Edexcel GCSE

Combined (Physics Content)

1SC0

Student Guide

This is my interpretation of the Edexcel Specification Issue 4 available on the Edexcel website

Please check their website for the most up-to-date specification as you prepare for your exams

v1.1
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Exams

There are six exams at the end of Year 11 for the Edexcel GCSE Combined Science course, two of these are for the Physics content.

Paper 5: Physics 1	▪ Key Concepts of Physics ▪ Motion and Forces ▪ Conservation of Energy ▪ Waves ▪ Light and the Electromagnetic Spectrum ▪ Radioactivity	Multiple choice, short answer questions, calculations and extended open-response questions	1 hour 10 minutes	60 marks
Paper 6: Physics 2	▪ Key Concepts of Physics ▪ Energy – Forces doing Work ▪ Forces and their Effects ▪ Electricity and Circuits ▪ Magnetism and the Motor Effect ▪ Electromagnetic Induction ▪ The Particle Model ▪ Forces and Matter	Multiple choice, short answer questions, calculations and extended open-response questions	1 hour 10 minutes	60 marks

Each paper will have questions that allow you to **demonstrate** knowledge and understanding (~40%), **apply** knowledge and understanding (~40%) and **analyse** information and ideas (~20%).

There are both Foundation and Higher tiers available with grades from 1 (lowest) to 9 (highest) as well as a U for really low marks (unclassified).

Foundation	U	1-1	2-1	2-2	3-2	3-3	4-3	4-4	5-4	5-5			
Higher	U	-	4-4	5-4	5-5	6-5	6-6	7-6	7-7	8-7	8-8	9-8	9-9

Your grade will be calculated from the total marks you score out of 360 from all papers.

This guide will help you prepare for your exams. It contains the knowledge and skills you need to learn during the course and can be used as a checklist when you start your revision.

There are also hundreds of video tutorials you can watch on the website GCSE Physics Online to help you understand the physics in greater detail. Scan the QR code, or click on it on digital downloads, to go to the correct part of the website.

Physics Topics

You need to make sure that you have covered all the material in the following pages as you complete your GCSE Physics.

- Key Concepts of Physics
- Motion and Forces
- Conservation of Energy
- Waves
- Light and the Electromagnetic Spectrum
- Radioactivity

- Key Concepts of Physics
- Energy – Forces doing Work
- Forces and their Effects
- Electricity and Circuits
- Magnetism and the Motor Effect
- Electromagnetic Induction
- The Particle Model
- Forces and Matter

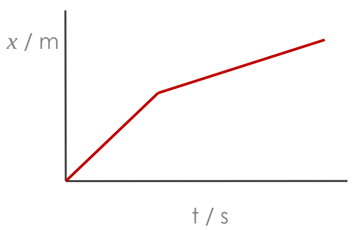
H = Higher tier in bold

Topics Common to Paper 5 and Paper 6

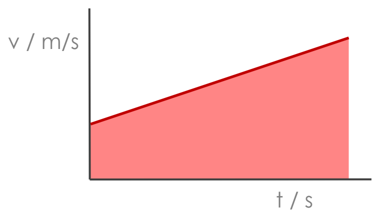
Topic 1 – Key Concepts of Physics		R	A	G
	Recall and use the SI units for physical quantities: ▪ metre (m) ▪ kilogram (kg) ▪ second (s) ▪ ampere (A) ▪ kelvin (K) ▪ mole (mol)			
	Recall and use multiples and sub-multiples of units, including: ▪ giga (G) ▪ mega (M) ▪ kilo (k) ▪ centi (c) ▪ milli (m) ▪ micro (μ) ▪ nano (n)			
	Convert between different units, including hours to seconds.			
	Use significant figures and standard form where appropriate.			

Topics for Paper 5

<table>
<tr><th colspan="2">Topic 2 – Motion and Forces</th><th>R</th><th>A</th><th>G</th></tr>
<tr><td></td><td>Explain that a scalar quantity has magnitude (size) but no specific direction.</td><td></td><td></td><td></td></tr>
<tr><td></td><td>Explain that a vector quantity has both magnitude (size) and a specific direction.</td><td></td><td></td><td></td></tr>
<tr><td></td><td>Explain the difference between vector and scalar quantities.</td><td></td><td></td><td></td></tr>
<tr><td></td><td>Recall vector and scalar quantities, including:
<table><tr><th>Vector</th><th>Scalar</th></tr><tr><td>Displacement
Velocity
Acceleration
Force
Weight
Momentum</td><td>Distance
Speed
Mass
Energy</td></tr></table></td><td></td><td></td><td></td></tr>
<tr><td></td><td>Recall that velocity is speed in a stated direction.</td><td></td><td></td><td></td></tr>
<tr><td></td><td>Recall and use the equations:
(average) speed = distance ÷ time
(metre per second, m/s) (metre, m) (s)

distance travelled = average speed × time
(metre, m) (metre per second, m/s (s)</td><td></td><td></td><td></td></tr>
<tr><td></td><td>Analyse distance/time graphs, including determination of speed from the gradient.

