Waseley Sixth

A Level Physics Bridging Course

Welcome to Physics!

This pack has been designed to help you bridge the gap from GCSE to AS Level to ensure that you understand what you've let yourself in for and that you are ready for your new course in September.

You will start by looking at the topics covered in Year 12 and 13 in the Physics OCR A course and give you an idea of how the course will be structured and what resources are available and when you will be doing tests, exams and practical assessments.

Then you will review what you already know and be given some work to do to make sure you're all ready to start in September to give yourself the best chance of success.

How hard is this physics course going to be?

Physics is one of the toughest A Levels you could have chosen!
The students who work the hardest do the best.

Over the course you will have 5 hours of lessons a week that will cover all the theory and practical skills you will need.
You will be given homework questions nearly every lesson and these will be expected to be completed by the next lesson in most cases.

At A Level you are expected to be spending 5 hours per week out of class completing homework, reviewing your work and reading around the subject.

In addition to the lessons you will receive, there is plenty of support available:

- Teachers: Your teacher is you first point of call as they are the experts – you will have 2 experienced teachers who will always offer their time when they are available to help you in and out of lessons.
- Notes and differentiated questions: We have produced a full set of notes that accompany each lesson. These notes are targeted to the lesson objectives that we have written and have HW questions that tie into the learning outcomes. You will be expected to print these off or ask us to, to organise these in a folder and add any extra notes that you write in or out of lessons and bring these along to lessons where we will check these regularly.

- Physics Clinic: The Physics clinic will run once a week after school and you are invited to come along with specific questions about physics. You will get help with homework or revision here so you aren't stuck at home for hours on something that somebody may be able to help you with in seconds. In the first term, these sessions will also specifically focus on the mathematical requirements of the course and deal with any issues regarding the practical skills assessments.

- Textbook: You will be given a textbook. These have notes, questions and revision tips and quizzes so make sure you use them!
- Revision Guides: We will order some revision guides in the Autumn term and we would encourage you to buy one.
- Specification and past papers: Download an OCR Physics A specification from: www.ocr.org.uk

Do I need to be good at Maths?

The simple answer to this is that yes – it helps.

BUT the course has been developed so that all of the Physics in AS level can be explained with a good understanding of GCSE Mathematics.

At A2 some more difficult maths is necessary to help explain concepts and analyse data but these skills will be developed as you study.

If you have chosen to do maths as one of your A Level courses then you will have an advantage, especially if you are taking mechanics modules as there is a massive overlap, but it is not essential.
A summary of the mathematical requirements appear below:

1 Arithmetic and numerical computation:
(a) recognise and use expressions in decimal and standard form;
(b) use ratios, fractions and percentages;
(c) use calculators to find and use power, exponential and logarithmic functions;
(e) use calculators to handle sin *x*, cos *x*, tan *x* when *x* is expressed in degrees or radians.
2 Handling data:
(a) use an appropriate number of significant figures;
(b) find arithmetic means;
(c) make order of magnitude calculations.
3 Algebra:
(a) understand and use the symbols: =, <, <<, >>, >, ∝, ~;
(b) change the subject of an equation;
(c) substitute numerical values into algebraic equations using appropriate units for physical quantities;
(d) solve simple algebraic equations.
4 Graphs:
(a) translate information between graphical, numerical and algebraic forms;
(b) plot two variables from experimental or other data;
(c) understand that $y = mx + c$ represents a linear relationship;
(d) determine the slope and intercept of a linear graph;
(e) draw and use the slope of a tangent to a curve as a measure of rate of change;
(f) understand the possible physical significance of the area between a curve and the x axis and be able to calculate it or measure it by counting squares as appropriate;
(g) use logarithmic plots to test exponential and power law variations;
(h) sketch simple functions including $y = k/x$, $y = kx^2$, $y = k/x^2$, $y = \sin x$, $y = \cos x$, $y = e^{-x}$.
5 Geometry and trigonometry:
(a) calculate areas of triangles, circumferences and areas of circles, surface areas and volumes of rectangular blocks, cylinders and spheres;
(b) use Pythagoras' theorem, and the angle sum of a triangle;
(c) use sin, cos and tan in physical problems;
(d) understand the relationship between degrees and radians and translate from one to the other;
(e) use relationship for triangles:

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C} \text{ and } a^2 = b^2 + c^2 - 2bc\cos A.$$

Bridging the Gap

Everything at A Level builds on your GCSE knowledge, skills and understanding and so you will first need to review everything you have done in Core and Additional GCSE.

Some have an advantage in that you have also done GCSE Physics – you will also have to review this work.

For those of you that didn't do GCSE Physics, you will have to look over this content for the first time.

On the following pages you will find checklists that include everything you need to know before we start the AS course. It will be your Homework over the Summer to ensure that you have revised it all thoroughly. Tick off the statements as you revise them.

At the back of this booklet is a quiz that you must bring to your first Physics lesson in September and hand it in to your teacher. They will mark it and give it back to you.

Core Physics

Heat Transfer

Are you able…

- ❑ To evaluate ways in which heat is transferred in and out of bodies and ways in which the rates of these transfers can be reduced.

Do you understand…

- ❑ Thermal (infra red) radiation is the transfer of energy by electromagnetic waves.
- ❑ All bodies emit and absorb thermal radiation.
- ❑ The hotter a body is the more energy it radiates.
- ❑ Dark, matt surfaces are good absorbers and good emitters of radiation.
- ❑ Light, shiny surfaces are poor absorbers and poor emitters of radiation.
- ❑ The transfer of energy by conduction and convection involves particles and how this transfer takes place.
- ❑ Under similar conditions different materials transfer heat at different rates.
- ❑ The shape and dimensions of a body affect the rate at which it transfers heat.
- ❑ The bigger the temperature difference between a body and its surroundings, the faster the rate at which heat is transferred.

Energy efficiency

Are you able…

- ❑ To describe the intended energy transfers/transformations and the main energy wastages that occur with a range of devices
- ❑ To calculate the efficiency of a device using:

  $$\text{efficiency} = \frac{\text{useful energy transferred by the device}}{\text{total energy supplied to the device}}$$

- ❑ To evaluate the effectiveness and cost effectiveness of methods used to reduce energy consumption.

Do you understand…

- ❑ Energy cannot be created or destroyed. It can only be transformed from one form to another form.
- ❑ When energy is transferred and/or transformed only part of it may be usefully transferred/transformed.
- ❑ Energy which is not transferred/transformed in a useful way is wasted.

- ❑ Both wasted energy and the energy which is usefully transferred/transformed are eventually transferred to their surroundings which become warmer.

- ❑ Energy becomes increasingly spread out and becomes increasingly more difficult to use for further energy transformations.

- ❑ The greater the percentage of the energy that is usefully transformed in a device, the more efficient the device is.

Electrical energy

Are you able…

- ❑ To compare and contrast the particular advantages and disadvantages of using different electrical devices for a particular application

- ❑ To calculate the amount of energy transferred from the mains using:
  energy transferred = power × time
  (kilowatt-hour, kWh) (kilowatt, kW) (hour, h)

- ❑ To calculate the cost of energy transferred from the mains using:
  total cost = number of kilowatt-hours × cost per kilowatt-hour

Do you understand…

- ❑ Examples of energy transformations that everyday electrical devices are designed to bring about.

- ❑ Examples of everyday electrical devices designed to bring about particular energy transformations.

- ❑ The amount of electrical energy a device transforms depends on how long the appliance is switched on and the rate at which the device transforms energy.

- ❑ The power of an appliance is measured in watts (W) or kilowatts (kW).

- ❑ Energy is normally measured in joules (J).

- ❑ Electricity is transferred from power station to consumers along the National Grid.

- ❑ The uses of step-up and step-down transformers in the National Grid.

- ❑ Increasing voltage (potential difference) reduces current, and hence reduces energy losses in the cables.

Generating electricity

Are you able…

- ❑ To compare and contrast the particular advantages and disadvantages of using different energy sources to generate electricity.

Do you understand…

- ❑ In most power stations an energy source is used to heat water. The steam produced drives a turbine which is coupled to an electrical generator.

- ❑ Common energy sources include coal, oil and gas, which are burned to produce heat and uranium/plutonium, in which nuclear fission produces heat.

- ❑ Energy from renewable energy sources can be used to drive turbines directly.

- ❑ Renewable energy sources used in this way include wind, the rise and fall of water due to waves and tides, and the falling of water in hydroelectric schemes.

- ❑ Electricity can be produced directly from the Sun's radiation using solar cells.

- ❑ In some volcanic areas hot water and steam rise to the surface. The steam can be tapped and used to drive turbines. This is known as geothermal energy.

- ❑ Using different energy resources has different effects on the environment. These effects include the release of substances into the atmosphere, noise and visual pollution, and the destruction of wildlife habitats.

- ❑ The advantages and disadvantages of using fossil fuels, nuclear fuels and renewable energy sources to generate electricity. These include the cost of building power stations, the start-up time of power stations, the reliability of the energy source, the relative cost of energy generated and the location in which the energy is needed.

