G: Explain Circuits with Voltage Current Resistance and Power
Level 3
Prerequisites: Know Circuit Vocabulary (Short Answer)
Points To: Advanced Current

Objectives:

- Use the terms voltage, current, resistance, and power to explain why electric circuits operate the way they do, such as why a light bulb lights or does not light, or why one bulb is brighter than another.

- Use observations and measurements to confirm or disprove various theories about electrical circuits.

- Create counterexamples to confirm or disprove various theories about electrical circuits.

The point of this assignment is to practice your knowledge of how electric circuits work by explaining to other physics students that have misconceptions about how circuits work.

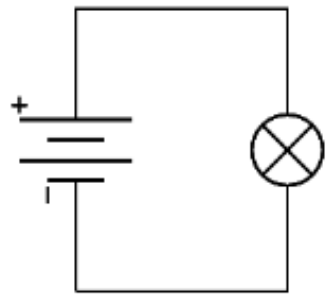
The gang of confused physics students:
Confused Katie
Befuddled Bobby
Baffled Betty
Bamboozled Buddy
Bewitched Brian
Thoroughly Muddled Millie

When explaining, you need to *refer to one of these principles*.
Principles:

1. A higher voltage means you have more current.
2. More voltage and more current means more power (brighter light bulbs!)
3. More resistance means you have *less current*.
4. Less resistance means you have *no current*.
5. No resistance at all means you have *a dangerous level of current*, called a *short circuit*. It typically overheats quickly.
6. Short circuits are often built by *accidentally* creating a path around a resistor.
7. If given multiple options, electric current will take the path with *least resistance*. This can result in a *short circuit*.
8. A series circuit that is broken *at any point* will stop all current in the entire circuit.
9. A parallel circuit that is broken *on a particular branch* will stop current along that branch. Current in other branches is unaffected.
10. Wiring light bulbs in series *increases the resistance*. (thus meaning *less current*)
11. Wiring light bulbs in parallel *decreases the resistance* (thus meaning *more current*).
12. Bulbs in series need to split the voltage between then (thus meaning less power).
13. Bulbs in parallel have access to all the voltage from the battery (thus have more power).

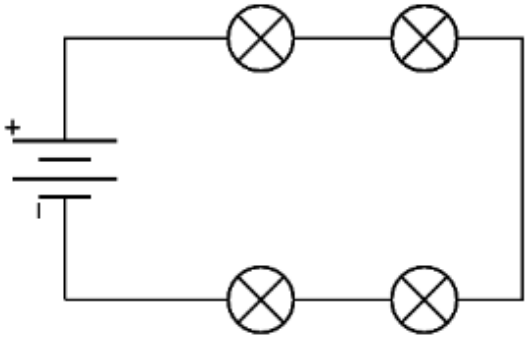
Note: All of the principles derive from Ohm's Law, Kirchoff's Laws, and the Conservation of Energy.

1. Confused Katie builds a circuit like this:



and smiles as the light bulb turns on!

She loves the light so much that she creates another circuit like this:



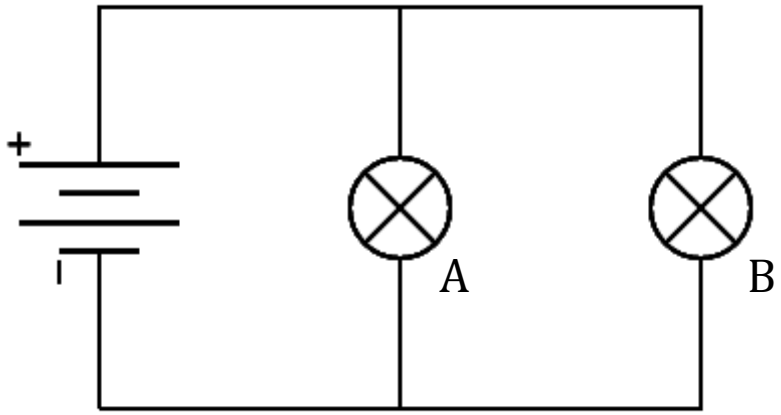
But, sadly, none of the light bulbs appear lit.
Confused Katie sighs and says, “My battery is just not strong enough to light four light bulbs.”

But Katie is wrong. It is strong enough to light four light bulbs!

Draw a new circuit which shows Katie how the battery can light four bulbs.

Explain, using the principles written above, Katie’s circuit does not work, but the new one does:

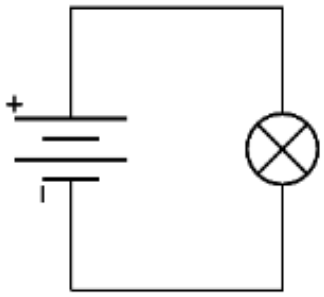
2. Baffled Betty:
Baffled Betty builds the following circuit:



She unscrews light "B" from its socket, and notices that light bulb "A" stays on.
She then gets a piece of stone and carves into it:
"Betty's Law: When one light bulb is unscrewed from its socket, all other light bulbs remain on."

Please draw a *counterexample circuit* for Betty's Law. A *counterexample circuit* is one that disproves Betty's Law.

