Electric Circuits Notes

1 – Circuits

In the last chapter we examined how static electric charges interact with one another. These fixed electrical charges are not the same as the electricity that we use in everyday life, current electricity.

Current electricity is all about… the flow of electrons.

The number of charges flowing per second is defined by the specific quantity – current.

Current (I): $I = \frac{q}{t}$

The unit of current is Amperes or amps (A).

However, current will not flow through a conductor unless there is
(1) a potential difference (voltage source).
(2) a complete circuit.

Some examples of voltage sources that we use everyday are: batteries (cells) and electrical outlets.

Consider a river. The rate of water flowing down the river is its *current*. Note that we talk about the **rate** of water flowing, not the **speed** that the individual water molecules are moving.
The same is true for electric circuits, where the current represents how many electrons pass a certain point in a certain amount of time.

Voltage (V):

The units of voltage are volts (V)

Resistance (R):

The units of resistance are ohms (Ω)

These three quantities are related using Ohm's Law:

$V = IR$

Electric Current

Consider a circuit of a battery connected to a light bulb.

Which direction does the current flow?

Unfortunately, there are two ways to consider this.

1) Electron Flow: The direction that the electrons actually move. The electrons go from the negative terminal to the positive terminal.

2) Conventional Current: Flow of positive charge. Positive charges flow from the positive terminal to the negative terminal.

Although a little confusing (and more than a little irritating) we need to recall that **electric potential** is defined in terms of moving positive charge. And the **direction** of an **electric field** is defined as the direction that a positive charge will move in that field.

In this class, unless otherwise stated, we will always use conventional current (+ to −)!!!

Power

We often talk about the amount of power used by different electrical devices. This is often confused with **voltage** or **energy**.

Recall that power is… the rate of doing work

From the definition of power and Ohm's Law we can derive some formulae to describe **electric power**.

$$P = \frac{W}{t} = \frac{\Delta E}{t} \quad \text{and } E_p = \Delta V q$$

$P = IV$

$P = I^2R$

$P = \frac{V^2}{R}$

Example: An electric fan has a resistance of 12 Ω and requires 0.75 A of current to function properly. What voltage is required to operate the fan?

$V = IR$

$V = (0.75)(12) = 9.0\,V$

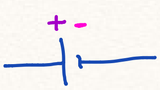
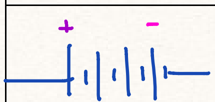
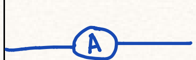
Example: An electric heater emits 1.00×10^2 W when connected to a 120 V power line. What is the resistance in the heater?

$P = \frac{V^2}{R}$

$R = \frac{V^2}{P} = \frac{(120)^2}{(1.00 \times 10^2)} = 140\,\Omega$

Lulu Lemon?

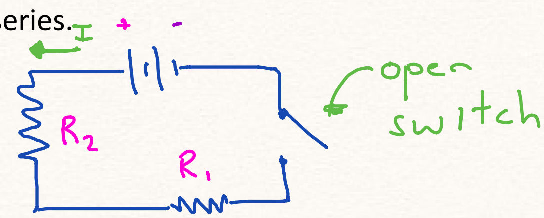
To draw the various devices that can make up electric circuits, we use on **schematic diagrams** that are…

Schematic	Name	Function
	wire	transfer of current
	open switch	stops flow of current in a wire
	closed switch	allows flow of current in a wire
	resistor	resists flow of current in a wire
	Single cell	Source of power within a circuit (potential difference)
	Battery	See Above.
	Ammeter	Measures current at a point in a circuit
	Voltmeter	Meassures voltage at a given point in a circuit

There are two ways that we can attach devices to a circuit.

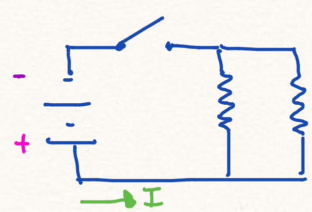
(1) Series: only one path for current to flow

Ex. Draw a battery of two cells connected to two resistors in series.



(2) Parallel: multiple pathways for current to flow

Ex. Draw a battery of two cells connected to two resistors in parallel.



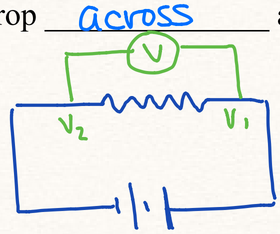
Measuring Voltage and Current

We can measure the voltage in a circuit using a ____voltmeter____ and the current in a circuit using an ____ammeter____.

We need to connect these two devices in different ways.

A voltmeter must be connected in ____parallel____. This is because a voltmeter measures the voltage drop ____across____ a device.

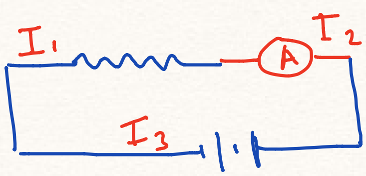
Ex.



$\Delta V = V_2 - V_1$

An ammeter must be connected in ____series____. This is because an ammeter measures the current ____through____ a circuit.

Ex.



$I_1 = I_2 = I_3$

One last note…

There are two types of current. DC (____direct____ ____current____) means it flows in one direction such as the current from a ____battery____. AC (____alternating____ ____current____) means that it alternates the direction of flow. In the case of home electric circuits, they alternate at 60 Hz.

As fun as it sounds AC is a little advanced for us just yet so we will be sticking to DC in this course.