<u>Electromagnetic spectrum</u>

Are you able…

- ❑ To evaluate the possible hazards associated with the use of different types of electromagnetic radiation

- ❑ To evaluate methods to reduce exposure to different types of electromagnetic radiation.

Do you understand…

- ❑ Electromagnetic radiation travels as waves and moves energy from one place to another.

- ❑ All types of electromagnetic waves travel at the same speed through a vacuum (space).

- ❑ The electromagnetic spectrum is continuous but the wavelengths within it can be grouped into types of increasing wavelength and decreasing frequency:
  gamma rays, X-rays, ultraviolet rays, visible light, infra red rays, microwaves and radio waves.

- ❑ Different wavelengths of electromagnetic radiation are reflected, absorbed or transmitted differently by different substances and types of surface.

- ❑ When radiation is absorbed the energy it carries makes the substance which absorbs it hotter and may create an alternating current with the same frequency as the radiation itself.

- ❑ Different wavelengths of electromagnetic radiation have different effects on living cells. Some radiations mostly pass through soft tissue without being absorbed, some produce heat, some may cause cancerous changes and some may kill cells. These effects depend on the type of radiation and the size of the dose.

- ❑ The uses and the hazards associated with the use of each type of radiation in the electromagnetic spectrum.

- [ ] Radio waves, microwaves, infra red and visible light can be used for communication.

- [ ] Microwaves can pass through the Earth's atmosphere and are used to send information to and from satellites and within mobile phone networks.

- [ ] Infra red and visible light can be used to send signals along optical fibres and so travel in curved paths.

- [ ] Communication signals may be analogue (continuously varying) or digital (discrete values only, generally on and off). Digital signals are less prone to interference than analogue and can be easily processed by computers.

- [ ] Electromagnetic waves obey the wave formula:
  wave speed = frequency × wavelength
  (metre/second, m/s) (hertz, Hz) (metre, m)

Radioactivity

Are you able…

- [ ] To evaluate the possible hazards associated with the use of different types of nuclear radiation

- [ ] To evaluate measures that can be taken to reduce exposure to nuclear radiations

- [ ] To evaluate the appropriateness of radioactive sources for particular uses, including as tracers, in terms of the type(s) of radiation emitted and their half-lives.

Do you understand…

- [ ] The basic structure of an atom is a small central nucleus composed of protons and neutrons surrounded by electrons.

- [ ] The atoms of an element always have the same number of protons, but have a different number of neutrons for each isotope.

- [ ] Some substances give out radiation from the nuclei of their atoms all the time, whatever is done to them. These substances are said to be radioactive.

- [ ] Identification of an alpha particle as a helium nucleus, a beta particle as an electron from the nucleus and gamma radiation as electromagnetic radiation.

- [ ] Properties of the alpha, beta and gamma radiations limited to their relative ionising power, their penetration through materials and their range in air.

- [ ] Alpha and beta radiations are deflected by both electric and magnetic fields but gamma radiation is not.

- [ ] The uses of and the dangers associated with each type of nuclear radiation.

- [ ] The half-life of a radioactive isotope is defined as the time it takes for the number of nuclei of the isotope in a sample to halve or the time it takes for the count rate from a sample containing the isotope to fall to half its initial level.

Origins of the universe

Are you able…

- ❑ To compare and contrast the particular advantages and disadvantages of using different types of telescope on Earth and in space to make observations on and deductions about the universe.

Do you understand…

- ❑ If a wave source is moving relative to an observer there will be a change in the observed wavelength and frequency.
- ❑ There is a red-shift in light observed from most distant galaxies.
- ❑ The further away galaxies are the bigger the red-shift.
- ❑ How the observed red-shift provides evidence that the universe is expanding and supports the big bang theory (that the universe began from a very small initial point).
- ❑ Observations of the solar system and the galaxies in the universe can be carried out on the Earth or from space.
- ❑ Observations are made with telescopes that may detect visible light or other electromagnetic radiations such as radio waves or X-rays

Describing Movement

Are you able:

- ❑ To construct distance-time graphs for a body moving in a straight line when the body is stationary or moving with a constant speed
- ❑ To construct velocity-time graphs for a body moving with a constant velocity or a constant acceleration
- ❑ *To calculate the speed of a body from the slope of a distance-time graph*
- ❑ *To calculate the acceleration of a body from the slope of a velocity-time graph*
- ❑ *To calculate the distance travelled by a body from a velocity-time graph*

Do you understand that:

- ❑ 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:
  acceleration = change in velocity (metre/second, m/s)
  (metre/second^2 m/s^2) 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.

Force and acceleration

Are you able:

- ❑ to draw and interpret velocity-time graphs for bodies that reach terminal velocity, including a consideration of the forces acting on the body
- ❑ to calculate the weight of a body using:
  weight = mass × gravitational field strength
  (newton, N) (kilogram, kg) (newton/kilogram, N/kg)

Do you understand that:

- ❑ 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:
  resultant force = mass × acceleration
  (newton, N) (kilogram, kg) (metre/second^2, m/s^2)
- ❑ When a vehicle travels at a steady speed the frictional forces balance the driving force
- ❑ 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
- ❑ The faster a body moves through a fluid the greater the frictional force which acts 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.

<u>Work and energy</u>

Are you able:

- ❑ to discuss the transformation of kinetic energy to other forms of energy in particular situations.

Do you understand that:

- ❑ 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:
  work done = force applied × distance moved in direction of force
  (joule, J) (newton, N) (metre, m)
- ❑ 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:*
  kinetic energy = ½ × mass × speed^2

(joule, J) *(kilogram, kg) ((metre/second)^2, (m/s)^2)*

Momentum

Are you able:

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

- ❑ to use the ideas of momentum to explain safety features.

Do you understand that:

- ❑ Momentum, mass and velocity are related by the equation:

momentum = mass × velocity
(kilogram metre/second, kg m/s) (kilogram, kg) (metre/second, m/s)

- ❑ 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:*

force = change in momentum (kilogram metre/second, kg(m/s))
(newton, N) time taken for the change (second, s)

Static electricity

Are you able:

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

- ❑ to explain how static electricity can be useful.

Do you understand that:

- ❑ 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

- ❑ Electrical charges can move easily through some substances, eg 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

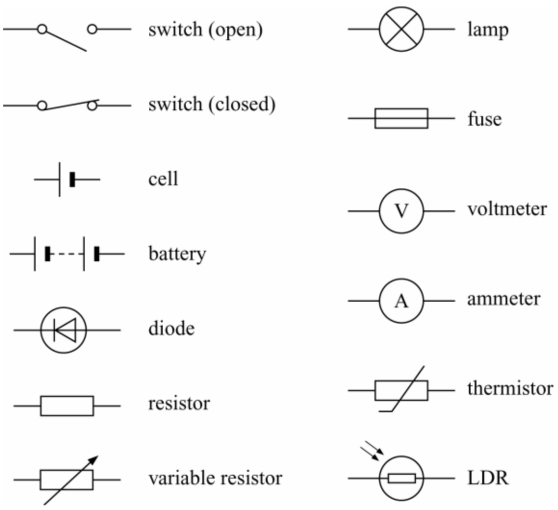
- *The greater the charge on an isolated body the greater the potential difference between the body and earth. If the potential difference becomes high enough a spark may jump across the gap between the body and any earthed conductor which is brought near it*

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

Current electricity

Are you able:

- to interpret and draw circuit diagrams using standard symbols. The following standard symbols should be known:

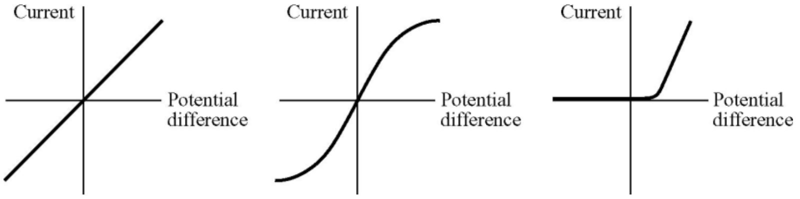


- to apply the principles of basic electrical circuits to practical situations.

Do you understand that:

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

A resistor at constant temperature   A filament lamp   A diode



- 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:

potential difference = current × resistance
(volt, V)   (ampere, A)   (ohm, Ω)

- ❑ 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 (ie 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.

<u>Mains electricity</u>

Are you able:

- ❑ to recognise errors in the wiring of a three-pin plug

- ❑ to recognise dangerous practice in the use of mains electricity

- ❑ to compare potential differences of d.c. supplies and the peak potential differences of a.c. supplies from diagrams of oscilloscope traces

- ❑ *to determine the period and hence the frequency of a supply from diagrams of oscilloscope traces.*

Do you understand that:

- ❑ 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

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

- ❑ The structure of electrical cable
- ❑ The structure of a three-pin plug
- ❑ Correct wiring of a three-pin plug
- ❑ 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 energy and power

Are you able:

- ❑ to 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.

