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VIDEO | EXAM Q&A

Topic 1. Key concepts of physics

Video: **Key concepts of Physics**

- Know the units which will be used throughout the GCSE physics course
- Remember and use metric prefixes (from nano to giga)
- Understand and use standard form|Convert between decimal and standard form
- Write numbers to a certain number of significant figures
- Convert between units (such as from years to seconds)

Topic 2. Motion and forces

Video: **Scalars and vectors**

- Explain the difference between a scalar and a vector quantity
- Perform simple calculations on the addition of two or more vectors which are acting in the same plane
- Give examples of both scalar and vector quantities

Video: **Distance and displacement, speed and velocity**

- Know that distance and speed are scalar quantities and displacement and velocity are vector quantities
- Perform simple calculations with regard to distances traveled and the displacement of an object from a given position
- Recall and apply the equation for the distance travelled by an object which is travelling at uniform speed ($s = v\,t$)
- Recall typical the speeds of walking, running, cycling, driving and a number of different common modes of transportation
- Calculate average speed for non-uniform motion
- (HT) Explain (with examples) how the motion of an object in a circular path can occur at uniform speed but with constantly changing velocity
- (HT) Explain the meaning of the term 'centripetal force'

Video: **Distance-time graphs**

- Understand that the motion of an object can be described in a convenient and easy-to-understand manner using a distance-time graph
- Plot a distance-time graph
- Interpret a distance-time graph
- Calculate the speed at which an object is travelling at a given point in time by measuring the gradient (slope) of its distance-time graph at that point
- (HT) When the speed of an object is changing (in other words, when it's accelerating or decelerating) calculate its speed by measuring the gradient of the tangent to its distance-time graph at a given point

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Video: **Acceleration**

- Understand that the velocity of an object which is accelerating is increasing with time
- Understand that the velocity of an object which is decelerating is decreasing with time (and that a deceleration can be thought of as a negative acceleration)
- Recall and apply the equation for acceleration based on its change and velocity and the time taken
- Apply the equation for the acceleration of an object which relates its acceleration to its final and initial velocities and the distance over which the acceleration occurred

Video: **Velocity-time graphs**

- Understand the use of velocity-time graphs in describing the uniform and non-uniform motion of an object
- Plot a velocity-time graph from given data|Interpret a velocity-time graph
- Calculate the acceleration of an object at a given point in time from the gradient of its velocity-time graph at that point
- (HT) Calculate the distance travelled by an object (or displacement of the object) from the area under its velocity-time graph
- (HT) Determine the area under a velocity-time graph by using the 'counting squares' method (as appropriate)

Video: **Resultant forces**

- Explain what is meant by a resultant force
- Calculate the resultant of two or more collinear forces which are acting on object (forces which are acting along a single line)

Video: **Gravity**

- Explain the difference between the mass on an object (in kilograms) and its weight (in newtons)
- Describe the factors which affect the gravitational force exerted between any two massive objects (objects with mass)
- Recall and apply the equation for the weight of an object (W = mg)
- Explain the meaning of the term "centre of mass"

Video: **Newton's laws of motion**

- Recall and explain the meaning of Newton's first law and apply it to a range of situations
- (HT) Understand why Newton's first law of sometimes referred to as the 'law of inertia'
- Recall and explain the meaning of Newton's second law and apply it to a range of situations
- Recall and apply the equation for Newton's second law (F = m a)
- (HT) Calculate the inertial mass of an object from its acceleration and the resultant force which is acting on it and explain what is meant by the inertial mass of an object
- Investigate experimentally the factors which affect the acceleration of an object
- Recall and explain the meaning of Newton's third law and apply it to a range of situations

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Video: **Falling objects**

- Understand that an object which is falling through a fluid (a liquid or a gas) will initially accelerate due to gravity|Understand that as the velocity of a falling object increases, the resistive force acting in a direction opposite to its direction of motion (either air resistance of fluid drag) will increases in magnitude, and that this will decrease the resultant force acting on the object in its direction of motion
- Understand that, when the resistive force acting on a falling object increases to the point at which it becomes equal to its weight, it will no longer accelerate (it will have reached its terminal velocity)
- Draw and interpret velocity-time graphs for a falling object which reaches terminal velocity
- Explain the changing motion of a falling object in terms of the forces which are acting on it