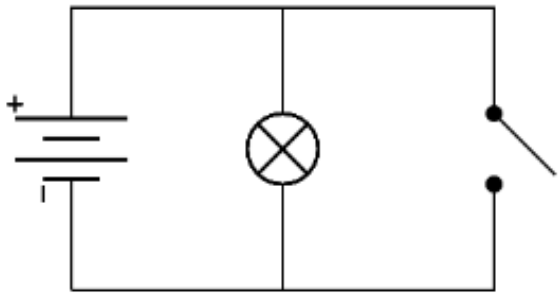
3. Befuddled Bob
Befuddled Bob starts out by building a simple circuit like this:



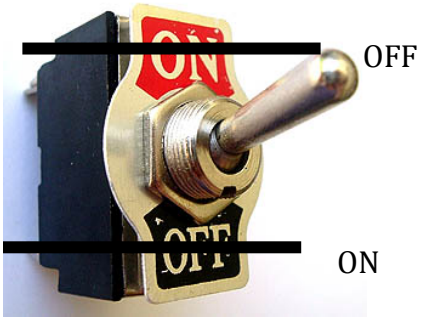
and the light bulb turns on!

Bob decides he wants to get a switch, and bought this snazzy switch he got from an electronics store:

And then decides he wants to add a switch, so he adds one on like this:



Befuddled Bob plays with the switch for awhile, and is very befuddled indeed. He then takes his snazzy switch, crosses off the "ON" sign and replaces it with "OFF," then crosses the "OFF" sign and replaces it with "ON."

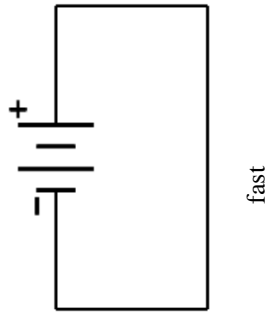


Bob is befuddled indeed if he thinks this is how things are supposed to work! Please draw what Bob should have done.

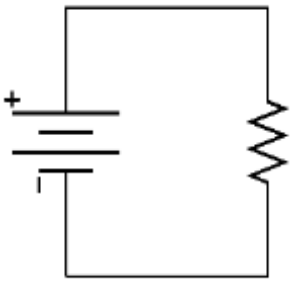
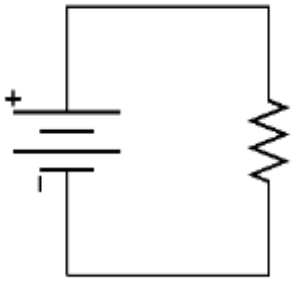
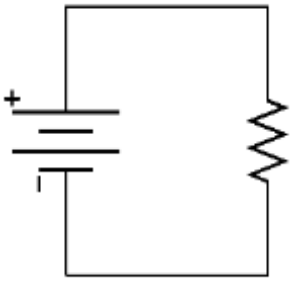
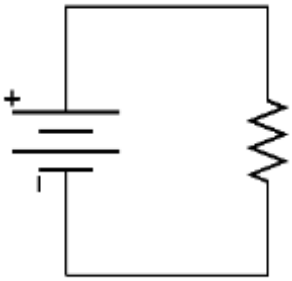
Then, *using the principles listed above*, explain why Bob's switch worked the opposite of how he thought it should.

How a resistor affects current:

4. A student builds a circuit with no resistor. The circuit is dangerously high, indicated by the word "fast."

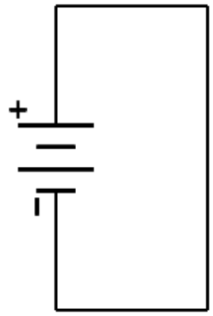


Realizing her error, the student adds a resistor to the circuit in order to reduce the total current. Chose the answer that *best indicates* how the current of the electrons changes.

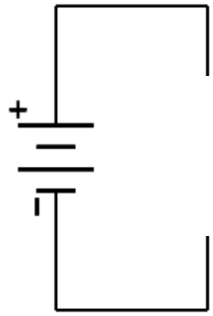
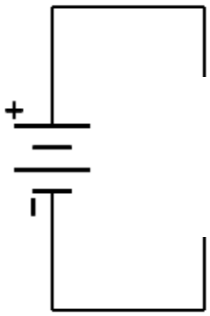
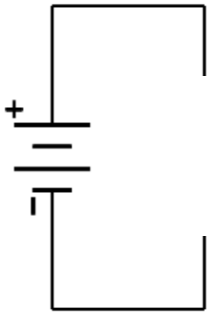
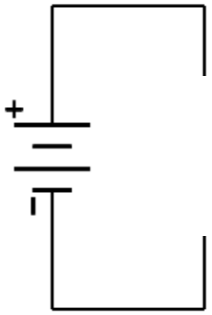
A.	B.	C.	D.
slow  fast	fast  slow	fast  fast	slow  slow

Using the principles above, explain why this answer is true and the other three answers must be false.

5. A student builds a dangerous circuit, and electrons are flowing!



Realizing the mistake, the student immediately cuts a whole in the circuit. Which of the diagrams below *best* indicates where the does and does not flow.

A.	B.	C.	D.
YES  NO	YES  YES	NO  YES	NO  NO

Refer the to rules above to defend your answer.

Coming Soon:

A re-evaluation of the statement “electrons take the path of least resistance”
and why it should be replaced by “electric current is greater when resistance is lower.”

the misconception that light bulbs “use up electrons” as they pass.

Why doesn’t the first light bulb in a series turn on before the second one?

Why aren’t some light bulbs brighter than others in a series circuit?

Can you disprove that in a series circuit, current always stays the same.