</td><td></td><td></td><td></td></tr>
<tr><td></td><td>Recall and use the equation:
acceleration = change in velocity ÷ time taken
(metre per second squared, m/s²) (m/s) (s)

$a = \frac{(v - u)}{t}$</td><td></td><td></td><td></td></tr>
</table>

	Use the equation: (final velocity)^2 – (initial velocity)^2 = 2 × acceleration × distance (m/s) (m/s) (m/s^2) (m) $v^2 - u^2 = 2 \times a \times x$			
	Analyse velocity/time graphs to: ▪ compare acceleration from gradients qualitatively ▪ calculate the acceleration from the gradient (for uniform acceleration only) ▪ determine the distance travelled using the area between the graph line and the time axis (for uniform acceleration only)  			
	Describe a range of laboratory methods for determining the speeds of objects, such as the use of light gates.			
	Recall some typical speeds encountered in everyday experience for wind and sound, and for walking, running, cycling and other transportation systems.			
	Recall that the acceleration, g, in free fall is 10 m/s^2 and be able to estimate the magnitudes of everyday accelerations.			
	Recall Newton's first law and use it in the following situations: ▪ where the resultant force on a body is zero, i.e. the body is moving at a constant velocity or is at rest ▪ where the resultant force is not zero, i.e. the speed and/or direction of the body changes			
	Recall and use Newton's second law as: force = mass × acceleration (newton, N) (kilogram, kg) (m/s^2) $F = m \times a$			

	Define weight, recall and use the equation: weight = mass × gravitational field strength (N) (kg) (newton per kilogram, N/kg) $W = m \times g$			
	Describe how weight is measured.			
	Describe the relationship between the weight of a body and the gravitational field strength.			
	Core Practical: Investigate the relationship between force, mass and acceleration by varying the masses added to trolleys.			
H	**Explain that an object moving in a circular orbit at constant speed has a changing velocity (qualitative only).**			
H	**Explain that for motion in a circle there must be a resultant force known as a centripetal force that acts towards the centre of the circle.**			
H	**Explain that inertial mass is a measure of how difficult it is to change the velocity of an object (including from rest) and know that it is defined as the ratio of force over acceleration.**			
	Recall and apply Newton's third law to equilibrium situations.			
H	**Apply Newton's third law to collision interactions and relate it to the conservation of momentum in collisions.**			
H	**Define momentum, recall and use the equation:** **momentum = mass × velocity** **(kilogram metre per second, kg m/s) (kg) (m/s)** $p = m \times v$			
H	**Describe examples of momentum in collisions.**			
H	**Use Newton's second law as:** **force = change in momentum ÷ time** **(N) (kg m/s) (s)** $F = \frac{(mv - mu)}{t}$			
	Explain methods of measuring human reaction times and recall typical results.			

	Recall that the stopping distance of a vehicle is made up of the sum of the thinking distance and the braking distance.			
	Explain that the stopping distance of a vehicle is affected by a range of factors including: ▪ the mass of the vehicle ▪ the speed of the vehicle ▪ the driver's reaction time ▪ the state of the vehicle's brakes ▪ the state of the road ▪ the amount of friction between the tyre and the road surface			
	Describe the factors affecting a driver's reaction time including drugs and distractions.			
	Explain the dangers caused by large decelerations.			
H	**Estimate the forces involved in typical situations on a public road involving large decelerations.**			

	Topic 3 – Conservation of Energy	R	A	G
	Recall and use the equation to calculate the change in gravitational PE when an object is raised above the ground: change in gravitational potential energy (joule, J) = mass (kg) × gravitational field strength (N/kg) × change in vertical height (metre, m) $\Delta GPE = m \times g \times \Delta h$			
	Recall and use the equation to calculate the amount of energy associated with a moving object: kinetic energy (J) = ½ × mass (kg) × speed^2 (m/s) $KE = \frac{1}{2} \times m \times v^2$			
	Draw and interpret diagrams to represent energy transfers.			
	Explain what is meant by conservation of energy.			
	Analyse the changes involved in the way energy is stored when a system changes, including: ▪ an object projected upwards or up a slope ▪ a moving object hitting an obstacle ▪ an object being accelerated by a constant force ▪ a vehicle slowing down ▪ bringing water to a boil in an electric kettle			
	Explain that where there are energy transfers in a closed system there is no net change to the total energy in that system.			
	Explain that mechanical processes become wasteful when they cause a rise in temperature so dissipating energy in heating the surroundings.			
	Explain, using examples, how in all system changes energy is dissipated so that it is stored in less useful ways.			
	Explain ways of reducing unwanted energy transfer including through lubrication and thermal insulation.			
	Describe the effects of the thickness and thermal conductivity of the walls of a building on its rate of cooling qualitatively.			

	Recall and use the equation: $$\textit{efficiency} = \frac{\textit{(useful energy transferred by the device)}}{\textit{(total energy supplied to the device)}}$$			
H	**Explain how efficiency can be increased.**			
	Describe the main energy sources available for use on Earth, including: ▪ fossil fuels ▪ nuclear fuel ▪ bio-fuel ▪ wind ▪ hydroelectricity ▪ the tides ▪ the Sun			
	Compare the ways in which both renewable and non-renewable sources are used.			
	Explain patterns and trends in the use of energy resources.			

Topic 4 - Waves		R	A	G
	Recall that waves transfer energy and information without transferring matter.			
	Describe evidence that with water and sound waves it is the wave and not the water or air itself that travels.			
	Define and use the terms frequency and wavelength as applied to waves.			
	Use the terms amplitude, period, wave velocity and wavefront as applied to waves.			
	Describe the difference between longitudinal and transverse waves by referring to sound, electromagnetic, seismic and water waves.			
	Recall and use both the equations below for all waves: wave speed (metre/second, m/s) = frequency (hertz, Hz) × wavelength (metre, m) $v = f \times \lambda$ wave speed (m/s) = distance (m) ÷ time (s) $v = \frac{x}{t}$			
	Describe how to measure the velocity of sound in air and ripples on water surfaces.			
	Explain how waves will be refracted at a boundary in terms of the change of direction.			
H	**Explain how waves will be refracted at a boundary in terms of the change of speed.**			
H	**Recall that different substances may absorb, transmit, refract or reflect waves in ways that vary with wavelength.**			
	Core Practical: Investigate the suitability of equipment to measure the speed, frequency and wavelength of a wave in a solid and a fluid.			

