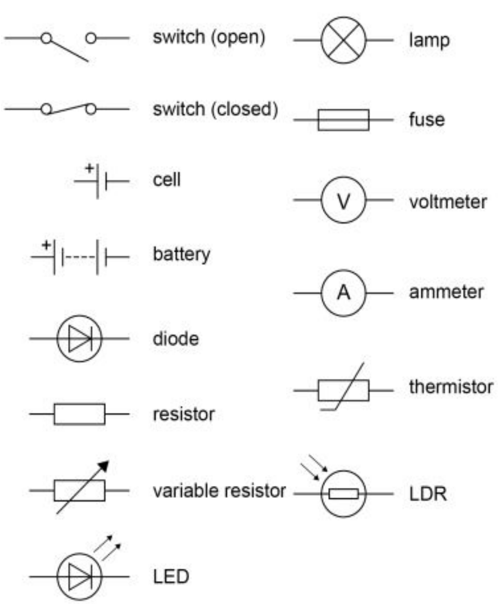
AQA Physics - Electricity Journey of Knowledge Part 1

Context and introduction to the unit: Electric charge is a fundamental property of matter everywhere. Understanding the difference in the microstructure of conductors, semiconductors and insulators makes it possible to design components and build electric circuits. Many circuits are powered with mains electricity, but portable electrical devices must use batteries of some kind. Electrical power fills the modern world with artificial light and sound, information and entertainment, remote sensing and control. The fundamentals of electromagnetism were worked out by scientists of the 19th century. However, power stations, like all machines, have a limited lifetime. If we all continue to demand more electricity this means building new power stations in every generation – but what mix of power stations can promise a sustainable future?

From Key Stage 3, pupils should have learnt that **current is a flow of charge**, and that the **current and potential difference vary in series and parallel circuits**. They should also understand the **concept of resistance** and be familiar with using **ammeters and voltmeters** to take basic measurements.

CORE KNOWLEDGE

6.2.1.1 Standard circuit diagram symbols - Circuit diagrams use standard symbols.



6.2.1.2 Electrical charge and current For electrical charge to flow through a closed circuit the circuit must include a source of potential difference. Electric current is a flow of electrical charge. The size of the electric current is the rate of flow of electrical charge. Charge flow, current and time are linked by the equation:

charge flow = current × time (Q = I x t)

Charge flow, Q, in coulombs, C. Current, I, in amperes, A (amp is acceptable for ampere) . Time, t, in seconds, s. A current has the same value at any point in a single closed loop.

6.2.1.3 Current, resistance and potential difference The current (I) through a component depends on both the resistance (R) of the component and the potential difference (V) across the component. The greater the resistance of the component the smaller the current for a given potential difference (pd) across the component. Questions will be set using the term potential difference. Students will gain credit for the correct use of either potential difference or voltage. Current, potential difference or resistance can be calculated using the equation:

potential difference = current × resistance (V = I x R)

Potential difference, V, in volts, V. Current, I, in amperes, A. Resistance, R, in ohms, Ω.

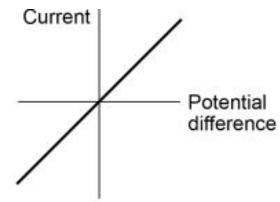
6.2.1.4 Resistors The current through an ohmic conductor (at a constant temperature) is directly proportional to the potential difference across the resistor. This means that the resistance remains constant as the current changes.

The resistance of components such as lamps, diodes, thermistors and LDRs is not constant; it changes with the current through the component. The resistance of a filament lamp increases as the temperature of the filament increases.

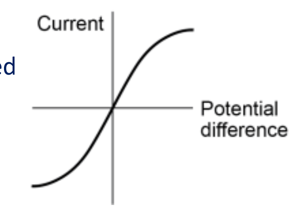
The current through a diode flows in one direction only. The diode has a very high resistance in the reverse direction.

6.2.1.4 Resistors The resistance of a thermistor decreases as the temperature increases. The applications of thermistors in circuits include a thermostat or to prevent a phone Overheating. The resistance of an LDR decreases as light intensity increases. Examples of application of LDRs in circuits include switching lights on when it gets dark.

