Circuit Math 2 Name _____

What you need to learn from this packet:

- Review and practice solving circuits with equations, especially with inconvenient numbers and decimals.
- Figure out how adding new resistors affects a circuit, and reflect upon this.
- Solve problems in which *different than normal* information is given. (Rather than only voltage and resistance)

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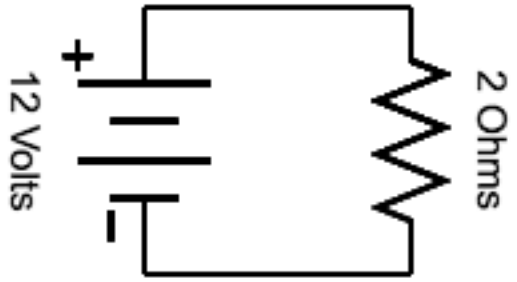
**Math Investigation: Adding resistors in series and parallel**
To improve your knowledge of circuits, compare what happens when resistors are added in series, and what happens when they are added in parallel. You will find that something intuitive happens when they are added in series and something counterintuitive happens when they are added in parallel.

**Part A: Series circuits**

Imagine you are building series circuits out of 12-volt batteries and 2-ohm resistors. As you add each resistor, mathematically analyze each circuit.

A.1. One resistor:




| | Total Circuit |
|---|---|
| Voltage (V) | |
| Current (A) | |
| Resistance (Ω) | |
| Power (W) | |

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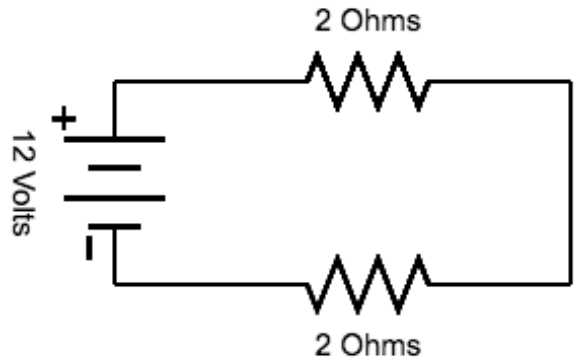
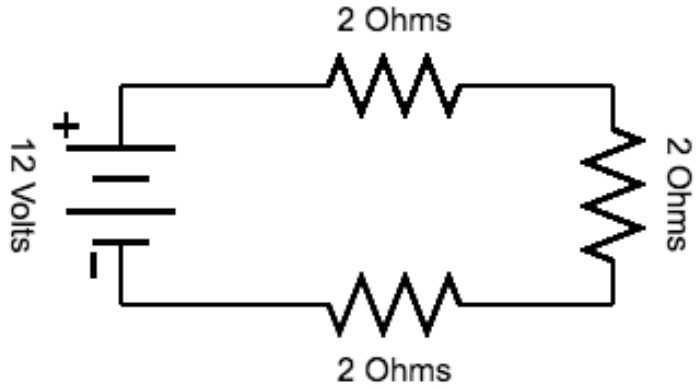
A.2. Two resistors:




| | Resistor 1 | Resistor 2 | Total Circuit |
|---|---|---|---|
| Voltage (V) | | | |
| Current (A) | | | |
| Resistance (Ω) | | | |
| Power (W) | | | |

A.3. Three resistors:




| | Resistor 1 | Resistor 2 | Resistor 3 | Total Circuit |
|---|---|---|---|---|
| Voltage (V) | | | | |
| Current (A) | | | | |
| Resistance (Ω) | | | | |
| Power (W) | | | | |

