**Physics Unit 1 – Energy**

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| **Unit 1: Equations I need to know.** | **** | **** |
| **Work done (W) = force applied (F) x distance (s)**  (joules, J) (newtons, N) (metres, m) |  |  |
| **Change in GPE store( *∆Ep*) = mass (*m*) x gravitational x change in**  **field strength (*g*) height** (***∆h)***  (joules, J) (kg) (N/kg) (m) |  |  |
| **Kinetic energy (Ek) = ½ x mass (*m*) x speed2 (*v2*)**  (joules, J) (kg) (m/s2) |  |  |
| **efficiency = useful output energy transferred by the device** (Joules)  **total input energy transferred to the device** (Joules) |  |  |
| **Power (P)** (watts, W) **= energy transferred to appliance (E)** (joules, J)  **time taken for energy to be transferred (t)** (seconds, s) |  |  |
| **( X 100)**  **efficiency = useful power out**  **total power in** |  |  |
| **P1.1 - Energy changes in a system, and the ways energy is stored before and after such changes** | | |
| Describe a system as an object or group of objects |  |  |
| Describe all the changes involved in the way energy is stored when a system changes, for common situations: e.g an object projected upwards an object projected upwards, a moving object hitting an obstacle, an object accelerated by a constant force, a vehicle slowing down, bringing water to a boil in an electric kettle |  |  |
| Calculate the amount of energy associated with a moving object (kinetic energy), a stretched spring and an object raised above ground level (using the equations above – they need to be LEARNED) |  |  |
| Calculate the amount of elastic potential energy stored in a stretched spring using the equation: *elastic potential energy* = 0.5 × *spring constant* × *extension*2 ( you don’t need to learn this one!) |  |  |
| Calculate the amount of energy stored in or released from a system as its temperature changes using the equation: *change in thermal energy* = *mass* × *specific heat capacity* × *temperature change* |  |  |
| State that the specific heat capacity of a substance is the amount of energy required to raise the temperature of one kilogram of the substance by one degree Celsius |  |  |
| Power is defined as the rate at which energy is transferred or the rate at which work is done |  |  |
| Know that an energy transfer of 1 joule per second is equal to a power of 1 watt |  |  |
| Give examples that illustrate the definition of power e.g comparing two electric motors that both lift the same weight through the same height but one does it faster than the other |  |  |
| **P1.2 – Conservation and dissipation of energy** | | |
| Describe that energy can be transferred usefully, stored or dissipated, but cannot be created or destroyed |  |  |
| Describe with examples where there are energy transfers in a closed system, that there is no net change to the total energy |  |  |
| Describe, with examples, how in all system changes energy is dissipated, so that it is stored in less useful ways. This energy is often described as being ‘wasted’. |  |  |
| Explain ways of reducing unwanted energy transfers, for example through lubrication and the use of thermal insulation |  |  |
| Explain the higher the thermal conductivity of a material the higher the rate of energy transfer by conduction across the material |  |  |
| Describe how the rate of cooling of a building is affected by the thickness and thermal conductivity of its walls |  |  |
| Calculate the energy efficiency for any energy transfer (using equation above) |  |  |
| Describe ways to increase the efficiency of an intended energy transfer (HT) |  |  |
| **P1.3 – National and global energy resources** | | |
| State and describe the main energy resources available for use on Earth: fossil fuels (coal, oil and gas), nuclear fuel, bio-fuel, wind, hydroelectricity, geothermal, the tides, the Sun and water waves. |  |  |
| Define a renewable energy resource as one that is being (or can be) replenished as it is used |  |  |
| State the uses of energy resources include: transport, electricity generation and heating |  |  |
| Distinguish between energy resources that are renewable and energy resources that are non-renewable |  |  |
| Compare ways that different energy resources are used, the uses to include transport, electricity generation and heating |  |  |
| Explain why some energy resources are more reliable than others |  |  |
| Describe the environmental impact arising from the use of different energy resources |  |  |
| Explain patterns and trends in the use of energy resources |  |  |
| Consider the environmental issues that may arise from the use of different energy resources |  |  |
| Explain that science has the ability to identify environmental issues arising from the use of energy resources but not always the power to deal with the issues because of political, social, ethical or economic considerations. |  |  |

