Cumbernauld Academy

Physics

Electricity and Electronics

Summary Notes
Version 2.0 September 2016

SCN 3-09a
SCN 3-10a
SCN 4-09b
SCN 4-09c

ACfE

Charges

1. There are two types of charge
    a. Positive and
    b. Negative
2. 'Like' charges repel (Positive will push away positive and negative will push away negative).
3. Unlike charges attract (Positive and negative will pull together)
4. Rubbing a plastic rod will make it charged.

Conductors and Insulators

1. Conductors are materials that allow electricity to flow through them.
2. Insulators are materials that do not allow electricity to flow through them.
3. Examples of conductors are all metals and carbon.
4. Examples of insulators are non metals.

Electricity on the Move - Energy!

You will have seen examples of different types of energy during this course e.g. Chemical (in batteries), Heat, Kinetic (movement), Electrical and Light.

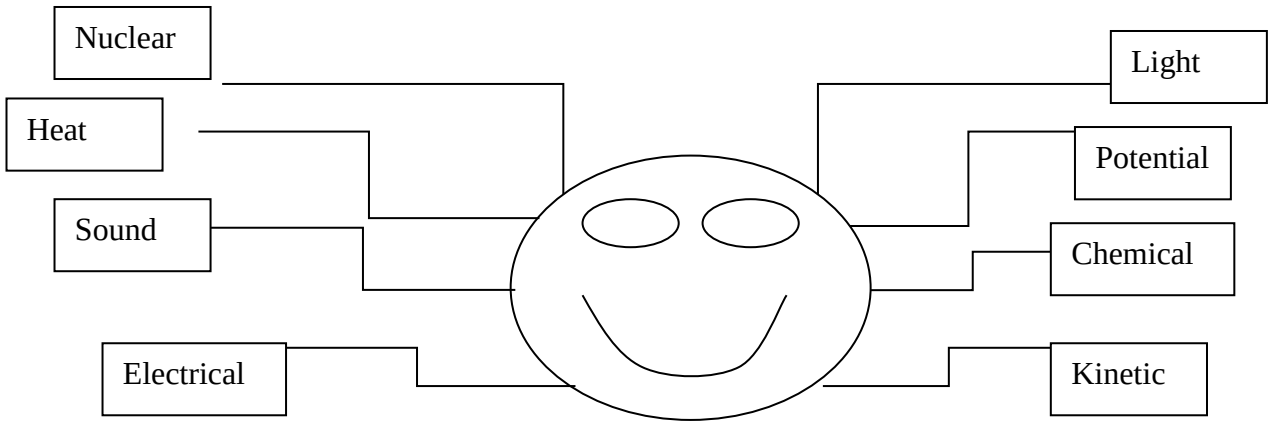
You may be able to think of more examples, as there are eight different types of energy.

Each time you change one type of energy into another, it becomes less useful.

Examples of Energy Changes:

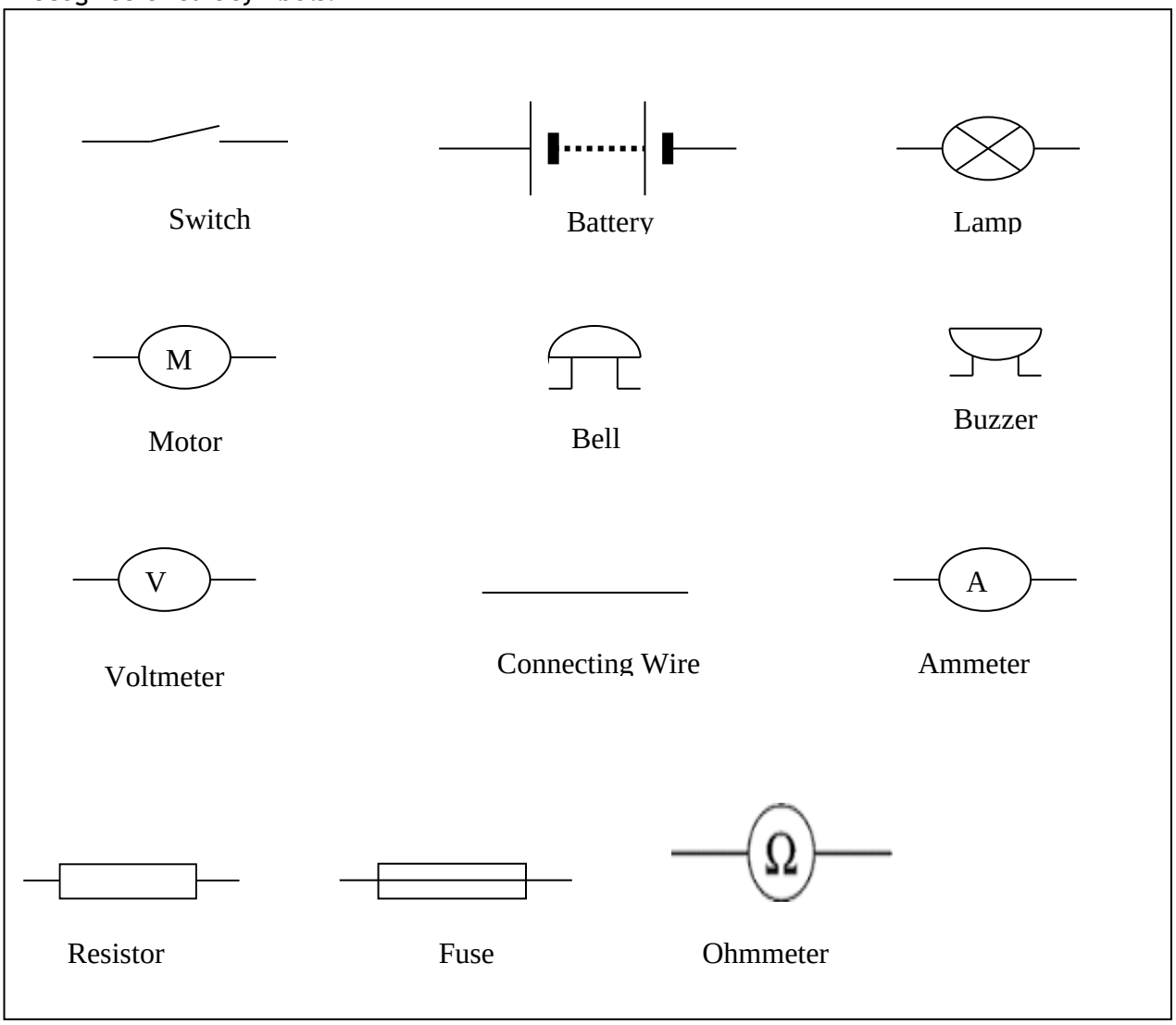
Bell Circuit: Electrical to Sound
Heater: Electrical to Heat
Motor: Electrical to Kinetic
Battery: Chemical to Electrical
Lamp (bulb): Electrical to Light

Think of the *Energy Spider*, as it has eight legs.



Circuit Symbols

1. The flow of electric charges in a circuit is called the electric current.
2. An electric current flows round a circuit if there is a battery/power source connected in it and as long as there is a complete path.
3. Recognise circuit symbols:



4. Electrons flow from the negative terminal (-) to the positive terminal (+) of a battery

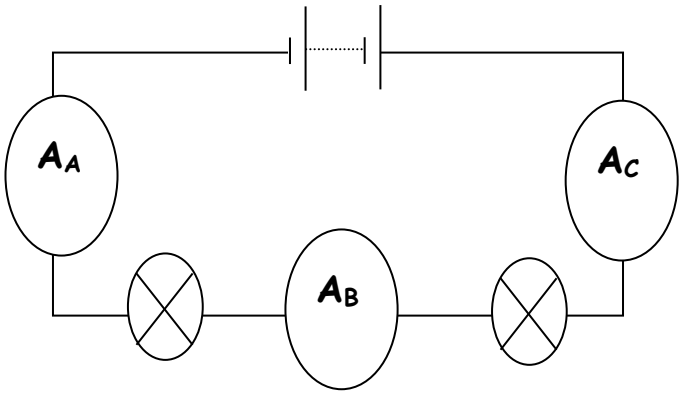
5. When the switch is open no current flows and when closed the current does flow in a complete circuit.