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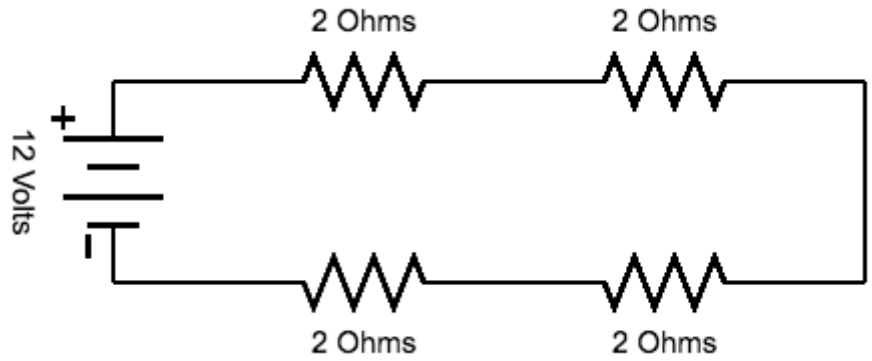
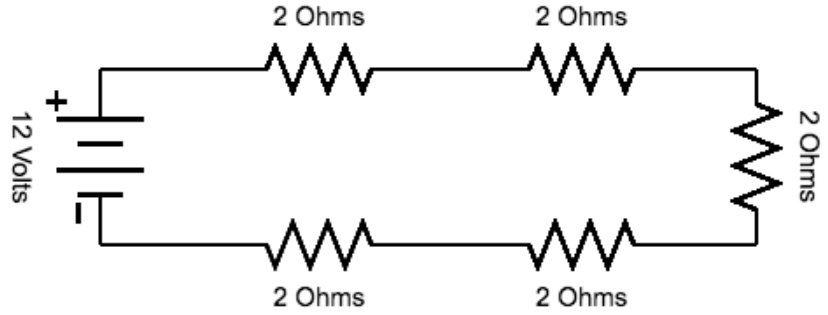
A.4. Four resistors:




| | Resistor 1 | Resistor 2 | Resistor 3 | Resistor 4 | Total Circuit |
|---|---|---|---|---|---|
| Voltage (V) | | | | | |
| Current (A) | | | | | |
| Resistance (Ω) | | | | | |
| Power (W) | | | | | |

A.5. Five resistors:




| | Resistor 1 | Resistor 2 | Resistor 3 | Resistor 4 | Resistor 5 | Total Circuit |
|---|---|---|---|---|---|---|
| Voltage (V) | | | | | | |
| Current (A) | | | | | | |
| Resistance (Ω) | | | | | | |
| Power (W) | | | | | | |

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A.6. Summarize the findings from 1 – 5 in this table:

| Number of resistors | Total Resistance (Ω) | Total Current (A) | Power of each resistor (W) | Total Power (W) |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |

A.6 What happens to the total resistance as you add more resistors?

A.7 What happens to the total current as you add more resistors?

A.8 What happens to the power of each resistor as you add more resistors?

A.9 What happens to the total power as you add more resistors?

**A.10** If your resistor is a light bulb, the *power* is the variable that shows how bright the light bulb is. Does what happens to the *power* when you add new resistors correspond with what you observed while doing an actual lab?

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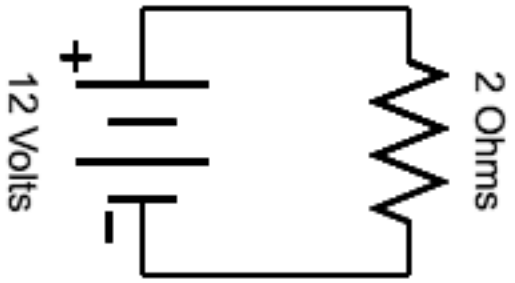
**Part B: Parallel circuits and total resistance**

Imagine you are building parallel circuits from a 12-volt battery and 2-ohm resistors. As you add each resistor, mathematically analyze each circuit.

