**GCSE Physics AQA Topic 2**

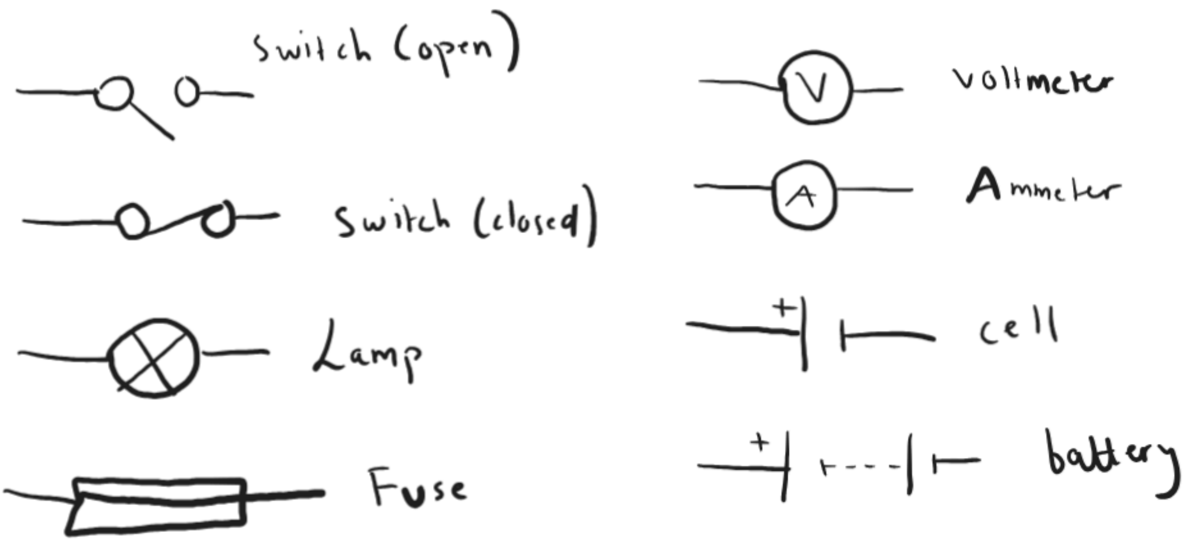
- Triple Science Content only in purple
- Triple Science and Higher Content Only in blue

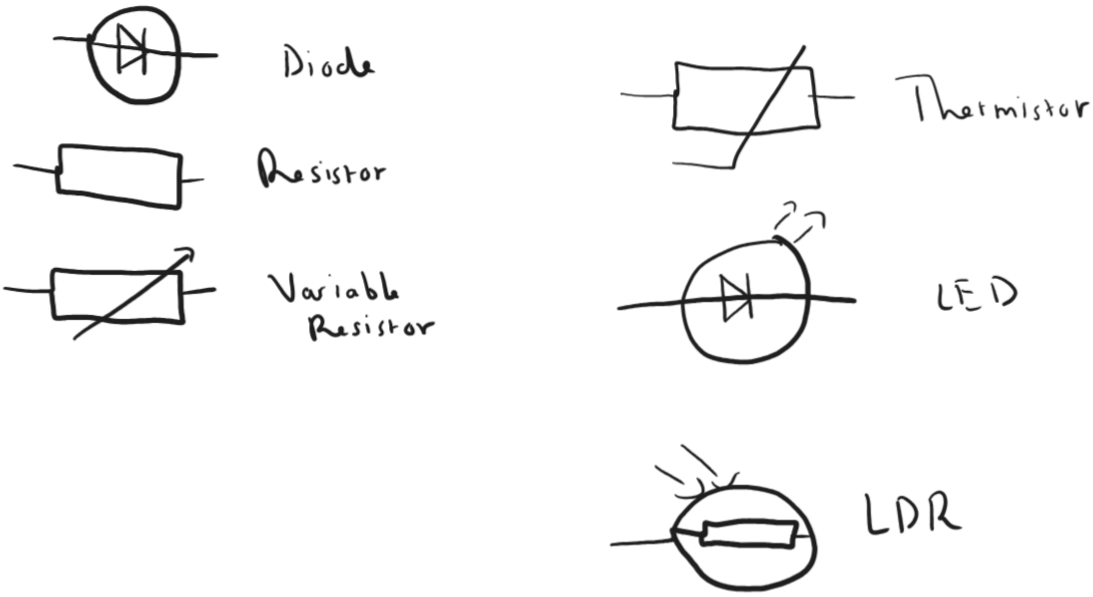
## 2. Electricity

### 2.1 Current, Potential Difference, and Resistance

#### 2.1.1 Standard Circuit Diagram Symbols:

- Recognize symbols for components like **cells**, **batteries**, **resistors**, **lamps**, **switches**, **ammeters**, and **voltmeters**.
  - Circuit diagrams show how components are connected and how current flows.






