

AQA Additional Science - Physics

Describing Motion

Even when things are moving in a straight line, describing their movement is not easy. They can move with different speeds and can also change their speed and/or direction (accelerate). Graphs can help us to describe the movement of the body.

These may be distance-time graphs or velocity-time graphs.

Construct distance-time graphs for a body moving in a straight line when the body is stationary or moving with a constant speed

Construct velocity-time graphs for a body moving with a constant velocity or a constant acceleration

Calculate the speed of a body from the slope of a distance-time graph.

Calculate the acceleration of a body from the slope of a velocity-time graph

Calculate the distance travelled by a body from a velocity-time graph.

Distance – time and speed – time graphs

The slope of a distance-time graph represents speed.

The velocity of a body is its speed in a given direction.

The acceleration of a body is given by:

$$\begin{array}{l} \text{acceleration} \\ (\text{metre/second}^2 \text{ m/s}^2) \end{array} = \frac{\text{change in velocity (metre/second, m/s)}}{\text{time taken for change (second, s)}}$$

The slope of a velocity-time graph represents acceleration.

The area under a velocity-time graph represents distance travelled.

Speeding Up and Slowing Down

To change the speed of a body an unbalanced force must act on it.

Draw and interpret velocity-time graphs for bodies that reach terminal velocity, including a consideration of the forces acting on the body

Calculate the weight of a body using:

$$\begin{array}{l} \text{weight} \\ (\text{Newton, N}) \end{array} = \begin{array}{l} \text{mass} \\ (\text{kilogram, kg}) \end{array} \times \begin{array}{l} \text{gravitational field strength} \\ (\text{Newton/kilogram, N/kg}) \end{array}$$

Forces and Motion

Whenever two bodies interact, the forces they exert on each other are equal and opposite.

A number of forces acting on a body may be replaced by a single force which has the same effect on the body as the original forces all acting together. The force is called the resultant force.

If the resultant force acting on a stationary body is zero the body will remain stationary.

If the resultant force acting on a stationary body is not zero the body will accelerate in the direction of the resultant force.

If the resultant force acting on a moving body is zero the body will continue to move at the same speed and in the same direction.

If the resultant force acting on a moving body is not zero the body will accelerate in the direction of the resultant force.

Force, mass and acceleration are related by the equation:

$$\begin{array}{l} \text{resultant force} \\ (\text{Newton, N}) \end{array} = \begin{array}{l} \text{mass} \\ (\text{kilogram, kg}) \end{array} \times \begin{array}{l} \text{acceleration} \\ (\text{metre/second}^2, \text{ m/s}^2) \end{array}$$

When a vehicle travels at a steady speed the frictional forces balance the driving force.

Stopping Distance

The greater the speed of a vehicle the greater the braking force needed to stop it in a certain distance.

The stopping distance of a vehicle depends on the distance the vehicle travels during the driver's reaction time and the distance it travels under the braking force.

A driver's reaction time can be affected by tiredness, drugs and alcohol.

A vehicle's braking distance can be affected by adverse road and weather conditions and poor condition of the vehicle.

Terminal velocity

The faster a body moves through a fluid the greater the frictional force acting on it.

A body falling through a fluid will initially accelerate due to the force of gravity. Eventually the resultant force on the body will be zero and it will fall at its terminal velocity.

Movement Energy

When a body speeds up or slows down, its kinetic energy increases or decreases. The forces which cause the change in speed do so by transferring energy to, or from, the body.

Discuss the transformation of kinetic energy to other forms of energy in particular situations.

Work and Energy

When a force causes a body to move through a distance, energy is transferred and work is done.

Work done = energy transferred.

The amount of work done, force and distance are related by the equation:

$$\begin{array}{l} \text{Work done} \\ \text{(Joule, J)} \end{array} = \begin{array}{l} \text{force applied} \\ \text{(Newton, N)} \end{array} \times \begin{array}{l} \text{distance moved in direction of force} \\ \text{(metre, m)} \end{array}$$

Work done against frictional forces is mainly transformed into heat.