Ammeters

1. Current is a flow of electrons and is measured using an ammeter

2. The unit of current is the ampere, or amps (A)
3. The greater the number of batteries in a circuit the larger the current and the brighter the lamp
4. **Ammeters are always connected in series.**

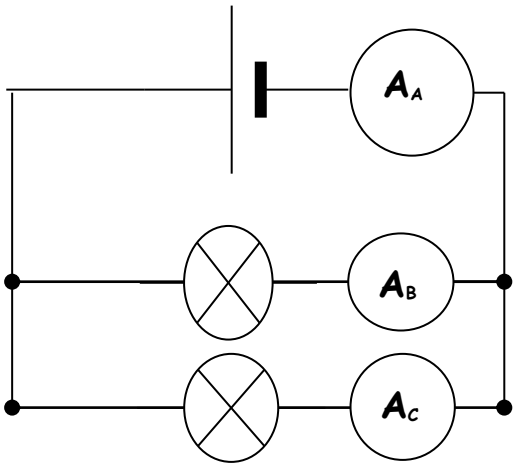
Series Circuits (and Ammeters)



1. This is a series circuit, as there is only one path round the circuit
2. The current at all points in a series circuit is the same.
3. If one lamp fails in a series circuit all the lamps will go out!
4. Adding more lamps causes the other lamps to become dimmer.
5. Christmas tree lights are an example of lamps connected in series. If one bulb goes out then this is like a break in the circuit, so no current can flow.

Parallel Circuits (and Ammeters)

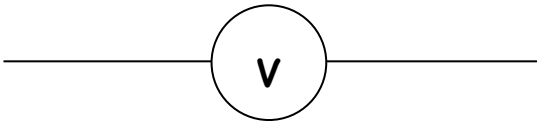
1. This is a parallel circuit, as there is more than one path round the circuit
2. The current in each branch of a parallel circuit add up to give the current drawn from the battery. The current splits up!



Supply Current $A_A = A_B + A_C$ **or** $I_A = I_B + I_C$

3. A parallel circuit allows appliances to be switched on or off independently.
4. Removing one lamp from a parallel circuit has no effect on the brightness of the other lamps. The current still has other paths to flow through.

Voltmeters



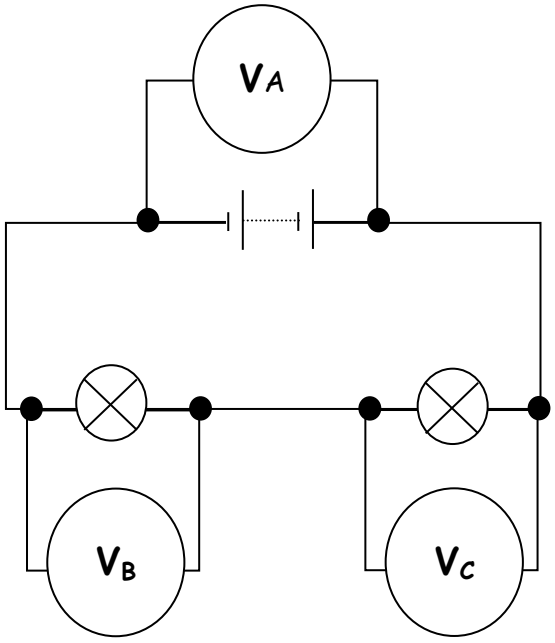
1. Recognise the symbol for a voltmeter.
2. Voltmeters are used to measure Voltage. Voltage is measured in Volts (V).
3. The voltage is an electrical force that pushes the electrons around the circuit.
4. As the number of batteries, connected in series, are increased the current and the voltage increase. Since the force pushing the electrons round the circuit increases.
5. The Voltage of a battery is a measure of the energy carried by the electrons around the circuit.
6. **Voltmeters are always connected in parallel.**

Current and Voltage in Series and Parallel

	Series	Parallel
Current	Stays the same	Splits up
Voltage	Splits up	Stays the same