Video: **Momentum 1**

- (HT) Recall and apply the equation for the momentum of an object (p = m v)
- (HT) Explain what is meant by a closed system
- (HT) Explain what is meant by the idea of the conservation of momentum in a closed system
- (HT) Describe and explain examples of the transfer and conservation of momentum in a closed system (such as what happens in a collision or explosion)

Video: **Momentum 2**

- (HT) Recall and explain the meaning of the Principle of Conservation of Momentum
- (HT) Perform calculations regarding the transfer of momentum within a closed system (such as in a collision or an explosion)
- (HT) Explain how the average force exerted on an object is related to its change in momentum and the time over which the force acts
- (HT) Perform calculations with regard to the change in momentum of an object, the force exerted on it, and the time over which the force acts
- (HT) Explain how a number of safety devices work (including but not limited to air bags, seat belts, crumple zones, cushioned running shoes, crash mats and padded helmets)

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Video: **Forces and braking**

- Understand what is meant by the stopping, thinking and braking distances of a vehicle, and the relationship between each of these measurements
- Describe the factors which affect the reaction time of a driver
- Describe a simple method by which the reaction time of a person can be investigated
- Estimate how the distance over which a vehicle can stop in an emergency varies over a range of initial speeds of the vehicle
- Interpret graphs relating the speed at which a vehicle is travelling to its stopping distance for a range of vehicles, road conditions and driver
- Identify and explain the factors which affect the braking distance of a vehicle
- Explain that, when a force is applied to the brakes of a vehicle, work is done by the frictional force between its brake pads and the wheel, and that this reduces the kinetic energy of the vehicle and causes the temperature of the brakes to increase
- (HT) Estimate the typical forces involved with the deceleration of a vehicle based on given data

Topic 3. Conservation of energy

Video: **Energy stores and transfers**

- To understand the ways in which energy can be stored in a system and transferred from one energy store to another within a system
- To understand that energy transfers will occur when a system is changed by heating, the doing of work, or the flow of an electric current
- To be able to perform calculations involving changes in the kinetic energy and gravitational potential energy within a system

Video: **Energy conservation and efficiency**

- Understand the meaning of the Principle of Conservation of Energy
- (HT) Describe a number of ways in which unwanted energy transfers ('wasted' energy) within a system can be minimised
- Describe and explain the ways in which thermal energy is lost from a building, and the steps which can be taken to minimise such losses
- Explain what is meant by the 'thermal conductivity' of a material
- Recall and apply both forms of the equation for the efficiency of an energy transfer
- Understand and perform calculations using Sankey diagrams
- Plan and interpret the results of an experiment in which the effectiveness of a number of different thermal insulators is investigated

Video: **Energy resources**

- Describe the main energy resources available for use on Earth
- Explain the difference between renewable and non-renewable energy resources
- Discuss the advantages and disadvantages of the main energy resources with reference to their use in transport, electricity generation and heating

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Topic 4. Waves

Video: **Transverse and longitudinal waves**

- Describe what is meant by a wave
- Explain the difference between transverse and longitudinal waves
- Give examples of both transverse and longitudinal waves

Video: **Properties of waves**

- Describe the meaning of the amplitude, wavelength, frequency and period of a wave, and measure any one of these quantities from a suitable wave diagram
- Recall and apply the wave equation which links the speed of a wave to its frequency and wavelength
- Apply the equation linking the period of a wave to its frequency
- Describe experimental methods for measuring the speed of sound waves in air, water waves in a ripple tank and waves on a vibrating string, and interpret data relating to each of these experiments
- Use wavefront diagrams to describe the motion of a wave
- Understand and apply the concept that the wavelength of a wave is proportional to its speed, but that its frequency remains constant when it travels from one medium into another

Video: **Refraction**

- Understand and apply the terms 'angle of incidence' and 'angle of refraction'
- Understand that refraction can occur when a wave travels from one medium (material) into another
- Understand that refraction does not occur when a wave is normally incident on a boundary
- (HT) Explain why refraction occurs (in terms of the change of speed of a wave when it travels from one medium into another)
- (HT) Use wavefront diagrams to describe the refraction of water (and other) waves