For an object that is able to recover its original shape, elastic potential is the energy stored in the object when work is done on the object to change its shape.

The kinetic energy of a body depends on its mass and its speed.

Calculate the kinetic energy of a body using the equation:

$$\begin{array}{l} \text{kinetic energy} \\ \text{(Joule, J)} \end{array} = \frac{1}{2} \times \begin{array}{l} \text{mass} \\ \text{(kilogram, kg)} \end{array} \times \begin{array}{l} \text{speed}^2 \\ \text{((metre/second)}^2, \text{ (m/s)}^2) \end{array}$$

Momentum

The faster a body is moving the more kinetic energy it has. It also has momentum.

When working out what happens to bodies as a result of explosions or collisions it is more useful to think in terms of momentum than in terms of energy.

Use the conservation of momentum (in one dimension) to calculate the mass, velocity or momentum of a body involved in a collision or explosion

Use the ideas of momentum to explain safety features.

Momentum changes

Momentum, mass and velocity are related by the equation:

$$\begin{array}{l} \text{momentum} \\ \text{(kilogram metre/second, kg m/s)} \end{array} = \begin{array}{l} \text{mass} \\ \text{(kilogram, kg)} \end{array} \times \begin{array}{l} \text{velocity} \\ \text{(metre/second, m/s)} \end{array}$$

Momentum has both magnitude and direction.

When a force acts on a body that is moving, or able to move, a change in momentum occurs.

Momentum is conserved in any collision/explosion provided no external forces act on the colliding/exploding bodies.

Force, change in momentum and time taken for the change are related by the equation:

$$\begin{array}{l} \text{Force} \\ \text{(Newton, N)} \end{array} = \frac{\text{change in momentum (kilogram metre/second, kg(m/s))}}{\text{time taken for the change (second, s)}}$$

Static Electricity

Static electricity can be explained in terms of electrical charges. When electrical charges move we get an electric current.

Explain why static electricity is dangerous in some situations and how precautions can be taken to ensure that the electrostatic charge is discharged safely

Explain how static electricity can be useful.

What is Static Electricity?

When certain insulating materials are rubbed against each other they become electrically charged.

Negatively charged electrons are rubbed off one material onto 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 bodies are brought together they exert a force on each other.

Two bodies that carry the same type of charge repel. Two bodies that carry different types of charge attract.

Current

Electrical charges can move easily through some substances, e.g. metals.

The rate of flow of electrical charge is called the current.

A charged body can be discharged by connecting it to earth with a conductor. Charge then flows through the conductor.

The greater the charge on an isolated body the greater the potential difference between the body and earth. If the potential difference becomes high enough a spark may jump across the gap between the body and any earthed conductor which is brought near it.

Electrostatic charges can be useful, for example in photocopiers and smoke precipitators and the basic operation of these devices.