Voltage in a Series Circuit

1. The voltage across each component in a series circuit adds together to give the battery voltage.



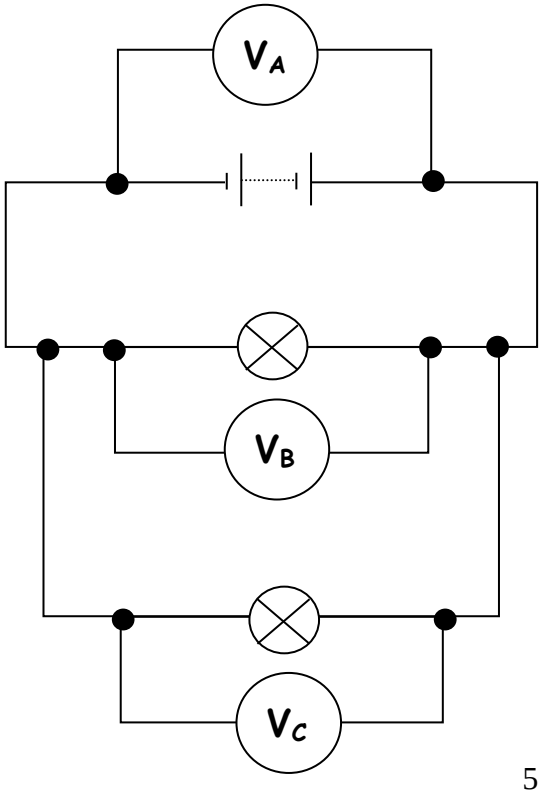
$V_A = V_B + V_C$

Voltage in a parallel circuit

1. The voltage across components connected in parallel is the same as the battery voltage.

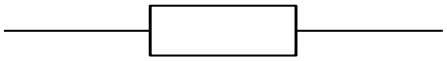
$$V_A = V_B = V_C$$

2. Domestic appliances are connected in parallel
3. Think about your houselights. You are able to turn one light on at a time. Not every light in the house needs to be on all at the same time does it? This is because your house lights are part of a parallel circuit.



Resistance

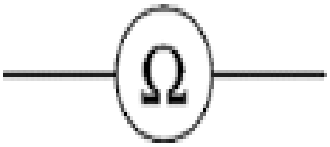
A substance which opposes (or resists) the flow of current through it is called a Resistor.

The symbol for a resistor is 

Resistance is the opposition to current in a circuit.

Resistance is measured in units called **Ohms** or **Ω**.

The meter which is used to measure resistance is called and ohmmeter.

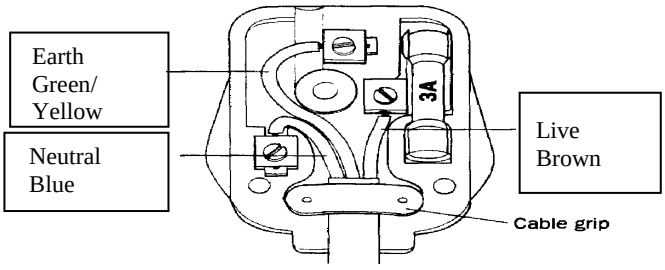
An ohmmeter has symbol 

The current in a circuit decreases if the resistance increases. The resistance of a wire depends on the type of material it is made of.

The resistance of a wire can be altered by changing its length or its thickness.
A long wire has a larger resistance than a short wire.
A thick wire has a shorter resistance than a thin wire.
A component with resistance turns electrical energy into heat Energy, an example of this can be seen in a filament lamp.

Plugs and Fuses

1. A wire will heat up and melt as the current flowing through increases.
2. Thin wire will require less current to flow before it melts than thick wire.
3. A fuse is a piece of wire which melts when the current is too high creating a break in the circuit.
4. ***A fuse protects the flex from overheating. Reducing the risk of fire (safety device).***
5. Resistance is a measure of how much the components hold back the current.
6. The greater the resistance the smaller the current.
7. A plug has three terminals-live, neutral and earth.
8. ***The live wire is brown, the neutral is blue and the earth is green/yellow.***



Miniature Circuit Breakers

Domestic electricity uses miniature circuit breakers rather than cartridge fuses.
Advantages of miniature circuit breakers over fuses:

- They are easily reset
- They are more sensitive to current change.

Magnets and Electromagnets

1. ***State that when a current flows in a wire there is a magnetic force round the wire.***
2. Describe how to construct an electromagnet (Battery, iron, wire)
3. Give two uses of an electromagnet

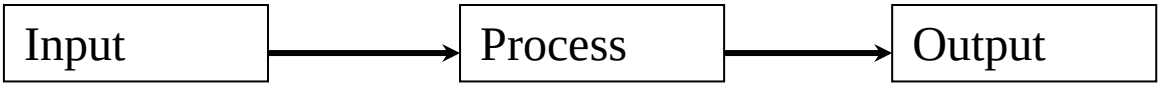
4. State that the strength of an electromagnet is increased if:

- The current is increased
- The number of turns increased
- The wire is wrapped round a piece of iron.

