point.

Also acceptable: None.

7. Vinegar poured on baking soda fizzes and then stops while plenty of liquid remains. Explain why it stopped. Then predict what happens if you add more vinegar, and what happens if you add more baking soda. 2 pts

Answer: It stopped because one reactant, the baking soda, was all used up; a reaction continues only while both reactants are present, and it does not 'run out of energy'. Adding more vinegar does nothing, because there is no baking soda left to react. Adding more baking soda restarts the fizzing, because the leftover liquid still contains acid.

Why: The leftover test is the chapter's evidence that reactions stop when a reactant is consumed. Both predictions are needed.

Also acceptable: If the student assumes the vinegar ran out, accept the mirror-image predictions as long as they are consistent with that assumption and the reason is 'a reactant was used up'.

- Stopped because baking soda was used up
- More vinegar: no fizz
- More baking soda: fizz returns

8. A strike-anywhere match has all of its reactants mixed in the head, yet it does not react in the box. Striking it starts the reaction mainly by 1 pt

Answer: B. Heating the head through friction.

Why: The reactants are already mixed; a little energy from friction is needed to start the reaction. Cooling starts other reactions (the brown smog gas), not this one.

Also acceptable: None.

9. True or false: Two different substances can never have the same melting point. Give a one-line reason. 1 pt

Answer: False. Different substances can happen to share a melting point, which is why a matching melting point does not prove two samples are the same and why chemists compare more than one property.

Why: This is the accurate correction to the idea that one property is a fingerprint on its own.

Also acceptable: Accept 'false, a melting point match could be a coincidence'.

10. A solid that appears when two clear solutions are mixed is called a _____. It is evidence that a product with a very low _____ in water has formed. 2 pts

Answer: precipitate; solubility.

Why: A precipitate is a solid that forms in a liquid because a product barely dissolves; the yellow lead iodide in the textbook example is one.

Also acceptable: Accept 'solid' for the first blank only with half credit; the term is precipitate.

11. Draw a two-box model of the vinegar and baking soda reaction. The BEFORE box must name both reactants and the AFTER box must name at least two products. Write the clue on the arrow between the boxes. Below the boxes, write one property comparison (with the two values from q5) and label it 'confirms'. 3 pts

Answer: BEFORE box: sodium bicarbonate (baking soda) and acetic acid (from vinegar). AFTER box: carbon dioxide and sodium acetate (and water). Arrow labeled with the clue: fizzing or bubbles (a temperature drop is also acceptable). Below: 'solubility at 20 °C: 9.6 g per 100 mL before, 121 g per 100 mL after' labeled 'confirms'.

Why: Check that both reactants are in BEFORE, at least two products are in AFTER, the clue sits on the arrow and not inside a box, and the confirming comparison is a property with the q5 values rather than the fizz.

Also acceptable: Accept 'vinegar' and 'baking soda' as the reactant names; accept 'does not fizz with fresh vinegar' as a second confirming comparison, but the solubility values must appear.

- Both reactants named in BEFORE
- At least two products named in AFTER
- Clue on the arrow
- Solubility comparison with 9.6 and 121 labeled 'confirms'

12. Bubbles rise in a kettle of boiling water and bubbles rise when vinegar meets baking soda. One is a physical change and the other is a chemical reaction. Say which is which, explain where the gas comes from in each case, and name one test on what is left behind that would show the difference. 2 pts

Answer: The kettle is a physical change: the bubbles are water vapor, which is water in its gas state, and when the steam cools it becomes water again. The vinegar and baking soda is a chemical reaction: the gas is carbon dioxide, a substance that was not present as a gas in either reactant, and it forms as the reactants are used up. A test on what is left behind: let the kettle water cool and it still boils at 100 °C and freezes at 0 °C (same substance), while the liquid from the fizzing cup, dried, leaves a solid with a different solubility (121 versus 9.6 g per 100 mL at 20 °C) that no longer fizzes with vinegar (different substance).

Why: Bubbles are a shared clue; the source of the gas and a property of what remains separate the two cases.

Also acceptable: Accept a test on the gas itself (steam condenses to water; carbon dioxide turns limewater cloudy) if the student also notes that the solid left after the fizz differs from baking soda.

- Kettle physical, fizz chemical
- Gas source explained for each
- A property test on what is left for at least one case

Part B: Synthesis

13. A friend says, 'Chemists cannot know a reaction happened unless they look at the atoms.' Write a paragraph of four to six sentences that disagrees. Use one example of a change from this chapter, name two characteristic properties that would be compared before and after, explain why they must be measured under the same conditions, and say what clues alone cannot do. 4 pts

Answer: Model paragraph: Chemists do not need to see atoms to know a reaction happened, because every pure substance has its own characteristic properties, and a different substance shows different ones. When baking soda meets vinegar, the fizz is a clue, but the proof comes afterward: the dry solid left behind dissolves 121 g per 100 mL of water at 20 °C while baking soda dissolves only 9.6 g, and the new solid does not fizz when fresh vinegar is added. Those two properties, solubility and reactivity with an acid, point the same way, so a new substance formed. Both solubility tests must be done at the same temperature, because solubility changes with temperature and an unfair comparison could invent or hide a difference. Clues such as bubbles, warmth or a new color can only say that something happened; they cannot say whether the substance that remains is new, because boiling, dissolving and a shaken soda show the same clues without making anything new. Comparing properties before and after is what turns a clue into a conclusion.

Why: Full credit requires a clear disagreement, one chapter example, two named characteristic properties, the same-conditions point, and the statement that clues alone cannot identify a new substance, in four to six sentences.

Also acceptable: Any chapter example works: the aspirin powders (melting point and solubility), the steel wool (magnet and density), the lead iodide precipitate (solubility and color), or the heated baking soda (solubility and mass loss).

- Disagrees with the friend
- One example of a change from the chapter
- Two characteristic properties named (from solubility, melting point, boiling point, density, odor, flammability, or a chemical property such as reacting with vinegar)
- Same conditions explained (temperature)
- States what clues cannot do
- Four to six sentences

Teacher notes

Scoring guide: 23 points in total (q1, q2, q3, q6, q8, q9 one point each; q4, q5, q7, q10, q12 two points each; q11 three points; q13 four points). Items 5, 6, 12 and 13 are the ones that produce evidence toward MS-PS1-2; the rest retrieve supporting ideas. The solubility values in q5 and q11 (9.6 and 121 g per 100 mL at 20 °C) are the baking soda and sodium acetate figures used in W4 and W5, so students who did those sheets will recognize them; the identity of the product is not required. Watch q3 and q9 for the two common reversals (heat as proof; one shared property as identity), and q7 for 'ran out of energy'. Use q13 together with W1 to show students how their first explanation has changed since the start of the chapter.

Scaffold offered to students: Three questions to carry through the quiz

For any item about a change, ask in order: (1) Is the stuff at the end the same substance as the stuff at the start? (2) What was seen, and is that a clue or a measured property? (3) What property, compared before and after at the same temperature, would settle it? For the calculation in q5, 50 mL is half of 100 mL, so halve each solubility. For q11, label the arrow with what you would notice (the fizz) and put the property values underneath, not on the arrow.

Extension: Write the item that catches the mistake

Choose the misconception you think classmates are most likely to hold at the end of this chapter (for example, 'bubbles prove a reaction', 'dissolving is a chemical change' or 'a reaction stops when it runs out of energy'). Write one multiple-choice item whose wrong options each come from that misconception, with a short answer key explaining why each wrong option tempts someone and why the right option is right. Then write a second item in which the property data given are **not enough** to decide, and the correct answer is 'test needed'.