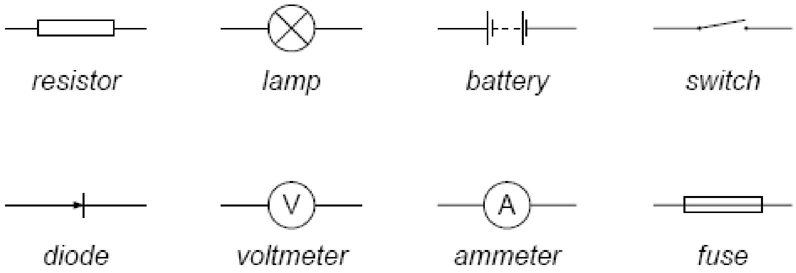
Science AS90191 Describe Aspects of Physics.

<u>Circuits and components</u>

An **electric current** is the movement of electrons (negatively charged particles). A **circuit** is made up of components connected together by wires so that electrons can move through the components. There must be a complete circuit (pathway) for electricity to flow.
A **power supply** - a cell, a battery (a collection of cells) or a power pack (variable power supply) provides the electrical energy to the moving electrons.

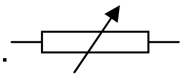
<u>Components</u>



You will be provided with these symbols in the examination.

Components where electrons will **lose some electrical energy** are:

- lamps (turn electrical energy into heat and light energy).
- resistors (turn electrical energy into heat energy). Resistors may be fixed or variable.



Components that **measure quantities** in electrical circuits are:

- ammeter - measures <u>current</u>.
- voltmeter - measures <u>voltage</u> or <u>potential difference</u>.

Other components are:

- switches - control flow of electricity. Switches are just metal contacts that can be touched together to let *current* flow ("*circuit is complete"*) or held apart to stop *current* from flowing ("*circuit is incomplete/broken"*).
- wires - made of copper metal (conductor) covered with plastic (an insulator).
- fuses – thin wire that melts ("*fuse blows*") when too large a current flows through it.
- diodes – components which allow the current to flow in one direction only.

<u>Conductors and insulators</u>

Conductors allow electrons to move through them easily. Metals are good conductors of electricity. In conductors, atoms hold only loosely to some of their electrons. These electrons move through the material passing from atom to atom. In **insulators**, atoms hold on tightly to all their electrons. It is difficult for electrons to move through an insulator. Good insulators: Glass - supports for filaments in light bulbs, Porcelain - fuse holders, PVC - coating electrical wires and cables.

Good conductors	
material	use
copper	underground electrical cables
aluminium	overhead electrical cables
gold	important contacts in electronic circuits
zinc	batteries
carbon* (*C is non-metal)	electrodes in dry cells & brushes in motors

<u>Circuit diagrams</u>

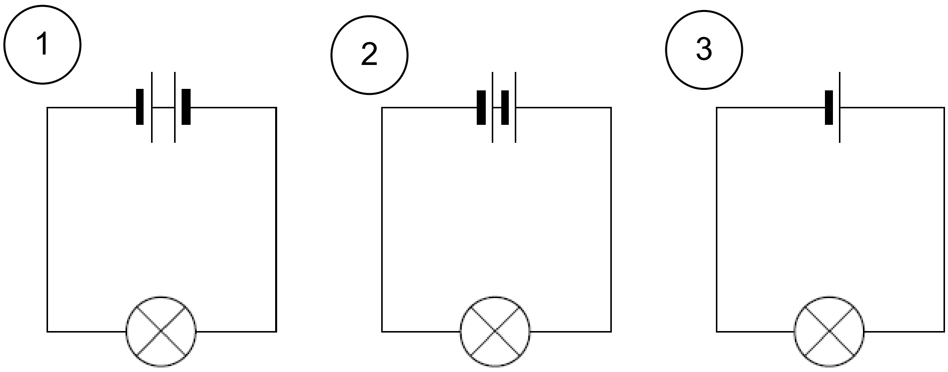
These show the components and how they are connected together. Draw in pencil and use a ruler!!! Draw neatly and without any gaps in the connecting wires. A rectangular shape is used for the layout. Switches are <u>always</u> drawn open.

 correct  wrong

Current

A current will flow through an electrical component (or device) only if there is a voltage or potential difference (p.d.) across its ends. The bigger the voltage across a component, the bigger the current that flows through it. Current is NOT used up as it travels around a circuit.

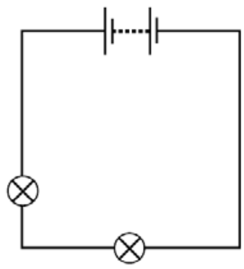
Current is given the symbol **I** and is measured in amperes which is abbreviated to amps and has the symbol **A**. Eg. I = 3.5A means the current is 3.5 amps. Small currents are measured in mA. 1000 mA = 1 A.



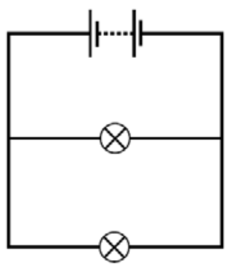
1. Bulb won't glow – batteries connected wrongly (- + + -)
2. Bulb in 2 glows more brightly than in the bulb in 3 (more voltage and more current).
3. Bulb in 3 glows less brightly than in the bulb in 2.