Video: **Waves meeting boundaries**

- (HT) Recall that, when a wave meets the boundary between one medium (material) and another, it can be either refracted, reflected, transmitted or absorbed
- (HT) Explain how the colour of an object is affected by the amount of light of different wavelengths which is absorbed and reflected by its surface
- (HT) Understand that objects will absorb and reflect different types of waves by different amounts
- (HT) Perform calculations on the way in which the speed and wavelength of a wave change as it moves from one medium into another (Exam Style Questions)

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VIDEO | EXAM Q&A

Video: **Sound waves**

- (HT) Identify sound as a longitudinal wave, and describe how the particles in the medium through which a sound wave is travelling form a series of compressions and rarefactions in the material
- (HT) Recall the (maximum) range of human hearing
- (HT) Explain the sequence of processes which occur within the human body which allow us to hear a sound
- (HT) Explain how the cochlea works
- (HT) Compare the human ear with the operation of a moving-coil microphone

Video: **Uses of sound waves**

- (HT) Recall that ultrasound refers to sound waves which are above the frequency range of human hearing
- (HT) Recall that infrasound refers to sound waves which are below the frequency range of human hearing
- (HT) Describe and explain the use of ultrasound in both medicine and industry
- (HT) Describe and explain the application of sound waves in sonar systems and animal echolocation
- (HT) Perform (pulse-echo) calculations to determine the depth into a given material at which hidden boundaries (interfaces) are located
- (HT) Describe the differences between seismic P-waves and S-waves
- (HT) Describe the basic internal structure of the Earth
- (HT) Explain the paths taken by P-waves and S-waves through the Earth, and how these paths provide information on the internal structure of the planet

Topic 5. Light and the electromagnetic spectrum

Video: **Reflection and Total Internal Reflection**

- Understand that, when a wave arrives at a boundary between one material and another, it can be partially or fully reflected
- Understand and apply the law of reflection to a range of problems
- Draw and interpret both ray and wavefront diagrams which describe the reflection of a wave from a surface
- Know the conditions which are required for total internal reflection to occur
- Use ray diagrams to describe the total internal reflection of a light ray at a boundary

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Video: **Lenses**

- Describe the difference between a convex (converging) and a concave (diverging) lens and recall the symbols used to represent both types of lenses in ray diagrams
- Use ray diagrams to describe the effect of convex and concave lenses on the paths of parallel rays of light which are incident onto their surfaces (parallel to their principal axes)
- Describe and understand the difference between a real and a virtual image (and that the image produced by a convex lens can be either real or virtual, but that the image produced by a concave lens is always virtual)
- Produce ray diagrams which allow the position, nature and size of the image of an object which is produced by a lens to be determined
- Recall that a lens which is more curved will have a shorter focal length (and vice versa)

Video: **Visible light**

- Recall that what we perceive to be white light is a mixture of all of the colours of the visible spectrum
- Describe and explain the 'splitting up' of white light into the colours of the visible spectrum using a prism
- Explain the differences between transparent, translucent, and opaque objects
- Explain the differences between and use ray diagrams to describe both specular and diffuse reflection
- Understand that the colour of an opaque object depends on the fact that different wavelengths of light will be absorbed and reflected by its surface by different amounts
- Describe and explain how the apparent colour of an object changes depending on the wavelength of the light which is used to illuminate it
- Describe the use of colour filters and explain their effect on the apparent colour of an object

Video: **Electromagnetic waves 1**

- Describe the electromagnetic (EM) spectrum, and recall the order of the main types of EM waves (from the shortest to the longest wavelength)
- Recall the properties which all EM waves have in common
- Explain what is meany by the refraction of an EM wave
- Draw and interpret ray diagrams to describe the refraction of an EM wave
- Describe and explain the results of an experiment in which the refraction of light as it travels from one medium to another is investigated

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Video: **Electromagnetic waves 2**