	Topic 5 – Light and the Electromagnetic Spectrum	R	A	G
	Recall that all electromagnetic waves are transverse and that they travel at the same speed in a vacuum.			
	Explain, with examples, that all electromagnetic waves transfer energy from source to observer.			
	Core Practical: Investigate refraction in rectangular glass blocks in terms of the interaction of electromagnetic waves with matter.			
	Recall the main groupings of the continuous electromagnetic spectrum including (in order): ▪ radio waves ▪ microwaves ▪ infrared ▪ visible (including the colours of the visible spectrum) ▪ ultraviolet ▪ x-rays ▪ gamma rays			
	Describe the electromagnetic spectrum as continuous from radio waves to gamma rays and that the radiations within it can be grouped in order of decreasing wavelength and increasing frequency.			
	Recall that our eyes can only detect a limited range of frequencies of electromagnetic radiation.			
H	**Recall that different substances may absorb, transmit, refract or reflect electromagnetic waves in ways that vary with wavelength.**			
H	**Explain the effects of differences in the velocities of electromagnetic waves in different substances.**			
	Recall that the potential danger associated with an electromagnetic wave increases with increasing frequency.			

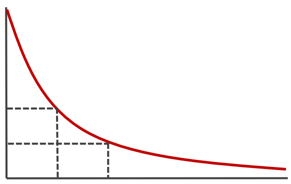
	Describe the harmful effects on people of excessive exposure to electromagnetic radiation, including: ▪ microwaves: internal heating of body cells ▪ infrared: skin burns ▪ ultraviolet: damage to surface cells and eyes, leading to skin cancer and eye conditions ▪ x-rays and gamma rays: mutation or damage to cells in the body			
	Describe some uses of electromagnetic radiation: ▪ radio waves: including broadcasting, communications and satellite transmissions ▪ microwaves: including cooking, communications and satellite transmissions ▪ infrared: including cooking, thermal imaging, short range communications, optical fibres, television remote controls and security systems ▪ visible light: including vision, photography and illumination ▪ ultraviolet: including security marking, fluorescent lamps, detecting forged bank notes and disinfecting water ▪ x-rays: including observing the internal structure of objects, airport security scanners and medical x-rays ▪ gamma rays: including sterilising food and medical equipment, and the detection of cancer and its treatment			
H	**Recall that radio waves can be produced by, or can themselves induce, oscillations in electrical circuits.**			
	Recall that changes in atoms and nuclei can: ▪ generate radiation over a wide frequency range ▪ be caused by absorption of a range of radiations			

Topic 6 - Radioactivity

	Topic 6 - Radioactivity	R	A	G
	Describe an atom as a positively charged nucleus, consisting of protons and neutrons, surrounded by negatively charged electrons, with the nuclear radius much smaller than that of the atom and with almost all of the mass in the nucleus.			
	Recall the typical size (order of magnitude) of atoms and small molecules.			
	Describe the structure of nuclei of isotopes using the terms atomic (proton) number and mass (nucleon) number and using symbols in the format using symbols in the format: mass number 13 atomic number 6 $^{13}_{6}C$			
	Recall that the nucleus of each element has a characteristic positive charge, but that isotopes of an element differ in mass by having different numbers of neutrons.			
	Recall the relative masses and relative electric charges of protons, neutrons, electrons and positrons.			
	Recall that in an atom the number of protons equals the number of electrons and is therefore neutral.			
	Recall that in each atom its electrons orbit the nucleus at different set distances from the nucleus.			
	Explain that electrons change orbit when there is absorption or emission of electromagnetic radiation.			
	Explain how atoms may form positive ions by losing outer electrons.			

Particle	Mass	Charge
proton	1	+1
electron	1/2000	-1
neutron	1	0

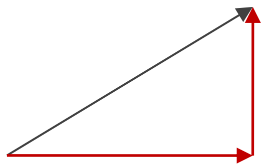
	Recall that: ▪ alpha ▪ β– (beta minus) ▪ β+ (positron) ▪ gamma rays ▪ neutron radiation are emitted from unstable nuclei in a random process.			
	Recall that alpha, β– (beta minus), β+ (positron) and gamma rays are ionising radiations.			
	Explain what is meant by background radiation.			
	Describe the origins of background radiation from Earth and space.			
	Describe methods for measuring and detecting radioactivity - limited to photographic film and a Geiger–Müller tube.			
	Recall that an alpha particle is equivalent to a helium nucleus, a beta particle is an electron emitted from the nucleus and a gamma ray is electromagnetic radiation.			
	Compare alpha, beta and gamma radiations in terms of their abilities to penetrate and ionise.			
	Describe how and why the atomic model has changed over time including reference to the plum pudding model and Rutherford alpha particle scattering leading to the Bohr model.			
	Describe the process of β– decay (a neutron becomes a proton plus an electron).			
	Describe the process of β+ decay (a proton becomes a neutron plus a positron).			
	Explain the effects on the atomic (proton) number and mass (nucleon) number of radioactive decays (α, β, γ and neutron emission).			
	Recall that nuclei that have undergone radioactive decay often undergo nuclear rearrangement with a loss of energy as gamma radiation.			
	Use given data to balance nuclear equations in terms of mass and charge.			
	Describe how the activity of a radioactive source decreases over a period of time.			

	Recall that the unit of activity of a radioactive isotope is the Becquerel, Bq.			
	Explain that the half-life of a radioactive isotope is the time taken for half the undecayed nuclei to decay or the activity of a source to decay by half.			
	Explain that it cannot be predicted when a particular nucleus will decay but half-life enables the activity of a very large number of nuclei to be predicted during the decay process.			
	Use the concept of half-life to carry out simple calculations on the decay of a radioactive isotope, including graphical representations. 			
	Describe the dangers of ionising radiation in terms of tissue damage and possible mutations and relate this to the precautions needed.			
	Explain the precautions taken to ensure the safety of people exposed to radiation, including limiting the dose for patients and the risks to medical personnel.			
	Describe the differences between contamination and irradiation effects and compare the hazards associated with these two.			