**Videos:**

<https://goo.gl/zPK4UU> - broken into 15 short videos here

**Revision guide reference:**

Higher page: 167 - 178

Foundation page: 167 - 179

**Physics Unit 2 – Electricity**

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| **Unit 2 – Equations I need to know** | **** | **** |
| **charge flow (*Q*) = current (***I***) x time taken (*t*)**  (coulombs, C) (amperes, A) (seconds, s) |  |  |
| **potential difference = energy transferred *(E)*** (joules, J)  *(Volts, V)* **charge (*Q*)** (coulombs, C) |  |  |
| **resistance (*R*) = potential difference (***V***)** (volts, V)  (ohms, Ω) **current (*I*)** (coulombs, C) |  |  |
| **power supplied (*P*) = current (***I***) x potential difference (*V*)**  (watts, W) (amperes, A) (volts, V) |  |  |
| **Power (*P*)** (watts, W) **= energy transferred *(E)*** (joules, J)  **time (*t*)** (seconds, s) |  |  |
| **power (*P*) = current2 (*I2*) x resistance (*R*)**  (watts, W) (amperes, A) (ohms, Ώ) |  |  |
| **P2.1 – Current, potential difference and resistance** | | |
| Draw and interpret circuit diagrams: switch, cell, battery, diode, resistor, variable resistor, LED, lamp, fuse, voltmeter, ammeter, thermistor, LDR |  |  |
| Describe electric current as a flow of electrical charge. The size of the electric current is the rate of flow of electrical charge |  |  |
| Explain that the current (*I*) through a component depends on both the resistance (*R*) of the component and the potential difference (*V*) across the component. |  |  |
| Describe that the greater the resistance of the component the smaller the current for a given potential difference (pd) across the component |  |  |
| Current, potential difference or resistance can be calculated using the equation:  *potential difference* = *current* × *resistance* |  |  |
| Explain that, for some resistors, the value of *R* remains constant but that in others it can change as the current changes. |  |  |
| Know the current through an ohmic conductor (at a constant temperature) is directly proportional to the potential difference across the resistor. This means that the resistance remains constant as the current changes |  |  |
| Draw and recognise I-V graphs for: an ohmic resistor, filament lamp, diode |  |  |
| Explain why the resistance of a filament lamp increases as the temperature of the filament increases |  |  |
| Describe that the current through a diode flows in one direction only. The diode has a very high resistance in the reverse direction |  |  |
| State that the resistance of a thermistor decreases as the temperature increases |  |  |
| Know some applications of thermistors in circuits e.g a thermostat is required |  |  |
| State that the resistance of an LDR decreases as light intensity increases |  |  |
| Know some applications of LDRs in circuits e.g switching lights on when it gets dark is required |  |  |
| Explain the design and use of a circuit to measure the resistance of a component by measuring the current through, and potential difference across, the component |  |  |
| Draw an appropriate circuit diagram using correct circuit symbols |  |  |
| **P2.2 – Series and parallel circuits** | | |
| Explain the difference between a series and parallel circuit |  |  |
| Know the rules for components connected in series:   * there is the **same** current through each component * the total potential difference of the power supply is **shared** between the components * the total resistance of two components is the **sum of the resistance of each component**. (*R***t**o**tal** = *R*1 + *R*2) |  |  |
| Know the rules for components connected in parallel:   * the potential difference across each component is the **same** * the total current through the whole circuit is the **sum of the currents** through the separate components * the total resistance of two resistors is less than the resistance of the smallest individual resistor |  |  |
| Use circuit diagrams to construct and check series and parallel circuits that include a variety of common circuit components |  |  |
| Explain qualitatively why adding resistors in series increases the total resistance whilst adding resistors in parallel decreases the total resistance |  |  |
| Explain the design and use of dc series circuits for measurement and testing purposes |  |  |
| Calculate the currents, potential differences and resistances in dc series circuits |  |  |
| Solve problems for circuits which include resistors in series using the concept of equivalent resistance |  |  |
| **P2.3 – Domestic uses and safety** | | |
| Explain that mains electricity is an ac supply. Know that in the United Kingdom the domestic electricity supply has a frequency of 50 Hz and is about 230 V |  |  |
| Explain the difference between direct and alternating potential difference |  |  |
| State that most electrical appliances are connected to the mains using three-core cable |  |  |
| The insulation covering each wire is colour coded for easy identification:  live wire – brown  neutral wire – blue  earth wire – green and yellow stripes |  |  |
| Know that the live wire carries the alternating potential difference from the supply. The neutral wire completes the circuit. The earth wire is a safety wire to stop the appliance becoming live |  |  |
| Know that the potential difference between the live wire and earth (0 V) is about 230 V. The neutral wire is at, or close to, earth potential (0 V). The earth wire is at 0 V, it only carries a current if there is a fault |  |  |
| Explain that a live wire may be dangerous even when a switch in the mains circuit is open |  |  |
| Explain the dangers of providing any connection between the live wire and earth |  |  |
| **P2.4 – Energy transfers** | | |
| Explain how the power transfer in any circuit device is related to the potential difference across it and the  current through it, and to the energy changes over time: recall and use power equations |  |  |
| Explain that the amount of energy an appliance transfers depends on how long the appliance is switched on for and the power of the appliance |  |  |
| Describe how different domestic appliances transfer energy from batteries or ac mains to the kinetic energy of electric motors or the energy of heating devices |  |  |
| State that work is done when charge flows in a circuit |  |  |
| Explain how the power of a circuit device is related to:  • the potential difference across it and the current through it  • the energy transferred over a given time |  |  |
| Describe, with examples, the relationship between the power ratings for domestic electrical appliances and the changes in stored energy when they are in use. |  |  |
| Know that The National Grid is a system of **cables and transformers** linking power stations to consumers |  |  |
| Step-up transformers are used to increase the potential difference from the power station to the transmission cables. This decreases current and energy losses and increases efficiency. |  |  |

**Videos:**

<https://goo.gl/sDEJH2> - Videos 1-21.

