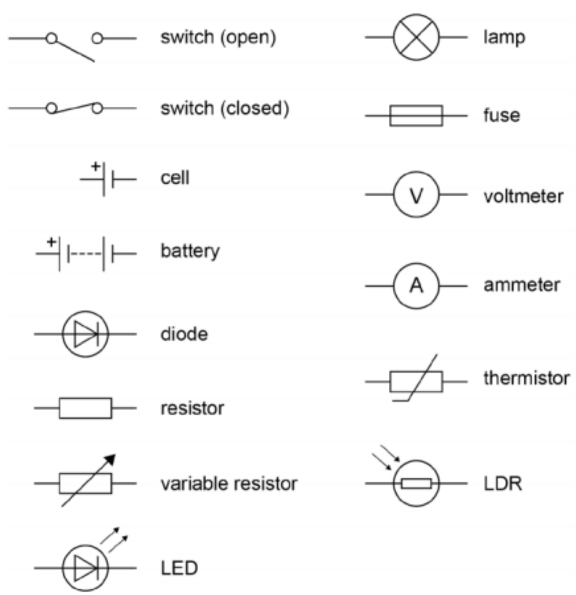
6.2 Electricity

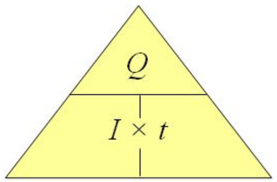
Section 1: Circuit Diagram symbols

Circuit diagrams use standard symbols.



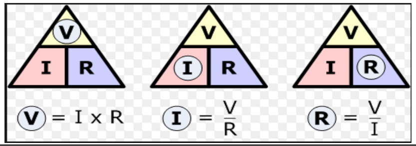
Section 2 Electrical Charge

1. Charge flow = current x time
2. charge flow (Q): in **coulombs (C)**
3. Current (I): in **amperes (A)**
4. Time (t): in **seconds (s)**
5. A current has the **same** value at any point in a single closed loop



Section 3 Current, resistance and potential difference.

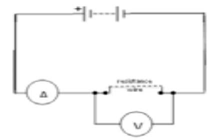
1. The **current (I)** through a component depends on both the **resistance (R)** of the component and the **potential difference (V)** across the component.
2. **The greater the resistance** of the component the **smaller the current** for a given potential difference (pd) across the component.
3. potential difference = current × resistance
4. **(V = I R)**
5. potential difference (V): **in volts (V)**
6. Current (I): **in amperes (A)**
7. Resistance (R): **in ohms (Ω)**



Section 4a) Resistance Required Practical - Resistance of a wire varying by length

1. Connect a lead from the **positive** socket of power pack to the positive side of the **ammeter**.
2. Connect a lead from the **negative** side of the **ammeter** (this may be black) to the crocodile clip at the zero end of the ruler.

1. Connect a lead from the other crocodile clip to the negative side of the **battery**.
2. The main loop of the circuit is now complete. Use this lead as a switch to disconnect the battery between readings.
3. Connect a lead from the positive side of the **voltmeter** to the crocodile clip the **ammeter** is connected to.
4. Connect a lead from the negative side of **the voltmeter** to the other crocodile clip.

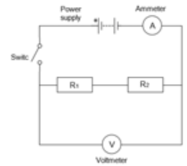


7. Record on a table the: **length of the wire between the crocodile clips, the readings on the ammeter, the readings on the voltmeter**.
8. Move crocodile clip and record the **new ammeter and voltmeter readings.**
9. Repeat for **differen**t lengths of wire.
10. **Calculate and record the resistance** for each length of wire using the equation:

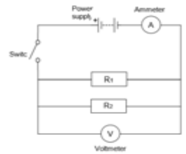
$$\text{resistance in } \Omega = \frac{\text{potential difference in V}}{\text{current in A}}$$

Section 4b Resistance Required Practical – Resistors in Series and Parallel

1. Connect the circuit for **two resistors** in **series,** as shown in the diagram.



2. Switch on and record the readings on the **ammeter** and **the voltmeter**.
3. Use these readings **to calculate** the **total resistance** of the circuit.
4. Now set up the circuit **for two resistors** in **parallel.** Switch on and record the readings on **the ammeter** and the **voltmeter**.
5. Use these readings to **calculate** the **total resistance** of the circuit.



6. With one single resistor in the circuit, the total resistance would be 10 ohms. What is the effect on the total resistance of adding:
   - another **identical** resistor **in series**
   - another **identical** resistor in **parallel**?
7. You could also try setting up a circuit with three resistors in series and one with three resistors in parallel.

Section 5: Rules of series and parallel circuits

For components connected in **series**:
- there is the **same current** through each component
- the total **potential difference** of the power supply is **shared** between the components
- the **total resistance** of two components is the **sum of** the resistance of **each** component.

$R_{total} = R_1 + R_2$

Resistance (R): **in ohms (Ω)**

For components connected in **parallel**:
- the **potential difference** across each component is the **same**
- the total **current** through the whole circuit is the **sum of** the currents through the **separate** components
- the **total resistance** of two resistors is **less than** the resistance of the **smallest** individual resistor.

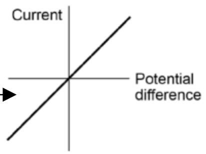
Section 6: Direct and Alternating Current

Mains electricity is an ac supply.
In the United Kingdom the domestic electricity supply has a frequency of 50 Hz and is about 230 V.
Direct current flows in one direction only.
Alternating current constantly changes direction.