- Describe the uses and hazards of each of the seven main types of electromagnetic (EM) waves
- (HT) Explain why the properties of EM waves from a given part of the EM spectrum mean that it is suitable for particular applications
- Understand the meaning of the term 'ionising radiation' and interpret dose data related to the extent to which gamma rays, x-rays and short-wavelength ultraviolet waves can lead to the damaging ionisation of the atoms that make up cells within the body
- (HT) Explain the production, transmission and receiving of radio waves using radio antennae
- Know how to perform and interpret the results of an experiment in which the factors that affect the amount of infrared radiation absorbed or radiated (emitted) by a surface is investigated

Video: **Thermal radiation**

- (HT) Know that all objects will emit and absorb infrared (thermal) radiation, regardless of their temperature
- (HT) Describe how the (intensity and wavelength of the) radiation emitted by an object changes with temperature
- (HT) Describe how the temperature of an object is affected by the rate at which it absorbs and emits (thermal) radiation
- (HT) Describe, understand and draw and interpret diagrams to explain the various factors which affect the temperature of the Earth

Topic 6. Radioactivity

Video: **Atoms and isotopes**

- Describe the basic structure of the atom and the properties of protons, neutrons and electrons
- Recall the radius of a typical atom
- Recall that most of the mass of an atom is located in its positive nucleus (where its protons and neutrons are located)
- Use atomic notation and know and understand the terms mass number and atomic numbe
- |Understand that a neutral atom becomes a charged ion when it loses or gains electrons
- Explain the meaning of the term isotope
- Describe the Bohr model of the atom, and explain how it can be used to explain the fact that a given element will only emit electromagnetic radiation of certain wavelengths (or 'colours')

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VIDEO | EXAM Q&A

Video: **The development of the model of the atom**

- Describe the plum pudding model
- Describe the Geiger-Marsden alpha scattering experiment (often called the Rutherford experiment)
- Describe the results of the Geiger-Marsden experiment
- Explain how the results of the Geiger-Marsden experiment disproved the plum pudding model of the atom, and what they told us about the structure of the atom
- Describe the Bohr model of the atom, and explain how it can be used to explain the fact that a given element will only emit electromagnetic radiation of certain wavelengths (or 'colours')

Video: **Radioactive decay**

- Describe what is meant by the term 'unstable nucleus' and explain the random nature of radioactive decay
- Explain the meaning of the term 'activity' as applied to a radioactive source
- Understand the meaning of the term 'count rate' and recall that the count rate from a source may be measured using a Geiger-Muller (GM) tube
- Recall that the radiation which is emitted from the nucleus in a nuclear decay event may take the form of an alpha particle, a beta (minus or plus) particle, a gamma ray or a neutron
- Be aware of the nature of each of these types of nuclear radiation, describe their properties (including their penetration through materials, their range in air and their ionising power)
- Complete balanced nuclear equations to describe the processes of alpha, beta (minus and plus), gamma and neutron decay

Video: **Half-life**

- Know that the activity of a radioactive source can be measured using a Gieger-Muller tube (connected to a rate meter) or photographic film
- Explain what is meant by the half-life of a radioactive isotope
- Determine the half-life of a radioactive isotope from information on the way in which its activity, mass, number of nuclei or the count rate recorded from it change with time|Interpret graphs which describe the decay of a radioactive substance with time
- (HT) Express as a ratio the decline in the radioactive emission from a substance after a given number of half-lives

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Video: **Irradiation and radioactive contamination**

- Describe the effects which ionising radiation can have on cells within the body
- Explain the difference between the irradiation and the contamination of an object
- Recall and discuss the factors which affect the level of risk posed by an object which has been contaminated with a radioactive substance
- Compare the hazards between objects or substances which have been contaminated with those which have been irradiated
- Describe the precautions which should be taken to protect against the hazards of irradiation
- Compare the relative contamination risk posed by different radioactive isotopes based on their amounts, half-lives, and the types of nuclear radiation which they emit
- (HT) Solve problems in which the fraction of nuclei present after a whole number of half-lives is calculated