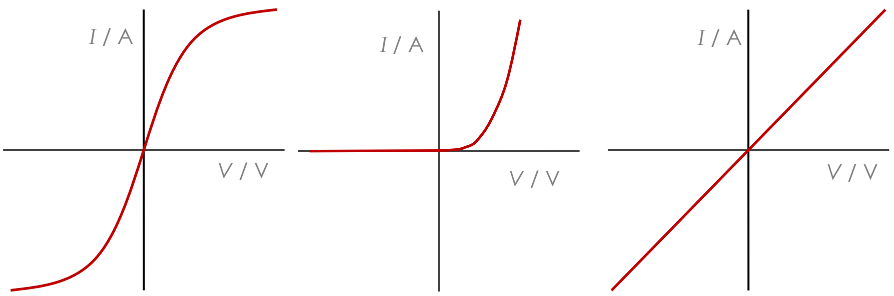
Topics for Paper 6

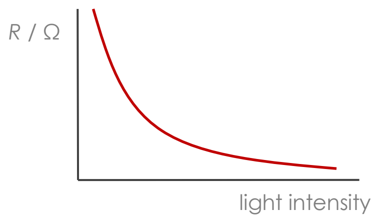
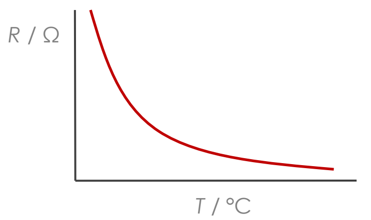
	Topic 8 – Energy – Forces doing Work	R	A	G
	Describe the changes involved in the way energy is stored when systems change.			
	Draw and interpret diagrams to represent energy transfers.			
	Explain that where there are energy transfers in a closed system there is no net change to the total energy in that system.			
	Identify the different ways that the energy of a system can be changed ▪ through work done by forces ▪ in electrical equipment ▪ in heating			
	Describe how to measure the work done by a force and understand that energy transferred (joule, J) is equal to work done (joule, J).			
	Recall and use the equation: work done = force × distance moved in the direction of the force (joule, J) (N) (metre, m) $E = F \times d$			
	Describe and calculate the changes in energy involved when a system is changed by work done by a force.			
	Recall and use the equation to calculate the change in gravitational PE when an object is raised above the ground: change in gravitational potential energy = mass × gravitational field strength × change in vertical height (J) (kg) (N/kg) (m) $\Delta GPE = m \times g \times \Delta h$			
	Recall and use the equation to calculate the amount of energy associated with a moving object: kinetic energy = ½ × mass × speed^2 (J) (kg) (m/s) $KE = \frac{1}{2} \times m \times v^2$			

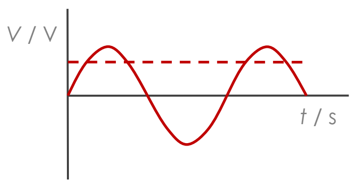
	Explain, using examples, how in all system changes energy is dissipated so that it is stored in less useful ways.			
	Explain that mechanical processes become wasteful when they cause a rise in temperature so dissipating energy in heating the surroundings.			
	Define power as the rate at which energy is transferred and use examples to explain this definition.			
	Recall and use the equation: power = work done ÷ time taken (watt, W) (joule, J) (second, s) $P = \frac{E}{t}$			
	Recall that one watt is equal to one joule per second, J/s.			
	Recall and use the equation: $efficiency = \frac{(useful\ energy\ transferred\ by\ the\ device)}{(total\ energy\ supplied\ to\ the\ device)}$			

	Topic 9 – Forces and their Effects	R	A	G
	Describe, with examples, how objects can interact ▪ at a distance without contact, linking these to the gravitational, electrostatic and magnetic fields involved ▪ by contact, including normal contact force and friction ▪ producing pairs of forces which can be represented as vectors			
	Explain the difference between vector and scalar quantities using examples.			
H	**Use vector diagrams to illustrate resolution of forces, a net force, and equilibrium situations (scale drawings only).** 			
H	**Draw and use free body force diagrams.**			
H	**Explain examples of the forces acting on an isolated solid object or a system where several forces lead to a resultant force on an object and the special case of balanced forces when the resultant force is zero.**			
	Explain ways of reducing unwanted energy transfer through lubrication.			

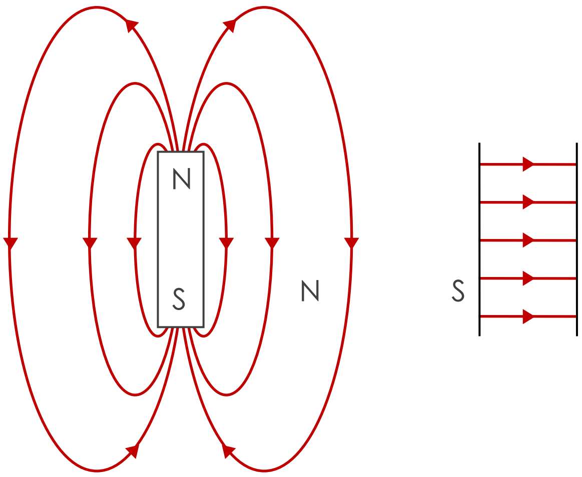
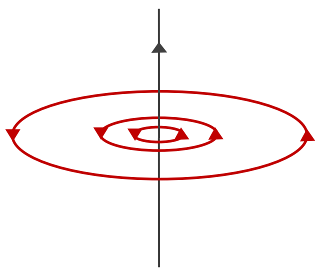
Topic 10 – Electricity and Circuits		R	A	G
	Describe the structure of the atom, limited to the position, mass and charge of protons, neutrons and electrons.			
	Draw and use electric circuit diagrams representing them with the conventions of positive and negative terminals, and the symbols that represent: ▪ cells ▪ batteries ▪ switches ▪ voltmeters ▪ ammeters ▪ resistors ▪ variable resistors ▪ lamps ▪ motors ▪ diodes ▪ thermistors ▪ LDRs ▪ LEDs			
	Describe the differences between series and parallel circuits.			
	Recall that a voltmeter is connected in parallel with a component to measure the potential difference (voltage), in volt, across it.			
	Explain that potential difference (voltage) is the energy transferred per unit charge passed and hence that the volt is a joule per coulomb.			
	Recall and use the equation: energy transferred (joule, J) = charge moved (coulomb, C) × potential difference (volt, V) $E = Q \times V$			
	Recall that an ammeter is connected in series with a component to measure the current, in amp, in the component.			
	Explain an electric current as the rate of flow of charge and that the current in metals is a flow of electrons.			
	Recall and use the equation: charge (coulomb, C) = current (ampere, A) × time (s) $Q = I \times t$			