Electronics

Input, Process and Output.

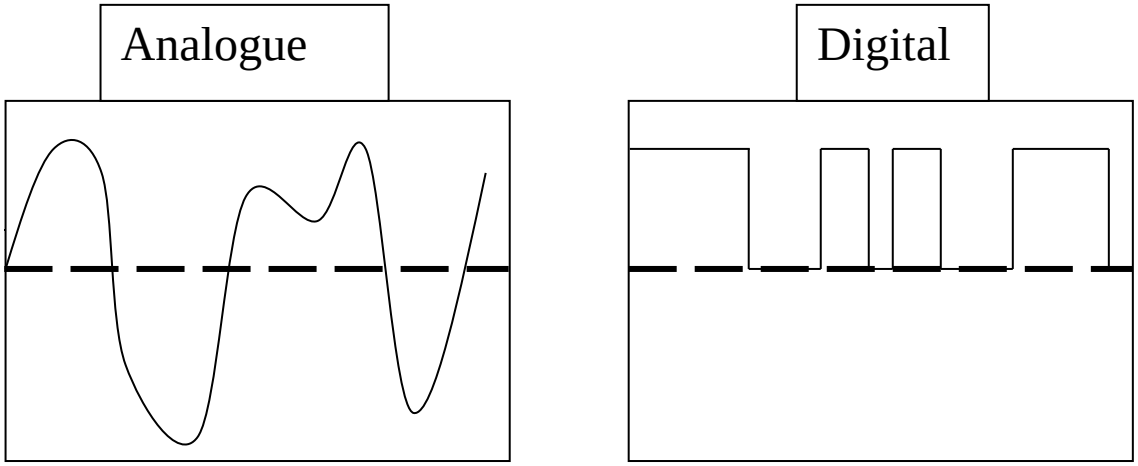
Every electronic system has three main parts; Input, Process and Output.



Digital Inputs/Outputs can only be On (logic 1) or Off (logic. 0).

Digital and Analogue Signals

When viewed on a screen, they would look something like this:



- An Analogue signal can be Off, fully on, and everything in between.
- Digital Inputs/Outputs can only be On (logic 1) or Off (logic. 0).

Devices Summary

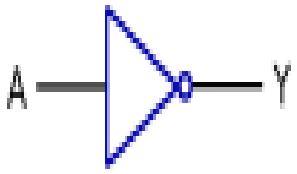
Device Name	**Type**	**Analogue or Digital**	**Energy Change**
Microphone	Input	Analogue	Sound to Electrical
Thermistor	Input	Analogue	Heat to Electrical
Light Dependant Resistor (LDR)	Input	Analogue	Light to Electrical
Switch	Input	Digital	Movement to Electrical
Loudspeaker	Output	Analogue	Electrical to sound

Logic Gates and Truth Tables

Logic Gates are used to control many electronic devices. There are three different types, and they all do a different job.

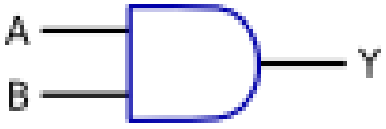
***The NOT Gate* will invert any Input that you put into it**. So a high voltage becomes a low voltage, and vice versa.

Input	Output
Low (0)	High (1)
High (1)	Low (0)



***The AND Gate* needs two Logic 1 Inputs to work**. Think of a bank vault that need to separate keys to be turned to open it. Or a missile launch that requires two people to press two different buttons.

Input A	Input B	Output
Low (0)	Low (0)	Low (0)
Low (0)	High (1)	Low (0)
High (1)	Low (0)	Low (0)
High (1)	High (1)	High (1)



***The OR Gate* needs only one Logic 1 Input to give a Logic 1 Output**. Think of a shop with a panic alarm. It should only take one person to push a button to sound the alarm.

Input A	Input B	Output
Low (0)	Low (0)	Low (0)
Low (0)	High (1)	High (1)
High (1)	Low (0)	High (1)
High (1)	High (1)	High (1)