Switch the Route

Design a circuit that controls one light from two locations

PHY.5.9 "Enrichment: Design and draw a schematic of a circuit that will turn on/off a light from two locations in a room like those found in most homes."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Read the passage. Underline each connection you need to draw in the schematic, then circle the switch positions that make the lamp turn on or off.

A Light at Either End

1. In a long hallway, a lamp should respond at either doorway, regardless of where someone last flipped a switch. A simple series circuit with two ordinary on/off switches cannot do this: opening either switch breaks the only route, so the other switch cannot restore it. Instead, a familiar home lighting circuit uses two **three-way switches**. Despite the name, each has two positions and three current-carrying terminals: one common terminal and two traveler terminals. Electrically, each switch acts as a single-pole, double-throw switch, joining its common terminal to exactly one traveler terminal at a time.

2. To sketch the working circuit, start with a voltage source and label its supply conductor hot and its return conductor neutral. Connect hot to the common terminal of switch A. Draw two separate traveler wires from A's traveler terminals to the matching traveler terminals of switch B. Connect B's common terminal to one side of the lamp, then connect the lamp's other side to neutral. Do not join the traveler wires together. In a real installation, protective grounding and electrical codes also matter, but this paper schematic shows only the current path that controls the lamp.

3. Trace a possible route from hot through switch A, along a traveler, through switch B, and through the lamp to neutral. When both switches select the same traveler, that route is complete and the lamp turns on. When they select different travelers, the route is broken and the lamp stays off. Flipping either switch changes which traveler its common terminal touches, so flipping either one reverses the lamp's state. This is why the switches work independently as controls at opposite ends of the hallway. Keep crossing wires unconnected unless you mark a junction.

2 ANSWER WITH EVIDENCE

Use the passage

1. Describe the connections you would draw from the hot conductor to the lamp, including both switches.

2. Both switches select traveler 1. Trace the complete route through your proposed circuit, starting at hot.

3. Switch A selects traveler 1, and switch B selects traveler 2. Is the lamp on or off? Describe one switch change that would turn it on.

4. A sketch joins the two traveler wires together before they reach switch B. Why will flipping either switch no longer turn the lamp off?

3 YOUR TURN

Your own words

Draw a labeled schematic for a stairwell lamp controlled at the top and bottom of the stairs. Show the lamp on with both switches selecting traveler 2, label hot, neutral, both commons, and both travelers, then write one sentence explaining what happens if the top switch is flipped.

ANSWER KEY

Switch the Route

HIGH SCHOOL · PHY.5.9

PART 1 · READ AND MARK

Read the passage. Underline each connection you need to draw in the schematic, then circle the switch positions that make the lamp turn on or off. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Describe the connections you would draw from the hot conductor to the lamp, including both switches.	**Connect hot to A's common, connect A's two travelers separately to B's matching travelers, and connect B's common to the lamp.**
2	Both switches select traveler 1. Trace the complete route through your proposed circuit, starting at hot.	**Hot to A's common, traveler 1, B's common, lamp, then neutral. The lamp is on.**
3	Switch A selects traveler 1, and switch B selects traveler 2. Is the lamp on or off? Describe one switch change that would turn it on.	**The lamp is off. Flip either switch so both select the same traveler.**
4	A sketch joins the two traveler wires together before they reach switch B. Why will flipping either switch no longer turn the lamp off?	**Both switch positions now lead to the joined wires, so there is always a complete route through the lamp.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

The schematic connects hot to the top switch's common. Two separate wires connect its traveler 1 and traveler 2 terminals to the matching terminals on the bottom switch. The bottom switch's common connects to the lamp, and the lamp connects to neutral. Both switches are drawn selecting traveler 2, completing the path through the lamp. If the top switch is flipped, it selects traveler 1, breaking the path and turning the lamp off.

Accept any clear schematic that keeps the travelers separate and places the lamp between one switch's common and neutral. The two switches may trade locations in the circuit if hot connects to one common and the lamp connects to the other.