	Describe that when a closed circuit includes a source of potential difference there will be a current in the circuit.			
	Recall that current is conserved at a junction in a circuit.			
	Explain how changing the resistance in a circuit changes the current and how this can be achieved using a variable resistor.			
	Recall and use the equation: potential difference (volt, V) = current (ampere, A) × resistance (ohm, Ω) $V = I \times R$			
	Explain why, if two resistors are in series, the net resistance is increased, whereas with two in parallel the net resistance is decreased.			
	Calculate the currents, potential differences and resistances in series circuits.			
	Explain the design and construction of series circuits for testing and measuring.			
	Core Practical: Construct electrical circuits to: ▪ *investigate the relationship between potential difference, current and resistance for a resistor and a filament lamp* ▪ *test series and parallel circuits using resistors and filament lamps*			
	Explain how current varies with potential difference for the following devices and how this relates to resistance ▪ filament lamps ▪ diodes ▪ fixed resistors 			

	Describe how the resistance of a light-dependent resistor (LDR) varies with light intensity.  			
	Describe how the resistance of a thermistor varies with change of temperature (negative temperature coefficient thermistors only).  			
	Explain how the design and use of circuits can be used to explore the variation of resistance in the following devices ▪ filament lamps ▪ diodes ▪ thermistors ▪ LDRs			
	Recall that, when there is an electric current in a resistor, there is an energy transfer which heats the resistor.			
	Explain that electrical energy is dissipated as thermal energy in the surroundings when an electrical current does work against electrical resistance.			
	Explain the energy transfer (as above) as the result of collisions between electrons and the ions in the lattice.			
	Explain ways of reducing unwanted energy transfer through low resistance wires.			
	Describe the advantages and disadvantages of the heating effect of an electric current.			

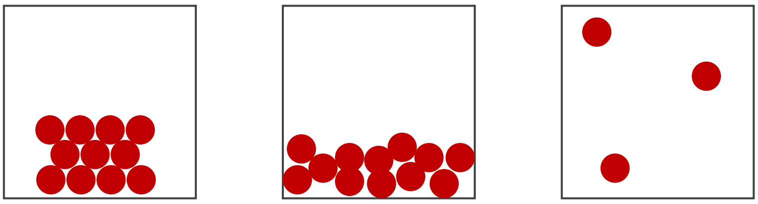
	Use the equation: energy transferred = current × potential difference × time (joule, J) (ampere, A) (volt, V) (second, s) $E = I \times V \times t$			
	Describe power as the energy transferred per second and recall that it is measured in watt.			
	Recall and use the equation: power = energy transferred ÷ time taken (watt, W) (joule, J) (second, s) $P = \frac{E}{t}$			
	Explain how the power transfer in any circuit device is related to the potential difference across it and the current in it.			
	Recall and use the equations: electrical power = current × potential difference (watt, W) (ampere, A) (volt, V) $P = I \times V$ electrical power = current² × resistance (W) (A) (ohm, Ω) $P = I^2 \times R$			
	Describe how, in different domestic devices, energy is transferred from batteries and the a.c. mains to the energy of motors and heating devices.			
	Explain the difference between direct and alternating voltage.  			
	Describe direct current (d.c.) as movement of charge in one direction only and recall that cells and batteries supply direct current (d.c.).			

	Describe that in alternating current (a.c.) the movement of charge changes direction.			
	Recall that in the UK the domestic supply is a.c., at a frequency of 50 Hz and a voltage of about 230 V.			
	Explain the difference in function between the live and the neutral mains input wires.			
	Explain the function of an earth wire and of fuses or circuit breakers in ensuring safety.			
	Explain why switches and fuses should be connected in the live wire of a domestic circuit.			
	Recall the potential differences between the live, neutral and earth mains wires.			
	Explain the dangers of providing any connection between the live wire and earth.			
	Describe, with examples, the relationship between the power ratings for domestic electrical appliances and the changes in stored energy when they are in use.			

	Topic 12 – Magnetism and the Motor Effect	R	A	G
	Recall that unlike magnetic poles attract and like magnetic poles repel.			
	Describe the uses of permanent and temporary magnetic materials including cobalt, steel, iron and nickel.			
	Explain the difference between permanent and induced magnets.			
	Describe the shape and direction of the magnetic field around bar magnets and for a uniform field, and relate the strength of the field to the concentration of lines. 			
	Describe the use of plotting compasses to show the shape and direction of the field of a magnet and the Earth's magnetic field.			
	Explain how the behaviour of a magnetic compass is related to evidence that the core of the Earth must be magnetic.			
	Describe how to show that a current can create a magnetic effect around a long straight conductor, describing the shape of the magnetic field produced and relating the direction of the magnetic field to the direction of the current. 			
	Recall that the strength of the field depends on the size of the current and the distance from the long straight conductor.			

