Pack Design Lab

Read evidence, then plan a chemical thermal-energy device.

MS-PS1-6 "Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes. Clarification Statement: Emphasis is on the design..."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the design criteria and circle the controlled conditions in the passage. Number each change the team could make to improve its device.

Testing a Chemical Pack

1. Engineers can build a single-use cold pack by keeping water in one sealed pouch and a dissolving solid in another. When a user breaks the inner seal, the substances mix. If the dissolving process absorbs thermal energy, energy moves from the pack and nearby surroundings into the mixture. The outside of the pack becomes cooler. A useful design keeps the mixture contained, allows energy to transfer through the pack wall, and prevents leaks. The goal is not simply the lowest temperature, but a safe, useful cooling effect for a planned time.

2. Before testing, a team writes criteria and a fair procedure. Their cold pack must lower the temperature of 100 milliliters of water by at least 8 degrees Celsius and keep it below its starting temperature for 10 minutes. The team uses the same starting water temperature, the same container, and the same 100 milliliters of water in every trial. They measure temperature with the same thermometer at the start and once each minute. These controlled conditions help the team connect differences in results to one planned design change.

3. One trial uses 25 grams of calcium chloride in 100 milliliters of water. The water temperature rises, but the pack becomes too warm for the cooling goal. In another trial, 25 grams of ammonium chloride is used with 100 milliliters of water. This pack cools the water, yet it returns near its starting temperature after only four minutes. The team can modify the type of solid, its amount, or its concentration in water. They change one factor at a time. After each test, they compare temperature change and time with criteria, then choose the next design.

2 ANSWER WITH EVIDENCE

Use the passage

1. How does an absorbing dissolving process make the outside of a cold pack cooler?

2. What are the two criteria the team's cold pack must meet?

3. Name two conditions the team keeps the same in every trial, and explain why.

4. Why does the ammonium chloride pack need another modification before it meets the team's goal?

3 YOUR TURN

Your own words

Design a sealed chemical pack that either warms or cools 100 milliliters of water. State your temperature-and-time criterion, the solid and amount you would test, two conditions you would control, and one change you would make after a result that does not meet your criterion.

ANSWER KEY

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GRADES 6-8 · MS-PS1-6

PART 1 · READ AND MARK

Underline the design criteria and circle the controlled conditions in the passage. Number each change the team could make to improve its device. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	How does an absorbing dissolving process make the outside of a cold pack cooler?	**Thermal energy moves from the pack and nearby surroundings into the dissolving mixture.**
2	What are the two criteria the team's cold pack must meet?	**It must lower 100 milliliters of water by at least 8 degrees Celsius and keep the water below its starting temperature for 10 minutes.**
3	Name two conditions the team keeps the same in every trial, and explain why.	**Any two: starting water temperature, container, amount of water, thermometer, or measurement schedule. Keeping them the same helps connect result differences to one planned design change.**
4	Why does the ammonium chloride pack need another modification before it meets the team's goal?	**It cools the water, but the water returns near its starting temperature after four minutes, not the required 10 minutes.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

I will design a sealed cold pack using 25 grams of ammonium chloride dissolved in 100 milliliters of water. My criterion is to lower the water temperature by at least 6 degrees Celsius and keep it below its starting temperature for 8 minutes. I will keep the starting water temperature and container the same in every trial. If the pack cools for less than 8 minutes, I will test a larger amount of ammonium chloride while keeping the water amount the same.

Accept designs that use a chemical process to release or absorb thermal energy and include a measurable temperature-and-time criterion. Students should identify an amount, at least two controlled conditions, and one reasonable single-factor modification.