

Rubbing or Reacting? A Claim-Evidence-Reasoning Case

Learning target: I can use temperature, mass and color evidence from a controlled test to argue what makes an iron hand warmer warm and which direction energy flows, and explain the result with the bond model.

Claim, evidence, reasoning

About 40 min

Individual

MS-PS1-6 · practice

writing

data analysis

Name _____

Date _____

Period _____

Directions

Read the scenario, then study the test table and the mass-and-color notes. The data are a teaching dataset invented to be realistic; the people are fictional. Answer the warm-up questions first; they organize your evidence. Then write your Claim, Evidence and Reasoning in the boxes. A strong response names specific numbers, uses the words system and surroundings, and explains the energy flow with the idea of bonds breaking and forming. Answer the follow-up question last.

You will need: This worksheet, Pencil, Scrap paper for the comparison grid

The scenario

Dev is sure he knows why a cloth hand warmer gets hot. 'You rub it between your hands,' he says. 'Rubbing makes heat. It's friction, not chemistry.' His lab partner Priya is not convinced: the pouches are sealed in a plastic wrapper, and the instructions say to open the wrapper and *shake*, not rub. They decide to settle it with a test. They buy three identical 30.0 g pouches of iron-powder hand warmer and one pouch of plain sand of the same mass and size, and they borrow a probe thermometer, a balance and a large zip bag that can be filled with nitrogen gas from the chemistry stockroom.

How each pouch was treated (room at 21 °C) — Pouch 1: wrapper opened in ordinary air; pouch laid still on the bench, never rubbed. **Pouch 2:** wrapper opened in ordinary air; rubbed steadily between gloved hands for all 20 minutes. **Pouch 3:** wrapper opened inside the zip bag after the bag had been flushed with nitrogen and sealed; rubbed steadily through the bag for 20 minutes. **Pouch 4:** the sand pouch, opened in ordinary air and rubbed steadily for 20 minutes. Each pouch was weighed before opening and again the next morning, and its color was recorded.

Probe temperature of each pouch (teaching dataset)

Simulated teaching dataset: the numbers are invented to be realistic, not measured.

Time (min)	Pouch 1: air, still (°C)	Pouch 2: air, rubbed (°C)	Pouch 3: nitrogen, rubbed (°C)	Pouch 4: sand, air, rubbed (°C)
0	21	21	21	21
2	26	27	22	22
5	33	34	22	22
10	41	42	21	22
20	45	45	21	22

Simulated readings for a classroom scenario. The probe was pressed against the outside of each pouch; gloved hands were used so that skin warmth did not reach the pouch.

Mass and color notes (same teaching scenario)

Simulated teaching dataset: the numbers are invented to be realistic, not measured.

Pouch	Mass before (g)	Mass next morning (g)	Change (g)	Color of powder next morning
1: air, still	30.0	31.9	+1.9	red-brown
2: air, rubbed	30.0	32.0	+2.0	red-brown
3: nitrogen, rubbed	30.0	30.0	0.0	gray, unchanged
4: sand, air, rubbed	30.0	30.0	0.0	tan, unchanged

Warm-up: organize the evidence

1. Compare pouches 1 and 2. What do they have in common, what is different, and what does the comparison tell you about rubbing?

2. Compare pouches 2 and 3. What is the only difference in how they were treated, and what happened to the temperature in each?

3. Why did Priya include the sand pouch (pouch 4)? What result from it matters for Dev's idea?

4. Pouches 1 and 2 gained about 2 g and turned red-brown; pouch 3 did neither. What do a mass gain and a color change tell you about what happened to the iron, and where could the extra mass have come from?

Your argument

CLAIM

Claim: State what causes the hand warmer to warm up, and say whether the process is exothermic or endothermic.

EVIDENCE

Evidence: Give at least three specific pieces of evidence from the table and the notes, with numbers. For each one, say which idea it supports or rules out (friction, or a reaction between iron and oxygen).

REASONING

Reasoning: Explain how your evidence connects to your claim. Name the system and the surroundings in this test, say which way energy crossed the boundary and how you know, and explain where the released energy came from using bonds breaking and forming. Do not say that energy was created.

Follow-up

5. Dev now agrees but asks: 'Then why do the instructions say to shake the pouch?' Using what the nitrogen bag showed, give a reason that shaking might help even though rubbing does not supply the energy.

6. Describe one result that, if it had appeared in the table, would have **supported** Dev's friction claim instead.

A comparison grid before you write

On scrap paper, draw a grid with the four pouches across the top and these rows down the side: air or nitrogen; rubbed or still; temperature at 20 min; mass change; color change. Fill it in from the tables. Then look for pairs that differ in only one way: pouches 1 and 2 differ only in rubbing; pouches 2 and 3 differ only in air versus nitrogen. Each pair is one piece of evidence, and the thing that differed is what the pair tests.

Hot enough from friction?

The sand pouch rose only 1 °C with 20 minutes of steady rubbing. Rubbing does transfer energy (your hands do work on the pouch), so friction is not nothing. Design a test that would measure how hard and how long you would have to rub a sand pouch to reach 45 °C, and predict whether it is possible before your hands tire. Then write two or three sentences explaining why engineers chose a chemical reaction rather than friction for a device that must stay warm for hours, using the word surroundings.