Do you understand that:

- ❑ 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
  power = energy transformed (joule, J) / time *(second, s)*
  (watt, W)
- ❑ Power, potential difference and current are related by the equation:
  power = current × potential difference
  (watt, W) (ampere, A) (volt, V)
- ❑ *Energy transformed, potential difference and charge are related by the equation:*
  energy transformed = potential difference × charge
  (joule, J) (volt, V) (coulomb, C)
- ❑ *The amount of electrical charge that flows is related to current and time by the equation:*
  charge = current × time
  (coulomb, C) (ampere, A) (second, s)

Nuclear decay

Are you able:

- ❑ *to explain how the Rutherford and Marsden scattering experiment led to the plum pudding model of the atom being replaced by the nuclear model.*

Do you understand that:

- ❑ 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.
- ❑ The effect of alpha and beta decay on radioactive nuclei.
- ❑ The origins of background radiation.

<u>Nuclear fission and nuclear fusion</u>

Are you able:

- ❑ to sketch a labelled diagram to illustrate how a chain reaction may occur.

Do you understand that:

- ❑ 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 is the joining of two atomic nuclei to form a larger one.
- ❑ Nuclear fusion is the process by which energy is released in stars.

Further

Title	Objectives	
Moments	The turning effect of a force is called the moment. The size of the moment is given by the equation: moment = force x perpendicular distance from the line of action of the force to the axis of rotation. **HT** to calculate the size of a force, or its distance from an axis of rotation, acting on a body that is balanced□	
Principle of moments	**HT** If a body is not turning, the total clockwise moment must be exactly balanced by the total anticlockwise moment about any axis.	
Centre of mass	to describe how to find the centre of mass of a thin sheet of a material The centre of mass of a body is that point at which the mass of the body may be thought to be concentrated. If suspended, a body will come to rest with its centre of mass directly below the point of suspension. The centre of mass of a symmetrical body is along the axis of symmetry.	
Stability	**HT** to analyse the stability of bodies by considering their tendency to topple. **HT** Recognise the factors that affect the stability of a body. **HT** If the line of action of the weight of a body lies outside the base of the body there will be a resultant moment and the body will tend to topple.	
Circular Motion	to identify which force(s) provide(s) the centripetal force in a given situation When a body moves in a circle it continuously accelerates towards the centre of the circle. This acceleration changes the direction of motion of the body, not its speed. The resultant force causing this acceleration is called the centripetal force. The direction of the centripetal force is always towards the centre of the circle.	
Circular motion analysis	to interpret data on bodies moving in circular paths. The centripetal force needed to make a body perform circular motion increases as: □□the mass of the body increases; □□the speed of the body increases; □□the radius of the circle decreases.	
Gravitational Attraction	Gravitational force provides the centripetal force that allows planets and satellites to maintain their circular orbits. The further away an orbiting body is the longer it takes to make a complete orbit. To stay in orbit at a particular distance, smaller bodies, including planets and satellites, must move at a particular speed around larger bodies. The bigger the masses of the bodies the bigger the force of gravity between them. As the distance between two bodies increases the force of gravity between them decreases.	
Satellites	Communications satellites are usually put into a geostationary orbit above the equator. Monitoring satellites are usually put into a low polar orbit.	
Reflection (from plane mirrors)	The normal is a construction-line perpendicular to the reflecting/refracting surface at the point of incidence. The angle of incidence is equal to the angle of reflection. The nature of an image is defined by its size relative to the object,	
Reflection	to construct ray diagrams to show the formation of images by plane, convex and concave mirrors.	
Reflection (concave mirrors)	The nature of the image produced by a convex mirror. The nature of the image produced by a concave mirror for an object placed at different distances from the mirror. to construct ray diagrams to show the formation of images by plane, convex and concave mirrors to calculate the magnification produced by a lens or mirror using the formula: $\text{magnification} = \frac{\text{image height}}{\text{object height}}$	

Refraction	Refraction at an interface.	
Refraction by a prism	Refraction by a prism.	
Diverging Lenses	The nature of the image produced by a diverging lens. to construct ray diagrams to show the formation of images by diverging lenses and converging lenses	
Converging lenses	The nature of the image produced by a converging lens for an object placed at different distances from the lens. The use of a converging lens in a camera to produce an image of an object on a detecting device (eg film). to calculate the magnification produced by a lens or mirror using the formula: $\text{magnification} = \frac{\text{image height}}{\text{object height}}$	
Sound	Sound is caused by mechanical vibrations and travels as a wave. Sound cannot travel through a vacuum.	
Looking at sound	The quality of a note depends upon the waveform. Sound waves can be reflected and refracted. The pitch of a note increases as the frequency increases. The loudness of a note increases as the amplitude of the wave increases. to compare the amplitudes and frequencies of sounds from diagrams of oscilloscope traces.	
Ultrasound	Sounds in the range 20-20 000 Hz can be detected by the human ear. Electronic systems can be used to produce ultrasound waves which have a frequency higher than the upper limit of hearing for humans. Ultrasound waves are partially reflected when they meet a boundary between two different media. The time taken for the reflections to reach a detector is a measure of how far away such a boundary is. Ultrasound waves can be used in industry for cleaning and quality control. Ultrasound waves can be used in medicine for pre-natal scanning. to determine the distance between interfaces in various media from diagrams of oscilloscope traces. to compare the amplitudes and frequencies of ultrasounds from diagrams of oscilloscope traces. **HT** to determine the distance between interfaces in various media from diagrams of oscilloscope traces.	
Motor effect	When a conductor carrying an electric current is placed in a magnetic field, it may experience a force. The size of the force can be increased by: □□increasing the strength of the magnetic field □□increasing the size of the current. The conductor will not experience a force if it is parallel to the magnetic field. The direction of the force is reversed if either the direction of the current or the direction of the magnetic field is reversed.	
Making motors	to explain how the motor effect is used in simple devices.	
Generator Effect	If an electrical conductor ‘cuts’ through magnetic field lines, an electrical potential difference is induced across the ends of the conductor. If a magnet is moved into a coil of wire, an electrical potential difference is induced across the ends of the coil. If the wire is part of a complete circuit, a current is induced in the wire. If the direction of motion, or the polarity of the magnet, is reversed, the direction of the induced potential difference and the induced current is reversed. The generator effect also occurs if the magnetic field is stationary and the coil is moved. The size of the induced potential difference increases when: □□the speed of the movement increases □□the strength of the magnetic field increases □□the number of turns on the coil increases □□the area of the coil is greater.	
AC Generators	**HT** to explain from a diagram how an a.c. generator works, including the purpose of the slip rings and brushes.	

Transformers	The basic structure of the transformer. An alternating current in the primary coil produces a changing magnetic field in the iron core and hence in the secondary coil. This induces an alternating potential difference across the ends of the secondary coil.	
Uses of transformers	to determine which type of transformer should be used for a particular application. **HT** The potential difference (p.d.) across the primary and secondary coils of a transformer are related by the equation: $\frac{\text{p.d. across primary}}{\text{p.d. across secondary}} = \frac{\text{number of turns on primary}}{\text{number of turns on secondary}}$ In a step-up transformer the potential difference across the secondary coil is greater than the potential difference across the primary coil. In a step-down transformer the potential difference across the secondary coil is less than the potential difference across the primary coil. The uses of step-up and step-down transformers in the National Grid.	
Stars, Galaxies and the Universe	Our Sun is one of the many billions of stars in the Milky Way galaxy. The Universe is made up of billions of galaxies. Stars form when enough dust and gas from space is pulled together by gravitational attraction. Smaller masses may also form and be attracted by a larger mass to become planets. Gravitational forces balance radiation pressure to make a star stable.	
Lifecycle of a star	A star goes through a life cycle (limited to the life cycle of stars of similar size to the Sun and stars much larger than the Sun). Fusion processes in stars produce all naturally occurring elements. These elements may be distributed throughout the Universe by the explosion of a star (supernova) at the end of its life.	
Making elements	to explain how stars are able to maintain their energy output for millions of years to explain why the early Universe contained only hydrogen but now contains a large variety of different elements.	

Name………………………………… [/55]

Bridging the Gap - HW Quiz

Energy and energy resources

1 Thermal energy can be transferred in different ways.

Match the words in the list with the numbers **1** to **4** in the sentences.

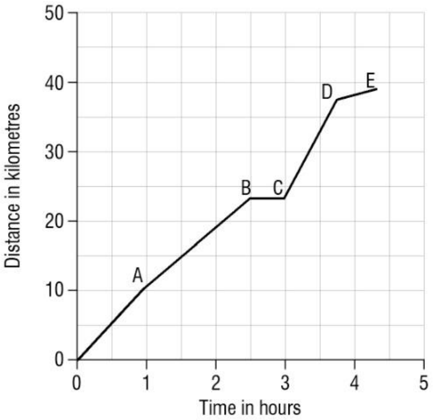
A electrons .... **B** liquids ....

C particles .... **D** solids ....

