

Clue, Proof or Not Yet: The Evidence Sort

Learning target: I can work with a group to sort described changes into reactions confirmed by a property comparison, physical changes shown by a property comparison, and changes where only a clue has been seen, and I can defend each placement with the evidence on the card.

Collaborative investigation

About 50 min

Small group

MS-PS1-2 · practice

collaboration

discussion

data analysis

Standards connections

MS-PS1-2 (practice, deciding from before-and-after property evidence whether each change made a new substance): Every card pairs what was seen with the result of a property test (or notes that none was done). Groups must use the test result, not the clue, to place each card, which builds the before-and-after analysis the PE assesses; the individual section checks that each student can do it alone.

Purpose: practice · **Time:** about 50 minutes · **Format:** small-group

Answers with reasoning

Eleven evidence cards

1 Card 1: Ice in lemonade

What was seen: the drink cooled from 20 °C to 5 °C; the cubes shrank and disappeared. Test result: liquid that dripped from a melting cube froze at 0 °C and boiled at 100 °C, the same as the water the cubes were made from.

2 Card 2: Steel wool pad in vinegar and hydrogen peroxide

What was seen: the pad warmed by 8 °C, turned orange-brown and crumbled. Test result: a magnet lifted a fresh pad but not the orange crumbs; the fibers of a fresh pad bend, while the crumbs snap. Reference values: iron has a density of 7.87 g/cm³; rust has a density of about 5.2 g/cm³.

3 Card 3: Sparkling water opened

What was seen: a hiss and streams of bubbles for a minute. Test result: the gas turned limewater cloudy, so it is carbon dioxide; the label says carbon dioxide was dissolved into the water at the factory; the flat water left behind froze at 0 °C.

4 Card 4: Calcium chloride pellets in water

What was seen: the water warmed from 21 °C to 38 °C and the pellets vanished. Test result: when the water was evaporated and the teacher dried the solid in a hot oven, a white solid was left whose solubility at 20 °C matched the original pellets within 1 g per 100 mL, and it warmed fresh water in the same way when added again.

5 Card 5: Sugar heated in a pan

What was seen: white crystals turned into a clear liquid, then golden brown, with a new smell. Test result: the brown material dissolved in water to give a brown liquid; evaporating that liquid left a brown, sticky solid, not white crystals. Fresh sugar dissolves to give a colorless liquid and comes back as white crystals.

6 Card 6: Glow stick snapped

What was seen: a bright green glow for hours; the stick felt slightly warm. Test result: no test was done on the liquid inside.

7 Card 7: Two clear solutions mixed

What was seen: a solution of Epsom salt and a solution of washing soda were poured together; the mixture turned cloudy white at once and a white solid settled; the temperature did not change. Test result: the dried white solid dissolved less than 0.1 g per 100 mL at 20 °C; both starting solids dissolve more than 20 g per 100 mL at 20 °C.

8 Card 8: Salt water in a sunny dish

What was seen: over two days the water vanished and white crystals appeared on the dish. Test result: the crystals dissolved 36 g per 100 mL at 20 °C, the same as the table salt used to make the salt water, and they were small cubes like the original grains.

9 Card 9: Hydrogen peroxide with a pinch of yeast

What was seen: foam rose up the cup and the cup warmed by 6 °C. Test result: the gas made a glowing splint burst into flame; no gas came out of the peroxide bottle before the yeast was added; the liquid left in the cup did nothing when fresh yeast was added.

10 Card 10: Kettle boiling

What was seen: bubbles roared up from the bottom and steam poured from the spout. Test result: steam caught on a cold lid turned into drops that froze at 0 °C; the water left in the kettle still boiled at 100 °C.

11 Card 11: Banana on the counter

What was seen: over four days the peel turned brown and spotted and the fruit went soft. Test result: no test was done.

