Heat Transfer Lab

Read how a team designs and tests an insulated container.

MS-PS3-3 "Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer. Clarification Statement: Examples of devices could include an insulated box, a solar cooker..."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline each design choice meant to minimize thermal energy transfer, circle the conditions kept the same, and number the result and conclusion in the last paragraph 1 and 2. These marks show how a design is tested fairly.

Testing a Cooler Box

1 Thermal energy moves from warmer objects to cooler objects. A lunch box can slow this transfer when it holds a cold drink on a hot day. A design team chose a small cardboard box, cotton fabric, aluminum foil, tape, and a thermometer. They decided their goal was to minimize thermal energy transfer into the box. Their success measure was simple: after 20 minutes outdoors, the water with the smaller temperature increase would be better insulated.

2 First, the team built two boxes of the same size. One was a plain cardboard comparison box. In the other, they lined the inside walls and lid with cotton fabric, then covered the outside with aluminum foil. They put equal amounts of water at the same starting temperature into matching cups. Both boxes sat side by side in sunlight. This fair test changed the insulation design while keeping container size, water amount, starting temperature, location, and test time the same.

3 At the end, the water in the plain box had warmed by 8 degrees Celsius. The water in the lined box had warmed by 3 degrees Celsius. The team concluded that their lining minimized thermal energy transfer better than plain cardboard during this test. They could improve confidence in the result by repeating the test several times and comparing the temperature changes. If they wanted an even better design, they could test another insulating material while keeping the same fair-test conditions.

2 ANSWER WITH EVIDENCE

Use the passage

1. What was the team's design goal, and what measurement showed whether the design worked?

2. What did the team change in its fair test? Name three conditions it kept the same.

3. Which box minimized thermal energy transfer better? Use the temperature results as evidence.

4. What is one step the team could take to make its conclusion more reliable?

3 YOUR TURN

Your own words

Build a solar warming device that maximizes thermal energy transfer into water, using safe classroom materials, and test it against a plain cup of water. In your report, name the materials and design features, state what you kept the same, record both starting and ending temperatures after the same test time, decide which device worked better, and name one revision you will test.

ANSWER KEY

Heat Transfer Lab

GRADES 6-8 · MS-PS3-3

PART 1 · READ AND MARK

Underline each design choice meant to minimize thermal energy transfer, circle the conditions kept the same, and number the result and conclusion in the last paragraph 1 and 2. These marks show how a design is tested fairly. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	What was the team's design goal, and what measurement showed whether the design worked?	**Their goal was to minimize thermal energy transfer into the box. The better design had the smaller water temperature increase after 20 minutes.**
2	What did the team change in its fair test? Name three conditions it kept the same.	**They changed the insulation design. They kept the container size, water amount, starting temperature, location, and test time the same. Any three conditions are correct.**
3	Which box minimized thermal energy transfer better? Use the temperature results as evidence.	**The lined box minimized transfer better because its water warmed by 3 degrees Celsius, compared with 8 degrees Celsius in the plain box.**
4	What is one step the team could take to make its conclusion more reliable?	**Repeat the test several times and compare the temperature changes.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

I built a solar warming cup by placing a black-paper-wrapped cup holding 100 mL of water inside a foil-lined cereal-box reflector and covering the top with clear plastic wrap. I tested it beside an uncovered plain cup holding 100 mL of water. Both cups started at 21 degrees Celsius and sat in the same sunny place for 20 minutes. The solar warming cup reached 29 degrees Celsius, while the plain cup reached 24 degrees Celsius, so my device transferred more thermal energy to the water. I will add a second foil flap and repeat the test with the same water amount, starting temperature, place, and time.

Accept varied designs and results when students document an actual constructed device and comparison test. The report should include measured temperatures, fair-test controls, a conclusion supported by the data, and a testable revision.