Conduction occurs mainly in ……**1**…… All metals are good conductors because they have a lot of free ……**2**……. Convection occurs in gases and ……**3**…… Radiation does not involve ……**4**…… *(4 marks)*

Motion

2 The graph shows how far a marathon runner travels during a race.



(a) What was the distance of the race?

.... (1)

(b) How long did it take the runner to complete the race?

.... (1)

(c) What distance did the runner travel during the first 2 hours of the race?

.... (1)

(d) For how long did the runner rest during the race?

.... (1)

(e) Ignoring the time for which the runner was resting, between which two points was the runner moving the slowest?

Give a reason for your answer.

....

.... (2)

Speeding up Slowing down

3 a) When two objects interact, they exert ………………. and ………………. forces on each other.

b) The unit of force is the ………………. (symbol …..).

c) A moving object acted on by a resultant force:

i) in the same direction as the direction of its motion ………………………..,

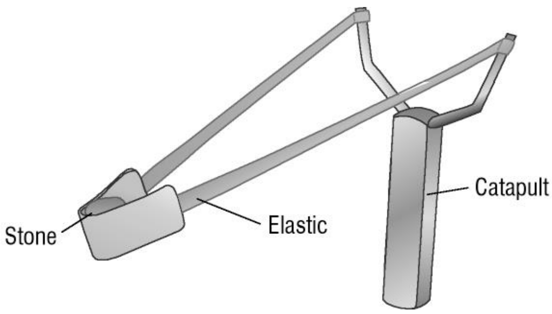
ii) in the opposite direction to its direction of motion ……………………….. .

d) Resultant force = ………………………………….. × ……………………………………………..
(in ………) (in kg) (in ………)

(11)

Work energy and momentum

4 The picture shows a catapult.



(a) When a force is applied to the stone, work is done in stretching the elastic and the stone moves backwards.

(i) Write down the equation you could use to calculate the work done.

.... (1)

(ii) The average force applied to the stone is 20 N. This moves it backwards 0.15 m. Calculate the work done and give its unit.

....

....

.... (3)

(b) The work done is stored as energy.

(i) What type of energy is stored in the stretched elastic?

.... (1)

(ii) What type of energy does the stone have when it is released?

………………………………………………………………………………………….. (1)

Turning forces

5 There are many satellites orbiting the Earth in circular paths.

(a) (i) What force provides the centripetal force that allows satellites to maintain their circular orbits?

.... (1)

(ii) A satellite moving at a steady speed in a circular orbit is continuously accelerating. Explain why.

....

.... (2)

(b) Some satellites are in *geostationary orbits*.

(i) What is meant by a *geostationary orbit*?

.... (1)

(ii) What is the time period of a geostationary orbit?

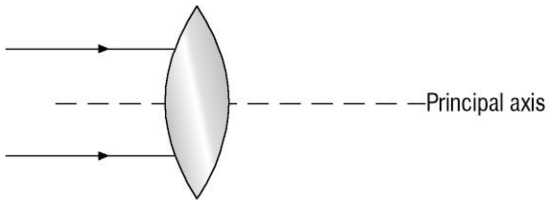
.... (1)

(iii) What type of satellite is usually put into a geostationary orbit?

.... (1)

Light and sound

6 (a) (i) Complete the diagram below to show what happens to the two rays of light after they enter the lens. (2)

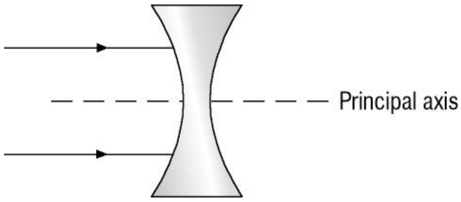


(ii) Put an **F** on the diagram to label the principal focus of the lens. (1)

(iii) What word can be used to describe this type of lens?

.... (1)

(b) (i) Complete the diagram below to show what happens to the two rays of light after they enter the lens. (2)



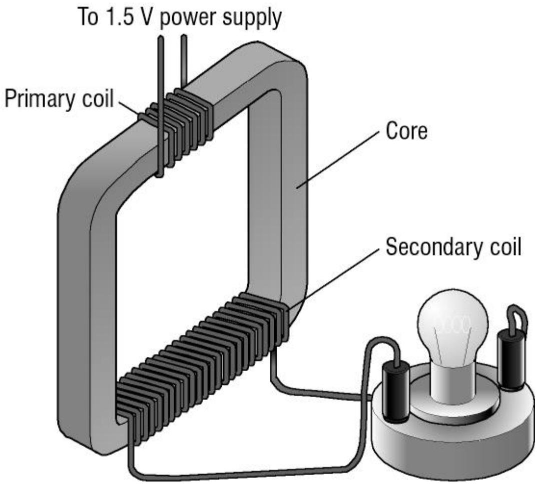
(ii) Put an **F** on the diagram to label the principal focus of the lens. (1)

(iii) What word can be used to describe this type of lens?

.... (1)

Electromagnetism

7 The diagram shows a transformer.



(a) Explain how an alternating current in the primary coil produces an alternating current through the lamp.

....

....

.... (4)

(b) The potential difference across the primary coil is 1.5 V. There are 6 turns on the primary coil and 24 turns on the secondary coil.

Calculate the potential difference across the lamp.

....

....

(4)

Stars and space

8 The sentences below describe the life cycle of a star such as the Sun.

A The star contracts to form a white dwarf.

B The star is in a stable state.

C The star expands to form a red giant.

D Gravitational forces pull dust and gas together and the star is formed.

(a) Put the sentences in the correct order. (3)

(b) At which stage in its life is the Sun, **A**, **B**, **C** or **D**?

.... (1)

(c) What balances the gravitational forces to make a star stable?

....

....

.... (2)

A Level Physics Essential Key Words and Terms

absolute scale of temperature	A scale for measuring temperature based on absolute zero and the triple point of pure water, with gradations equal in size to those of the Celsius scale; unit kelvin (K).
absolute zero	The lowest possible temperature, the temperature at which substances have minimum internal energy.
absorption coefficient	A measure of the absorption of X-ray photons by a substance, also known as attenuation coefficient – SI unit m^{-1}.
absorption line spectrum	A set of specific frequencies of electromagnetic radiation visible as dark lines in an otherwise continuous spectrum.
acceleration	The rate of change of velocity, a vector quantity.
acceleration of free fall	The rate of change of velocity of an object falling in a gravitational field, symbol ‘g’.
acoustic impedance	The product of the density ρ of a substance and the speed ‘c’ of ultrasound in that substance – symbol Z, SI unit $kgm^{-2}s^{-1}$.
acoustic matching	The use of two substances with similar acoustic impedance to minimise reflection of ultrasound at the boundary between them.
activity	The rate at which nuclei decay or disintegrate in a radioactive source, measured in Becquerels (Bq) or decays per second.
alpha radiation	Ionising radiation consisting of particles comprising two neutrons and two protons with a charge of +2e.
air resistance	The drag or resistive force experienced by objects moving through the air.
ammeter	A device used to measure electric current -it must be placed in series and ideally have zero resistance.
amount of substance	A measure of the amount of matter in moles.
ampere	The base SI unit of electric current symbol A. Defined as the current flowing in two parallel wires in a vacuum 1m apart such that there is an attractive force of 2.0×10^{-7}N per metre length of wire between them.

amplitude	The maximum displacement from the equilibrium position (can be positive or negative).
angle of incidence	The angle between the direction of travel of an incident wave and the normal at a boundary between two media.
angle of reflection	The angle between the direction of travel of a reflected wave and the normal at a boundary between two media.
angular frequency	A quantity used in oscillatory motion – equal to the product of frequency and 2π.
angular velocity	The rate of change of angle for an object moving in a circular path – symbol ω.
anion	A negatively charged ion, one which is attracted to an anode.
annihilation	The complete destruction of a particle and its antiparticle in an interaction that releases energy in the form of identical photons.
anode	A positively charged electrode.
antiparticle	The antimatter counterpart of a particle, with the opposite charge to the particle and exactly the same rest mass as the particle.
antiphase	Particles oscillating completely out of step with each other.
aphelion	The furthest point from the Sun in an orbit.
Archimedes' Principle	The upthrust on an object in a fluid is equal to the weight of the fluid it displaces.
arcminute	A minute of arc;1° = 60 arcminutes.
arcsecond	A second of arc; 1 arcminute = 60 arcseconds.
astronomical unit	The mean distance from the earth to the Sun.
atomic mass unit	One atomic mass unit (1u) is one-twelfth the mass of a neutral carbon–12 atom.
atomic number	The number of protons in a nucleus – symbol Z.
attenuation	The decrease in the intensity of electromagnetic radiation as it passes through matter or space.
attenuation coefficient	A measure of the absorption of X-ray photons by a substance.
average speed	The rate of change in distance calculated over a complete journey.
average velocity	The rate of change of displacement over a complete journey.
Avogadro constant	6.02×10^{23}, the number of atoms in 0.012kg of carbon-12; symbol N_A.
background radiation	The radiation emitted by the surroundings, which must be measured before radiation produced in an experiment can usefully be measured.
baryon	Any hadron made with a combination of three quarks.
base unit	One of seven units that form the building blocks of the SI measurement system.
battery	A collection of cells that transfers chemical energy into electrical energy.