Video: **Background radiation**

- Explain the meaning of the term 'background radiation'
- Recall and describe the range of natural and artificial sources of the background radiation to which we are exposed
- Understand the effect of background radiation on measurements of the count rate of a radioactive source, and correct for these 'background counts' in calculations

Video: **Uses of ionising radiation**

- Describe and explain the uses of nuclear radiations in medicine for both the exploration of internal organs and the control or destruction of unwanted tissue
- Evaluate the choice of radioactive substance for a given medical treatment (limited to the form of radiation which it emits and its half-life)
- Describe and explain the technique of positron emission tomography (PET)
- Describe and explain both internal and external radiotherapy
- Describe and explain the use of radiation in leak testing, thickness monitoring and smoke detectors
- Describe and explain the technique of carbon dating
- Calculate the age of a fossil or artefact using carbon dating data

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Video: **Nuclear fission and fusion**

- Describe the process of nuclear fission
- Explain the difference between spontaneous and induced fission
- Complete balanced nuclear equations to describe the fission of a large, unstable nucleus
- Explain how the energy released in the nuclear fission reactions occurring within a nuclear reactor is used for the generation of electricity in a nuclear power station
- Describe the basic structure of a nuclear reactor, and explain the role of the control rods and shielding
- Explain what is meant by a chain reaction, and draw and interpret diagrams to describe a nuclear fission chain reaction
- Explain the difference between a controlled and an uncontrolled chain reaction
- Describe the process of nuclear fusion
- Complete balanced nuclear equations to describe the fusion of two light nuclei
- Explain why energy is released in a fusion reaction
- Evaluate the potential for the use of nuclear fusion for the generation of electricity

Topic 7. Astronomy

Video: **The solar system**

- Describe the basic structure of the solar system and recall the order of the eight planets in terms of their distance from the sun
- Describe the dwarf planets, asteroids, asteroid belt, comets, and natural satellites (moons)
- Understand that the solar system is just one of a huge number of planetary systems which make up the Milky Way galaxy
- Explain how the gravitational field strength at the surface of a planet affects the weight of an object
- State the factors which affect the gravitational field strength at the surface of a planet
- Describe and explain the historical evidence for a sun-centred (heliocentric) solar system
- Describe how methods for observing the universe have changed with time
- Describe and explain the differences between earth and space-based telescopes

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Video: **Orbital motion**

- Explain how gravitational forces can cause one object to orbit another
- Explain how the speed of a satellite remains constant while its velocity is constantly changing
- Explain how the radius of the circular orbit of a satellite will change when its speed increases or decreases
- (HT) Know that it is gravity that provides the centripetal forces which keeps a satellite in orbit
- Perform calculations to determine the speed at which one object is orbiting another
- Describe the differences between three types of satellite orbits (geostationary, low earth and polar)

Video: **The life cycle of a star**

- Describe and explain the formation of a star from a nebula
- Describe the evolution of a star which is around the same size as the sun
- Describe the evolution of a star which is much more massive (contains more mass) than the sun
- Explain the balance of forces which allow a main sequence star to remain stable
- Understand that fusion processes in stars produce all of the naturally occurring elements which are heavier than hydrogen, but that elements which are heavier than iron are only produced in supernovae

Video: **Red-shift and the origin of the Universe**

- Explain what is meant by red-shift
- Describe how the spectra of light which we observe from distant stars is red-shifted, and that the degree of red-shift increases with distance
- Explain how red-shift provides evidence that the universe is expanding
- Describe the differences between the Big Bang and Steady State theories, and understand why the observation of red-shift can be explained by either theory
- Explain what is meant by Cosmic Microwave Background (CMB) radiation
- Understand why only the Big Bang theory can explain the occurrence of CMB radiation, which is why the observation of CMR radiation led to the State State theory being abandoned by most scientists

Topic 8. Energy - forces doing work

Video: **Forces, motion and work done**

- Understand that, when a force causes an object to move through a distance, work is done by the force
- Recognise that the work done by a force is equal to the amount of energy transferred by it
- Recall and apply the equation for the work done by a force on an object (E = F d)
- Understand that, when work is done against the frictional forces which are acting on an object, its temperature may rise