B.1. One resistor:




| | Total Circuit |
|---|---|
| Voltage (V) | |
| Current (A) | |
| Resistance (Ω) | |
| Power (W) | |

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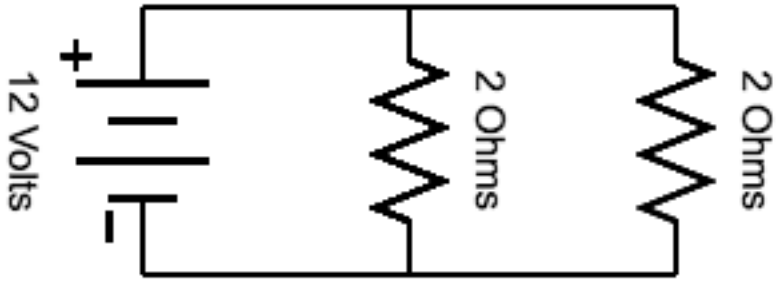
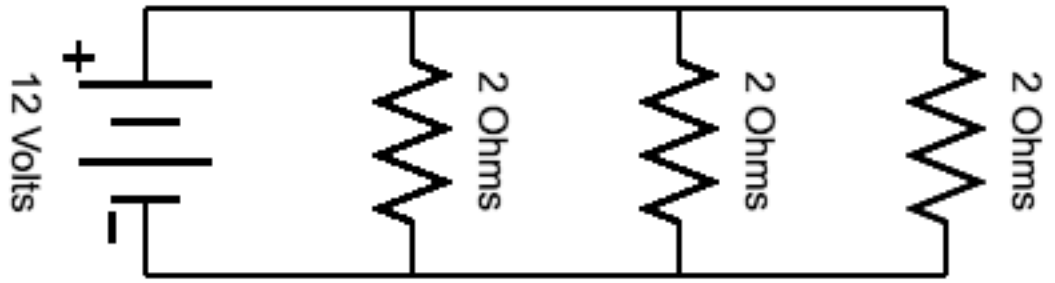
B.2. Two resistors:




| | Resistor 1 | Resistor 2 | Total Circuit |
|---|---|---|---|
| Voltage (V) | | | |
| Current (A) | | | |
| Resistance (Ω) | | | |
| Power (W) | | | |

B.3. Three resistors:




| | Resistor 1 | Resistor 2 | Resistor 3 | Total Circuit |
|---|---|---|---|---|
| Voltage (V) | | | | |
| Current (A) | | | | |
| Resistance (Ω) | | | | |
| Power (W) | | | | |

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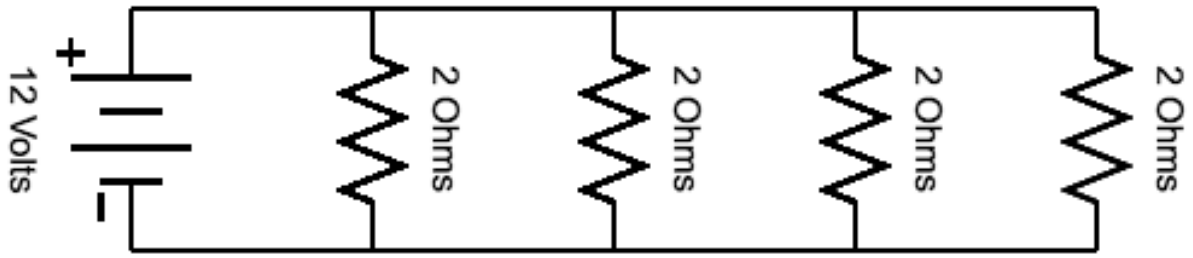
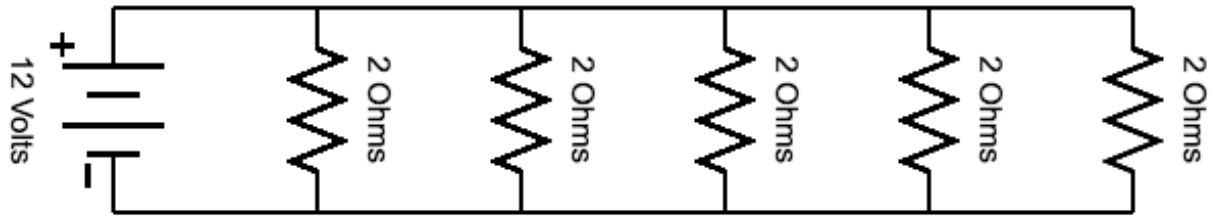
B.4. Four resistors:




| | Resistor 1 | Resistor 2 | Resistor 3 | Resistor 4 | Total Circuit |
|---|---|---|---|---|---|
| Voltage (V) | | | | | |
| Current (A) | | | | | |
| Resistance (Ω) | | | | | |
| Power (W) | | | | | |