**Revision guide reference:**

Higher pages: 179 – 190

Foundation pages: 180 – 192

**Physics Unit 3 – Particle model of matter**

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| **P1.1 – Changes of state and the particle model** | **** | **** |
| Calculate the density of a material:  **Density (kg/m3) = mass (kg)**  **volume (m3)** |  |  |
| Use the particle model to explain: the different states of matter & differences in density |  |  |
| Recognise/draw simple diagrams to model the difference between solids, liquids and gases |  |  |
| Explain the differences in density between the different states of matter in terms of the arrangement of atoms or molecules |  |  |
| Describe how, when substances change state (melt, freeze, boil, evaporate, condense or sublimate), mass is conserved |  |  |
| Explain that changes of state are physical changes which differ from chemical changes because the material recovers its original properties if the change is reversed |  |  |
| **P2.2 – Internal energy and energy transfers** | | |
| Define internal energy as: energy is stored inside a system by the particles (atoms and molecules) that make up the system |  |  |
| State that internal energy is the total kinetic energy and potential energy of all the particles (atoms and molecules) that make up a system. |  |  |
| Know that heating changes the energy stored within the system by increasing the energy of the particles that make up the system. This either raises the temperature of the system or produces a change of state. |  |  |
| Calculate the amount of energy stored in or released from a system as its temperature changes using the equation: *change in thermal energy* = *mass* × *specific heat capacity* × *temperature change* |  |  |
| State that the specific heat capacity of a substance is the amount of energy required to raise the temperature of one kilogram of the substance by one degree Celsius |  |  |
| Describe the energy needed for a substance to change state is called latent heat. When a change of state occurs, the energy supplied changes the energy stored (internal energy) but not the temperature |  |  |
| Define specific latent heat of a substance: the amount of energy required to change the state of one kilogram of the substance with no change in temperature |  |  |
| *Apply the equation: energy of or a change of state (J)* = *mass (kg)* × *specific latent heat (J/kg)* |  |  |
| Define Specific latent heat of fusion – change of state from solid to liquid |  |  |
| Define Specific latent heat of vaporisation – change of state from liquid to vapour |  |  |
| Interpret heating and cooling graphs that include changes of state |  |  |
| Distinguish between specific heat capacity and specific latent heat |  |  |
| **P3.3 – Particle model and pressure** | | |
| Describe that the molecules of a gas are in constant random motion. The temperature of the gas is related to the average kinetic energy of the molecules |  |  |
| Explain that changing the temperature of a gas, held at constant volume, changes the pressure exerted by the gas |  |  |
| Explain how the motion of the molecules in a gas is related to both its temperature and its pressure |  |  |
| Explain qualitatively the relation between the temperature of a gas and its pressure at constant volume |  |  |