becquerel	A unit of activity – one Becquerel is an activity of one decay per second.
beta decay	A neutron in an unstable nucleus decays into a proton, an electron and an electron antineutrino (β^- decay), or a proton into a neutron, a positron and an electron neutrino (β^+ decay).
beta radiation	Ionising radiation consisting of fast-moving electrons (β^-) or (β^+) emitted from unstable nuclei, with a charge of −e or +e respectively.
Big Bang	The theory that at a moment in the past all the matter in the Universe was contained in a single point (singularity), the beginning of space and time, that expanded rapidly outward.
binding energy	The minimum energy required to completely separate a nucleus into its constituent protons and neutrons.
binding energy per nucleon	The binding energy divided by the number of protons and neutrons in the nucleus; the greater the binding energy per nucleon, the more tightly bound are the nucleons within the nucleus.
black body	An idealised object that absorbs all the electromagnetic radiation incident on it and, when in thermal equilibrium, emits a characteristic distribution of wavelengths at a specific temperature.
black hole	The remnant core of a massive star after it has gone supernova and the core has collapsed so far that in order to escape it an object would need an escape velocity greater than the speed of light, and therefore nothing, not even photons, can escape.
blue shift	The shortening of observed wavelength that occurs when a wave source is moving towards the observer – in astronomy, if a galaxy is moving towards the Earth, the absorption lines in its spectrum will be blue shifted.
Boltzmann constant	The molar gas constant R divided by the Avogadro constant N_A, a constant that related the mean kinetic energy of the atoms or molecules in a gas to the gas temperature – symbol 'k'.
Boyle's law	The pressure of an ideal gas is inversely proportional to its volume, provided that the mass of gas and the temperature do not vary.
braking distance	Distance travelled by a vehicle from the time the brakes are applied until the vehicle stops.
breaking strength	The stress value at the point of fracture, calculated by dividing the breaking force by the cross-sectional area.
brittle	Property of a material that does not show plastic deformation and deforms very little under high stress.
Brownian motion	The continuous random motion of small particles suspended in a fluid, visible under a microscope.
capacitance	The charge stored per unit potential difference across a capacitor.
capacitor	A component that stores charge, consisting of two plates separated by an insulator (dielectric).

carbon dating	A method for determining the age of organic material, by comparing the activities, or the ratios, of carbon-14 and carbon-12 nuclei of the dead material of interest and similar living material.
cathode	A negatively charged electrode.
cation	A positively charged ion, one which is attracted to a cathode.
cell	A device that transfers chemical energy into electrical energy.
Celsius scale	A temperature scale with 100 degrees between the freezing point and the boiling point of pure water at atmospheric pressure 1.01×10^3Pa.
centre of gravity	An imaginary point at which the entire weight of an object appears to act.
centre of mass	A point through which any externally applied force produces straight-line motion but no rotation.
centripetal acceleration	The acceleration of any object travelling in a circular path at constant speed, which always acts towards the centre of the circle.
centripetal force	A force that keeps a body moving with a constant speed in a circular path.
chain reaction	A reaction in which the neutrons from an earlier fission stage are responsible for further fission reactions leading to an exponential growth in the rate of the reactions.
Chandrasekhar limit	The mass of a star's core beneath which the electron degeneracy pressure is sufficient to prevent gravitational collapse, 1.44 solar masses.
charge carrier	A particle with charge that moves through a material to form an electric current – for example, an electron in a metal wire.
closed system	An isolated system that has no interaction with its surroundings.
cloud chamber	A detector of ionising radiation consisting of a chamber filled with air saturated with vapour at a very low temperature so that droplets of liquid condense around ionised particles left along the path of radiation.
coherence	Two wave sources, or waves, that are coherent have a constant phase difference.
collimator	Part of a gamma camera, a honeycomb of long, thin tubes made from lead that absorbs any photons arriving at an angle to the axis of the tubes so that a clear picture is obtained.
comet	A small, irregular body made of ice, dust, and small pieces of rock in an orbit around the Sun – as they approach the Sun, some comets develop spectacular tails.
component	One of the two perpendicular vectors obtained by resolving a vector.
compression	The decrease in length of an object when a compressive force is exerted on it.
compression (waves)	A moving region in which the medium is denser or has higher pressure than the surrounding medium.

compressive deformation	A change in the shape of an object due to compressive forces.
compressive force	Two or more forces together that reduce the length or volume of an object.
conical pendulum	A simple pendulum that, instead of swinging back and forth, rotates in a horizontal circle at constant speed.
conservation of charge	A conservation law which states that electric charge can neither be created or be destroyed – the total charge in any interaction must be the same before and after the interaction.
constant speed	Motion in which the distance travelled per unit time stays the same.
constant velocity	Motion in which the change in displacement per unit time stays the same.
constructive interference	Superposition of two waves in phase so that the resultant wave has greater amplitude than the original waves.
continuous spectrum	A spectrum in which all visible frequencies or wavelengths are present.
control rods	Rods made of a material whose nuclei readily absorb neutrons (commonly boron or cadmium) which can be moved into or out of a reactor core.
conventional current	A model used to describe electric current in a circuit – conventional current travels from positive to negative – it is the direction in which positive charges would travel.
coolant	A substance that removes the thermal energy produced from reactions within a fission reactor.
corrected count rate	The radiation count rate measured in an experiment minus the background count rate.
cosmological principle	The assumption that, when viewed on a large enough scale, the Universe is homogeneous and isotropic, and the laws of Physics are universal.
coulomb	The derived SI unit of electrical charge, symbol C; 1 coulomb of electric charge passes a point in one second when there is an electric current of one ampere, 1C = 1As.
Coulomb's Law	Any two point charges exert an electrostatic (electrical) force on each other that is directly proportional to the product of their charges and inversely proportional to the square of their separation.
couple	A pair of equal and opposite forces acting on a body but not in the same straight line.
coupling gel	A gel with acoustic impedance similar to that of skin smeared onto the transducer and the patient's skin before an ultrasound scan in order to fill air gaps and ensure that almost all the ultrasound enters the patient's body.
critical angle	The angle of incidence at the boundary between two media that will produce an angle of refraction of 90°.
crystallography	A method for determining the structure of a substance by studying the interference patterns produced by waves passing through a crystal of the substance.

damping	An oscillation is damped when an external force that acts on the oscillator has the effect of reducing the amplitude of the oscillations.
dark energy	A hypothetical form of energy that fills all of space and would explain the accelerating expansion of the Universe.
dark matter	A hypothetical form of matter spread throughout the galaxy that neither emits nor absorbs light – it could explain the differences between the predicted and observed velocities of stars in galaxies.
daughter nucleus	A new nucleus formed following radioactive decay.
de Broglie equation	An equation relating the wavelength and the momentum of a particle. $\lambda = h/p$.
decay constant	The probability of decay of an individual nucleus per unit time.
density	The mass per unit volume of a substance.
derived quantity	A quantity that comes from a combination of base units.
derived unit	A unit used to represent a derived quantity, such as N for force.
destructive interference	Superposition of two waves in antiphase so that the waves cancel each other out and the resultant wave has smaller amplitude than the original waves.
diffraction	The phenomenon in which waves passing through a gap or around an obstacle spread out.
diffraction grating	A glass or plastic slide on which as many as 1000 lines per millimetre are ruled, at a spacing that diffracts visible wavelengths of light.
diode	A semiconductor component that allows current only in one particular direction.
displacement	The distance travelled in a particular direction – it is a vector with magnitude and direction.
displacement (waves)	The distance from the equilibrium position in a particular direction – displacement is a vector so it has a positive or negative value.
drag force	The resistive force exerted by a fluid on an object moving through it.
Doppler effect	The change in the frequency and wavelength of waves received from an object moving relative to an observer compared with what would be observed without relative motion.
driving frequency	The frequency with which the periodic driver is applied to a system in forced oscillation.
ductile	Property of a material that has a large plastic region in a stress-strain graph, so can be drawn into wires.
efficiency	The ratio of useful output energy to total input energy, often expressed as a percentage.
elastic deformation	A reversible change in the shape of an object due to a compressive or tensile force – removal of stress or force will return the object to its original shape and size.