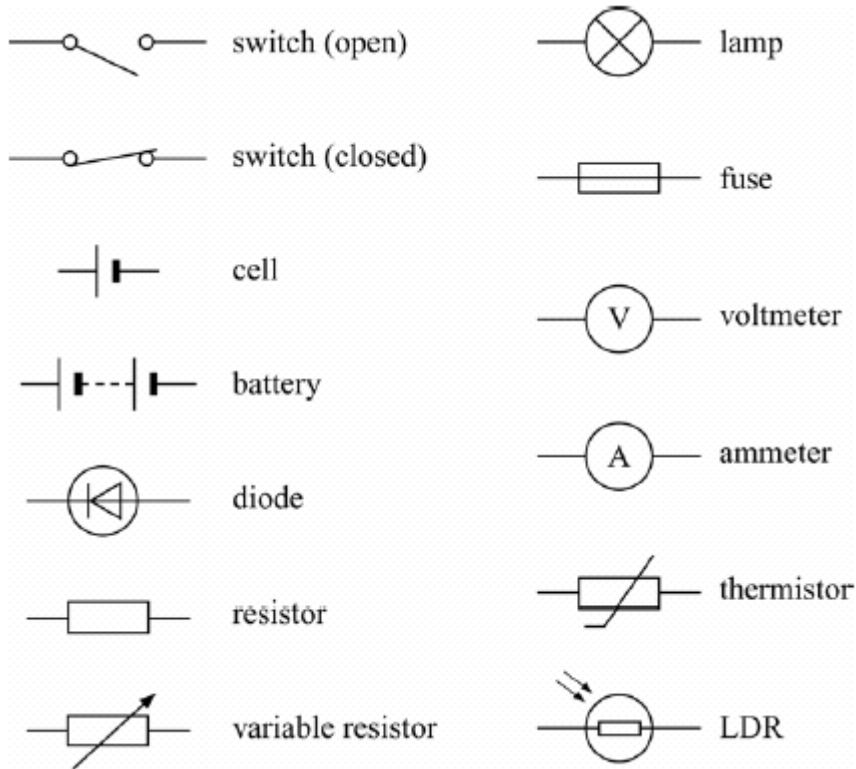
Electrical Current

The size of the current in a circuit depends on how hard the supply tries to push charge through the circuit and how hard the circuit resists having charge pushed through it.

Interpret and draw circuit diagrams using standard symbols.

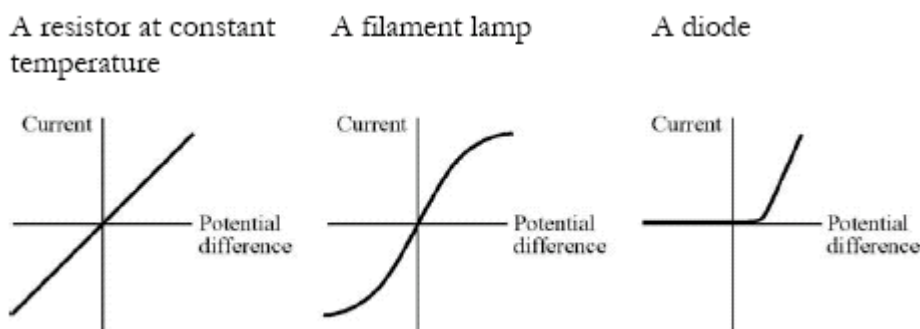
Apply the principles of basic electrical circuits to practical situations.

The following standard symbols should be known:



Current, Voltage and Resistance

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



The current through a resistor (at a constant temperature) is directly proportional to the potential difference across the resistor.

Potential difference, current and resistance are related by the equation:

$$\begin{array}{l} \text{potential difference} \\ \text{(volt, } V) \end{array} = \begin{array}{l} \text{current} \\ \text{(ampere, } A) \end{array} \times \begin{array}{l} \text{resistance} \\ \text{(ohm, } \Omega) \end{array}$$

The resistance of a component can be found by measuring the current through and potential difference across, 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.

The resistance of a **light-dependent resistor** (LDR) decreases as light intensity increases.

The resistance of a **thermistor** decreases as the temperature increases (i.e. knowledge of negative temperature coefficient thermistor only is required).

The current through a component depends on its resistance. The greater the resistance, the smaller the current for a given potential difference across the component.

The potential difference provided by cells connected in series is the sum of the potential difference of each cell (depending on the direction in which they are connected).

For components connected in series:

- * the total resistance is the sum of the resistance of each component
- * there is the same current through each component
- * the total potential difference of the supply is shared between the components.

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.

Mains Electricity

Mains electricity is useful but can be very dangerous. It is important to know how to use it safely.

Recognise errors in the wiring of a three-pin plug

Recognise dangerous practice in the use of mains electricity

Compare potential differences of d.c. supplies and the peak potential differences of a.c. supplies from diagrams of oscilloscope traces

Determine the period and hence the frequency of a supply from diagrams of oscilloscope traces.

D.C. and A.C.

Cells and batteries supply current which always passes in the same direction. This is called direct current (d.c.).

An alternating current (a.c.) is one which is constantly changing direction. Mains electricity is an a.c. supply. In the UK it has a frequency of 50 cycles per second (50 hertz).

UK mains supply is about 230 volts.

Three Pin Plugs

Most electrical appliances are connected to the mains using cable and a three-pin plug.