	Explain how inside a solenoid (an example of an electromagnet) the fields from individual coils ▪ add together to form a very strong almost uniform field along the centre of the solenoid ▪ cancel to give a weaker field outside the solenoid			
H	**Recall that a current carrying conductor placed near a magnet experiences a force and that an equal and opposite force acts on the magnet.**			
H	**Explain that magnetic forces are due to interactions between magnetic fields.**			
H	**Recall and use Fleming's left-hand rule to represent the relative directions of the force, the current and the magnetic field for cases where they are mutually perpendicular.**			
H	**Use the equation:** **force on a conductor at right angles to a magnetic field carrying a current (newton, N) = magnetic flux density (tesla, T) × current (A) × length (m)** $F = B \times I \times l$ **Magnetic flux density can be measured in tesla, T, or newton per ampere metre, N/A m**			

Topic 13 – Electromagnetic Induction		R	A	G
H	**Recall the factors that affect the size and direction of an induced potential difference, and describe how the magnetic field produced opposes the original change.**			
H	**Explain how an alternating current in one circuit can induce a current in another circuit in a transformer.**			
H	**Recall that a transformer can change the size of an alternating voltage.**			
	Explain why, in the national grid, electrical energy is transferred at high voltages from power stations, and then transferred at lower voltages in each locality for domestic uses as it improves the efficiency by reducing heat loss in transmission lines.			
	Explain where and why step-up and step-down transformers are used in the transmission of electricity in the national grid.			
	Use the power equation (for transformers with100% efficiency): potential difference across primary coil × current in primary coil = potential difference across secondary coil × current in secondary coil $V_p \times I_p = V_s \times I_s$			

	Topic 14 – The Particle Model	R	A	G
	Use a simple kinetic theory model to explain the different states of matter (solids, liquids and gases) in terms of the movement and arrangement of particles. 			
	Recall and use the equation: density (kilogram per cubic metre, kg/m³) = mass (kg) ÷ volume (cubic metre, m³) $\rho = \frac{m}{V}$			
	Core Practical: Investigate the densities of solid and liquids.			
	Explain the differences in density between the different states of matter in terms of the arrangements of the atoms or molecules.			
	Describe that when substances melt, freeze, evaporate, boil, condense or sublimate mass is conserved and that these physical changes differ from some chemical changes because the material recovers its original properties if the change is reversed.			
	Explain how heating a system will change the energy stored within the system and raise its temperature or produce changes of state.			
	Define the terms specific heat capacity and specific latent heat and explain the differences between them.			
	Use the equation: change in thermal energy (joule, J) = mass (kg) × specific heat capacity (joule per kilogram degree Celsius, J/kg °C) × change in temperature (°C) $\Delta Q = m \times c \times \Delta\theta$			

	Use the equation: thermal energy for a change of state = mass × specific latent heat (joule, J) (kg) (joule per kilogram, J/kg) $Q = m \times L$			
	Explain ways of reducing unwanted energy transfer through thermal insulation.			
	Core Practical: Investigate the properties of water by determining the specific heat capacity of water and obtaining a temperature-time graph for melting ice.			
	Explain the pressure of a gas in terms of the motion of its particles.			
	Explain the effect of changing the temperature of a gas on the velocity of its particles and hence on the pressure produced by a fixed mass of gas at constant volume (qualitative only).			
	Describe the term absolute zero, −273 °C, in terms of the lack of movement of particles.			
	Convert between the kelvin and Celsius scales.			

	Topic 15 – Forces and Matter	R	A	G
	Explain, using springs and other elastic objects, that stretching, bending or compressing an object requires more than one force.			
	Describe the difference between elastic and inelastic distortion.			
	Recall and use the equation for linear elastic distortion including calculating the spring constant: force exerted on a spring (newton, N) = spring constant (newton per metre, N/m) × extension (metre, m) $F = k \times x$			
	Use the equation to calculate the work done in stretching a spring: energy transferred in stretching (joules, J) = ½ × spring constant (N/m) × extension² (m) $E = \frac{1}{2} \times k \times x^2$			
	Describe the difference between linear and non-linear relationships between force and extension.			
	Core Practical: Investigate the extension and work done when applying forces to a spring.			

Working Scientifically

Alongside the Physics content that you learn during your GCSE course, there are also scientific skills that you must be able to apply to your own practical work, when analysing other people's results and to questions you may be asked.

Area	Development of Scientific Thinking
Scientific Theories	Understand how scientific methods and theories develop over time.
Using Models	Use a variety of models, such as representational, spatial, descriptive, computational and mathematical, to solve problems, make predictions and to develop scientific explanations and an understanding of familiar and unfamiliar facts.
Power and Limitations of Science	Appreciate the power and limitations of science, and consider any ethical issues that may arise.
Scientific Applications	Explain everyday and technological applications of science; evaluate associated personal, social, economic and environmental implications; and make decisions based on the evaluation of evidence and arguments.
Risks	Evaluate risks both in practical science and the wider societal context, including perception of risk in relation to data and consequences.
Peer Review	Recognise the importance of peer review of results and of communicating results to a range of audiences.
Area	**Experimental Skills**
Hypotheses	Use scientific theories and explanations to develop hypotheses.
Experiments	Plan experiments or devise procedures to make observations, produce or characterise a substance, test hypotheses, check data or explore phenomena. Apply a knowledge of a range of techniques, instruments, apparatus and materials to select those appropriate to the experiment. Carry out experiments appropriately, having due regard to the correct manipulation of apparatus, the accuracy of measurements and health and safety considerations.
Sampling	Recognise when to apply a knowledge of sampling techniques to ensure any samples collected are representative.
Measurements	Make and record observations and measurements using a range of apparatus and methods.
Evaluation	Evaluate methods and suggest possible improvements and further investigations.