**Videos:**

<https://goo.gl/fEt3nR> - broken into 9 short videos here

**Revision guide reference:**

Higher pages: 191 – 194

Foundation pages: 193 – 196

**Physics Unit 4 – Atomic Structure**

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| **P4.1 – Atoms and isotopes** | **** | **** |
| Know that atoms have a radius of about 1 x 10-10 metres |  |  |
| Describe the structure of an atom. Positively charged nucleus composed of protons and neutrons surrounded by negatively charged electrons |  |  |
| Know the radius of the nucleus is less than 1/10 000 of the radius of an atom. An atoms is mostly empty space |  |  |
| Describe how the electrons are arranged in energy levels (shells) |  |  |
| Know that if atoms **absorb** electromagnetic radiation electrons can move further away from the nucleus |  |  |
| Know that if atoms **emit** electromagnetic radiation electrons can move closer to the nucleus |  |  |
| Know that the number of protons and electrons in an atom are equal so they have no overall charge |  |  |
| State that all atoms of an element have the same number of protons. This can be identified by the atomic number |  |  |
| Recall that the total number of protons and neutrons in an atom is called its mass number |  |  |
| Recall the definition of an isotope: Atoms of the same element can have different numbers of neutrons |  |  |
| Describe that atoms turn into positive ions if they lose one or more outer electron |  |  |
| Explain how new experimental evidence may lead to a scientific model being changed or replaced |  |  |
| Describe that before the discovery of the electron, atoms were thought to be tiny spheres that could not be divided |  |  |
| State that the discovery of the electron led to the plum pudding model of the atom |  |  |
| Describe the plum pudding model: a ball of positive charge with negative electrons embedded in it |  |  |
| Explain the results from the alpha particle scattering experiment led to the conclusion that the mass of an atom was concentrated at the centre (nucleus) and that the nucleus was charged. This nuclear model replaced the plum pudding model |  |  |
| Know that Niels Bohr adapted the nuclear model by suggesting that electrons orbit the nucleus at specific distances. The theoretical calculations of Bohr agreed with experimental observations |  |  |
| Describe that later experiments led to the idea that the positive charge of any nucleus could be subdivided into a whole number of smaller particles, each particle having the same amount of positive charge. The name proton was given to these particles |  |  |
| Know experimental work of James Chadwick provided the evidence to show the existence of neutrons within the nucleus. This was about 20 years after the nucleus became an accepted scientific idea |  |  |
| Recall the order in which sub atomic particles were discovered: electron, proton, neutron |  |  |
| Describe why the new evidence from the scattering experiment led to a change in the atomic model |  |  |
| Describe the difference between the plum pudding model of the atom and the nuclear model of the atom |  |  |
| **P4.2 – Atoms and nuclear radiation** | | |
| Describe why some atomic nuclei are unstable |  |  |
| Know the nucleus gives out radiation as it changes to become more stable. This is a random process called radioactive decay |  |  |
| Know that activity is the rate at which a source of unstable nuclei decays |  |  |
| Recall that activity is measured in Becquerel (Bq) |  |  |
| Know count-rate is the number of decays recorded each second by a detector (e.g Geiger-Muller tube) |  |  |
| Recall the 4 types of nuclear radiation that may be emitted:  • an alpha particle (α) – this consists of two neutrons and two protons, it is the same as a helium nucleus  • a beta particle (β) – a high speed electron ejected from the nucleus as a neutron turns into a proton  • a gamma ray (γ) – electromagnetic radiation from the nucleus  • a neutron (n) |  |  |
| Know the ionising power of each type of nuclear radiation, and what materials they can pass through |  |  |
| Explain the range in air of each type of nuclear radiation |  |  |
| Give uses of radiation and evaluate the best sources of radiation to use in a given situation |  |  |
| Recall and interpret the nuclear equations for alpha and beta decay |  |  |
| Recall that alpha decay causes both the mass and charge of the nucleus to decrease e.g |  |  |
| Recall that beta decay does not cause the mass of the nucleus to change but does cause the charge of the nucleus to increase e.g |  |  |
| Know that the emission of a gamma ray does not cause the mass or the charge of the nucleus to change |  |  |
| State that radioactive decay is random. It is impossible to know when each atom will decay |  |  |
| Explain that the half-life of a radioactive isotope is 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 (or activity) from a sample containing the isotope to fall to half its initial level |  |  |
| Explain the concept of half-life and how it is related to the random nature of radioactive decay |  |  |
| Determine the half-life of a radioactive isotope from given information i.e. graphs |  |  |
| Calculate the net decline, expressed as a ratio, in a radioactive emission after a given number of half-lives |  |  |
| Explain what radioactive contamination is: the unwanted presence of materials containing radioactive atoms on other materials. The hazard from contamination is due to the decay of the contaminating atoms. The type of radiation emitted affects the level of hazard |  |  |
| Describe that irradiation is the process of exposing an object to nuclear radiation. The irradiated object does not become radioactive |  |  |
| Compare the hazards associated with contamination and irradiation |  |  |
| Suggest suitable precautions must be taken to protect against any hazard that the radioactive source used in the process of irradiation may present |  |  |
| Understand that it is important for the findings of studies into the effects of radiation on humans to be published and shared with other scientists so that the findings can be checked by peer review |  |  |

**Videos:**

<https://goo.gl/vqRmLM> - broken into 11 short videos here **Revision guide reference:**

