Cooling Under Test

How experimental designs and tools shape a fair test

FSL.3C.1 "Analyze the methods and choice of tools used in simple and complex experimental designs."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline two decisions that make the comparisons fair, circle the two measurement tools the team uses, and number the four combinations in the complex design. Your marks will help you track how the team tests each factor.

Will a Sleeve Keep Water Warm?

1. A cafeteria team wants to know whether a foam sleeve keeps water warm in a reusable jar. They pour the same volume of water at 40°C into identical jars and place them in a room at 20°C. Their outcome is the drop in water temperature after 15 minutes, not how warm a jar feels to the touch. A temperature probe placed at the same depth in each jar measures the water directly. A surface thermometer would measure the outside of the jar instead, which might give a misleading picture of the water inside. Before testing, the team checks that the probes agree in one water bath.

2. For a simple design, the team puts a foam sleeve on one jar and leaves another bare. They keep the jars apart so one does not block air from reaching the other. Both receive water from the same mixed batch at the same time. The team records each jar's starting temperature and its temperature 15 minutes later, then compares the drops. They repeat the paired test on several days, switching which jar gets the sleeve. Repeating tests helps reveal whether one unusual reading drove the result; switching jars reduces the chance that a slight difference between jars explains it.

3. A more complex design asks whether moving air changes how well the sleeve works. The team tests four combinations: bare jar with fan off, sleeved jar with fan off, bare jar with fan on, and sleeved jar with fan on. Each combination has repeated trials, with identical water volumes, starting temperatures, and test times. A handheld air-speed meter checks that fan-on trials receive similar airflow at the same jar distance. The team compares sleeved and bare jars within each fan setting, then compares those differences across settings. This shows whether airflow changes the sleeve's effect, rather than confusing fan effects with sleeve effects.

2 ANSWER WITH EVIDENCE

Use the passage

1. Why is a temperature probe inside the water a better tool for this test than a surface thermometer?

2. How does switching which jar gets the sleeve strengthen the simple design?

3. Why does the complex design compare sleeved and bare jars within each fan setting before comparing the results across settings?

4. What problem could the air-speed meter help the team detect in the fan-on trials?

3 YOUR TURN

Your own words

Design a test to find out whether lid use and starting water temperature affect how fast water cools in cups. In one paragraph, name the groups you would test, what you would measure, two conditions you would keep the same, and why your measurement tool fits the task.

ANSWER KEY

Cooling Under Test

HIGH SCHOOL · FSL.3C.1

PART 1 · READ AND MARK

Underline two decisions that make the comparisons fair, circle the two measurement tools the team uses, and number the four combinations in the complex design. Your marks will help you track how the team tests each factor. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Why is a temperature probe inside the water a better tool for this test than a surface thermometer?	**The probe measures the water temperature directly, while a surface thermometer measures the jar's outside, which may not reflect the water temperature.**
2	How does switching which jar gets the sleeve strengthen the simple design?	**It reduces the chance that a slight difference between the jars, rather than the sleeve, explains the result.**
3	Why does the complex design compare sleeved and bare jars within each fan setting before comparing the results across settings?	**Comparing jars within each fan setting isolates the sleeve's effect at that setting. Comparing those effects shows whether airflow changes how well the sleeve works.**
4	What problem could the air-speed meter help the team detect in the fan-on trials?	**It could reveal that some fan-on trials receive different amounts of airflow, making their temperature drops harder to compare fairly.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

I would test four groups: lids on and off, each with water starting at 35°C and 45°C. I would use the same type of cup and the same amount of water in every trial. A temperature probe in each cup would measure the water at the start and after 10 minutes, so I could calculate each temperature drop. The probe fits the task because I need the water's temperature, not the temperature of the cup's outside. I would repeat each group and compare lid effects at each starting temperature.

Accept other fair designs that test all four lid and starting-temperature combinations. Responses should name a tool that measures water temperature, hold at least two relevant conditions constant, and explain why the tool fits.