elastic limit	The value of stress or force beyond which elastic deformation becomes plastic deformation, and the material or object will no longer return to its original shape and size when the stress of force is removed.
elastic potential energy	The energy stored in an object because of its deformation.
electric charge	A physical property, symbol 'q' or 'Q', either positive or negative, measured in Coulombs C.
electric current	The rate of flow of charge, symbol I, measured in Amperes, A; normally a flow of electrons in metals or a flow of ions in electrolytes.
electric field strength	The force experienced per unit positive charge at that point.
electric potential	The work done by an external force per unit positive charge to bring a charge from infinity to a point in an electric field – unit volt or JC^{-1}.
electric potential difference	The work done by an external force per unit positive charge to move charge between two points in an electric field.
electricity meter	A device that measures the electrical energy supplied in kWh to a house form the grid.
electrolyte	A liquid containing ions that are free to move and so to conduct electricity.
electromagnetic spectrum	The full range of frequencies of electromagnetic waves, from gamma rays to radio waves.
electromagnetic wave	Transverse waves with oscillating electric and magnetic field components such as light and X-rays, that do not need a medium to propagate – they travel at a speed of $3 \times 10^8 ms^{-1}$ in a vacuum.
electromotive force (emf)	Defined as the energy transferred from chemical to electrical energy per unit charge.
electron gun	A device that uses a large accelerating potential difference to produce a narrow beam of electrons.
electronvolt	A derived unit of energy used for subatomic particles and photons, defined as the energy transferred to or from an electron when it passes through a potential difference of 1 volt; 1eV is equivalent to 1.6×10^{-19J}.
elementary charge	The electric charge equivalent to the charge on a proton, 1.60 x 10-^{19}C; symbol 'e'.
emission line spectrum	A set of specific frequencies of electromagnetic radiation, visible as bright lines in spectroscopy.
energy	The capacity for doing work, measured in Joules, J.
energy level	A discrete (quantised) amount of energy that an electron within an atom is permitted to possess.
equilibrium	A body is in equilibrium when the net force and net moment acting on it are zero.
escape velocity	The minimum velocity at which an object has just enough energy to leave a gravitational field.
Faraday's Law	The magnitude of the induced emf is directly proportional to the rate of change of magnetic flux linkage.
fission	A process in which a large nucleus splits into two smaller nuclei after absorbing a neutron.

Fleming's Left Hand Rule	Gives direction of force experienced by a current carrying wire placed perpendicular to the external magnetic field.
force	A push or pull on an object, measured in Newtons, N.
force constant	A quantity determined by dividing force by extension for an object obeying Hooke's Law – called constant of proportionality 'k' in Hooke's Law, measured in Nm^{-1}.
force-extension graph	A graph of force against extension with the area under the graph equal to the work done on the material.
force-time graph	A graph of net force against time with the area under the graph equal to the impulse.
forced oscillation	An oscillation in which a periodic driver force is applied to an oscillator.
free electron	An electron in a metal that is not bound to an atom and is free to move – sometimes called a delocalised electron.
free fall	The motion of an object accelerating under gravity with no other force acting on it.
free-body diagram	A diagram that represents the forces acting on a single object.
frequency	The number of complete oscillations per unit time – unit Hertz (Hz).
fundamental frequency	The lowest frequency at which an object can vibrate.
fundamental mode of vibration	A vibration at the fundamental frequency.
fundamental particle	A particle that has no internal structure and hence cannot be split into smaller particles.
fusion	A process in which two smaller nuclei join together to form one larger nucleus.
galaxy	A collection of stars and interstellar dust and gas bound together by their mutual gravitational force.
gamma radiation	Ionising radiation consisting of high energy photons, with wavelengths less than about 10^{-13}m, which travel at the speed of light.
gamma rays	Short wavelength electromagnetic waves, with wavelengths from 10^{-10}m to 10^{-16}m.
geostationary satellite	A satellite that remains in the same position relative to a spot on the Earth's surface, by orbiting in the direction of the Earth's rotation over the equator with a period of 24 hours.
gravitational field	A field created around any object with mass, extending all the way to infinity but diminishing as the distance from the centre of mass of the object increases.
gravitational field lines	Lines of force used to map the gravitational field pattern around an object having mass.
gravitational field strength, g	The gravitational force exerted per unit mass at a point within a gravitational field.
gravitational potential	The work done per unit mass to bring an object from infinity to a point in the gravitational field – unit Jkg^{-1}.
gravitational potential energy	The capacity for doing work as a result of an objects position in a gravitational field.

ground state	The energy level with the most negative value possible for an electron within an atom – the most stable energy state of an electron.
hadron	A particle or antiparticle that is affected by the strong nuclear force, and, if charged, by the electromagnetic force – for example, a proton.
half-life	The average time it takes for half the number of active nuclei in a sample of an isotope to decay.
harmonic	A whole-number multiple of the fundamental frequency.
heavy damping	Damping that occurs when the damping forces are large and the period of the oscillations increases slightly with the rapid decrease in amplitude.
Hertzsprung-Russell diagram	A graph showing the relationship between the luminosity of stars in our galaxy (y axis) and their average surface temperature (x axis).
Hooke's Law	The force applied is directly proportional to the extension of the spring unless the limit of proportionality is exceeded.
Hubble constant	The gradient of a best fit line for a plot of recessional speed against distance from Earth of other galaxies.
Hubble's Law	The recessional speed v of a galaxy is almost directly proportional to its distance d from the Earth.
hysteresis loop	A loop shaped plot obtained when for example loading and unloading a material produces different deformations.
ideal gas	A model of a gas including assumptions that simplify the behaviour of real gases.
impedance matching	The use of two substances with similar acoustic impedance to minimise reflection of ultrasound at the boundary between them.
impulse	The area under a force-time graph – the product of force and the time for which the force acts.
in phase	Particles oscillating perfectly in time with each other (reaching their maximum positive displacement at the same time) are in phase.
inelastic collision	A collision in which kinetic energy is transferred to other forms eg. heat.
induced fission	Nuclear fission occurring when a nucleus becomes unstable upon absorbing another neutron.
inflation	A phase of astonishing acceleration of the expansion of the Universe thought to have occurred 10^{-35}s after the Big Bang.
infrared waves	Electromagnetic waves with wavelengths from 10^{-3}m to 7×10^{-7}m.
instantaneous speed	The speed at the moment it is measured – speed over an infinitesimal interval of time.
intensity (waves)	The radiant power passing through a surface per unit area – unit Wm^{-2}.
interference	Superposition of two progressive waves from coherent sources to produce a resultant wave with a displacement equal to the sum of the individual displacements from the two waves.

interference pattern	A pattern of constructive and destructive interference formed as waves overlap.
internal energy	The sum of the randomly distributed kinetic and potential energies of the atoms, ions, or molecules within the substance.
internal resistance	The resistance of a source of emf (eg a cell) due to its construction which causes a loss in energy/voltage as the charge passes through the source, symbol 'r', SI unit ohm, Ω.
ion	An atom that has either lost or gained electrons and so has a net charge.
ionic solution	An ionic compound dissolved in a liquid to form a electrolyte.
ionising radiation	Any form of radiation that can ionise atoms by removing an electron to leave a positive ion.
isotopes	Nuclei of the same element that have the same atomic number but different nucleon numbers.
I-V characteristic	A description of the relationship between the electric current in a component and the potential difference across it.
kelvin	The SI base unit of the absolute scale of temperature.
kilowatt-hour	A derived unit of energy most often associated with paying for electrical energy, symbol kWh.
kinetic energy	The energy associated with an object as a result of its motion.
lepton	A fundamental particle or antiparticle that is not affected by the strong or nuclear force – for example an electron.
light dependent resistor	An electrical component with a resistance that decreases as the light intensity incident on it increases.
light emitting diode	A type of diode that emits light when it conducts electricity.
light year	The distance travelled by light in a vacuum in a time of one year. (9.46×10^{15}m).
limit of proportionality	The value of stress or force beyond which stress is no longer directly proportional to strain.
linear momentum	The product of the mass and velocity of a particle, measured in $kgms^{-1}$ or Ns.
longitudinal wave	A wave in which the medium is displaced in the same line as the direction of energy transfer – oscillations of the medium particles are parallel to the direction of the wave travel.
lost volts	The potential difference across the internal resistor of a source of emf.
luminosity	The total radiant power output of a star – symbol L, unit W.
magnetic field lines	Lines of force drawn to represent a magnetic field pattern.
magnetic field patterns	Visual representations used in interpreting the direction and strength of magnetic fields.
magnetic flux	The product of the component of the magnetic flux density perpendicular to a given area and that cross-sectional area. $Ø = BA\cos\theta$.
magnetic flux density	The strength of a magnetic field – defined by the equation F/IL, where F is the force on a current carrying conductor placed at right angles to a magnetic field, I is the current in