Higher pages: 195-200

Foundation pages: 193-196

**PAPER 2**

**Physics Unit 5 – Forces**

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| **Unit 5 – Equations I need to know** | **** | **** |
| **Weight (W) = mass (m) × gravitational field strength (g)**  (newtons, N) (kilograms, kg) (N/kg) |  |  |
| **work done (W) = force (F) × distance (s) (along the line of action of the force)**  (joules, J) (newtons, N) (metres, m) |  |  |
| **force applied to a spring (F) = spring constant (k) × extension (e)**  (newtons, N) (N/m) (metres, m) |  |  |
| **distance travelled (s) = speed (v) × time (t)**  (metres, m) (metres per second, m/s) (seconds, s) |  |  |
| **Acceleration (a) = change in velocity (u-v)** (metres per second, m/s)  (Metres per second2, m/s2) **time taken (t)** (seconds, s) |  |  |
| **resultant force (F) = mass (m) × acceleration (a)**  (newtons, N) (kilograms, kg) (Metres per second2, m/s2) |  |  |
| **Momentum (p) = mass (m) × velocity (v)**  (kilogram metres per second, kg m/s) (kilgorams, kg), (metres per second, m/s) |  |  |
| **P5.1 Forces and their interactions** | **** | **** |
| Scalar quantities have magnitude only. |  |  |
| Vector quantities have magnitude and an associated direction. Force is a vector quantity. |  |  |
| A vector quantity may be represented by an arrow. The length of the arrow represents the magnitude, and the direction of the arrow the direction of the vector quantity. |  |  |
| A force is a push or pull that acts on an object due to the interaction with another object. All forces between objects are either: • contact forces – the objects are physically touching • non-contact forces – the objects are physically separated. |  |  |
| Examples of contact forces include friction, air resistance, tension and normal contact force. |  |  |
| Examples of non-contact forces are gravitational force, electrostatic force and magnetic force. |  |  |
| Describe the interaction between pairs of objects which produce a force on each object. The forces to be represented as vectors. |  |  |
| Weight is the force acting on an object due to gravity. The force of gravity close to the Earth is due to the gravitational field around the Earth. |  |  |
| The weight of an object depends on the gravitational field strength at the point where the object is. |  |  |
| The weight of an object can be calculated using the equation:  weight = mass × gravitational field strength  W  = m g  weight, W, in newtons, N mass, m, in kilograms, kg gravitational field strength, g, in newtons per kilogram, N/kg |  |  |
| The weight of an object may be considered to act at a single point referred to as the object’s ‘centre of mass’. The weight of an object and the mass of an object are directly proportional. Weight is measured using a calibrated spring-balance (a newtonmeter). |  |  |
| A number of forces acting on an object may be replaced by a single force that has the same effect as all the original forces acting together. This single force is called the resultant force. |  |  |
| Calculate the resultant of two forces that act in a straight line. |  |  |
| (HT only) Describe examples of the forces acting on an isolated object or system and use free body diagrams to describe qualitatively examples where several forces lead to a resultant force on an object, including balanced forces when the resultant force is zero. |  |  |
| (HT only) A single force can be resolved into two components acting at right angles to each other. The two component forces together have the same effect as the single force. |  |  |
| (HT only) Students should be able to use vector diagrams to illustrate resolution of forces, equilibrium situations and determine the resultant of two forces, to include both magnitude and direction. |  |  |
| **P5.2 Work done and energy transfer** | | |
| When a force causes an object to move through a distance work is done on the object. So a force does work on an object when the force causes a displacement of the object. |  |  |
| The work done by a force on an object can be calculated using the equation:  work done = force × distance moved along the line of action of the force  W  = F s  work done, W, in joules, J force, F, in newtons, N distance, s, in metres |  |  |
| One joule of work is done when a force of one newton causes a displacement of one metre. 1 joule = 1 newton-metre. Describe the energy transfer involved when work is done. Convert between newton-metres and joules. |  |  |
| Work done against the frictional forces acting on an object causes a rise in the object’s temperature. |  |  |
| Give examples of the forces involved in stretching, bending or compressing an object |  |  |
| Explain why, to change the shape of an object (by stretching, bending or compressing), more than one force has to be applied – this is limited to stationary objects only |  |  |
| Describe the difference between elastic deformation and inelastic deformation caused by stretching forces. |  |  |
| The extension of an elastic object, such as a spring, is directly proportional to the force applied, provided that the limit of proportionality is not exceeded. |  |  |
| force = spring constant × extension  F  = k e  force, F, in newtons, N spring constant, k, in newtons per metre, N/m extension, e, in metres, m |  |  |
| This relationship also applies to the compression of an elastic object, where ‘e’ would be the compression of the object. A force that stretches (or compresses) a spring does work and elastic potential energy is stored in the spring. Provided the spring is not inelastically deformed, the work done on the spring and the elastic potential energy stored are equal. |  |  |
| Describe the difference between a linear and non-linear relationship between force and extension. |  |  |
| Calculate a spring constant in linear cases. |  |  |
| Interpret data from an investigation of the relationship between force and extension. |  |  |
| Calculate work done in stretching (or compressing) a spring (up to the limit of proportionality) using the equation: elastic potential energy = 0.5 × spring constant × extension 2  Ee    = 1/2 x k x e2 |  |  |
| Calculate relevant values of stored energy and energy transfers. |  |  |
| **P5.6 Forces and motion** | | |
| Distance is how far an object moves. Distance does not involve direction. Distance is a scalar quantity. |  |  |
| Displacement includes both the distance an object moves, measured in a straight line from the start point to the finish point and the direction of that straight line. Displacement is a vector quantity. |  |  |
| Express a displacement in terms of both the magnitude and direction. |  |  |
