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| OCR Gateway: Physics A GCSE specification | **Revision Guide page reference**  **ISBN**  9781407176895 | **Exam Practice Book page reference**  **ISBN**  9781407176901 | **Revision and Exam Practice Book page reference**  **ISBN**  9781407176918 |
| For GCSE exams 2018 onwards |
| **Higher Tier in bold** |
| Paper 1 assesses content from Topics P1-P4 and P9 | | | |
| Topic P1: Matter | | | |
| P1.1 The particle model | | | |
| P1.1a describe how and why the atomic model has changed over time  To include the Thomson, Rutherford (alongside Geiger and Marsden) and Bohr models | 51 | 45 | 53, 183 |
| P1.1b describe the atom as a positively charged nucleus 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 | 49-50 | 42-4 | 51-2, 180-2 |
| P1.1c recall the typical size (order of magnitude) of atoms and small molecules  To include knowledge that it is typically 1x10–10m | 49-50 | 42-4 | 51-2, 180-2 |
| P1.1d define density | 41 | 36 | 43, 174 |
| P1.1e explain the differences in density between the different states of matter in terms of the arrangements of the atoms and molecules | 41-4 | 36-7 | 43-6, 174-5 |
| P1.1f apply the relationship between density, mass and volume to changes where mass is conserved | 41-2 | 37 | 43-4, 175 |
| P1.2 Changes of state | | | |
| P1.2a describe how mass is conserved when substances melt, freeze, evaporate, condense or sublimate | 41-4 | 37 | 43-6, 175 |
| P1.2b describe that these physical changes differ from chemical changes because the material recovers its original properties if the change is reversed | 43-4 | 37 | 45-6, 175 |
| P1.2c describe how heating a system will change the energy stored within the system and raise its temperature or produce changes of state | 13-5, 43-4 | 13, 37 | 15-7, 45-6, 151, 175 |
| P1.2d define the term specific heat capacity and distinguish between it and the term specific latent heat | 13-5, 43-4 | 13, 37 | 15-7, 45-6, 151, 175 |
| P1.2e apply the relationship between change in internal energy of a material and its mass, specific heat capacity and temperature change to calculate the energy change involved | 13-5 | 13 | 15-7, 151 |
| P1.2f apply the relationship between specific latent heat and mass to calculate the energy change involved in a change of state | 43-4 | 37 | 45-6, 175 |
| P1.3 Pressure | | | |
| P1.3a explain how the motion of the molecules in a gas is related both to its temperature and its pressure  To include application to closed systems only | 45-7 | 40-1 | 47-9, 178-9 |
| P1.3b Explain the relationship between the temperature of a gas and its pressure at constant volume (qualitative only) | 45-7 | 40-1 | 47-9, 178-9 |
| P1.3c recall that gases can be compressed or expanded by pressure changes and that the pressure produces a net force at right angles to any surface | 45-7 | 40-1 | 47-9, 178-9 |
| P1.3d explain how increasing the volume in which a gas is contained, at constant temperature can lead to a decrease in pressure behaviour regarding particle velocity and collisions | 45-7, 76-7 | 40-1, 62-4 | 47-9, 78-9, 178-9, 200-2 |
| **P1.3e explain how doing work on a gas can increase its temperature**  **To include examples such as a bicycle pump** | **45-7** | **40-1** | **47-9, 178-9** |
| P1.3f describe a simple model of the Earth’s atmosphere and of atmospheric pressure  To include an assumption of uniform density; knowledge of layers is not expected | 77 | 63 | 79, 201 |
| **P1.3h describe the factors which influence floating and sinking** | 76-7 | 62-4 | 78-9, 200-2 |
| **P1.3i explain why pressure in a liquid varies with depth and density and how this leads to an upwards force on a partially submerged object** | 45-7, 76-7 | 40-1, 62-4 | 47-9, 78-9, 178-9, 200-2 |
| **P1.3j calculate the differences in pressure at different depths in a liquid**  **To include knowledge that g is the strength of the gravitational field and has a value of 10N/kg near the Earth’s surface** | 45-7, 76-7 | 40-1, 62-4 | 47-9, 78-9, 178-9, 200-2 |
| Topic P2: Forces | | | |
| P2.1 Motion | | | |
| P2.1a describe how to measure distance and time in a range of scenarios | 78-9 | 65-6 | 80-1, 203-4 |
| P2.1b describe how to measure distance and time and use these to calculate speed | 78-9 | 65-6 | 80-1, 203-4 |
| P2.1c make calculations using ratios and proportional reasoning to convert units and to compute rates  To include conversion from non-SI to SI units | 13, 105 | 15, 48, 88 | 15, 107, 153, 186, 226 |
| P2.1d explain the vector–scalar distinction as it applies to displacement and distance, velocity and speed | 64-5 | 54 | 66-7, 192 |
| P2.1e relate changes and differences in motion to appropriate distance-time, and velocity-time graphs; interpret lines and slopes | 78-81 | 65-8 | 80-3, 203-6 |
