# Keep the Heat

Use test results to evaluate a cup sleeve design.

**MS-PS3-3** "Design, construct, and test a device that either minimizes or maximizes thermal energy transfer. (SEP: 6; DCI: PS3.A, PS3.B, ETS1.A, ETS1.B; CCC: Energy/Matter) May include alignment to MS-ETS1-1 and MS-ETS1-2"

NAME _____ DATE _____

## 1 READ AND MARK

Read it twice

**YOUR JOB** Underline the team's goal and two conditions they kept the same. Circle the three final temperatures, then number them 1 for lowest, 2 for middle, and 3 for highest.

### A Sleeve for Hot Water

1. Before a science club's outdoor meeting, students want a cup of hot water to stay warm. They decide to test sleeves for a reusable cup indoors first. Their goal is for water starting at 60°C to remain at or above 50°C after 20 minutes in the same room. A sleeve could slow thermal energy transfer from the warmer water, through the cup, to the cooler air. Temperature readings can show how much the water cools, though temperature and thermal energy are not the same thing.

2. The team makes one thin paper sleeve and one thick felt sleeve, leaving a third cup bare. All three cups have the same size, material, and lid. An adult pours the same amount of 60°C water into each cup. The cups sit side by side, away from sunlight and drafts. The team measures each cup's water temperature with the same thermometer after 20 minutes. Keeping these conditions alike helps the team compare the sleeves rather than differences in cups or surroundings.

3. After 20 minutes, the bare cup's water is 45°C. The paper-sleeved cup's water is 48°C. The felt-sleeved cup's water is 53°C. Warm water loses thermal energy as it cools; a sleeve may reduce that transfer by slowing how heat moves through the cup and into the room. The students record the final temperatures instead of deciding by touch, since a cooler-feeling outside surface does not always tell them the water temperature. Their test lasted only 20 minutes in one room, so it does not show what would happen after an hour outside.

## 2 ANSWER WITH EVIDENCE

Use the passage

1. Which cup sleeve met the team's goal? Use a temperature from the test to support your choice.

2. How much warmer was the water in the paper-sleeved cup than in the bare cup after 20 minutes? What does that difference suggest about thermal energy transfer?

3. Why did the team use cups with the same lids and the same amount of water?

4. Do these results prove that the felt sleeve would keep water above 50°C after an hour outdoors? Explain.

## 3 YOUR TURN

Your own words

Draw and label a new sleeve design using paper, felt, or both for a lidded cup. In two sentences, explain how you would test whether it keeps 60°C water at or above 50°C after 30 minutes in a cold hallway, using a bare cup for comparison.

**ANSWER KEY**

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**GRADES 6-8 · MS-PS3-3**

## PART 1 · READ AND MARK

Underline the team's goal and two conditions they kept the same. Circle the three final temperatures, then number them 1 for lowest, 2 for middle, and 3 for highest. Accept any marking that follows this job and points at the right text.

## PART 2 · ANSWERS

| # | QUESTION | ANSWER |
|---|---|---|
| 1 | Which cup sleeve met the team's goal? Use a temperature from the test to support your choice. | **The felt sleeve met the goal. Its water was 53°C after 20 minutes, which is above 50°C.** |
| 2 | How much warmer was the water in the paper-sleeved cup than in the bare cup after 20 minutes? What does that difference suggest about thermal energy transfer? | **It was 3°C warmer. Under these test conditions, the paper sleeve reduced thermal energy transfer compared with the bare cup.** |
| 3 | Why did the team use cups with the same lids and the same amount of water? | **Keeping the lids and water amounts the same helps them compare the sleeves without those differences affecting the results.** |
| 4 | Do these results prove that the felt sleeve would keep water above 50°C after an hour outdoors? Explain. | **No. The team tested the cups for only 20 minutes indoors, not for an hour outdoors.** |

## PART 3 · YOUR TURN (SAMPLE ANSWER)

Sketch labels: lidded cup, two felt layers, paper outer wrap. I would put the same amount of 60°C water in my wrapped cup and an identical bare cup, then leave both in the same cold hallway for 30 minutes. I would measure both water temperatures; my design meets the goal only if its water is at least 50°C.

Accept any labeled sleeve made with the listed materials if the test uses comparable cups and conditions, checks water temperature after 30 minutes, and applies the 50°C goal. A design does not need to outperform the bare cup to meet the stated goal.