Part A: The group sort

1. Make three spaces on the desk labeled REACTION CONFIRMED (a property of what is left differs from the starting substance), PHYSICAL CHANGE SHOWN (a property of what is left matches the starting substance) and NOT YET (a change was seen but no property test was done).
2. Place each card by its **test result**, not by what was seen. If the card says no test was done, it goes in NOT YET no matter how dramatic the change looked.
3. For every card in REACTION CONFIRMED, write on a sticky note the property that differed. For every card in PHYSICAL CHANGE SHOWN, write the property that matched.
4. Rate each REACTION CONFIRMED card's evidence as strong (a measured property such as solubility, density or melting or boiling point, or a chemical property shown to be lost) or fair (a difference in appearance or behavior only). Write the rating on the sticky note.
5. For each NOT YET card, agree on one property test that would move it to another pile, and what result would send it where.

6. Fill in the group record. Every member must be able to explain every placement.

Group record (fill in)

Pile	Card numbers	Property that differed or matched (one per card)
Reaction confirmed		
Physical change shown		
Not yet		

1. Group answer: Which card did your group argue about longest, which piles were the two choices, and what sentence on the card finally settled it?

Answer: Any card with the two candidate piles and the deciding sentence. Common choices: Card 3 (bubbles say reaction, but 'carbon dioxide was dissolved into the water at the factory' settles physical change); Card 4 (warmth says reaction, but 'solubility matched within 1 g per 100 mL' settles physical change); Card 6 (light says reaction, but 'no test was done' settles NOT YET); Card 5 (students may want a number, but 'left a brown, sticky solid, not white crystals' settles reaction confirmed).

Why: The quality of the record matters: a specific card, two named piles, and a quoted or paraphrased sentence from the card.

Also acceptable: Any card with a genuine deciding sentence earns credit.

- Names a card and the two piles considered
- Cites the card sentence that decided it

2. Group answer: For each NOT YET card, write the test your group chose and the result that would move it to REACTION CONFIRMED.

Answer: Card 6 (glow stick): a chemist, not students (glow-stick liquids irritate skin and eyes and the inner tube is glass), could compare a property of the liquids from a fresh and a spent stick, such as whether the spent liquid glows when fresh activator is added, or its color or density; a spent liquid that cannot glow again and differs in a measured property would move the card to REACTION CONFIRMED. Card 11 (banana): compare a property of the brown peel with the fresh peel, for example whether the brown material dissolves in water as the fresh peel's surface does, or whether a fresh peel kept sealed away from air browns at the same rate; a measured difference in the brown material's properties, not just its color, would move the card to REACTION CONFIRMED.

Why: Any test counts if it compares a property of what is left with the starting material under the same conditions and the student says what result sends the card where. Both changes are in fact reactions, which the debrief can reveal.

Also acceptable: Accept 'the spent stick cannot be made to glow again' as a used-up-reactant test for Card 6.

- A test for Card 6 and a test for Card 11
- Each test compares a property before and after
- Each names the result that would confirm a reaction

3. Group answer: Which REACTION CONFIRMED card has the weakest evidence? Give its rating from step 4 and name one measurement that would make it strong.

Answer: Card 5 (sugar heated) is the weakest of the confirmed cards: its evidence is a color that survives dissolving and recovery, plus a new smell, with no measured value, so it rates 'fair'. A measurement that would make it strong: compare the melting behavior or the solubility at 20 °C of the brown solid with that of white sugar, or measure the density of each. Cards 2, 7 and 9 rate 'strong' because they use a magnet and density references (2), a solubility value (7) or a chemical property that the gas has and that the spent liquid has lost (9).

Why: Students must rank by the kind of evidence, not by how convincing the story sounds. Color and odor are properties, but a single appearance-based property is weaker than a measured characteristic value.

Also acceptable: A group that picks Card 2 because the density values are references rather than measurements has a defensible point if it proposes measuring the crumbs' density.

- Picks Card 5 (or defends another choice with the rating logic)
- Gives the rating
- Names a measurement (solubility, melting behavior, density) that would strengthen it

4. Group answer: Write the challenge the neighboring group made to one of your placements and how you answered it using the card.

