Light With Less

Test materials for a reliable, efficient circuit

PHS.9.4 "Use an engineering design process to construct and test conductors, semiconductors, and insulators using various materials to optimize efficiency.*"

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the design target, circle each material tested in the gap, and number the two actions that make the tests comparable and check whether the light is reliable.

A Light for the Lighthouse

1. A museum team needs a tiny model lighthouse that lights an LED without wasting battery power or leaving exposed metal that could short the circuit. Their design target is a visible light at the lowest reliable current. They use a 5 V battery, an LED, and a fixed 330 ohm resistor in series. The resistor limits current while they test materials. Two metal clips leave a gap where each sample can be inserted. The team keeps the battery, resistor, LED, and clip spacing the same for every trial. That way, a change in current can be linked mainly to the sample.

2. First, a copper wire gave a steady LED glow and a higher current reading than the team's strip of graphite. The graphite carried some current, but the LED was faint. With a silicon diode in the gap, current flowed when the diode faced one way; flipping it stopped the LED from lighting. A piece of plastic in the gap stopped current in either position. These trials tested a conductor, a semiconductor device, and an insulator in the same circuit. Each sample had to touch both clips, since a loose connection could otherwise be mistaken for a material that blocks current.

3. The team chose copper for the main path and installed the silicon diode so it would block current if someone reversed the battery leads. They wrapped plastic around exposed joins but left the needed contact points bare. To improve the design, they repeated five on-off tests and measured current at the same battery voltage. They rejected a sample that dimmed or lost contact, even if one trial used less current. Their final choice balanced low current, reliable light, and protection from shorts rather than simply picking the dimmest lamp.

2 ANSWER WITH EVIDENCE

Use the passage

1. The graphite strip may use less current than the copper wire. Why would the team still choose copper for the lighthouse?

2. How would you place the silicon diode to let the lighthouse light, and what would happen if you flipped it?

3. Why did the team put plastic around exposed joins instead of between the clips in the finished circuit?

4. A new sample makes the LED light once at a low current. What tests from the passage should the team use before choosing it?

3 YOUR TURN

Your own words

Design a 5 V key-detection tray that lights an LED when a metal key bridges two contacts but stays dark when a plastic token rests on them. In 5 to 6 sentences, describe how you would use a conductor, silicon diode, insulator, and resistor, then give two controlled tests and a result that would make you revise the design.

ANSWER KEY

Light With Less

HIGH SCHOOL · PHS.9.4

PART 1 · READ AND MARK

Underline the design target, circle each material tested in the gap, and number the two actions that make the tests comparable and check whether the light is reliable. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	The graphite strip may use less current than the copper wire. Why would the team still choose copper for the lighthouse?	**Copper gave a steady, visible LED glow, while the team's graphite strip made the LED faint. The target requires reliable visible light, not just low current.**
2	How would you place the silicon diode to let the lighthouse light, and what would happen if you flipped it?	**Place it in the direction that allowed current to flow in the trial. Flipping it stopped the LED from lighting.**
3	Why did the team put plastic around exposed joins instead of between the clips in the finished circuit?	**Plastic around the joins helps prevent shorts. Plastic between the clips would stop current and keep the LED off.**
4	A new sample makes the LED light once at a low current. What tests from the passage should the team use before choosing it?	**Keep the battery, resistor, LED, and clip spacing the same, then repeat five on-off tests and measure current at the same battery voltage. Check that the light stays visible and the sample does not lose contact.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

I would put two copper contacts in the tray so a metal key can bridge them. A resistor and LED would be in series with a 5 V battery, and a silicon diode would face the direction that lets current flow. Plastic would separate the contacts below their tips and cover other exposed joins. First, I would use the same circuit to test whether a key lights the LED while a plastic token does not. Second, I would compare two resistor values with the same key and battery, measuring current and checking that the light stays visible through five on-off trials. I would revise the contact spacing if the key failed to light the LED, and I would choose the lower-current resistor only if its light stayed visible.

Accept designs that keep the resistor in series, use the diode in its conducting direction, and place insulation without blocking the intended contact. Controlled tests should change one feature at a time and consider both current and reliable lighting.