

Energy in Reactions: Mastery Check

Learning target: I can identify the direction of energy flow from evidence, explain it with system, surroundings and bonds, place energy in an equation, and use prototype data to judge a device by temperature and time.

Retrieval and mastery check

About 30 min

Individual

MS-PS1-6 · practice

MS-ETS1-3 · supports

independent practice

writing

Name _____

Date _____

Period _____

Directions

Work alone. This check can be used as a quiz. Items 1 to 12 are quick retrieval: circle one letter for multiple choice, write T or F for true/false, show your work for numeric items, and label every drawing. Item 13 is a short synthesis; write it in complete sentences. The prototype readings in items 8 and 13 are a teaching scenario, not measurements from a real product.

You will need: This worksheet, Pencil, Calculator (optional)

Part A: Retrieval (items 1-12)

1. Which observation, by itself, shows that a reaction is exothermic? 1 pt
- ☐ A. It fizzes and makes bubbles
 - ☐ B. A thermometer in the surroundings rises
 - ☐ C. It needs a spark to get started
 - ☐ D. The product is a different color from the reactants
2. A candle burns. Which of these belongs to the **surroundings**? 1 pt
- ☐ A. The wax that burns
 - ☐ B. The oxygen that combines with the wax
 - ☐ C. The carbon dioxide that forms
 - ☐ D. The nitrogen in the nearby air
3. True or false: An instant cold pack feels cold because cold flows out of the pack and into your hand. 1 pt
- ☐ True ☐ False Explain your thinking:

4. A warming pack reads 23 °C when opened and 47 °C eight minutes later. Calculate the temperature rise and the average warming rate in °C per minute. Show your work. 2 pts

5. Which equation correctly shows the energy term for an instant cold pack in which ammonium chloride dissolves? 1 pt

- ☐ A. $\text{NH}_4\text{Cl} + \text{energy} \rightarrow \text{NH}_4^+ + \text{Cl}^-$
- ☐ B. $\text{NH}_4\text{Cl} \rightarrow \text{NH}_4^+ + \text{Cl}^- + \text{energy}$
- ☐ C. $\text{NH}_4\text{Cl} + \text{energy} \rightarrow \text{NH}_4^+ + \text{Cl}^- + \text{H}_2\text{O}$
- ☐ D. $\text{NH}_4\text{Cl} \rightarrow \text{NH}_4^+ + \text{Cl}_2 + \text{energy}$

6. In two sentences, explain why 'breaking the bonds in the iron' cannot be the source of a hand warmer's released energy, and what the real source is. 2 pts

7. A match will not burn until it is struck, and then it burns on its own. What does this show? 1 pt

- ☐ A. Burning a match is endothermic
- ☐ B. An exothermic reaction can need a small input to start; the net transfer decides
- ☐ C. The match stores cold until it is struck
- ☐ D. Friction supplies all the energy of the flame

8. Use the prototype table below. The criterion is 'stays at or above 38 °C for at least 2 hours.' From the readings, how long did the prototype stay at or above 38 °C, in hours, and by how much did it miss or beat the criterion? 2 pts

Prototype readings for items 8 and 13 (teaching scenario, room at 22 °C)

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

Time (min)	0	30	60	90	120	150	180
Pouch temperature (°C)	22	39	44	43	40	37	33

9. Draw a cold pack resting on a hand. Draw a boundary around the system, label the system and two parts of the surroundings, and draw one energy arrow across the boundary pointing the correct way. Write exothermic or endothermic under the drawing. 2 pts



10. A design brief says a warmer 'must reach 40 °C' and 'must not cost more than one dollar.' Which statement is a criterion and which is a constraint? Explain the difference in one sentence. 2 pts

11. Two warming packs are both at 45 °C. One holds three times as much reacting powder as the other. Which statement is correct? 1 pt

- ☐ A. They hold the same thermal energy because they are at the same temperature
- ☐ B. The larger pack holds more thermal energy and can keep warming a hand for longer
- ☐ C. The larger pack is hotter
- ☐ D. The smaller pack will last longer because it has less to cool

12. Which change is endothermic? 1 pt

- ☐ A. Iron powder reacts with oxygen and the pouch warms
- ☐ B. Citric acid and baking soda react in water and the cup cools
- ☐ C. A light stick glows for hours
- ☐ D. Calcium chloride dissolves and the water warms

Part B: Synthesis (item 13)

13. The prototype in the table above holds 15 g of iron in a thin cloth pouch. Its criteria are a peak of at least 42 °C and at least 2 hours at or above 38 °C; its constraint is never above 50 °C. (a) Say which criteria it met and which it missed, with numbers. (b) Using the ideas of reaction rate, total energy released and the surroundings, propose ONE change to the design, predict its effect on both peak temperature and time, and explain why you would change only one thing before the next test. 4 pts

Two rules that answer most items

Rule 1: the direction of energy flow is decided only by what the surroundings do (warm up, cool down) or by light and sound leaving; fizzing, color and needing a start do not count. Rule 2: breaking bonds always takes energy in and forming bonds always gives energy out, so the energy a reaction releases comes from forming new bonds giving out more than breaking old ones took in. For the numeric items, write the subtraction first and the division second, with units on every number.

Write the fourteenth item

Write one more multiple-choice item for this check that tests the difference between a freezer gel pack and an instant cold pack. Include four options, exactly one correct, and write a one-sentence explanation for why each wrong option is wrong. Then write a second item that tests the equation placement rule for an exothermic dissolving process such as calcium chloride, with the correct balanced ion equation as one option.