What is the structure of electrical cable.

What is the structure of a three-pin plug.

What is the correct wiring of a three-pin plug.

Fuses and Earth

If an electrical fault causes too great a current the circuit should be switched off by a fuse or a circuit breaker.

When the current in a fuse wire exceeds the rating of the fuse it will melt, breaking the circuit.

Appliances with metal cases are usually earthed.

The earth wire and fuse together protect the appliance and the user.

The live terminal of the mains supply alternates between positive and negative potential with respect to the neutral terminal.

The neutral terminal stays at a potential close to zero with respect to earth.

Electrical Power

Electrical appliances transform energy. The power of an electrical appliance is the rate at which it transforms energy. Most appliances have their power and the potential difference of the supply they need printed on them. From this we calculate their current and the fuse they need.

Calculate the current through an appliance from its power and the potential difference of the supply and from this determine the size of fuse needed.

Current, Charge and Power

Electric current is the rate of flow of charge.

When an electrical charge flows through a resistor, electrical energy is transformed into heat energy.

The rate at which energy is transformed in a device is called the power

$$\begin{array}{l} \text{power} \\ (\text{watt}, W) \end{array} = \frac{\text{energy transformed}}{\text{time}} \quad \begin{array}{l} (\text{joule}, J) \\ (\text{second}, s) \end{array}$$

Power, potential difference and current are related by the equation:

$$\begin{array}{l} \text{power} \\ (\text{watt}, W) \end{array} = \begin{array}{l} \text{current} \\ (\text{ampere}, A) \end{array} \times \begin{array}{l} \text{potential difference} \\ (\text{volt}, V) \end{array}$$

Energy transformed, potential difference and charge are related by the equation:

$$\begin{array}{l} \text{energy transformed} \\ (\text{Joule}, J) \end{array} = \begin{array}{l} \text{potential difference} \\ (\text{volt}, V) \end{array} \times \begin{array}{l} \text{charge} \\ (\text{coulomb}, C) \end{array}$$

The amount of electrical charge that flows is related to current and time by the equation:

$$\begin{array}{l} \text{charge} \\ (\text{coulomb}, C) \end{array} = \begin{array}{l} \text{current} \\ (\text{ampere}, A) \end{array} \times \begin{array}{l} \text{time} \\ (\text{second}, s) \end{array}$$

Radioactive Decay

Understand what happens to radioactive substances when they decay we need to understand the structure of the atoms from which they are made.

Explain how the Rutherford and Marsden scattering experiment led to the ‘plum pudding’ model of the atom being replaced by the nuclear model.

Atomic Structure

What are the relative masses and relative electric charges of protons, neutrons and electrons.

In an atom the number of electrons is equal to the number of protons in the nucleus. The atom has no net electrical charge.

Atoms may lose or gain electrons to form charged particles called **ions**.

All atoms of a particular element have the same number of protons.

Atoms of different elements have different numbers of protons.

Atoms of the same element which have different numbers of neutrons are called **isotopes**.

The total number of protons in an atom is called its **atomic number**.

The total number of protons and neutrons in an atom is called its **mass number**.

Decay and Background

The effect of alpha and beta decay on radioactive nuclei.

The origins of background radiation

Fission and Fusion

Nuclear fission is the splitting of atomic nuclei and is used in nuclear reactors as a source of heat energy which can be transformed to electrical energy. Nuclear fusion is the joining together of atomic nuclei and is the process by which energy is released in stars.

Sketch a labelled diagram to illustrate how a chain reaction may occur.

Nuclear Fission

There are two fissionable substances in common use in nuclear reactors, uranium 235 and plutonium 239.

Nuclear fission is the splitting of an atomic nucleus.

For fission to occur the uranium 235 or plutonium 239 nucleus must first absorb a neutron

The nucleus undergoing fission splits into two smaller nuclei and 2 or 3 neutrons and energy is released.

The neutrons may go on to start a chain reaction.

Nuclear Fusion

Nuclear fusion is the joining of two atomic nuclei to form a larger one.

Nuclear fusion is the process by which energy is released in stars.