Components resist a current flowing through them. The bigger their resistance, the smaller the current produced by a particular voltage, or the bigger the voltage needed to produce a particular current.

Series and parallel circuits



In a **series** circuit the electrons all move along the same path, through one component, then another and so on. In a series circuit with two bulbs, if one bulb is removed or broken, the other bulb goes out. This is because current cannot flow in a circuit with a gap / break in it. As more and more bulbs are added in a series circuit they become dimmer and dimmer.



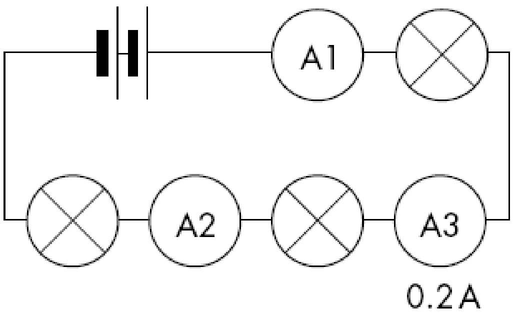
In a **parallel** circuit, the current has a "choice" of pathways. Most electrons go along the path which is easiest to move through (low resistance) but some move through the "more difficult" path (high resistance). If two bulbs are connected in parallel and one is removed or broken, the other continues to light as there is still a complete circuit for the electricity to flow around. As more and more bulbs are connected in parallel, they stay about the same brightness.

Extra Notes

Current in series & parallel circuits

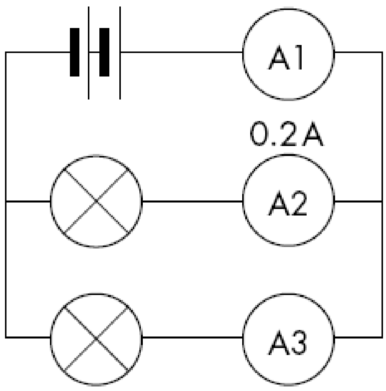
The ammeter is always connected in series with a component.

Series circuit



In the series circuit the same current flows through each component – ammeters A1 and A2 would both also read 0.2 A.
Reading on A1 = A2 = A3

Parallel circuit



In the parallel circuit the currents in different paths of the parallel circuit *may* not be the same.
But if the bulbs are identical, then A3 will read the same as A2 (0.2 A) and A1 will read 0.4 A.

The currents in all the separate branches add together to give the total current.

A1 = A2 + A3

Voltage

Voltage (also called potential difference) measures

- the energy lost across a component, or
- the energy supplied by the power supply / battery / cell

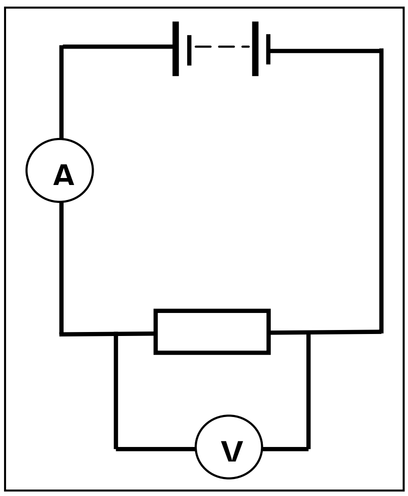
Voltage is measured in volts (symbol V) using a voltmeter. A voltmeter is always connected in parallel to the component for which the voltage is being measured.

In a series circuit, the voltage across the components **add up** to the voltage across the power supply. In a parallel circuit the voltage across parallel components are **equal.**

Resistance

Resistance is a measure of how difficult it is for electrons to move through a component. If electrons move easily through a component (low resistance), then the circuit has a large current. If it is difficult for electrons to move through a component (high resistance), then the current in the circuit is low. Resistance is measured in ohms (Ω). The resistance of a piece of wire depends on (a) the material it is made from, and (b) its dimensions. The resistance of a wire increases as its length increases and decreases as its thickness increases. A hot wire has a greater resistance than a cold wire.
Voltage, current and resistance are related by the formula **V = IR**

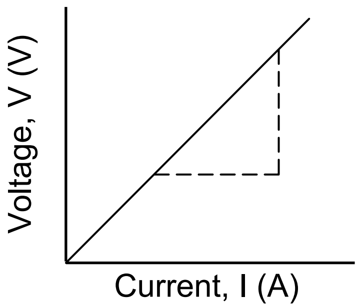
Ohm's Law.



Current-voltage graphs are used to show how the current through a component varies with the voltage across it.

If a conductor obeys Ohm's Law, the current will increase in proportion to the voltage. If you double the voltage, the current will also double. We say the current through a resistor (at a constant temperature) is directly proportional to the voltage across the resistor. (Ohm's Law. V = IR)

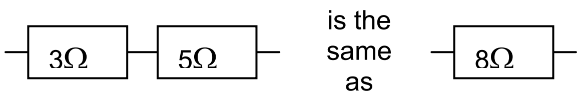
The gradient (rise/run) of a graph of V (y-axis) against I (x-axis) will give you the resistance.