Area	Analysis and Evaluation
Presenting Observations	Presenting observations and other data using appropriate methods.
Translating Data	Translating data from one form to another.
Mathematical Analysis	Carrying out and representing mathematical and statistical analysis.
Uncertainty	Representing distributions of results and making estimations of uncertainty.
Interpreting Data	Interpreting observations and other data (presented in verbal, diagrammatic, graphical, symbolic or numerical form), including identifying patterns and trends, making inferences and drawing conclusions.
Explanations	Presenting reasoned explanations, including relating data to hypotheses.
Evaluating Data	Being objective, evaluating data in terms of accuracy, precision, repeatability and reproducibility and identifying potential sources of random and systematic error.
Communication	Communicating the scientific rationale for investigations, methods used, findings and reasoned conclusions through paper-based and electronic reports and presentations using verbal, diagrammatic, graphical, numerical and symbolic forms.
Area	**Scientific Vocabulary**
Vocabulary	Use scientific vocabulary, terminology and definitions.
Quantities and Units	Recognise the importance of scientific quantities and understand how they are determined. Use SI units (e.g. kg, g, mg; km, m, mm; kJ, J) and chemical nomenclature unless inappropriate. Use prefixes and powers of ten for orders of magnitude (e.g. tera, giga, mega, kilo, centi, milli, micro and nano). Interconvert units. Use an appropriate number of significant figures in calculation.

Core Practicals

There are eight mandatory core practicals to complete in school for your GCSE Physics. You need to record the work that you have undertaken. The practical record must include the knowledge, skills and understanding you have obtained from the practical activities. Scientific diagrams should be included, where appropriate, to show the set-up and to record the apparatus and procedures used in practical work.

You will be assessed on these skills in your final written exams.

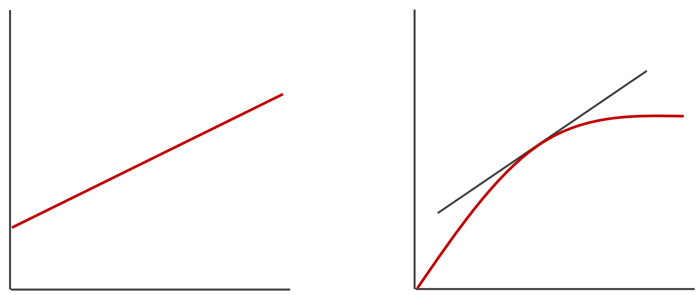
Topic	Core Practical Activity
2	Investigate the relationship between force, mass and acceleration by varying the masses added to trolleys.
4	Investigate the suitability of equipment to measure the speed, frequency and wavelength of a wave in a solid and a fluid.
5	Investigate refraction in rectangular glass blocks in terms of the interaction of electromagnetic waves with matter.
10	Construct electrical circuits to: a. investigate the relationship between potential difference, current and resistance for a resistor and a filament lamp b. test series and parallel circuits using resistors and filament lamps
14	Investigate the densities of solid and liquids.
14	Investigate the properties of water by determining the specific heat capacity of water and obtaining a temperature-time graph for melting ice.
15	Investigate the extension and work done when applying forces to a spring.

In addition, there are several suggested practicals for you to attempt in various course topics. Please see the next table:

Topic	Suggested Practicals
2	Investigate the acceleration, g, in free fall and the magnitudes of everyday accelerations.
	Investigate conservation of momentum during collisions.
	Investigate inelastic collisions with the two objects remaining together after the collision and also 'near' elastic collisions.
	Investigate the relationship between mass and weight.
	Investigate how crumple zones can be used to reduce the forces in collisions.
3	Investigate conservation of energy.
4	Investigate models to show refraction, such as toy cars travelling into a region of sand.
	Investigate refraction in rectangular glass blocks.
5	Investigate total internal reflection using a semi-circular block (glass or plastic).
	Construct devices using two converging lenses of differing focal lengths.
	Construct a simple spectrometer, from a CD or DVD, and use it to analyse common light sources.
	Investigate the areas beyond the visible spectrum, such as the work of Herschel and Ritter in discovering IR and UV respectively.
6	Investigate models which simulate radioactive decay.
8	Investigate power by moving up the stairs, step-ups onto a low platform or lifting objects of different weights.
9	Investigate levers and gears.
10	Investigate the power consumption of low-voltage electrical items.
11	Investigate the forces of attraction and repulsion between charged objects.
12	Construct an electric motor.
13	Investigate factors affecting the generation of electric current by induction.
14	Investigate the temperature and volume relationship for a gas.
	Investigate the volume and pressure relationship for a gas.
	Investigate latent heat of vaporisation.
15	Investigate the upthrust on objects in different liquids.
	Investigate the stretching of rubber bands.

Maths for GCSE Physics

Alongside the work you are already completing for your GCSE Maths, there are a number of skills that are used throughout GCSE Physics that you must be familiar with.

Topic	You must be able to:
Numbers	▪ Use numbers in decimal and standard form ($x10^n$) ▪ Use ratios, fractions and percentages ▪ Make estimates of the results of simple calculations
Data	▪ Use an appropriate number of significant figures ▪ Understand mean, mode and median ▪ Find the mean of a series of numbers ▪ Construct and interpret frequency tables and diagrams, bar charts and histograms ▪ Use a scatter diagram to identify a correlation between two variables ▪ Make order of magnitude calculations
Equations	▪ Use the symbols: = Equals ~ Approximately equal to ∝ Proportional < Less than << Much less than > Greater than >> Much greater than ▪ Change the subject (rearrange) equations and use them to solve numerical problems
Graphs	 ▪ Understand that $y = mx + c$ represents a linear relationship ▪ Work out the slope (gradient) and intercept from a graph ▪ Use a tangent to a curve to work out the gradient ▪ Calculate the area below a line and realise what this represents ▪ Plot two variables from experimental or other data
Shapes	▪ Calculate areas of rectangles and triangles ▪ Calculate the volume and surface area of a cube ▪ Use angles measured in degrees

Quantities and Units

You should be able to recognise and recall all of these quantities, units and their symbols.