| Speed does not involve direction. Speed is a scalar quantity. The speed of a moving object is rarely constant. When people walk, run or travel in a car their speed is constantly changing. The speed at which a person can walk, run or cycle depends on many factors including: age, terrain, fitness and distance travelled. Typical values may be taken as: walking ̴ 1.5 m/s running ̴ 3 m/s cycling ̴ 6 m/s. |  |  |
| It is not only moving objects that have varying speed. The speed of sound and the speed of the wind also vary. A typical value for the speed of sound in air is 330 m/s. |  |  |
| Make measurements of distance and time and then calculate speeds of objects. |  |  |
| For an object moving at constant speed the distance travelled in a specific time can be calculated using the equation: distance travelled = speed × time s  = v t  distance, s, in metres, m speed, v, in metres per second, m/s time, t, in seconds, s. |  |  |
| Calculate average speed for non-uniform motion. |  |  |
| The velocity of an object is its speed in a given direction. Velocity is a vector quantity. (HT only) Explain qualitatively, with examples, that motion in a circle involves constant speed but changing velocity. |  |  |
| If an object moves along a straight line, the distance travelled can be represented by a distance–time graph. The speed of an object can be calculated from the gradient of its distance–time graph. (HT only) If an object is accelerating, its speed at any particular time can be determined by drawing a tangent and measuring the gradient of the distance–time graph at that time. |  |  |
| Draw distance–time graphs from measurements and extract and interpret lines and slopes of distance–time graphs, translating information between graphical and numerical form. |  |  |
| The average acceleration of an object can be calculated using the equation:  acceleration = change in velocity/time taken a  = Δv/t  acceleration, a, in metres per second squared, m/s2 change in velocity, ∆v, in metres per second, m/s time, t, in seconds, s. An object that slows down is decelerating. |  |  |
| The acceleration of an object can be calculated from the gradient of a velocity–time graph. (HT only) The distance travelled by an object (or displacement of an object) can be calculated from the area under a velocity–time graph. |  |  |
| Draw velocity–time graphs from measurements and interpret lines and slopes to determine acceleration • (HT only) interpret enclosed areas in velocity–time graphs to determine distance travelled (or displacement) • (HT only) measure, when appropriate, the area under a velocity– time graph by counting squares. |  |  |
| The following equation applies to uniform acceleration:  (final velocity)2 – (initial velocity)2 = 2 × acceleration × distance v2 - u2 = 2 a s  final velocity, v, in metres per second, m/s initial velocity, u, in metres per second, m/s acceleration, a, in metres per second squared, m/s2 distance, s, in metres, m. |  |  |
| Near the Earth’s surface any object falling freely under gravity has an acceleration of about 9.8 m/s2 |  |  |
| An object falling through a fluid initially accelerates due to the force of gravity. Eventually the resultant force will be zero and the object will move at its terminal velocity. |  |  |
| **P5.6.2 Forces, accelerations and Newton’s Laws of motion** | | |
| Newton’s First Law: If the resultant force acting on an object is zero and: • the object is stationary, the object remains stationary • the object is moving, the object continues to move at the same speed and in the same direction. So the object continues to move at the same velocity. So, when a vehicle travels at a steady speed the resistive forces balance the driving force. So, the velocity (speed and/or direction) of an object will only change if a resultant force is acting on the object. |  |  |
| Apply Newton’s First Law to explain the motion of objects moving with a uniform velocity and objects where the speed and/or direction changes. |  |  |
| (HT only) The tendency of objects to continue in their state of rest or of uniform motion is called inertia. |  |  |
| Newton’s Second Law: The acceleration of an object is proportional to the resultant force acting on the object, and inversely proportional to the mass of the object. As an equation:  resultant force = mass × acceleration F  = m a  force, F, in newtons, N mass, m, in kilograms, kg acceleration, a, in metres per second squared, m/s2 |  |  |
| (HT only) Explain that: • inertial mass is a measure of how difficult it is to change the velocity of an object • inertial mass is defined as the ratio of force over acceleration. |  |  |
| Estimate the speed, accelerations and forces involved in large accelerations for everyday road transport. |  |  |
| Newton’s Third Law: Whenever two objects interact, the forces they exert on each other are equal and opposite. Students should be able to apply Newton’s Third Law to examples of equilibrium situations. |  |  |
| **P5.6.3 Forces and Braking** | | |
| The stopping distance of a vehicle is the sum of the distance the vehicle travels during the driver’s reaction time (thinking distance) and the distance it travels under the braking force (braking distance). For a given braking force the greater the speed of the vehicle, the greater the stopping distance. |  |  |
| Reaction times vary from person to person. Typical values range from 0.2 s to 0.9 s. A driver’s reaction time can be affected by tiredness, drugs and alcohol. Distractions may also affect a driver’s ability to react. |  |  |
| Explain methods used to measure human reaction times and recall typical results. Interpret and evaluate measurements from simple methods to measure the different reaction times of students and evaluate the effect of various factors on thinking distance based on given data. |  |  |
| The braking distance of a vehicle can be affected by adverse road and weather conditions and poor condition of the vehicle. Adverse road conditions include wet or icy conditions. Poor condition of the vehicle is limited to the vehicle's brakes or tyres. |  |  |
| Explain the factors which affect the distance required for road transport vehicles to come to rest in emergencies, and the implications for safety and estimate how the distance required for road vehicles to stop in an emergency varies over a range of typical speeds. |  |  |
| When a force is applied to the brakes of a vehicle, work done by the friction force between the brakes and the wheel reduces the kinetic energy of the vehicle and the temperature of the brakes increases. The greater the speed of a vehicle the greater the braking force needed to stop the vehicle in a certain distance. The greater the braking force the greater the deceleration of the vehicle. Large decelerations may lead to brakes overheating and/or loss of control. |  |  |
| Explain the dangers caused by large decelerations and (HT only) estimate the forces involved in the deceleration of road vehicles in typical situations on a public road. |  |  |

