Heat After Sunset

Design and test a system that puts solar heat to work.

E.8.10.4 "Using an engineering design process, develop a system to capture and distribute thermal energy that makes renewable energy more readily available and reduces human impact on the environment (e.g., building solar water heaters…"

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline where the system captures, stores, and distributes heat. Circle its design limits, then number the steps the volunteers will use to test and improve it.

A Greenhouse Heat Plan

1. At a neighborhood greenhouse, volunteers wanted to keep seedlings warm after sunset without running an electric heater all night. Their goal was to hold the growing area above 12°C for six hours after sunset on clear winter days. They had little money and could not place heavy tanks on the roof. They chose a small solar thermal system: a dark metal collector outside would absorb sunlight, while a pump would move water through it. Insulated pipes would carry the warmed water to a tank inside.

2. A second pump would move water from the tank through a coil under the plant benches and back to the tank. Heat would move from the warm water to the cooler air near the seedlings. At night, the collector pump would stop so water would not lose heat outdoors, but the second pump could keep sending stored heat to the benches. On cloudy days, the existing electric heater would serve as a backup. The system could reduce electricity use and related pollution, though making its parts would also use materials and energy.

3. Before building, the team measured how fast the greenhouse cooled on a clear evening. With the new system installed, they planned to record indoor temperature every hour for six hours on a similar evening. They would also record electricity used by the backup heater on both evenings. If the temperature fell below their goal, they could add insulation around the tank or enlarge the collector. They would retest after making just one change, so they could tell whether that change helped.

2 ANSWER WITH EVIDENCE

Use the passage

1. The volunteers cannot put a heavy tank on the roof. How does their design meet this limit while still capturing sunlight?

2. How does the system deliver heat to the seedlings after sunset without sending water through the outdoor collector?

3. What two kinds of measurements will help the team judge whether the system meets its goal and uses less electricity?

4. If the greenhouse gets too cold, what change could the team make, and why should they retest after only one change?

3 YOUR TURN

Your own words

Design a solar thermal system that provides warm handwashing water at a campsite. In five or six sentences, describe how it captures, stores, and delivers heat, give one design constraint, explain a test and possible improvement, and tell how it could reduce environmental impact.

ANSWER KEY

Heat After Sunset

GRADE 8 · E.8.10.4

PART 1 · READ AND MARK

Underline where the system captures, stores, and distributes heat. Circle its design limits, then number the steps the volunteers will use to test and improve it. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	The volunteers cannot put a heavy tank on the roof. How does their design meet this limit while still capturing sunlight?	**They place the collector outside to absorb sunlight and keep the water tank inside rather than on the roof.**
2	How does the system deliver heat to the seedlings after sunset without sending water through the outdoor collector?	**The collector pump stops at night. A second pump moves warm water from the insulated tank through a coil under the benches, where heat moves to the cooler air.**
3	What two kinds of measurements will help the team judge whether the system meets its goal and uses less electricity?	**They will measure indoor temperature each hour for six hours and record backup heater electricity use, then compare the results with the earlier evening.**
4	If the greenhouse gets too cold, what change could the team make, and why should they retest after only one change?	**They could add tank insulation or enlarge the collector. Changing one thing at a time helps them tell whether that change improved the result.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

I would mount a dark solar collector beside the wash station to heat water during the day. An insulated tank would store the warm water, and a pipe would deliver it to a mixing tap. A mixing valve would limit the water temperature so no one gets burned. I would measure the tap temperature every hour during a busy afternoon and check whether it stays between 30°C and 40°C. If the water cooled too soon, I would add insulation to the tank and test again. Using sunlight for some of the heating could lower electricity use and the pollution linked to producing that electricity.

Accept other workable heat-transfer designs and measurable tests. Students should connect a specific test result to an improvement and describe an environmental benefit without claiming the system has no impact.