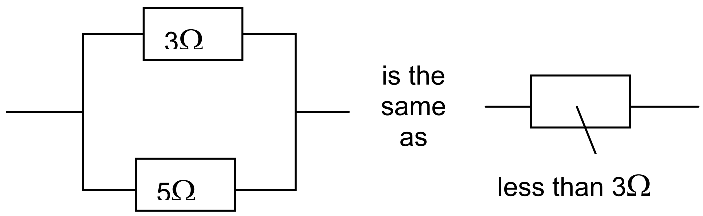


In metals resistance increases with temperature. In most practical circuits heating is an unavoidable consequence of passing a current through a conductor. So the resistance of hot components in a circuit will be more than when the circuit is switched off and they are cold. The resistance of a filament lamp increases as the temperature of the filament increases. (The graph is a curve – the resistor is "non-ohmic").

Resistors

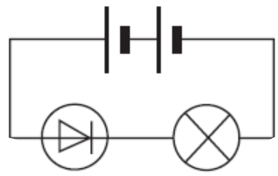
When components are connected in series their total resistance is the sum of their separate resistances. When they are in parallel the total resistance is LESS than the smaller of the two individual resistances.





Diodes

A diode only lets current flow one way. If it is connected with the arrow pointing to the negative terminal, current can easily flow. If it is the other way round, it will block the current. In the diagram opposite the bulb will glow. If the power supply OR diode was reversed, the bulb would not glow. A light-emitting diode or LED is a special kind of diode that glows when electricity passes through it.

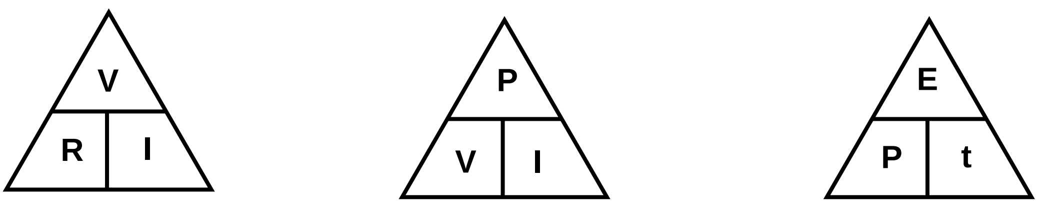


Power calculations

Electrons passing through a resistor lose electrical energy as heat. In an electrical circuit the <u>rate</u> at which electrons lose energy is called **Power**. Power has the symbol **P.**
Power (P) = voltage (V) x current (I) or **P = VI**
The unit for power is the **watt** which has the symbol **W.**
A power rating of one watt means that one joule of electrical energy is used per second. A power rating of one watt is written "1 W". For larger amounts of power, the unit **kilowatt** (symbol **kW**) is used. 1000 W = 1 kW = 1000 Js^{-1}.

Power is the rate at which energy is used: **P = E/t** where P is power (W), E is energy (J) and t is time (s)

Extra Notes



GLOSSARY

alternating current	current which regularly changes direction (AC)
ammeter	the component that measures current
amp (A)	unit of current (amp is short for ampere)
battery	several cells connected together, usually in series
cell	produces electrical energy from chemical reactions
circuit	a path through which electrons / electricity can flow
circuit diagram	diagram using symbols to represent components in a circuit & how they are connected together
component	item that can be connected in an electrical circuit
conductor	substance through which electricity can flow
conventional current	current which moves from the + (positive) terminal of the power supply to the - (negative) terminal
current (I)	movement of charged particles, usually electrons
diode	a component that allows current to flow through it in the direction of conventional current flow only
direct current	current that flows in only one direction (DC)
electron	negatively charged particle
good conductor	a component with low resistance
insulator	a substance having very high resistance
kilowatt (KW)	1 KW = 1000 W
lamp	a component which turns electrical energy into heat and light energy
megawatt (MW)	1000000 (1 million) watts
milliamp (mA)	a unit used to measure small currents; 1A = 1000 mA
non-ohmic conductor	a component that does not have constant resistance
Ohm (Ω)	the unit of resistance
Ohm's Law	law obeyed by components with a straight line voltage/current graph
ohmic conductor	a component that has a constant resistance
parallel	components connected in separate paths in a circuit so that there is a choice of paths
power	the electrical energy used by a component in a circuit
power pack	power supply that runs off the mains and allows different voltages to be selected
power supply	source of electrical energy in a circuit
resistance	a measure of how difficult it is for electrons to flow in a conductor
resistor	component that limits the flow of current in a circuit, converting electrical energy into heat energy
rheostat	resistor whose resistance can be altered
series	components arranged one after another to provide only one path
switch	component used to complete or break a circuit
variable resistor	resistor whose resistance can be altered (also called a rheostat)
volt (V)	the unit of voltage
voltage	a measurement of energy change in a circuit
voltmeter	the component that measures voltage
watt (W)	the unit of power