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| **P5.7 Momentum (HT only)** | | |
| Momentum is defined by the equation: momentum = mass × velocity p  = m v  momentum, p, in kilograms metre per second, kg m/s mass, m, in kilograms, kg velocity, v, in metres per second, m/s |  |  |
| In a closed system, the total momentum before an event is equal to the total momentum after the event. This is called conservation of momentum. |  |  |
| Use the concept of momentum as a model to: • describe and explain examples of momentum in an event, such as a collision |  |  |

**Videos:**

<https://goo.gl/YTzRGC>

<https://goo.gl/9zwCY8>

**Revision guide reference:**

Higher 201 – 217

Foundation 203 -218

**Physics Unit 6 – Waves**

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| **Unit 6 – Equations I need to know** | **** | **** |
| **wave speed = frequency × wavelength**  metres per second (m/s), hertz (Hz) metres (m) |  |  |
| **4.6.1 Waves in air, fluid and solids** | | |
| Waves may be either transverse or longitudinal. The ripples on a water surface are an example of a transverse wave. Longitudinal waves show areas of compression and rarefaction. Sound waves travelling through air are longitudinal. |  |  |
| Describe the difference between longitudinal and transverse waves. |  |  |
| Describe evidence that, for both ripples on a water surface and sound waves in air, it is the wave and not the water or air itself that travels. |  |  |
| Describe wave motion in terms of their amplitude, wavelength, frequency and period. The amplitude of a wave is the maximum displacement of a point on a wave away from its undisturbed position. The wavelength of a wave is the distance from a point on one wave to the equivalent point on the adjacent wave. The frequency of a wave is the number of waves passing a point each second. |  |  |
| period = 1/frequency T = 1/f  period, T, in seconds, frequency, f, in hertz, Hz |  |  |
| The wave speed is the speed at which the energy is transferred (or the wave moves) through the medium. All waves obey the wave equation: wave speed = frequency × wavelength v  = f  λ  wave speed, v, in metres per second, m/s frequency, f, in hertz, Hz wavelength, λ, in metres, m |  |  |
| Identify amplitude and wavelength from given diagrams |  |  |
| Describe a method to measure the speed of sound waves in air and a method to measure the speed of ripples on a water surface. |  |  |
| **4.6.2 Electromagnetic waves** | | |
| Electromagnetic waves are transverse waves that transfer energy from the source of the waves to an absorber. Electromagnetic waves form a continuous spectrum and all types of electromagnetic wave travel at the same velocity through a vacuum (space) or air. |  |  |
| The waves that form the electromagnetic spectrum are grouped in terms of their wavelength and their frequency. Going from long to short wavelength (or from low to high frequency) the groups are: radio, microwave, infrared, visible light (red to violet), ultraviolet, Xrays and gamma rays. |  |  |
| Our eyes only detect visible light and so detect a limited range of electromagnetic waves. |  |  |
| Give examples that illustrate the transfer of energy by electromagnetic waves. |  |  |
| (HT only) Different substances may absorb, transmit, refract or reflect electromagnetic waves in ways that vary with wavelength. Some effects, for example refraction, are due to the difference in velocity of the waves in different substances. |  |  |
| Construct ray diagrams to illustrate the refraction of a wave at a boundary. |  |  |
| (HT only) Use wave front diagrams to explain refraction in terms of the change of speed that happens when a wave travels from one medium to a different medium. |  |  |
| (HT only) Radio waves can be produced by oscillations in electrical circuits. When radio waves are absorbed they may create an alternating current with the same frequency as the radio wave itself, so radio waves can themselves induce oscillations in an electrical circuit. |  |  |
| Changes in atoms and the nuclei of atoms can result in electromagnetic waves being generated or absorbed over a wide frequency range. Gamma rays originate from changes in the nucleus of an atom. |  |  |
| Ultraviolet waves, X-rays and gamma rays can have hazardous effects on human body tissue. The effects depend on the type of radiation and the size of the dose. Radiation dose (in sieverts) is a measure of the risk of harm resulting from an exposure of the body to the radiation.  1000 millisieverts (mSv) = 1 sievert (Sv) |  |  |
| Ultraviolet waves can cause skin to age prematurely and increase the risk of skin cancer. X-rays and gamma rays are ionising radiation that can cause the mutation of genes and cancer. |  |  |
| Electromagnetic waves have many practical applications. For example: • radio waves – television and radio • microwaves – satellite communications, cooking food • infrared – electrical heaters, cooking food, infrared cameras • visible light – fibre optic communications • ultraviolet – energy efficient lamps, sun tanning • X-rays and gamma rays – medical imaging and treatments. |  |  |
| (HT) Give explanations why each type of electromagnetic wave is suitable for the practical application. |  |  |

**Videos:**

<https://goo.gl/Bvfiy2> - Videos 1 - 5 & 11 – 15 (ignore triple only)

<https://www.my-gcsescience.com/aqa/physics/> (waves topic)