Answer: Any real challenge with a card-based reply. Examples: 'Card 9 is just gas escaping like Card 3' answered with 'no gas came out of the peroxide bottle before the yeast was added, so the gas was not already there, and the spent liquid does nothing with fresh yeast'; 'Card 7 could be the solids just not dissolving' answered with 'both starting solids dissolve more than 20 g per 100 mL, and the new solid dissolves less than 0.1 g, so it is a different substance'; 'Card 8 is a reaction because crystals formed' answered with 'the crystals have the same solubility and shape as the original salt'.

Why: Look for a specific challenge and a reply that quotes the card's test result rather than restating the pile name.

Also acceptable: Any reasonable challenge and evidence-based reply earns credit.

- Records a specific challenge
- Reply uses the card's test result

Part C: Individual accountability (complete alone)

5. Cards 3 and 9 both produced a gas. Explain why they belong in different piles, using the sentence on each card that tells you where the gas came from.

Answer: Card 3 belongs in PHYSICAL CHANGE SHOWN because the card says the carbon dioxide 'was dissolved into the water at the factory': the gas was already present and only left the liquid when the pressure dropped, and the flat water is still water. Card 9 belongs in REACTION CONFIRMED because 'no gas came out of the peroxide bottle before the yeast was added' and the gas relights a glowing splint, a property neither starting material showed; the spent liquid also cannot make gas again, so a reactant was used up. Bubbles alone do not decide a pile; where the gas came from does.

Why: This checks the chapter's bubbles misconception at the individual level: gas is evidence only when it is a substance that was not present before.

Also acceptable: Accept 'the spent liquid does nothing with fresh yeast' as the Card 9 evidence.

- Card 3: gas was already dissolved, so physical
- Card 9: gas not present before and has a new property, so reaction
- Uses the card sentences

6. Cards 2 and 4 both got warm. Explain why they belong in different piles, naming the property that differed on one card and the property that matched on the other.

Answer: Card 2 belongs in REACTION CONFIRMED because a property differed: the fresh pad is attracted to a magnet and its fibers bend, while the orange crumbs are not attracted and snap, and the reference densities (7.87 versus about 5.2 g/cm³) differ. Card 4 belongs in PHYSICAL CHANGE SHOWN because a property matched: the recovered solid's solubility at 20 °C was within 1 g per 100 mL of the original pellets, and it warmed water again just as the pellets did. Warming happened in both, so the temperature change cannot be what decides the pile.

Why: Both cards share the temperature clue; only the property comparison separates them.

Also acceptable: Accept 'the crumbs snap instead of bending' as the differing property for Card 2.

- Card 2: magnet or density property differed
- Card 4: solubility matched
- States that warmth did not decide

7. Cards 1, 8 and 10 each show something appearing or disappearing (cubes vanishing, crystals appearing, steam leaving). What single kind of test result put all three in the same pile?

Answer: A property of what was left matched the starting substance: the melted ice and the condensed steam froze at 0 °C (and the kettle water still boiled at 100 °C), and the salt crystals dissolved 36 g per 100 mL at 20 °C, the same as the original salt. Something appearing or disappearing is a change of state or of mixing, and the matching property shows the substance is unchanged.

Why: The common thread is a matching characteristic property (freezing point, boiling point, solubility), which is what defines the physical-change pile.

Also acceptable: Accept 'the stuff that was left had the same properties as what we started with'.

- Identifies a matching characteristic property as the shared test result
- Names at least two of the three values

8. Write a rule, in your own words, for when a clue becomes proof that a new substance formed. Your rule must mention same conditions, a characteristic property, and what to do when no test has been done. Then apply your rule to Card 11 in one sentence.

Answer: Model rule: A clue (bubbles, heat, cold, light, a color, something vanishing or appearing) tells me to test, not to conclude. The clue becomes proof only when a characteristic property of what is left, such as solubility, density, melting or boiling point, odor, or a chemical property like fizzing or being attracted to a magnet, is measured under the same conditions as the starting substance and comes out different. If the property matches, the change was physical. If no test has been done, the honest label is 'not yet', however dramatic the clue. Applied to Card 11: the browning banana is a clue, so until someone compares a property of the brown material with the fresh peel, it stays in NOT YET.