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Video: **Power**

- Explain what is meant by power
- Recall that the amount of work done by a system is equal to the amount of energy transferred by it
- Recall and apply both general equations for power
- Perform calculations involving power and energy transfers

Topic 9. Forces and their effects

Video: **Contact and non-contact forces**

- Explain the effects which the action of one or more forces can have on an object
- Recall that force is a vector quantity, and use simple force diagrams to describe the effect which one or more forces will have on an object
- Understand the difference between contact and non-contact forces, and give examples of each

Video: **Components of a force and forces in equilibrium**

- (HT) Draw a free body (force) diagram to demonstrate how two or more forces can lead to a resultant force on an object (including situations in which the forces acting on the object are in equilibrium/balanced)
- (HT) Resolve a single force into two components which are at right angles to one another, and understand that these two components have the same overall (resultant/net) effect as the single force
- (HT) Use a scale (vector) diagram to determine the magnitude and direction of the resultant force acting on an object (to include cases where all of the forces are not necessarily acting along the same line or perpendicular to one another)
- (HT) Understand that, when three or more forces are in equilibrium with one another, their vectors will form a closed shape when added together (this will be a triangle in the case of three forces and a square/rectangle in the case of four)

Video: **Moments, levers and gears**

- Describe examples of how the action of one or more forces can cause an object to rotate
- Know that the turning effect of a force is called the moment of the force
- Recall and apply the equation for the moment of a force (M = F d)
- Understand and apply the Principle of Moments to problems involving two or more turning forces
- Describe and explain how both levers and gears can be used to transmit the rotational effects of forces
- Perform simple calculations regarding the use of levers and gears in transmitting the rotational effects of forces

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Topic 10. Electricity and circuits

Video: **Electric charge and current**

- Understand that an electric current is the flow of electric charge
- Learn and apply the equation linking charge, current and time (Q = I t)

Video: **Circuit symbols**

- To learn the common circuit symbols
- To know and understand the uses to which common components are put in an electric circuit

Video: **Potential difference, current and resistance**

- Understand the effect of increasing the potential difference across a component (in terms of energy transfer)
- Learn and apply the equation linking the potential difference (p.d.) across a component, the current flowing through it, and its resistance (V = IR)
- Use a circuit diagram to set up a circuit so that some of the factors which affect its resistance can be investigated

Video: **Resistors**

- Explain how to measure the resistance of a component (using a voltmeter and an ammeter)
- Draw a circuit diagram of and explain the operation of a circuit which allows for the I-V behaviour of a component to be investigated
- Describe and explain the I-V behaviour of an ohmic conductor, a filament bulb, a diode, an LDR and a (negative temperature coefficient) thermistor
- Explain the difference between ohmic and non-ohmic components

Video: **Series and parallel circuits**

- Understand the difference between connecting components in series and in parallel
- Identify series and parallel circuits (or sections of circuits)
- Recall, understand and apply the rules for current and potential difference when components are connected in series or in parallel
- Recall, understand and apply the equation for the total resistance of two resistors which are connected in series
- Describe and explain the effect on the total resistance of both resistors of connecting two resistors in parallel

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Video: **Investigating resistance in circuits**

- Recall how to carry out an experiment in which the effect of the length of a piece of wire on its resistance is investigated
- Recall and apply the meanings of the terms independent, dependent and control variable
- Understand some of the reasons for the collection of anomalous data in an experimental investigation
- Draw circuit diagrams and describe the carrying-out of experiments to help determine how the way in which resistors are connected in a circuit (whether in series or in parallel) affects their total resistance

Video: **Energy transfer and power in circuits**

- Recall and apply the equations linking power, current, potential difference and resistance
- Recall and apply the equation linking energy transfer, power and time (E = P t)
- Describe how this work is done by electrons as they flow through and collide with lattice ions within the resistor
- Know that the energy transferred by these electrons in collisions as they flow through a resistor can lead to an increase in the the temperature of the resistor and its surroundings
- Describe methods for reducing the resistance of wires and other resistive components with a circuit
- Recall and apply the equation linking energy transfer, charge flow and potential difference (E = Q V)
- Understand that work is done ON charge (energy is transferred TO it) when it flows through a cell, battery or other power supply
- Understand that work is done BY charge (energy is transferred FROM it) when it flows through any circuit component which has an electrical resistance