| **P2.1f interpret enclosed area in velocity-time graphs** | **78-81** | **65-8** | **80-3, 203-6** |
| P2.1g calculate average speed for non-uniform motion | 78-9 | 65-6 | 80-1, 203-4 |
| P2.1h apply formulae relating distance, time and speed, for uniform motion, and for motion with uniform acceleration | 78-81 | 65-70 | 80-3, 203-8 |
| P2.2 Newton’s laws | | | |
| P2.2a recall examples of ways in which objects interact  To include electrostatics, gravity, magnetism and by contact (including normal contact force and friction) | 38-9, 64-5 | 34-5, 54-5 | 40-1, 66-7, 172-3, 192-3 |
| P2.2b describe how such examples involve interactions between pairs of objects which produce a force on each object | 85-7 | 71-3 | 87-9, 209-211 |
| P2.2c represent such forces as vectors  To include drawing free body force diagrams to demonstrate understanding of forces acting as vectors | 64-5 | 54-5 | 66-7, 192-3 |
| P2.2d apply Newton’s First Law to explain the motion of an object moving with uniform velocity and also an object where the speed and/or direction change  To include looking at forces on one body and resultant forces and their effects (qualitative only) | 85-7 | 71-3 | 87-9, 209-211 |
| **P2.2e use vector diagrams to illustrate resolution of forces, a net force (resultant force), and equilibrium situations**  **To include scale drawings** | 67 | 56-7 | 69, 194-5 |
| **P2.2f describe examples of the forces acting on an isolated solid object or system**  **To include examples of objects that reach terminal velocity for example skydivers and applying similar ideas to vehicles** | 84 | 67-8 | 86, 105-6 |
| **P2.2g describe, using free body diagrams, examples where two or more forces lead to a resultant force on an object** | 68 | 56 | 70, 194 |
| **P2.2h describe, using free body diagrams, examples of the special case where forces balance to produce a resultant force of zero (qualitative only)** | 67 | 56 | 69, 194 |
| P2.2i apply Newton’s second law in calculations relating forces, masses and accelerations | 85-7 | 71-3 | 87-9, 209-211 |
| **P2.2j explain that inertia is a measure of how difficult it is to change the velocity of an object and that the mass is defined as the ratio of force over acceleration** | 85-7 | 71-3 | 87-9, 209-211 |
| **P2.2k define momentum and describe examples of momentum in collisions**  **To include an idea of the law of conservation of momentum in elastic collisions** | 90-1 | 76-8 | 92-3, 214-6 |
| P2.2l apply formulae relating force, mass, velocity and acceleration to explain how the changes involved are inter-related | 78-84 | 65-8 | 80-6, 203-6 |
| P2.2m use the relationship between work done, force, and distance moved along the line of action of the force and describe the energy transfer involved | 69-70 | 58 | 71-2, 196 |
| P2.2n calculate relevant values of stored energy and energy transfers; convert between newton-metres and joules | 69-70 | 58 | 71-2, 196 |
| P2.2o explain, with reference to examples, the definition of power as the rate at which energy is transferred | 16 | 14-5 | 18, 152-3 |
| P2.2p recall and apply Newton’s third law  To include application to situations of equilibrium and non-equilibrium | 85-7 | 71-3 | 87-9, 209-211 |
| **P2.2q explain why an object moving in a circle with a constant speed has a changing velocity (qualitative only)** | 79 | 68 | 81, 206 |
| P2.3 Forces in action | | | |
| P2.3a explain that to stretch, bend or compress an object, more than one force has to be applied  To include applications to real life situations | 71-3 | 59-60 | 73-5, 197-8 |
| P2.3b describe the difference between elastic and plastic deformation (distortions) caused by stretching forces | 71-3 | 59-60 | 73-5, 197-8 |
| P2.3c describe the relationship between force and extension for a spring and other simple systems  To include graphical representation of the extension of a spring | 71-3 | 59-60 | 73-5, 197-8 |
| P2.3d describe the difference between linear and non-linear relationships between force and extension | 71-3 | 59-60 | 73-5, 197-8 |
| P2.3e calculate a spring constant in linear cases | 71-3 | 59-60 | 73-5, 197-8 |
| P2.3f calculate the work done in stretching | 71-3 | 59-60 | 73-5, 197-8 |
| P2.3g describe that all matter has a gravitational field that causes attraction, and the field strength is much greater for massive objects | 64-5 | 55 | 66-7, 193 |
| P2.3h define weight, describe how it is measured and describe the relationship between the weight of an object and the gravitational field strength (g) (and) has a value of 10N/kg at the Earth’s surface  To include knowledge that the gravitational field strength is known as g and has a value of 10N/kg | 64-5 | 55 | 66-7, 193 |
