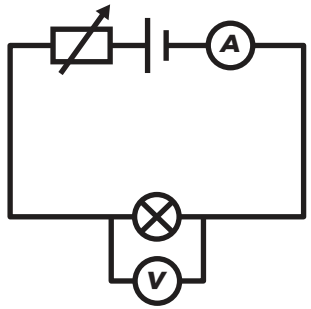
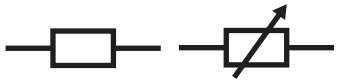
SECONDARY 2 SCIENCE WA3 CRASH COURSE

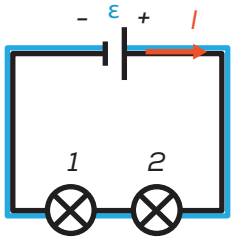
ELECTRICAL SYSTEMS CHEATSHEET

Circuit Components / Symbols	Circuit Diagram
Ammeter: measures **current**, connect in **series** 	
Voltmeter: measures **voltage/potential difference** across two points, connect in **parallel** 	
Fixed/variable resistor: fixed/variable resistance to restrict/vary the flow of current 	

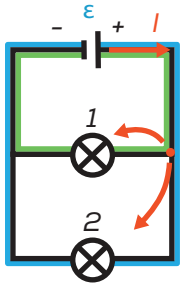
Ohm's Law

$V = I \times R$

Series Circuit



Parallel Circuit



Current: rate of flow of electric charge

$$\text{Current } (A) = \frac{\text{Charge } (C)}{\text{Time } (s)} \qquad I = \frac{Q}{t}$$

Same: $I = I_1 = I_2$

Split: $I = I_1 + I_2$

Electromotive force: work done by the source (battery) to drive a unit charge around a complete circuit

Voltage/Potential difference: work done to drive a unit charge through the component

$$\text{E.m.f. or Voltage } (V) = \frac{\text{Work done } (J)}{\text{Charge } (C)} \qquad \varepsilon \text{ or } V = \frac{W}{Q}$$

Split: $\varepsilon = V_1 + V_2$

Same: $\varepsilon = V_1 = V_2$

Resistance: ratio of potential difference across it to the current flowing through it

$$\text{Resistance } (\Omega) = \frac{\text{Voltage } (V)}{\text{Current } (A)} \qquad R = \frac{V}{I}$$

Factors affecting resistance

- Cross-sectional area/Thickness of wires
- Length of wires
- Material of wires (Resistivity)

Sum: $\text{Reff} = R_1 + R_2$

FF: $\frac{1}{\text{Reff}} = \frac{1}{R_1} + \frac{1}{R_2}$

Reff = flip above

Power is the energy converted per second *or* the rate at which electrical energy is converted into other forms of energy.

$$\textbf{(W) Power} = \frac{\textbf{Energy (J)}}{\textbf{Time (s)}}$$

Electrical energy consumption is based on kilowatt- hours (**kWh**).

$1 \text{ kWh} = 3.6 \times 10^6 \text{ J}$

$$\text{Energy } (J) = \text{Power } (W) \times \text{Time } (s)$$
$$= \text{Voltage } (V) \times \text{Current } (A) \times \text{Time } (s)$$

Cost = Electrical energy consumed (kWh) x Cost per unit

ELECTRICAL SYSTEMS CHEATSHEET

Four Effects of Electric Current

Chemical Effect

Electrolysis

Electroplating

Heating Effect

Nichrome wires are used as a heating element in electrical appliances (electric kettles) as they have **high resistance** and **high melting point**.

- High resistance ⟶ More heat released ⟶ Water heats up faster
- High melting point ⟶ Wires do not melt when a lot of heat is produced.

Magnetic Effect

FACTORS AFFECTING THE STRENGTH OF MAGNETIC FIELD OF AN ELECTROMAGNET

MAIN FACTOR	SUB-FACTOR	WEAKER MAGNETIC FIELD	STRONGER MAGNETIC FIELD
Amount of electric current		Lower ↓	Higher ↑
	Resistance	Higher ↑	Lower ↓
	Number of dry cells/batteries	Lower ↓	Higher ↑
Number of coils		Lower ↓	Higher ↑
Presence of soft iron core		Absent ✗	Present ✓

Lighting Effect

Tungsten is typically used in filament lamp as it has **high resistance and melting point**, allowing electrical energy to be converted to light and thermal energy.

Hazards of Electricity

- Damaged insulation
- Overheating cables
  - Overloaded power sockets
  - Use of inappropriate wires

Consequences of Electrical Hazards

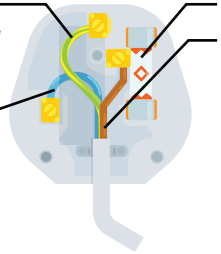
- Electric fires
- Electric shocks and Electrocution

Safety features

- **Earth wire**: prevents electric shock by providing an alternative path of low electrical resistance for the large current to flow directly from the live wire into the Earth

Earth wire
- *Connected to metal casing of electrical appliance*
- *Usually at 0 V*

Neutral wire
- *Carries current back to power supply*
- *Usually at 0 V*



Fuse

Live wire
- *Connected to fuse*
- *Delivers current to electrical appliances*
- *Fitted with fuses, switches and circuit breakers*
- *Usually at 220 V to 240 V*

- **Double insulation**: Electrical appliances with 2 pin plugs typically have a non-metallic casing like plastic, which is a poor conductor of electricity.
- A **fuse** consists of a short, thin piece of wire melts when a large current flows through it. The fuse rating of an electrical appliance should be **slightly higher** than the current the electrical appliance draws under normal conditions.
- **Circuit breaker**: When the electric current in a part of the circuit is too large, the circuit breaker for that part of the circuit turns off.

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