Video: **Mains electricity**

- Recall that mains electricity is an ac supply of electrical energy (which has a frequency of 50 Hz and an 'average' potential difference of 230 V in the UK)
- Explain the difference between direct and alternating potential difference (and current)
- Draw and interpret potential difference-time graphs for both dc and ac supplies
- Identify and explain the purpose of the live, neutral and earth wires in a three-core cable
- Explain the danger of providing an electrical connection between the live wire and earth
- Explain the operation of earth wires, fuses and double insulation

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Topic 11. Static electricity

Video: **Static electricity**

- Recall and understand the effects of the electrostatic forces exerted between combinations of positive and negative charges
- Understand that all objects contain both positive and negative charges due to the protons and electrons they contain
- Explain the charging of an object by friction in terms of the net (overall) transfer of electrons (negative charge) between it and the object which it is in contact with
- Describe and explain electrostatic phenomena (such as the way in which a charge balloon will stick to a wall or sparking will occur between the charged dome of a Van de Graaff generator and an earthed discharge sphere)
- Describe and explain the dangers of static electricity, with a particular focus on the production of sparks
- Describe and explain how earthing is used to remove the risk of sparks being produced when planes and automobiles are being refuelled
- Describe and explain some of the uses of static electricity (including its use in electrostatic spraying)

Video: **Electric fields**

- Explain what is meant by an electric field
- Explain the effect of an electric field on the motion of charged particles
- Be able to draw the electric field pattern around a positive or negative (isolated) charged sphere
- Be able to draw the electric field pattern between two parallel, oppositely-charged plates

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Topic 12. Magnetism and the motor effect

Video: **Magnetism**

- Describe the attractive and repulsive forces between the poles of two magnets which are brought close to one another
- Explain the difference between permanent and induced magnets
- Describe a test to check whether a magnet is permanent or induced
- Describe how to determine the magnetic field pattern around a bar magnet using a plotting compass
- Sketch the magnetic field pattern around a bar magnet
- Describe and sketch the uniform magnet between the opposite poles of two bar magnets
- Describe the behaviour of a navigational compass which is placed into a given point in the magnetic field of the Earth
- Understand that when a current flows through a wire, a magnetic field will be produced around the wire
- Understand and be able to use the right-hand grip rules for a straight current-carrying wire and for a solenoid
- Describe and sketch the magnetic field pattern around a straight current-carrying wire
- Describe and sketch the magnetic field pattern around and inside a solenoid

Video: **The motor effect**

- (HT) Understand that when a conductor carrying a current is placed into a magnetic field, the conductor and the magnet(s) producing the field will exert a force on one another (unless the conductor is parallel to the field lines)
- (HT) Use Fleming's left-hand rule to determine the direction of the force exerted on a current-carrying conductor which is at right angles to a magnetic field
- (HT) Understand and apply the equation for the force exerted on a current-carrying conductor which is at right angles to a magnetic field
- (HT) Describe the construction and explain the operation of an electric motor
- (HT) Describe the construction and explain the operation of moving-coil loudspeakers and headphones

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Topic 13. Electromagnetic induction

Video: **Electromagnetic induction**

- (HT) Explain the generator effect
- (HT) Understand that an induced current generates a magnetic field which opposes the original change
- (HT) Recall the factors which affect the size and direction of the induced potential difference/current
- (HT) Describe and explain the operation of an alternator and a dynamo
- (HT) Draw and interpret graphs of potential difference against time for the coil of an alternator and a generator
- (HT) Describe and explain the operation of a moving-coil microphone

Video: **Transformers**

- (HT) Describe and explain the construction of a transformer
- (HT) Explain the operation and functions of step-up and step-down transformers, with particular reference to their role in the National Grid
- (HT) Apply the equation linking the potential difference across the primary and secondary coils of a transformer to the number of turns on both coils to a range of problems

