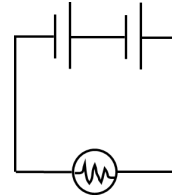


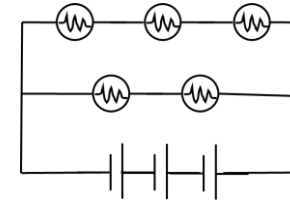
## Circuitry Worksheet Answer Key

1. Draw and then build a circuit with:

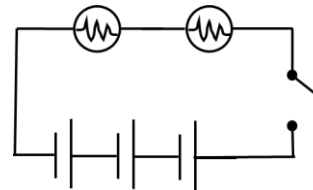
- a. One lamp in series with two batteries



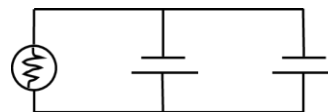
- b. A two lamp string in parallel with a three lamp string, both connected to three batteries in series.



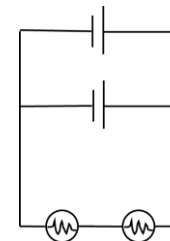
- c. Two lamps in series with a switch and three batteries.



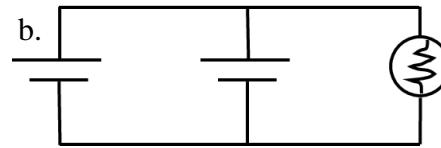
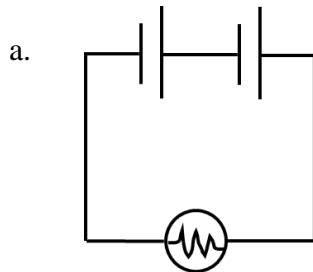
- d. Two batteries parallel with one lamp



- e. Two batteries in parallel with two lamps in series (two lamp string).



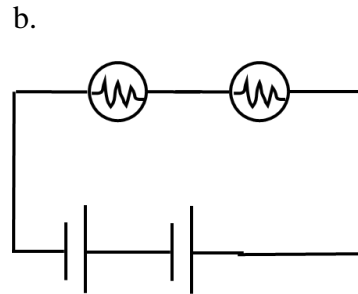
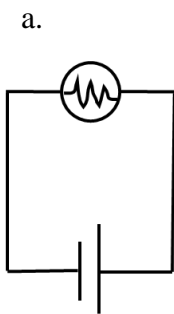
2. Build a circuit with two batteries in series with one bulb and then another with two batteries in parallel with a bulb.



How does the brightness of the bulbs in each of the circuits compare?

*The bulb in arrangement (a) is brighter. When batteries are in series the voltage is additive.*

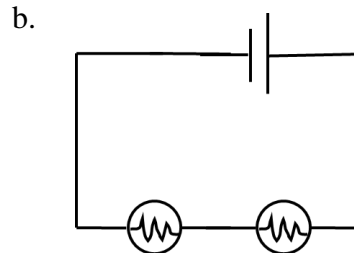
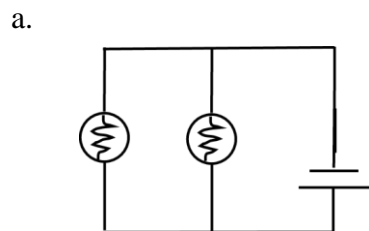
3. Now build one circuit with one bulb across one battery (a) and another with two bulbs in series across two batteries (b):



How does the brightness of the bulbs in each of the circuits compare?

*The bulbs are all the same brightness. This is because they have the same voltage running through them. Voltage in series is split across all the resistors (bulbs).*

4. Build a circuit with two lamps in parallel with one battery (a) and two lamps in series across one battery (b):



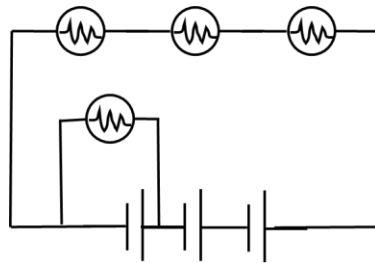
What do you notice about the brightness of the bulbs? *The bulbs in parallel series are brighter than the series bulbs*

Which circuit could you remove one lamp from and the other would stay lit? *parallel*

Which circuit has exactly the same amount of current flowing through each lamp? *series*

Which circuit has half the voltage of the battery across each lamp? *series*

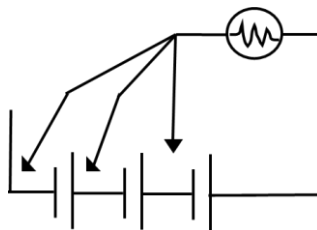
5. Now build a circuit with one lamp across one battery and then three lamps in series across three batteries in series:



Notice the lamps have the same brightness, which means there is a similar voltage across each lamp. This means the voltage is divided equally across the three lamps in the series. How much more current does the first battery have flowing through it versus the other two?

*In a series connection voltage is additive but the current or amp-hours is the same. However, the first battery has twice the current going through it as it is running two separate circuits.*

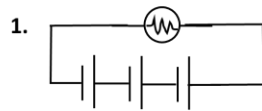
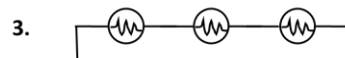
6. Build a circuit that you can easily switch one lamp across one, two, and three batteries.



How does the current and brightness change depending on the voltage (# of batteries) across the lamp?

*The brightness of each bulb will increase, the overall current will increase, but the current across each bulb will be the same as the resistance of each is the same.*

7. Build circuits in which you keep increasing the number of lamps in series across three batteries.



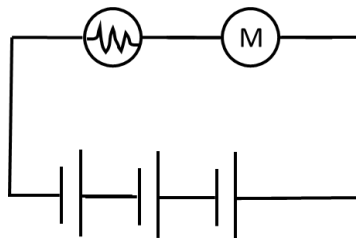
How many lamps can you put in series and still see the lamp filament is dimly lit?

*Students should observe the lights getting dimmer and dimmer*

What is the voltage across each lamp in a 6 lamp series if each battery is 1.5V?

$$4.5 \text{ V} / 6 \text{ lamps} = 0.75$$

8. Build a circuit with one lamp in series with the motor across three batteries in series.



Notice the direction the motor is spinning. Now swap the connections to the batteries (switch red and black cords). What happens?

*The motor will change directions when the polarity is switched*

Use your hand to briefly stop the motor, what happens to the light?

*When the motor is stopped the light will appear brighter*

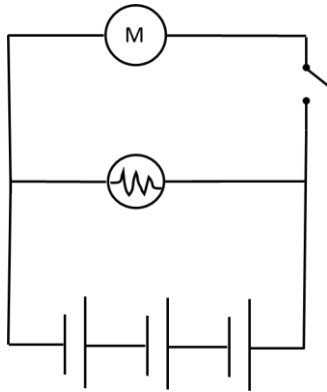
Does the light change when the motor is allowed to start back up?

*The light will dim again*

How does the motors behavior change when as you remove batteries across the series?

*The motor will run slower as voltage is lowered (batteries in series removed)*

9. Use the alligator clips to add a switch and put the motor and light in parallel.



Use the switch to stop the motor. How does this effect the brightness of the light? Is this different than what you observed in the previous experiment? Why or why not?

*When the motor this time the light will not be affected. The light is running on its own circuit separate from the motor.*

10. What other circuits can you imagine and build?? Draw them here!

*Have fun and use your imagination!*