6.2 Electricity

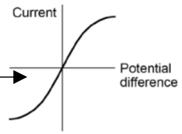
Section 7: Resistors

For some resistors, the value of R remains **constant**.
The current through a conductor is **directly proportional** to the potential difference across the resistor. This means that the **resistance** remains **constant** as the **current** changes.

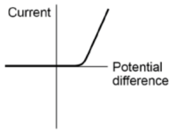


In other components, resistance can change as the current changes.

The **resistance** of a filament **lamp increases** as the **temperature** of the filament **increases**.



The current through a **diode** flows in one direction only. The diode has a very **high** resistance in the **reverse direction**.



The resistance of a **thermistor decreases** as the **temperature increases**.
The resistance of an **LDR decreases** as **light intensity increases**.

Section 9: Mains electricity

Most electrical **appliance**s are connected to the **mains** using **three-core cable**.
The insulation covering each wire is colour coded for easy identification:
live wire – brown
neutral wire – blue
earth wire – green and yellow stripes.
The **live wire** carries the **alternating potential difference** from the supply. The **neutral** wire **completes** the circuit. **The earth** wire is a **safety wire** to stop the appliance becoming live.

The **potential difference** between the **live wire** and **earth** (0 V) is about **230 V.** The **neutral wire** is at, or close to, earth potential **(0 V).** The earth wire is at 0 V, it only carries a current if there is a **fault**. A live wire may be **dangerous** even when a switch in the mains circuit is open.

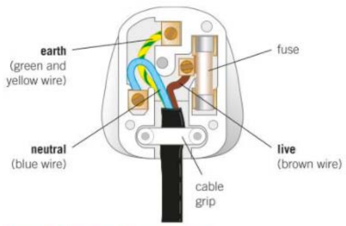


Figure 2 *Inside a three-pin plug*

Section 10: Power

1. The **power transfer** in any circuit device is related to the potential difference across it and the **current** through it, and to the energy changes over **time**:
2. power = potential difference × current
3. **(P = V I)**
4. power = current 2 × resistance
5. **($P = I^2 R$)**

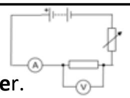
Power (P): **in watts (W)**
potential difference (V): **in volts (V)**
Current (I): **in amperes (A)**
Resistance (R): **in ohms (Ω)**

Section 11: Energy Transfer

1. Everyday **electrical appliances** are designed to bring **about energy transfers**.
2. The amount of energy an appliance transfers depends on **how long** the appliance is switched on for and the **power** of the appliance
3. **Work is done** when **charge flows** in a circuit
4. The amount of **energy transferred** by electrical work can be calculated using the equation: energy transferred = power × time
5. **E = P t**
6. energy transferred = charge flow × potential difference
7. **E = Q V**
8. energy transferred (E): **in joules (J)**
9. Power (P): **in watts (W)**
10. Time (t): **in seconds (s)**
11. charge flow (Q): **in coulombs (C)**
12. potential difference (V): **in volts (V)**

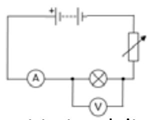
Section 8: Required Practical: Current and Potential Difference Characteristics.

<u>Resistor</u>



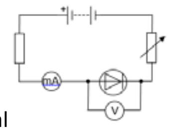
1. Connect the circuit.
2. Record readings on the **ammeter** and **voltmeter**.
3. Adjust **variable resistor** and record the new ammeter and voltmeter readings. **Repeat** to obtain several pairs of readings.
4. **Swap** connections on the battery. Now the **ammeter** is connected to the **negative terminal** and the **variable resistor** to the **positive**. The readings on the ammeter and voltmeter should now be **negative**.
5. Continue to record readings of **current** and **potential difference**.
6. Plot graph with: '**Current in A**' on y-axis, '**Potential difference in V**' on x-axis.
7. You should be able to draw **a straight** line of best fit through the **origin**. This is the **characteristic of a resistor**.

<u>Lamp</u>



1. Connect the circuit.
2. The lamp will get **hot**. Take care not to touch it.
3. Follow the same steps as for using a resistor.
6. Plot graph with: **'Current in A'** on y-axis, **'Potential difference in V'** on x-axis.
7. The **origin** will be in the **middle** of paper. Draw a **curved** line of best fit for your points.

<u>Diode</u>



1. Connect the circuit, adding in a **milliammeter**.
2. Reduce the battery potential difference to **less than 5V**.
3. Follow the same steps as for using a resistor.
6. Plot graph with**: 'Current in A'** on y-axis, '**Potential difference in V**' on x-axis.
7. The **origin** will probably be in the **middle of the bottom** of your graph paper. There should **not** be any **negative** values of current.

Section 12: The National Grid

1. The **National Grid** links power stations to **consumers**.
2. Electrical **power** is **transferred** from power stations to consumers using the National Grid.
3. **Step-up transformers** are used to **increase** the **potential difference** from the power station to the transmission cables
4. **Step-down transformers** are used to **decrease**, to a much lower value, the **potential difference** for domestic use.
5. The National Grid is an **efficient** way to transfer energy because it uses a **large** potential difference. Therefore **less** current is used to transfer **power**.
6. Power loss due to the **resistance** heating in the cables is **much reduced**.