B.5. Five resistors:




| | Resistor 1 | Resistor 2 | Resistor 3 | Resistor 4 | Resistor 5 | Total Circuit |
|---|---|---|---|---|---|---|
| Voltage (V) | | | | | | |
| Current (A) | | | | | | |
| Resistance (Ω) | | | | | | |
| Power (W) | | | | | | |

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B.6 Summarize your findings for 1 – 5in the following table.

| Number of resistors | Total Resistance (Ω) | Total Current (A) | Power of each resistor (W) | Total Power (W) |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |

B.7 What happens to the total resistance as you add more resistors? Is this intuitive or counterintuitive? [a *counterintuitive* concept is one that seems to defy basic logic]

B.8 What happens to the total current as you add more resistors?

B.9 What happens to the power of each resistor as you add more resistors?

B.10a) What happens to the total power as you add more resistors?

B.10b) If your resistor is a light bulb, the *power* reflects the brightness of the light bulb. If you have tried this experiment in a lab, does your math agree with what you observed? [It's okay if it doesn't. If it doesn't, there must be some factor you are not considering in this calculation. What do you think that is?]

B.11 Where does the battery die faster, in the parallel or series circuit? Why?

B.12 Remember, that even though the parallel circuit appears to be better in every way, there is a *cost* for adding current and adding power. Energy is never free! What is it?

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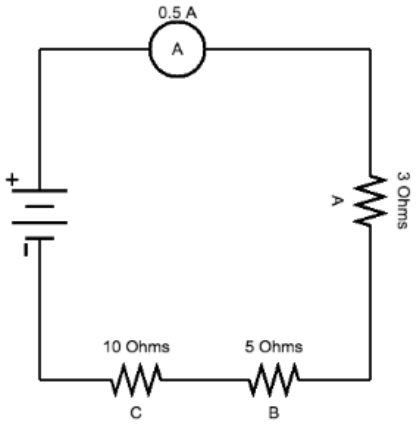
**Part C: Different Information Given**

In all problems to this point, you have known two pieces of information: the voltage of the battery and the resistance of each resistor.
Sometimes, however, different information is known. In the following problems, use the information represented on the meters in order to figure out the circuit.

| **Ammeter** |
|---|
| An ammeter is a device that measures the current in a circuit.<br>An ammeter is represented by the letter A in a circle.<br>An ammeter is always connected *in series* with the element it measures the current through. |
| **Voltmeter** |
| A voltmeter is a device that measures the potential difference (voltage) across a circuit element.<br>A voltmeter is represented by the letter V in a circle.<br>A voltmeter is always connected *in series* with the element it measures. |

**1.**




| | Resistor A | Resistor B | Resistor C | Total Circuit |
|---|---|---|---|---|
| Voltage (V) | | | | |
| Current (A) | | | | |
| Resistance (Ω) | | | | |
| Power (W) | | | | |

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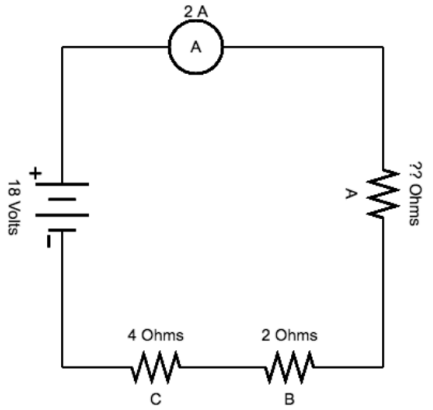
**2.**




| | Resistor A | Resistor B | Resistor C | Total Circuit |
|---|---|---|---|---|
| Voltage (V) | | | | |
| Current (A) | | | | |
| Resistance (Ω) | | | | |
| Power (W) | | | | |