Video: **The National Grid**

- Explain the function of the National Grid (or any large-scale electricity distribution network)
- Describe the main components of the National Grid and explain their function
- Understand and explain the need to transmit electrical energy across the country at a high potential difference ('high voltage') and appreciate the dangers involved with doing so
- Perform energy calculations on the transfer of electrical energy via the National Grid

Video: **Transformers and power transmission**

- Explain the operation and functions of step-up and step-down transformers, with particular reference to their role in the National Grid
- (HT) Apply the equation linking the potential difference across the primary and secondary coils of a transformer to the number of turns on both coils to a range of problems
- Apply the equation which relates the power in the primary and secondary coils of a perfectly-efficient transformer to a range of problems
- (HT) Explain why electrical power is transmitted at high potential differences

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Topic 14. Particle model

Video: **Density**

- Recall and apply the equation for the density of an object to solids, liquids and gases of fixed mass
- Explain how to measure the density of a regular or irregular solid or a liquid

Video: **Solids, liquids and gases**

- Use the particle model to explain the differences between solids, liquids and gases
- Explain the meaning of the term 'internal energy', and explain how the internal energy of a sample of a substance changes as changes from one state to another
- Recall and describe the various changes of state which can occur between the solid, liquid and gas states
- Explain the meaning of the term 'physical change'

Video: **Specific heat capacity and specific latent heat**

- Understand that increasing the internal energy of a system (through heating) can both increase its temperature and cause it to change state (from solid to liquid or from liquid to gas)
- Understand that decreasing the internal energy of a system (through cooling) can have the opposite effects
- Explain what is mean by the specific heat capacity of a substance
- Apply the equation for the specific heat capacity of a substance to a range of problems
- Explain the concept of latent heat and the meanings of the specific latent heat of fusion and specific latent heat of fusion of a substance
- Apply the equation for the latent heat of fusion and latent heat of vaporisation of a substance to a range of problems
- Describe experimental methods by which the specific heat capacity and specific latent heat of fusion of water can be determined

Video: **Pressure in gases**

- Use the particle model to explain why a gas exerts a pressure on the walls of its container
- Understand what is meant by absolute zero
- Be able to convert between the kelvin and degrees Celsius temperature scales
- Explain why changing the temperature of a fixed mass of gas (which is held at constant volume) causes the pressure exerted by it to increase
- Use the particle model to explain why decreasing the volume of a gas (at constant temperature) leads to an increase in pressure (and vice versa)
- Apply the equation which relates the pressure and volume of a gas at constant temperature (p V = constant) to a range of problems
- (HT) Explain why the temperature of a gas increases when work is done on it (and vice versa)

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Topic 15. Forces and matter

Video: **Forces and elasticity**

- Describe the effects which the action of two or more forces can have on the shape of an object
- Explain the difference between elastic and inelastic deformation
- Investigate experimentally the relationship between the force applied to a spring and its extension
- Interpret data from an investigation into the force applied to an object and its extension
- Understand that, as long as its limit of proportionality has not been exceeded, the force applied to an elastic object (such as a spring) is proportional to its extension
- Recall and apply the equation linking the force applied to an object and its extension ($F = k x$) which applies so long as the limit of proportionality of an object has not been exceeded
- Explain the relationship between elastic potential energy and the work which is done on (or by) a spring
- Apply the equation for the elastic potential energy of an object

Video: **Pressure and pressure differences in fluids**

- Know that a fluid is a liquid or a gas
- Understand why a fluid (which is at a temperature above absolute zero) exerts a pressure on the walls of its container, and know that the force exerted by this pressure is always perpendicular to the surface of the fluid
- Recall and apply the equation for the pressure exerted on a surface by a fluid ($p = F / A$)
- (HT) Explain why the pressure in a liquid increases with depth
- (HT) Apply the equation which relates the pressure caused by a liquid at a given depth within it to the height of the column of liquid above, the density of the liquid above, and the gravitational field strength
- (HT) Explain the origin of the upthrust force which is exerted on an object which is immersed in a liquid (or indeed a gas which is subject to a gravitational field)
- (HT) Describe the factors which affect whether an object will float or sink when submerged in a liquid|Understand the origin of atmospheric pressure
- Explain why atmospheric pressure decreases with altitude (height above the surface)