Pack Design Lab

Build, test and improve 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

First plan a contained chemical pack device that warms or cools 100 mL of water: state a measurable temperature-and-time goal, the material and amount, two controlled conditions and a possible design change. Then actually build, test and modify your device using a teacher-provided classroom thermal-pack kit, thermometer, timer, 100 mL measuring cylinder, outer container and approved insulating materials. Teacher supplies the written kit procedure, permitted quantities and handling limits; the reading's 25 g examples are not assembly directions. Wear goggles and keep the mixture contained. Draw your initial device and record its approved quantities. Test with 100 mL of fresh water: record starting temperature and readings each minute for ten minutes. Compare with your goal, change one approved feature such as insulation, and rebuild/retest with a fresh identical pack and fresh water. Keep starting temperature, water amount and measurement method matched. On separate paper submit both designs, both eleven-reading tables, actual temperature changes, time meeting the criterion, and an evidence-based improvement decision. Never invent successful results.

ANSWER KEY

Pack Design Lab

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)

A possible plan uses a teacher-approved cold-pack kit to cool 100 mL of water by at least 2°C and keep it below its starting temperature for two minutes. I record the actual labeled material and teacher-approved quantity before building a holder that maintains contact between pack and water container. I use the same water amount and starting temperature in both tests. After my first temperature/time record, I add one approved outer insulating layer and test a fresh identical pack with fresh water. My final comparison uses the two actual data tables; the change may help, make no clear difference, or reduce useful energy transfer. Results and a successful design cannot be supplied before the experiment.

Require an actual constructed device, initial test, evidence-based modification and retest, with complete temperature/time records. Teacher must provide an age-appropriate chemical thermal-pack kit with written instructions and permitted quantities; students use only approved materials and the teacher handles disposal. Keep mixtures contained, avoid skin/eye contact and wash hands. Do not open commercial packs unless their educational procedure explicitly calls for it. This exercise may modify insulation/contact geometry while holding chemical identity and dose fixed. Compare each trial's change from its own starting temperature and time meeting the criterion. Distinguish dissolution from necessarily producing a new substance: energy transfer during this chemical process is the standard's focus. The 25 g story is a hypothetical example, not a safe dosage recommendation.