| P2.3i recall the acceleration in free fall | 82-4 | 67-8 | 84-6, 205-6 |
| P2.3j apply formulae relating force, mass and relevant physical constants, including gravitational field strength (g), to explore how changes in these are inter-related | 64-5 | 55 | 66-7, 193 |
| P2.3k describe examples in which forces cause rotation  To include location of pivot points and whether a resultant turning force will be in a clockwise or anticlockwise direction | 74-5 | 76-8 | 76-7, 214-6 |
| P2.3l define and calculate the moment of the force in such examples  To include application of the principle of moments for objects which are balanced | 74-5 | 76-8 | 76-7, 214-6 |
| P2.3m explain how levers and gears transmit the rotational effects of forces  To include an understanding of ratios and how this enables gears and levers to work as force multipliers | 74-5 | 76-8 | 76-7, 214-6 |
| P2.3n recall that the pressure in fluids (gases and liquids) causes a net force at right angles to any surface | 76-7 | 62-4 | 78-9, 200-2 |
| P2.3o use the relationship between the force, the pressure and the area in contact  To include an understanding of how simple hydraulic systems work | 76-7 | 62-4 | 78-9, 200-2 |
| Topic P3: Electricity | | | |
| P3.1 Static and charge | | | |
| P3.1a describe that charge is a property of all matter and that there are positive and negative charges. The effects of the charges are not normally seen on bodies containing equal amounts of positive and negative charge, as their effects cancel each other out | 38-9 | 34-5 | 40-1, 172-3 |
| P3.1b describe the production of static electricity, and sparking, by rubbing surfaces, and evidence that charged objects exert forces of attraction or repulsion on one another when not in contact  To include the understanding that static charge only builds up on insulators | 38-9 | 34-5 | 40-1, 172-3 |
| P3.1c explain how transfer of electrons between objects can explain the phenomena of static electricity | 38-9 | 34-5 | 40-1, 172-3 |
| P3.1d explain the concept of an electric field and how it helps to explain the phenomena of static electricity  To include how electric fields relate to the forces of attraction and repulsion | 38-9 | 34-5 | 40-1, 172-3 |
| P3.1e recall that current is a rate of flow of charge (electrons) and the conditions needed for charge to flow  To include conditions for charge to flow: source of potential difference and a closed circuit | 28-9 | 23-5 | 30-1, 161-3 |
| P3.1f recall that current has the same value at any point in a single closed loop | 28-9 | 23-5 | 30-1, 161-3 |
| P3.1g recall and use the relationship between quantity of charge, current and time | 28-9 | 23-5 | 30-1, 161-3 |
| P3.2 Simple circuits | | | |
| P3.2a describe the differences between series and parallel circuits  To include positioning of measuring instruments in circuits and descriptions of the behaviour of energy, current and potential difference | 32-3 | 26-7 | 34-5, 164-5 |
| P3.2b represent d.c. circuits with the conventions of positive and negative terminals, and the symbols that represent common circuit elements  To include diodes, LDRs, ntc thermistors, filament lamps, ammeter, voltmeter and resistors | 34 | 28 | 36, 166 |
| P3.2c recall that current (I) depends on both resistance (R) and potential difference (V) and the units in which these are measured  To include the definition of potential difference | 28-9 | 23-5 | 30-1, 161-3 |
| P3.2d recall and apply the relationship between I, R and V, and that for some resistors the value of R remains constant but that in others it can change as the current changes | 30-1 | 23-5 | 32-3, 161-3 |
| P3.2e explain that for some resistors the value of R remains constant but that in others it can change as the current changes | 30-1 | 23-5 | 32-3, 161-3 |
| P3.2f explain the design and use of circuits to explore such effects  To include components such as wire of varying resistance, filament lamps, diodes, ntc thermistors and LDRs | 29-31 | 23-5 | 31-3, 161-3 |
| P3.2g use graphs to explore whether circuit elements are linear or non-linear | 30-1 | 23-5 | 32-3, 161-3 |
| P3.2h use graphs and relate the curves produced to the function and properties of circuit elements  To include components such as wire of varying resistance, filament lamps, diodes, ntc thermistors and LDRs | 30-1 | 23-5 | 32-3, 161-3 |
| P3.2i explain why, if two resistors are in series the net resistance is increased, whereas with two in parallel the net resistance is decreased (qualitative explanation only) | 30-1 | 23-5 | 32-3, 161-3 |