	the conductor and L is the length of the conductor in the magnetic field – symbol B, unit tesla (T).
magnetic flux linkage	The product of the number of turns in a coil N and the magnetic flux Ø.
main sequence	The main period on an H-R diagram in a star's life, during which it is stable.
mass	Amount of matter, a base quantity measured in kilograms kg.
mass defect	The difference between the mass of a nucleus and the mass of its completely separated constituent nucleons.
Maxwell-Boltzmann distribution	The distribution of the speeds of particles in a gas.
mean drift velocity	The average velocity of electrons as they move through a wire, symbol v, unit ms^{-1}.
mean square speed	The mean of the squared velocities (of all the particles in a gas).
medical tracer	A radiopharmaceutical, that is, a compound labelled with a radioisotope that can be traced inside the body using a gamma camera.
meson	Any hadron comprising a combination of a quark and an antiquark.
microwave background radiation	The microwave signal of uniform intensity detected from all directions in the sky, which fits the profile for a black body at a temperature of 2.7K.
microwaves	Long wavelength electromagnetic waves, with wavelengths from 10^{-1}m to 10^{-3}m.
moderator	A substance used to slow down the fast neutrons produced in fission reactions so that they can propagate the fission reaction.
molar gas constant	The constant in the equation of state of an ideal gas – symbol R, $8.31JK^{-1}mol^{-1}$.
molar mass	The mass of one mole of a substance.
mole	The amount of substance that contains as many elementary entities as there are atoms in 0.012kg of Carbon-12.
moment	The product of force and perpendicular distance from a pivot.
monochromatic light	Light of a single frequency.
natural frequency	The frequency of a free oscillation.
nebula	A cloud of dust and gas (mainly hydrogen), often many hundreds of times larger than our Solar System.
neutrino	A lepton that carries no charge and may have a tiny mass, less than a millionth the mass of an electron.
neutron	An electrically neutral particle, a hadron, found in the nucleus of atoms.
neutron star	The remnant core of a massive star after the star has gone supernova and the core has collapsed under gravity to an extremely high density. Almost entirely made of neutrons.
Newton's First Law	A body will remain at rest or continue to move with constant velocity unless acted upon by a resultant force.

Newton's Second Law	The rate of change of momentum of an object is directly proportional to the resultant force and takes place in the direction of the force.
Newton's Third Law	When two objects interact, each exerts an equal but opposite force on the other during the interaction.
Newton's Law of Gravitation	The force between two point masses is directly proportional to the product of their masses and inversely proportional to the square of the separation between them.
node	For a stationary wave, a point where the amplitude is always zero.
normal	An imaginary line perpendicular to a surface such as the boundary between one medium and another.
normal contact force	The force exerted by a surface on an object, which acts perpendicularly to the surface.
nucleon	A particle in the nucleus of an atom.
nucleon number	The total number of protons and neutrons in a nucleus; symbol A.
nucleus	The small, positively charged region at the centre of an atom where most of the mass of the atom is concentrated.
number density	The number of free electrons per cubic metre of a material, symbol n, unit m^{-3}.
ohm	The derived SI unit of resistance, symbol Ω - defined as the resistance of a component that has a potential difference of 1V per unit Ampere.
Ohm's Law	The potential difference across a conductor is directly proportional to the current in the component as long as its temperature remains constant.
optical fibre	A fibre made of glass designed with a varying refractive index in order to totally internally reflect pulses of visible or infrared light travelling through it.
oscillating motion	Repetitive motion of an object around its equilibrium position.
oscilloscope	A instrument that displays an electrical signal as a voltage against time trace on a screen.
out of phase	Particles that are neither in phase, nor in antiphase, are out of phase.
pair production	The replacement of a single photon with a particle and a corresponding antiparticle of the same total energy.
parallax angle	The angle of the apparent shift in the position of a relatively close star against the backdrop of much more distant stars as the Earth makes a quarter of an orbit around the Sun.
parallel (vectors)	In the same line and direction.
parallel circuit	A type of branching electrical circuit in which there is more than one path for the current – components in parallel have the same potential difference across them.
parent nucleus	A nucleus before the occurrence of radioactive decay.
parsec	The distance at which a radius of one AU subtends an angle of one arcsecond.
path difference	The difference in the distance travelled by two waves from their source to a specific point.

peak	The maximum positive amplitude of a transverse wave.
perihelion	The closest point to the Sun in an orbit.
perfectly elastic collision	A collision in which no kinetic energy is transferred.
period (oscillations)	The time taken to complete one oscillation.
period (waves)	The time taken for one complete wavelength to pass a given point.
phase	A phase of matter is its state (solid, liquid or gas).
phase difference	The difference between the displacement of particles
photoelectric effect	The emission of photoelectrons from a metal surface when electromagnetic radiation above a threshold frequency is incident on the metal.
photoelectric effect equation	Einstein's equation relating the energy of a photon, the work function of a metal, and the maximum kinetic energy of any emitted photoelectrons: $hf = Ø + KE_{max}$
photoelectrons	Electrons emitted from the surface of a metal by the photoelectric effect
photomultiplier tube	An apparatus that converts a photon of visible light into an electrical pulse, for example as part of a gamma camera.
photon	A quantum of electromagnetic energy – photon energy is given by $E = hf$, where h is the Planck constant and f the frequency of the electromagnetic radiation.
piezoelectric effect	The production of an electromotive force by some crystals, such as quartz, when they are compressed, stretched, twisted or distorted.
pivot	A point about which a body can rotate.
Planck constant	Symbol h, an important constant in quantum mechanics, 6.63×10^{-34} Js.
planet	An object in orbit around a star with a mass large enough for its own gravity to give it a round shape, that undergoes no fusion reactions, and that has cleared its orbit of most other objects.
planetary nebula	The outer layers of a red giant that have drifted off into space, leaving the hot core behind at the centre as a white dwarf.
planetary satellite	A body in orbit around a planet – it may be natural (a moon) or artificial.
plane polarised	Description of a transverse wave in which the oscillations are limited to only one plane.
plastic deformation	An irreversible change in the shape of an object due to a compressive or tensile force – removal of the stress or force produces permanent deformation.
plumb-line	A string with a weight used to provide a vertical reference line.
point mass	A mass with negligible volume.
polarisation	The phenomenon in which oscillations of a transverse wave are limited to only one plane.
polarity	The type of charge or the orientation of a cell relative to a component.

polymeric	Description of a material comprising of long-chain molecules, such as rubber, which may show large strains.
positive (charge)	One type of electric charge.
positron	The antiparticle of the electron.
potential difference (pd)	Defined as the energy transferred from electrical energy to other forms per unit charge.
potential divider	An electrical circuit designed to divide the potential difference across two or more components (often two resistors) in order to produce a specific output.
potentiometer	An electrical component with three terminals and some form of sliding contact that can be adjusted to vary the potential difference between two of the terminals.
power	The rate of work done, measured in Watts, W.
prefix	A word or letter placed before another one, for example, 5.0km is 5.0×10^3m.
pressure	The force exerted per unit cross-sectional area, measured in Pascals, Pa.
principle of conservation of energy	The total energy of a closed system remains constant – energy cannot be created nor can it be destroyed.
principle of conservation of momentum	Total momentum of a system remains the same before and after a collision.
principle of moments	For a body in rotational equilibrium, the sum of the anticlockwise moments about a point is equal to the sum of the clockwise moments about the same point.
principle of superposition of waves	When two similar types of wave meet at a point the resultant displacement at that point is equal to the sum of the displacements of the individual waves.
progressive wave	A wave in which the peaks and troughs, or compressions and rarefactions, move through the medium as energy id transferred.
projectile	An object that is thrown or propelled on the surface of the Earth.
proton	A positively charged particle, a hadron, found in the nucleus of atoms.
proton number	The atomic number, that is, the number of protons in a nucleus – symbol Z.
protostar	A very hot, very dense sphere of condensing dust and gas that is on the way to becoming a star.
P-waves	Primary waves – longitudinal waves that travel through the Earth from an earthquake.
quark	An elementary particle that can exist in six forms (plus their antiparticles) and joins with other quarks to make up hadrons.
quantisation	The availability of some quantities , such as energy or charge, only in certain discrete values.
quantity	A property of an object, substance, or phenomenon that can be measured.

quantum mechanics	The branch of Physics dealing with phenomena on the very small scale, often less than the size of an atom.
radial field	A symmetrical field that diminishes with $distance^2$ from its centre.
radian	The angle subtended by a circular arc with a length equal to the radius of the circle.
radiation pressure	Pressure from the photons in the core of a star which acts outwards to counteract the pressure from the gravitational force pulling the matter in the star inwards.
radioactivity	The process by which unstable nuclei split, or decay, emitting ionising radiation.
radiopharmaceutical	A radioisotope chemically combined with elements that will target particular tissues in order to ensure that the radioisotope reaches the correct organ or tumour for diagnosis and treatment.
radio waves	Long wavelength electromagnetic waves, with wavelengths greater than 10^{-1}m.
rarefaction	A moving region in which the medium is less dense or has less pressure than the surrounding medium.
ray	A line representing the direction of energy transfer of a wave, perpendicular to the wavefronts.
red giant	An expanding star at the end of its life, with an inert core in which fusion no longer takes place, but in which fusion of lighter elements continues in the shell around the core.
red shift	The lengthening of observed wavelength that occurs when a wave source is moving away from the observer.
red supergiant	A huge star in the last stages of its life before it 'explodes' in a supernova.
reflection	The change in direction of a wave at a boundary between two different media, so that the wave remains in the original medium.
refraction	The change in direction of a wave as it changes speed when it passes from one medium to another.
refractive index	The refractive index of a material n = c/v, where c is the speed of light through a vacuum and v is the speed of light through the material.
relative charge	A simplified measurement of the electric charge of a particle or object, measured as multiples of the elementary charge.
resistance	A property of a component calculated by dividing the potential difference across it by the current in it, symbol R, unit ohm, Ω.
resistivity	A property of a material, measured in Ωm, defined as the product of the resistance of a component made of the material and its cross-sectional area divided by its length.
resistor	An electrical component that obeys Ohm's Law , transferring electrical energy to thermal energy.