Quantity	Symbol	Unit	Symbol
Acceleration	a	metre per second squared	m/s^2
Activity	A	becquerel	Bq
Area	A	metre squared	m^2
Change in	Δ *(delta)*	-	-
Charge	Q	coulomb	C
Current	I	amp	A
Density	ρ *(rho)*	kilogram per cubic metre	kg/m^3
Distance or displacement	x	metre	m
Energy	E	joule	J
Extension	x	metre	m
Final velocity	v	metre per second	m/s
Force (resultant force)	F	newton	N
Frequency	f	hertz	Hz
Gravitational field strength	g	newton per kilogram	N/kg
Gravitational potential energy	GPE	joule	J
Height	h	metre	m
Initial velocity	u	metre per second	m/s
Kinetic energy	KE	joule	J
Magnetic flux density	B	tesla	T
Mass	m	kilogram	kg
Moment	M	newton metre	Nm
Momentum	p	kilogram metre per second squared	kg m/s^2
Number of turns	N	-	-
Potential difference	V	volt	V
Power	P	watt	W
Pressure	P	pascal	Pa
Resistance	R	ohm	Ω *(omega)*

Specific heat capacity	*c*	joule per kilogram degree Celcius	J/kg °C
Specific latent heat	*L*	joule per kilogram	J/kg
Speed	*v*	metre per second	m/s
Spring constant	*k*	newton per metre	N/m
Temperature	*θ* *(theta)*	degree Celsius	°C
Thermal energy	*Q*	joule	J
Time	*t*	second	s
Velocity	*v*	metre per second	m/s
Volume	*V*	metre cubed	m^3
Wave speed	*v*	metre per second	m/s
Wavelength	*λ* *(lambda)*	metre	m
Weight	*W*	kilogram	kg
Work done	*E*	joule	J

Equations

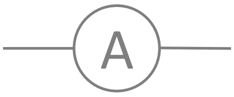
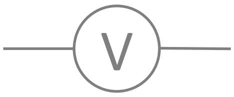
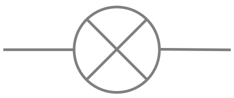
Only a few equations will be given to you in the exam on the Equation Sheet. You must be able to remember the rest of these equations.

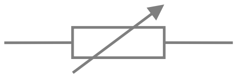
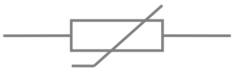
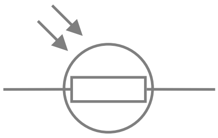
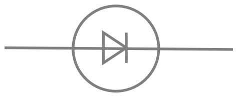
	Equation	Symbol
	(average) speed = distance ÷ time	$v = x / t$
	distance travelled = average speed × time	$x = v\,t$
	acceleration = change in velocity ÷ time taken	$a = (v - u) / t$
Equation Sheet	(final velocity)^2 – (initial velocity)^2 = 2 × acceleration × distance	$v^2 - u^2 = 2\,a\,x$
	force = mass × acceleration	$F = m\,a$
	weight = mass × gravitational field strength	$W = m\,g$
Higher	**momentum = mass × velocity**	$\mathbf{p = m\,v}$
Higher **Equation Sheet**	**force = change in momentum ÷ time**	$\mathbf{F = (mv - mu) / t}$
	change in gravitational potential energy = mass × gravitational field strength × change in vertical height	$GPE = m\,g\,h$
	kinetic energy = ½ × mass × speed^2	$KE = \frac{1}{2}\,m\,v^2$
	efficiency = $\frac{\text{(useful energy transferred by the device)}}{\text{(total energy supplied to the device)}}$	-
	wave speed = frequency × wavelength	$v = f\,\lambda$
	wave speed = distance ÷ time	$v = x / t$
	work done = force × distance moved in the direction of the force	$E = F\,d$
	power = work done ÷ time taken	$P = E / t$
	sum of clockwise moments = sum of anti-clockwise moments	$M_C = M_{AC}$
	energy transferred = charge moved × potential difference	$E = Q\,V$
	charge = current × time	$Q = I\,t$
	potential difference = current × resistance	$V = I\,R$

Equation Sheet	energy transferred = current × potential difference × time	$E = I V t$
	power = energy transferred ÷ time taken	$P = E / t$
	electrical power = current × potential difference	$P = I V$
	electrical power = current^2 × resistance	$P = I^2 R$
Higher **Equation Sheet**	**force on a conductor* = magnetic flux density × current × length** ***at right angles to a magnetic field carrying a current**	$\mathbf{F = B I l}$
Equation Sheet	potential difference across primary coil x current in primary coil = potential difference across secondary coil x current in secondary coil	$V_p I_p = V_s I_s$
	density = mass ÷ volume	$\rho = m / V$
Equation Sheet	change in thermal energy = mass × specific heat capacity × change in temperature	$\Delta Q = m c \Delta\theta$
Equation Sheet	thermal energy for a change of state = mass × specific latent heat	$Q = m L$
	force exerted on a spring = spring constant × extension	$F = k x$
Equation Sheet	energy transferred in stretching = ½ × spring constant × extension^2	$E = \frac{1}{2} k x^2$

Common Circuit Symbols

You must remember these circuit symbols and be able to draw them correctly in circuits.

Component	Symbol
Open Switch	
Closed Switch	
Cell	
Battery	
Ammeter	
Voltmeter	
Filament lamp	

Component	Symbol
Resistor	
Fuse	
Variable resistor	
Thermistor	
Light dependent resistor (LDR)	
Diode	
Light emitting diode (LED)