Project the Beetle

Test and improve a lens-based projector

PHS.6.7 "Enrichment: Use an engineering design process to design and construct an apparatus that forms images to project on a screen or magnify images using lenses and/or mirrors.*"

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the team's design goal, circle each change they make to the apparatus, and number the three checks in their final checklist. Use your marks to connect each change to a problem it addresses.

A Beetle on the Wall

1. A museum wants a portable device that projects the outline of a tiny beetle onto a white card. The outline must be large enough to trace, and visitors should see its legs clearly. A team places an LED behind a clear sheet with a dark beetle printed on it. They aim the light through a converging lens toward a movable card. The LED stays cooler than a typical lamp near the plastic sheet. A converging lens can form a real image on a screen when the object is farther from the lens than its focal length. The projected image is upside down.

2. The team uses a lens with an 8 cm focal length. At first, the beetle sheet sits 6 cm from the lens. Sliding the card back and forth never produces a sharp outline. They move the sheet to 12 cm from the lens. Now a sharp image appears when the card is about 24 cm beyond the lens. Its length is about twice the length of the beetle on the sheet. When the card moves closer to the lens, the outline becomes fuzzy again. The team records both distances so they can repeat the setup.

3. Even at the sharpest position, light spilling around the sheet washes out the legs. The team adds a black paper sleeve around the LED and sheet, leaving a clear path past the beetle and through the lens. The legs now stand out better, although the image does not grow larger. To make the projected beetle upright, they rotate the sheet half a turn before another test. Their final checklist asks whether the whole image fits on the card, whether its edges are sharp, and whether its legs are easy to see. Each change addresses a different problem.

2 ANSWER WITH EVIDENCE

Use the passage

1. Suppose the beetle sheet is 7 cm from the team's lens. Could moving only the card produce a sharp projected image? Explain using the lens's focal length.

2. Using the team's test results, where should you place the sheet and card to make an upright image about twice the beetle's length? How should you turn the sheet?

3. The sheet is 12 cm from the lens, but the card is only 18 cm beyond it. What would you change to sharpen the outline while keeping the sheet in place?

4. A sharp image has legs that are hard to see because light spills around the sheet. What addition would address this problem, and what does it change?

3 YOUR TURN

Your own words

Draw a labeled plan for a projector that makes a symbol of your choice fit inside a 10 cm wide card, using an LED, a transparent sheet, and a converging lens. In two sentences, describe how you would test the image and what you would change if it were fuzzy or too wide.

Project the Beetle

PART 1 · READ AND MARK

Underline the team's design goal, circle each change they make to the apparatus, and number the three checks in their final checklist. Use your marks to connect each change to a problem it addresses. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Suppose the beetle sheet is 7 cm from the team's lens. Could moving only the card produce a sharp projected image? Explain using the lens's focal length.	**No. The sheet would be inside the lens's 8 cm focal length, so moving the card alone would not produce a sharp real image on it.**
2	Using the team's test results, where should you place the sheet and card to make an upright image about twice the beetle's length? How should you turn the sheet?	**Place the sheet 12 cm before the lens and the card about 24 cm beyond it. Rotate the sheet half a turn.**
3	The sheet is 12 cm from the lens, but the card is only 18 cm beyond it. What would you change to sharpen the outline while keeping the sheet in place?	**Move the card farther from the lens, to about 24 cm beyond it.**
4	A sharp image has legs that are hard to see because light spills around the sheet. What addition would address this problem, and what does it change?	**Add a black paper sleeve around the LED and sheet. It blocks stray light and improves contrast without enlarging the image.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Sketch labels: LED, clear sheet with a 2 cm dark star, converging lens with an 8 cm focal length, 12 cm between sheet and lens, card about 24 cm beyond lens, black paper sleeve. I will measure the projected star and check that its full outline is sharp and no wider than 10 cm. If it is fuzzy, I will slide the card until it is sharp; if it is too wide, I will try a different sheet position and refocus the card.

Accept plans with a light source, an object farther from a converging lens than its focal length, and a screen on the other side. Revisions should address the stated test result, such as moving the screen to improve focus or adjusting object and screen positions to change image size.