**Electrical Charge and Current:**

- **Electric current** is the flow of charge through a conductor. It is only possible in a closed circuit with a source of potential difference (voltage).
- The **size of the current** depends on the rate of flow of electrical charge, measured in **amperes (A)**.
- $Q = It$
  Where:
  - Q = charge (in coulombs, C),
  - I = current (in amperes, A),
  - t = time (in seconds).

**Current, Resistance, and Potential Difference:**

- The **current** through a component depends on two things:
  - The **resistance** of the component.
  - The **potential difference (voltage)** across it.
- The greater the resistance, the smaller the current for a given potential difference.
- $V = IR$:
  Where:
  - V = potential difference (volts),
  - I = current (amperes),
  - R = resistance (ohms, Ω).

**Resistors:**

- **Ohmic conductors** (e.g., metal wires) have a constant resistance at a constant temperature, so the current is proportional to the potential difference.
- **Non-ohmic components** have changing resistance depending on conditions:
  - **Filament lamps**: Resistance increases as the filament gets hotter.
  - **Diodes**: Only allow current to flow in one direction and have high resistance in the reverse direction.
  - **Thermistors**: Resistance decreases as temperature increases.
  - **LDRs (Light Dependent Resistors)**: Resistance decreases as light intensity increases.

**Series and Parallel Circuits**

- **Series Circuits**:
  - Components are connected in a single path.
  - The current is the same through each component.
  - The total resistance is the sum of all the individual resistances:

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

- **Parallel Circuits**:
  - Components are connected in separate branches.
  - The potential difference is the same across each branch.
  - The total current is the sum of the currents through each branch.
  - The total resistance is less than the resistance of the smallest resistor:

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

**Direct and Alternating Current:**

- **Direct current (DC)**: Current flows in one direction only (e.g., from batteries).
- **Alternating current (AC)**: Current constantly changes direction.
  - UK mains electricity is **AC** with a frequency of **50 Hz** and a voltage of **230 V**.

**Mains Electricity:**

- Electrical appliances are connected to the mains using **three-core cables**:
  - **Live wire (brown)** – carries **230 V** AC from the supply. Dangerous even when switch is off.
  - **Neutral wire (blue)** – completes the circuit and carries current **away**.
  - **Earth wire (green/yellow)** – a **safety wire** that prevents electric shock by directing current to the ground if the case becomes live.

### Safety Features

- **Fuses** melt if too much current flows → breaks the circuit.
- **Circuit breakers (RCCBs)** detect differences in current between live and neutral and cut off supply instantly.
- **Double insulation** – devices with plastic casings don't need an earth wire.

**Energy Transfers**

**2.4.1 Power:**

- **Power** is the rate at which energy is transferred or work is done.
  - Formula:
- $P = IV$

  Where:
  - P = power (watts, W),

- V = potential difference (volts, V),
    - I = current (amperes, A).
- Another formula for power (using resistance):
- $P = I^2R$
  Where:
    - P = power (watts, W),
    - I = current (amperes, A),
    - R = resistance (ohms, Ω\OmegaΩ).

**Energy Transfers in Appliances:**

- Appliances transfer energy to perform work, such as heating, lighting, or moving something.
- The amount of energy transferred depends on the power rating of the appliance and how long it is used.
    - Formula:
- $E = Pt$
  Where:
    - E = energy transferred (joules, J),
    - P = power (watts, W),
    - t = time (seconds, s).

**The National Grid:**

- The **National Grid** distributes electricity from power stations to homes and businesses.
- **Step-up transformers** increase the potential difference to reduce energy losses during transmission, and **step-down transformers** lower it for safe domestic use.

**Static Electricity**

**Static Charge:**

- When two insulating materials are rubbed together, electrons move from one material to another, causing one material to become **negatively charged** (gains electrons) and the other to become **positively charged** (loses electrons).
- **Like charges repel**, and **opposite charges attract**.

## Electric Fields:

- **Electric fields** are created around charged objects. Other charges in the field experience a force.
- The strength of the electric field is strongest close to the charged object and weakens with distance.
- **Field lines**:
  - Field lines point **away** from positive charges and **toward** negative charges.
  - The closer the field lines, the stronger the field.

### Field Around a Single Charge:

- **Positive charge**: The field lines radiate **outward** from the charge.
- **Negative charge**: The field lines point **inward** toward the charge.

### Field Between Two Charges:

- **Two like charges** (e.g., both positive or both negative): The field lines **repel** each other. Between the two charges, the lines bend outward, showing a region of weaker field where the charges cancel each other out.
- **Two opposite charges** (positive and negative): The field lines move **from the positive charge to the negative charge**. This represents the attraction between opposite charges, with the lines curving toward the negative charge.

### Field Strength:

- The strength of the electric field depends on the **distance from the charge**:
  - **Closer** to the charge: The field is **stronger** (denser field lines).
  - **Farther away**: The field becomes **weaker** (field lines are more spread out).