Why: Full credit requires same conditions, a characteristic property, the 'not yet' category and a correct application to Card 11.

Also acceptable: A student who adds that the banana's browning is in fact a reaction, but still places the card in NOT YET on the evidence given, is reasoning well.

- Clue versus proof stated
- Same conditions mentioned
- A characteristic property named
- Rule for untested changes
- Card 11 placed in NOT YET with the reason

Scoring rubric

Criterion	4 • Exemplary	3 • Proficient	2 • Developing	1 • Beginning
Sorting by test result	All eleven cards placed correctly (reaction: 2, 5, 7, 9; physical: 1, 3, 4, 8, 10; not yet: 6, 11), each by the test result rather than the clue.	One card misplaced, or one card placed correctly but defended with the clue instead of the test.	Two or three cards misplaced, usually by treating bubbles, warmth or light as proof.	Four or more misplaced, or cards sorted by how dramatic the change looked.
Property evidence and ratings	Every placed card has the correct property named (differed or matched), and the strong/fair ratings separate measured values from appearance.	Properties named for most cards; one rating unjustified.	Properties named for some cards; ratings missing or based on the clue.	No properties named; sticky notes repeat the clue.
Tests for the NOT YET cards and defense	Both NOT YET cards get a before-and-after property test with the result that would confirm a reaction; the neighboring group's challenge is answered with card evidence.	Both tests proposed, but one lacks the deciding result, or the challenge is answered without card evidence.	One test proposed, or tests that only repeat the observation (for example, 'watch it longer').	No tests proposed; challenge not recorded.
Individual accountability (Part C)	All four Part C answers are accurate, cite card sentences, and show the student can separate clue from proof without the group.	Three of four accurate with card evidence; one thin.	Two accurate; others restate the group's piles without reasons.	Part C mostly blank or inaccurate.

Teacher notes

Print and cut one set of eleven cards per group; shuffle before dealing. Correct sort: REACTION CONFIRMED 2, 5, 7, 9; PHYSICAL CHANGE SHOWN 1, 3, 4, 8, 10; NOT YET 6, 11. Science behind the cards: Card 2 is iron reacting with oxygen and water to form rust (vinegar strips the fibers' coating and peroxide supplies oxygen fast); the iron and rust densities are real (7.87 and about 5.2 g/cm³). Card 4 is calcium chloride dissolving, which releases energy; the same substance returns on evaporation, but dried at room temperature it holds water of crystallization and no longer warms water as it dissolves, which is why the card has the teacher dry it hot before testing. Card 5 is caramelization, a set of reactions; the brown material is a mixture, so no single melting point is given. Card 7 is Epsom salt and washing soda solutions forming a magnesium carbonate precipitate; the solubility values on the card are simulated but realistic. Card 9 is hydrogen peroxide breaking down into water and oxygen, sped up by an enzyme in yeast that is not used up; the card's 'fresh yeast does nothing' shows the peroxide was consumed. Cards 6 and 11 are real reactions (chemiluminescence; enzyme browning), withheld from the confirmed pile on purpose because no test is given; reveal this in the debrief so students see that NOT YET is about the evidence in hand, not about the truth. Do not run any card as a demonstration from this sheet; Lab 2 covers the safe stations.

Scaffold offered to students: Cover the top half

If a card is hard to place, cover the 'What was seen' sentence with your hand and read only the 'Test result'. Ask: does the test compare a property of what is left with the same property of what we started with? If the properties match, it is the physical change pile. If they differ, it is the reaction pile. If no test was done, it is the NOT YET pile. Only after placing the card uncover the top half and notice how dramatic the clue was; that is the trap the sort is teaching you to avoid.

Extension: Make the twelfth card

Write a Card 12 for a change that looks like nothing happened (no bubbles, no heat, no color) but is a chemical reaction, and whose test result proves it with a measured property. The silver tarnish that forms on a spoon, or the slow change of a cut apple, are starting points, but you must invent the test and the numbers (label them as made up) so that a group could place the card without seeing anything dramatic. Then write one sentence on why this card is the hardest kind for Theo's 'if nothing changes it is physical' rule.