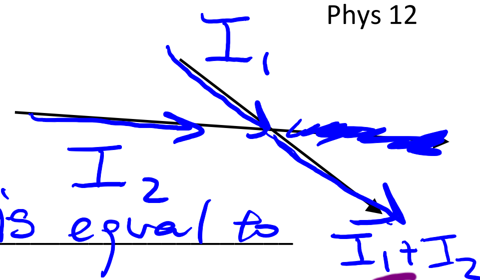
Name: ______________________________ Phys 12

**7.2 Kirchhoff's Laws**

*Question for the day: why does our circuit fuse blow up?*

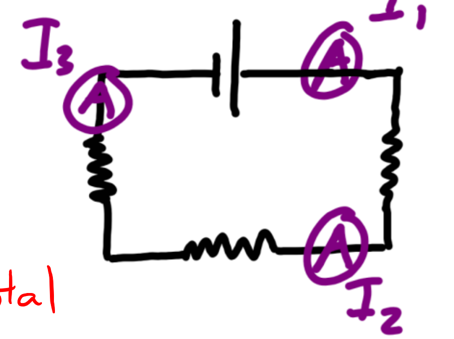
We'll need to consider Kirchhoff's Laws first.




**Kirchhoff's Current Law** states that the total amount of current entering a junction is equal to the total amount of current leaving the junction.

$I = \frac{Q}{t}$

For resistors in **series**, there is only one pathway, so no junctions.

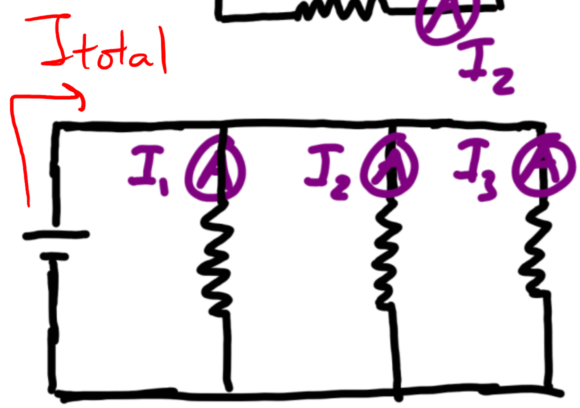



That means the current is the same everywhere in the circuit.

$I_{Total} = I_1 = I_2 = I_3$

Since I = Q/t, multiplying all the I's by time, t, gives us Q! The charge must also be the same everywhere.

$Q_{Total} = Q_1 = Q_2 = Q_3$




For resistors in **parallel**, your current branches off into multiple pathways. At each junction, the current either splits off or combines. Therefore, the current of each branch, must add up to the total current.

$I_{Total} = I_1 + I_2 + I_3$

Therefore, the charge Q:

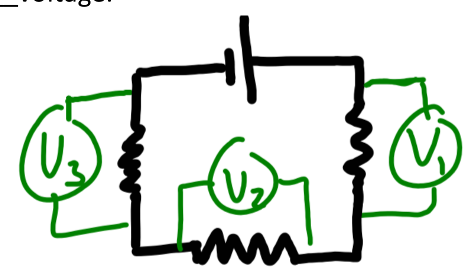
$Q_{Total} = Q_1 + Q_2 + Q_3$

**Kirchhoff's Voltage Law** states that the sum of the potential differences in a circuit must add up to the total voltage.

Otherwise, energy would not be conserved, breaking the law of conservation of energy.

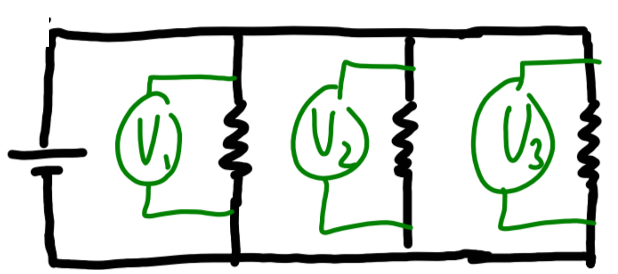
Across a resistor following the direction of the current, you would get a voltage drop. Across a battery/cell following the direction of the current, you would gain voltage.

For resistors in **series**, the potential drop going around the circuit should add up to the total voltage ($V_T$ across the battery)




$V_{Total} = V_1 + V_2 + V_3$

For resistors in **parallel**, since the potential difference drop happens at the same location in your circuit, the potential different across each resistor is the same.



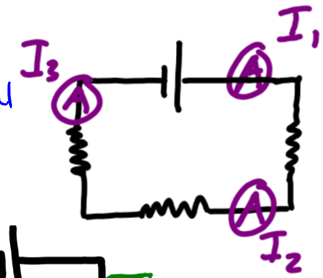

$V_{Total} = V_1 = V_2 = V_3$

HW: Worksheet 6.2 (all) and Inquiry question 6.2 (all)

Name: ________________________________

So, how do we calculate the total resistance in a circuit?

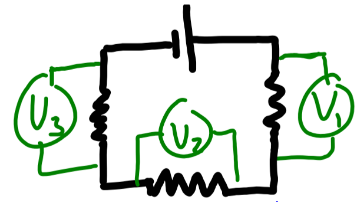
$V_{total} = I_{total} R_{total}$

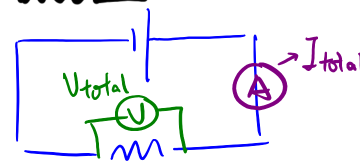



For resistors in **series:**

$\rightarrow V_{total} = V_1 + V_2 + V_3$

$R_{total} = R_1 + R_2 + R_3$




$R_{total} = R_1 + R_2 + R_3$

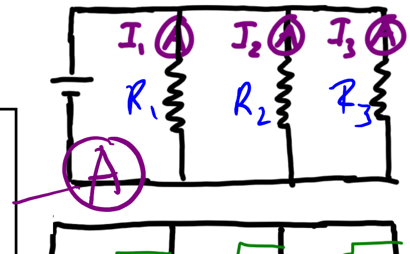
Think of it this way, more resistance in your circuit is like adding more roadblocks while you're driving. As a result, you'll have to drive slower.

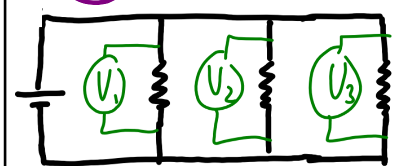
$V = IR$

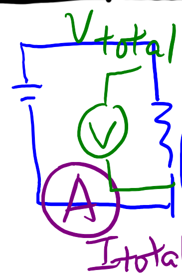
For resistors in **parallel**:

$I_{total} = I_1 + I_2 + I_3$

$\frac{1}{R_{total}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$




$R_{total} = \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)^{-1}$

TRY THIS! -> Refer to 7.2 Inquiry Questions

What about capacitors? Why do we connect capacitors in a circuit: __________ surges, __________ control, etc

Capacitors in **series:**

Capacitors in **parallel:**

Why? Try working it out using $Q = CV$, $V_{total} = V_1 + V_2 + V_3$, and $Q_{total} = Q_1 + Q_2 + Q_3$

How do these equations compare with the resistor ones?

HW: Worksheet 6.2 (all) and Inquiry question 6.2 (all)