Solar Heater Choices

Use criteria, constraints, science ideas, and test data to judge designs.

5.1.d "constructing and critiquing conclusions and explanations construct and/or support arguments with evidence, data, and/or a model describe how scientific ideas apply to design solutions generate and compare multiple solutions to problems..."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the criterion and the two constraints. Circle each test result, and number the two science ideas that explain the models.

Testing a Solar Heater

1. At an outdoor science club, a team designed a solar heater that could warm 250 milliliters of water. Their criterion was a temperature increase of at least 15 degrees Celsius after 20 minutes in sunlight. Their constraints were a cost of no more than $5 and a width of no more than 30 centimeters. They built three cardboard models.

2. Each model held the same amount of water and started at the same temperature. Model A had a black inside surface. Model B added one foil reflector, and Model C added two reflectors. Black surfaces absorb more light energy than shiny surfaces, while foil reflectors can direct additional sunlight toward the black surface. The team tested all models at the same time.

SOLAR HEATER TEST RESULTS

Model	Temperature Rise	Cost	Width
A	9 degrees Celsius	$2	24 cm
B	14 degrees Celsius	$3	28 cm
C	18 degrees Celsius	$5	30 cm

3. The results showed that Model C increased the water temperature by 18 degrees Celsius. It met the heating criterion and stayed within both constraints, but it used the greatest allowed width and cost. The team concluded that Model C was the best tested design. They also noted that a trial on a cloudy day would test whether this conclusion holds.

2 ANSWER WITH EVIDENCE

Use the passage

1. Which model meets the heating criterion and both constraints? Use data from the table to support your answer.

2. What science idea explains why foil reflectors might help a solar heater warm water?

3. Does the test data support the team's conclusion that Model C was the best tested design? Explain using the criterion and constraints.

4. What added test could make the team's conclusion stronger, and why?

3 YOUR TURN

Your own words

Design two covers for a cup of soil. The criterion is lowering the soil temperature by at least 3 degrees Celsius after 20 minutes in sunlight, and each cover must cost $4 or less and be no wider than 25 centimeters. Describe both, give a predicted temperature change for each, then choose one and use the idea that shade blocks sunlight to explain why it best meets the criterion and constraints.

ANSWER KEY

Solar Heater Choices

GRADE 5 · 5.1.d

PART 1 · READ AND MARK

Underline the criterion and the two constraints. Circle each test result, and number the two science ideas that explain the models. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Which model meets the heating criterion and both constraints? Use data from the table to support your answer.	**Model C. Its temperature rise was 18 degrees Celsius, its cost was $5, and its width was 30 cm.**
2	What science idea explains why foil reflectors might help a solar heater warm water?	**Foil reflectors can direct additional sunlight toward the black surface, which absorbs light energy.**
3	Does the test data support the team's conclusion that Model C was the best tested design? Explain using the criterion and constraints.	**Yes. Model C was the only model that reached at least a 15-degree Celsius increase, and it stayed at or below the $5 cost and 30 cm width limits.**
4	What added test could make the team's conclusion stronger, and why?	**Test the models on a cloudy day. This would show whether Model C still works best under different sunlight conditions.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Design A is a 20-centimeter cardboard roof on four sticks. It costs $2 and is predicted to lower the soil temperature by 4 degrees Celsius. Design B is a 24-centimeter white cardboard roof on four sticks. It costs $4 and is predicted to lower the temperature by 6 degrees Celsius. I would choose Design B because its larger roof should block more sunlight, it is predicted to meet the temperature criterion, and it stays within both constraints.

Accept evidence-based comparisons that accurately use the stated criterion, cost limit, and width limit. For the open task, accept varied designs and predictions if the student gives two solutions, compares them, and uses shade blocking sunlight as scientific reasoning.