<https://www.youtube.com/watch?v=9JPNVJ_LC3E> – 15 minute video on whole topic

**Revision guide reference:**

Higher page: 218 -226

Foundation page: 219 -228

**Physics Unit 7 – Magnetism and electromagnetism**

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| **4.7.1 Permanent and induced magnetism, magnetic forces and fields** | **** | **** |
| * The poles of a magnet are the places where the magnetic forces are strongest. When two magnets are brought close together they exert a force on each other. * Two like poles repel each other. * Two unlike poles attract each other. * Attraction and repulsion between two magnetic poles are examples of non-contact force. |  |  |
| Recall that a permanent magnet produces its own magnetic field. |  |  |
| Know that an induced magnet is a material that becomes a magnet when it is placed in a magnetic field. Induced magnetism always causes a force of attraction. When removed from the magnetic field an induced magnet loses most/all of its magnetism quickly |  |  |
| Describe:  • the attraction and repulsion between unlike and like poles for permanent magnets  • the difference between permanent and induced magnets. |  |  |
| Know the region around a magnet where a force acts on another magnet or on a magnetic material (iron, steel, cobalt and nickel) is called the magnetic field |  |  |
| State that the force between a magnet and a magnetic material is always one of attraction |  |  |
| Explain that the strength of the magnetic field depends on the distance from the magnet. The field is strongest at the poles of the magnet |  |  |
| Describe the direction of the magnetic field at any point is given by the direction of the force that would act on another north pole placed at that point. The direction of a magnetic field line is from the north (seeking) pole of a magnet to the south(seeking) pole of the magnet |  |  |
| Know that a magnetic compass contains a small bar magnet. The Earth has a magnetic field. The compass needle points in the direction of the Earth’s magnetic field |  |  |
| Describe how to plot the magnetic field pattern of a magnet using a compass |  |  |
| Draw the magnetic field pattern of a bar magnet showing how strength and direction change from one point to another |  |  |
| Explain how the behaviour of a magnetic compass is related to evidence that the core of the Earth must be magnetic |  |  |
| **4.7.2 The motor effect** | | |
| Describe that when a current flows through a conducting wire a magnetic field is produced around the wire. State that the strength of the magnetic field depends on the current through the wire and the distance from the wire |  |  |
| Explain that shaping a wire to form a solenoid increases the strength of the magnetic field created by a current through the wire. Explain the magnetic field inside a solenoid is strong and uniform |  |  |
| Know that the magnetic field around a solenoid has a similar shape to that of a bar magnet. Adding an iron core increases the strength of the magnetic field of a solenoid. An **electromagnet** is a solenoid with an iron core |  |  |
| Describe how the magnetic effect of a current can be demonstrated |  |  |
| Draw the magnetic field pattern for a straight wire carrying a current and for a solenoid (showing the direction of the field) |  |  |
| Explain how a solenoid arrangement can increase the magnetic effect of the current |  |  |
| *When a conductor carrying a current is placed in a magnetic field the magnet producing the field and the conductor exert a force on each other. This is called the motor effect* |  |  |
| *Students should be able to show that Fleming's left-hand rule represents the relative orientation of the force, the current in the conductor and the magnetic field* |  |  |
| *Students should be able to recall the factors that affect the size of the force on the conductor* |  |  |
| *For a conductor at right angles to a magnetic field and carrying a*  *current:*  *force = magnetic flux density × current × length*  *F = B I l*  *force, F, in newtons, N*  *magnetic flux density, B, in tesla, T*  *current, I, in amperes, A (amp is acceptable for ampere)*  *length, l, in metres, m* |  |  |
| Know that a coil of wire carrying a current in a magnetic field tends to rotate. This is the basis of an electric motor |  |  |
| Explain how the force on a conductor in a magnetic field causes the rotation of the coil in an electric motor |  |  |

**Videos:**

<https://goo.gl/yYAq2G> - Videos 1-6.

**Revision guide reference:**

Higher pages: 227 - 231

Foundation pages: 229 – 231

**Physics Required Practicals**

**Paper 1**

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| **Required practical activity 1:** An investigation to determine the specific heat capacity of one or more materials. The investigation will involve linking the decrease of one energy store (or work done) to the increase in temperature and subsequent increase in thermal energy stored |
| **Required practical activity 2 (Triple science only)** Investigate the effectiveness of different materials as thermal insulators and the factors that may affect the thermal insulation properties of a material |
| **Required practical activity 3:** Use circuit diagrams to set up and check appropriate circuits to investigate the factors affecting the resistance of electrical circuits. This should include:  • the length of a wire at constant temperature  • combinations of resistors in series and parallel. |
| **Required practical activity 4:** Use circuit diagrams to construct appropriate circuits to investigate the I–V characteristics of a variety of circuit elements including a filament lamp, a diode and a resistor at constant temperature |
| **Required practical activity 5:** Use appropriate apparatus to make and record the measurements needed to determine the densities of regular and irregular solid objects and liquids. Volume should be determined from the dimensions of a regularly shaped object and by a displacement technique for irregularly shaped objects. Dimensions to be measured using appropriate apparatus such as a ruler, micrometer or Vernier callipers |

**Paper 2**

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| **Required practical activity 6:** Investigate the relationship between force and extension for a spring |
| **Required practical activity 7:** Investigate the effect of varying the force on the acceleration of an object of constant mass and the effect of varying the mass of an object on the acceleration produced by a constant force. |
| **Required practical activity 8:** Make observations to identify the suitability of apparatus to measure the frequency, wavelength and speed of waves in a ripple tank and waves in a solid and take appropriate measurements |
| **Required practical activity 9 (Triple science only):** Investigate the reflection of light by different types of surface and the refraction of light by different substances. |
| **Required practical activity 10 (Triple science only):** Investigate how the amount of infrared radiation absorbed or radiated by a surface depends on the nature of that surface |

**Videos:**

**Paper 1**

Required practical 1: <https://goo.gl/NaH8bb>

Required practical 2: <https://goo.gl/KXz6Gm>

Required practical 3: [https://goo.gl/zkzdE9/](https://goo.gl/zkzdE9%20/) <https://goo.gl/jwFrtV>

Required practical 4: <https://goo.gl/B1q99t>

Required practical 5: <https://goo.gl/TxfGrL>

**Paper 2**

Required practical 6: <https://goo.gl/cXDW64>

Required practical 7: <https://goo.gl/Hz7PfF>

Required practical 8: <https://goo.gl/oxiGuf>

Required practical 9: <https://goo.gl/HPvu1w>

Required practical 10: <https://goo.gl/thDfD6>