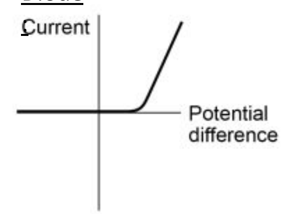
Resistor:



Lamp:



Diode



Disciplinary knowledge

Required practical activity 15: use circuit diagrams to set up and check appropriate circuits to investigate the factors affecting the resistance of electrical circuits. This should include: • the length of a wire at constant temperature • combinations of resistors in series and parallel WS 2.1,2.5,2.6,3.2,3.6,3.7

Vocabulary

Thermistor,, diode, LED, LDR, ohmic conductor

Reading is Power

The National Grid – Households could be paid to turn down heating

Where next?

Electricity (part 2)

AQA Physics - Electricity Journey of Knowledge Part 2

Context and introduction to the unit: Electric charge is a fundamental property of matter everywhere. Understanding the difference in the microstructure of conductors, semiconductors and insulators makes it possible to design components and build electric circuits. Many circuits are powered with mains electricity, but portable electrical devices must use batteries of some kind. Electrical power fills the modern world with artificial light and sound, information and entertainment, remote sensing and control. The fundamentals of electromagnetism were worked out by scientists of the 19th century. However, power stations, like all machines, have a limited lifetime. If we all continue to demand more electricity this means building new power stations in every generation – but what mix of power stations can promise a sustainable future?

From Key Stage 3, pupils should have learnt that **current is a flow of charge**, and that the **current and potential difference vary in series and parallel circuits**. They should also understand the **concept of resistance** and be familiar with using **ammeters and voltmeters** to take basic measurements.

CORE KNOWLEDGE

6.2.2 Series and parallel circuits There are two ways of joining electrical components, in series and in parallel. Some circuits include both series and parallel parts. 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.

6.2.3.1 Direct and alternating potential difference 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. Students should be able to explain the difference between direct and alternating potential difference.

6.2.3.2 Mains electricity Most electrical appliances 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.

6.2.4.1 Power 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:

power = potential difference × current ($P = V \times I$) and power = (current)² × resistance ($P = I^2 \times R$)

Power, P, in watts, W. Potential difference, V, in volts, V. Current, I, in amperes, A. Resistance, R, in ohms, Ω.

6.2.4.2 Energy transfers in everyday appliances Everyday electrical appliances are designed to bring about energy transfers. The amount of energy an appliance transfers depends on how long the appliance is switched on for and the power of the appliance. Domestic appliances transfer energy from batteries or ac mains to the kinetic energy of electric motors or the energy of heating devices. Work is done when charge flows in a circuit. The amount of energy transferred by electrical work can be calculated using the equation: **energy transferred = power × time ($E = P \times t$)** and **energy transferred = charge flow × potential difference ($E = Q \times V$)**

Energy transferred, E, in joules, J. Power, P, in watts, W. Time, t, in seconds, s. Charge flow, Q, in coulombs, C. Potential difference, V, in volts, V.

6.2.4.3 The National Grid The National Grid is a system of cables and transformers linking power stations to consumers. Electrical power is transferred from power stations to consumers using the National Grid. Step-up transformers are used to increase the potential difference from the power station to the transmission cables then step-down transformers are used to decrease, to a much lower value, the potential difference for domestic use. The National Grid system is an efficient way to transfer energy.

HT only: equation: potential difference across primary coil x current in primary coil = potential difference across secondary coil x current in secondary coil.

4.2.5.1 Static charge (Physics only) When certain insulating materials are rubbed against each other they become electrically charged. Negatively charged electrons are rubbed off one material and on to the other. The material that gains electrons becomes negatively charged. The material that loses electrons is left with an equal positive charge. When two electrically charged objects are brought close together they exert a force on each other. Two objects that carry the same type of charge repel. Two objects that carry different types of charge attract. Attraction and repulsion between two charged objects are examples of non-contact force.

4.2.5.2 Electric fields (Physics only) A charged object creates an electric field around itself. The electric field is strongest close to the charged object. The further away from the charged object, the weaker the field. A second charged object placed in the field experiences a force. The force gets stronger as the distance between the objects decreases.

Disciplinary knowledge

Required practical activity 16: use circuit diagrams to construct appropriate circuits to investigate the I–V characteristics of a variety of circuit elements, including a filament lamp, a diode and a resistor at constant temperature. WS 1.2, 1.4, 1.5

Vocabulary

Resistor, series and parallel circuits, direct and alternating current, power, domestic appliances, The National Grid

Reading is Power

The National Grid – Households could be paid to turn down heating

Where next?

AS/A Level Physics Electricity