resolving a vector	Splitting a vector into two component vectors perpendicular to each other.
resonance	The increase in amplitude of a forced oscillation when the driving frequency matches the natural frequency of the oscillating system.
rest mass	The mass of an object, such as a particle, when it is stationary.
restoring force	A force that tries to return a system to its equilibrium position.
resultant vector	A single vector that has the same effect as two or more vectors added together.
root mean square speed	The square root of the mean square speed (of all the particles in a gas).
satellite	A body orbiting around a planet.
scalar quantity	A quantity with magnitude (size) but no direction.
scintillator	Part of a gamma camera, often made of sodium iodide, which produces thousands of photons of visible light when struck by a single gamma photon.
semiconductor	A material with a lower number density than a typical conductor, for example silicon.
series	An arrangement of electrical components connected end-to-end that means that the current is the same in each component.
simple harmonic motion	Oscillating motion for which the acceleration of the object is directly proportional to its displacement and is directed towards some fixed point – characterised by the equation $a = \omega^2 x$.
solar system	A planetary system consisting of a star and at least one planet in orbit around it.
specific heat capacity	The energy required per unit mass to change the temperature by 1K; unit $Jkg^{-1}K^{-1}$.
specific latent heat	The energy required to change the phase per unit mass while at constant temperature – symbol L.
specific latent heat of fusion	The energy required to change unit mass of a substance from solid to liquid while at constant temperature – symbol L_f.
specific latent heat of vaporisation	The energy required to change unit mass of a substance from liquid to gas while at constant temperature – symbol L_v.
spectral line	A line in an emission line spectrum or absorption line spectrum at a specific wavelength.
spectroscopy	A technique in Physics in which spectral lines are identified and measured in order to identify the elements present within stars.
standard model	The current theory of particle physics that deals with elementary particles (quarks, electrons etc.) and their interactions.
stationary wave	A wave that remains in a constant position with no net transfer of energy and is characterised by its nodes or antinodes – also called a standing wave.

Stefan constant	The constant σ in Stefan's Law, $L = 4\pi r^2 \sigma T^4$, relating the luminosity L of a star to its surface area $4\pi r^2$ and its absolute surface temperature T: $\sigma = 5.67 \times 10^{-8}\ Wm^{-2}K^{-4}$.
stellar parallax	A technique used to determine the distance to stars that are relatively close to the Earth (less than 100pc) by comparing their apparent positions against distant stars at times 6 months apart.
step-down transformer	A transformer with fewer turns on the secondary than on the primary coil, and a lower output voltage than input voltage.
step-up transformer	A transformer with more turns on the secondary than on the primary coil, and a higher output voltage than input voltage.
stiffness	The ability of an object to resist deformation.
stopping distance	The total distance travelled from the time when a driver first sees a reason to stop to the time when the vehicle stops, the sum of the thinking distance and the braking distance.
strong material	A material with a large value for the ultimate tensile strength.
strong nuclear force	One of the four fundamental forces in nature, acting on hadrons and holding nuclei together.
superconductivity	A phenomenon in which the resistivity of a material falls to almost zero when the material is cooled below a certain temperature.
supernova	The implosion of a red supergiant at the end of its life, which leads to subsequent ejection of stellar matter into space, leaving an inert remnant core.
superposition (waves)	Overlap of two waves at a point in space.
S-waves	Secondary waves: transverse waves that travel through the Earth from an earthquake.
target metal	A metal with a high melting point used for the anode in an X-ray tube, for example tungsten.
tensile deformation	A change in the shape of an object due to tensile forces.
tensile force	Equal and opposite forces acting on a material to stretch it.
tensile strain	The extension per unit length, a dimensionless quantity.
tensile stress	The force per unit cross-sectional area, measured in Pa.
tension	The pulling force exerted by a string, cable or chain on an object.
terminal pd	The potential difference across an electrical power source – when there is no current this is equal to the emf of the source, but if there is a current in the source this is equal to the emf minus the lost volts.
terminal velocity	The constant speed reached by an object when the drag force (and upthrust) is equal and opposite to the weight of the object.
thermal equilibrium	A state in which there is no net flow of thermal energy between the objects involved, that is, objects in thermal equilibrium must be at the same temperature.

thermal neutron	A neutron in a fission reactor with mean kinetic energy similar to the thermal energy of particles within the reactor core – also known as a slow neutron.
thermionic emission	The emission of electrons from the surface of a heated piece of metal.
thermistor	An electrical component that has a resistance that decreases as the temperature increases (a negative temperature coefficient).
thinking distance	The distance travelled by a vehicle from when the driver first perceives a need to stop to when the brakes are applied.
threshold frequency	The minimum frequency of the electromagnetic radiation that will cause the emission of an electron from the surface of a particular metal – symbol f_0, measured in Hz.
threshold voltage	The minimum potential difference at which a diode begins to conduct.
time constant	The product of capacitance and resistance, CR, for a capacitor-resistor circuit – equal to the time taken for the potential difference (or current or charge) to decrease to e^{-1} (about 37%) of its initial value when the capacitor discharges through a resistor – symbol τ.
timebase	The time interval represented by one horizontal square on an oscilloscope screen.
torque (of a couple)	The product of one of the forces of a couple and the perpendicular distance between the forces.
total internal reflection	The reflection of all light hitting a boundary between two media back into the original medium when the light is travelling through the medium with the higher refractive index and the incidence angle at the boundary is greater than the critical angle.
transverse wave	A wave in which the medium is displaced perpendicular to the direction of energy transfer – the oscillations of medium particles are perpendicular to the direction of travel of the wave.
triple point	For a given substance, one specific temperature and pressure at which all three phases of that substance can exist in thermodynamic equilibrium.
trough	The maximum negative amplitude of a transverse wave.
ultimate tensile strength	The maximum stress that a material can withstand before it breaks.
ultraviolet	Electromagnetic waves with wavelengths from 4×10^{-7}m to 10^{-8}m.
ultrasound transducer	A device used both to generate and to receive ultrasound, which changes electrical energy into sound and sound into electrical energy.
uniform gravitational field	A gravitational field in which the field lines are parallel and the value for g remains constant.
Universe	Everything that exists within space and time.
unpolarised	Description of a transverse wave in which the oscillations occur in many places.

upthrust	The upward buoyant force exerted on a body immersed in a fluid.
vector quantity	A quantity with magnitude (size) and direction.
vector triangle	A triangle constructed to scale to determine the resultant of two vectors.
velocity	A vector quantity equal to the rate of change of displacement.
visible light	Electromagnetic waves, with wavelengths from 4×10^{-7}m to 7×10^{-7}m.
volt	The derived SI unit of potential difference and electromotive force, symbol V, defined as the energy transferred per unit charge, whether energy is either transferred to or from the charges – 1V is the pd across a component when 1J of energy is transferred per 1C passing through the component.
voltmeter	A device used to measure potential difference – it must be placed in parallel across components and ideally have an infinite resistance.
wave equation	A equation that relates the frequency f in hertz, the wavelength λ in metres, and the wave speed v in ms^{-1}: $v = f\lambda$.
wave speed	The distance travelled by the wave per unit time.
wavefront	A line of points in phase with each other in a wave, perpendicular to the direction of energy transfer.
wavelength	The minimum distance between two points oscillating in phase, for example the distance from one peak to the next or from one compression to the next.
wave-particle duality	A theory that states that matter has both particle and wave properties and also electromagnetic radiation has wave and particulate (photon) nature.
weak nuclear force	One of the four fundamental forces in nature, responsible for inducing beta-decay within unstable nuclei.
weight	The gravitational force on an object, measured in Newtons, N.
white dwarf	A very dense star formed from the core of a red giant, in which no fusion occurs.
Wien's Displacement Law	The peak wavelength λ_{max} at which the intensity of radiation from a black body is a maximum is inversely proportional to the absolute temperature T of the black body.
work	The product of force and the distance moved in the direction of the force, measured in J.
work function	The minimum energy needed to remove a single electron from the surface of a particular metal; symbol Ø, measured in J.
X-rays	Short wavelength electromagnetic waves, with wavelengths from 10^{-8}m to 10^{-13}m, which can be used in medical imaging.
X-ray tube	A piece of equipment that produces X-ray photons by firing electrons from a heated cathode across a large pd in an evacuated tube – X-ray photons are produced when the electrons are decelerated by hitting the target metal of the anode.

yield point	A point on a stress-strain graph beyond which the deformation is no longer entirely elastic.
Young modulus	The ratio of tensile stress to tensile strain when these quantities are directly proportional to each other, measured in Pa.