| P3.2j calculate the currents, potential differences and resistances in d.c. series and parallel circuits  To include components such as wire of varying resistance, filament lamps, diodes, ntc thermistors and LDRs | 29, 31, 34 | 23-5, 28 | 31, 33, 36, 161-3, 166 |
| P3.2k explain the design and use of such circuits for measurement and testing purposes | 29, 31 | 23-5 | 31, 33, 161-3 |
| P3.2l explain how the power transfer in any circuit device is related to the potential difference across it and the current, and to the energy changes over a given time | 28-9 | 23-5 | 30-1, 161-3 |
| P3.2m apply the equations relating potential difference, current, quantity of charge, resistance, power, energy, and time, and solve problems for circuits which include resistors in series, using the concept of equivalent resistance | 28-31 | 23-5 | 30-3, 161-3 |
| Topic P4: Magnetism and magnetic fields | | | |
| P4.1 Magnets and magnetic fields | | | |
| P4.1a describe the attraction and repulsion between unlike and like poles for permanent magnets  To include diagrams of magnetic field patterns around bar magnets to show attraction and repulsion | 111-2 | 94 | 113-4, 232 |
| P4.1b describe the difference between permanent and induced magnets | 111-2, 117-120 | 94-9 | 113-4, 119-122, 232-7 |
| P4.1c describe the characteristics of the magnetic field of a magnet, showing how strength and direction change from one point to another  To include diagrams to show how the strength of the field varies around them and ways of investigating this | 111-2 | 94 | 113-4, 232 |
| P4.1d explain how the behaviour of a magnetic (dipping) compass is related to evidence that the core of the Earth must be magnetic | 112 | 94 | 114, 232 |
| P4.1e describe how to show that a current can create a magnetic effect and describe the directions of the magnetic field around a conducting wire | 111-2 | 94 | 113-4, 232 |
| P4.1f recall that the strength of the field depends on the current and the distance from the conductor | 111-2 | 94 | 113-4, 232 |
| P4.1g explain how solenoid arrangements can enhance the magnetic effect | 113-6 | 96-9 | 115-8, 234-7 |
| P4.2 Uses of magnetism | | | |
| **P4.2a describe how a magnet and a current carrying conductor exert a force on one another** | 113-6 | 96-7 | 115-8, 234-5 |
| **P4.2b show that Fleming’s left-hand rule represents the relative orientations of the force, the current and the magnetic field** | 113-6 | 96-7 | 115-8, 234-5 |
| **P4.2c apply the equation that links the force on a conductor to the magnetic flux density, the current and the length of conductor to calculate the forces involved** | 114 | 96-7 | 116, 234-5 |
| **P4.2d explain how the force exerted from a magnet and a current-carrying conductor is used to cause rotation in electric motors**  **To include an understanding of how electric motors work but knowledge of the structure of a motor is not expected** | 113-6 | 96-7 | 115-8, 234-5 |
| **P4.2e recall that a change in the magnetic field around a conductor can give rise to an induced potential difference across its ends, which could drive a current, generating a magnetic field that would oppose the original change** | 113-6 | 96-7 | 115-8, 234-5 |
| **P4.2f explain how this effect is used in an alternator to generate a.c., and in a dynamo to generate d.c.** | 113-6 | 96-7 | 115-8, 234-5 |
| **P4.2g explain how the effect of an alternating current in one circuit, in inducing a current in another, is used in transformers** | 121-3 | 100-1 | 123-5, 238-9 |
| **P4.2h explain how the ratio of the potential differences across the two depends on the ratio of the numbers of turns in each** | 121-3 | 100-1 | 123-5, 238-9 |
| **P4.2i apply the equations linking the potential differences and numbers of turns in the two coils of a transformer** | 121-3 | 100-1 | 123-5, 238-9 |
| **P4.2j explain the action of the microphone in converting the pressure variations in sound waves into variations in current in electrical circuits, and the reverse effect as used in loudspeakers and headphones**  **To include an understanding of how dynamic microphones work using electromagnetic induction** | 120 | 100 | 122, 238 |
| Paper 2 assesses content from Topics P5-P8 and P9 | | | |
| Topic P5: Waves in matter | | | |
| P5.1 Wave behaviour | | | |
| P5.1a describe wave motion in terms of amplitude, wavelength, frequency and period | 93-5 | 80 | 95-7, 218 |
| P5.1b define wavelength and frequency | 93-5 | 80 | 95-7, 218 |
| P5.1c describe and apply the relationship between these and the wave velocity | 93-5 | 80 | 95-7, 218 |
| P5.1d apply formulae relating velocity, frequency and wavelength (M1c, M3c) M1c, M3c | 93-5 | 80 | 95-7, 218 |
| P5.1e describe differences between transverse and longitudinal waves  To include direction of travel and direction of vibration | 93-5 | 79 | 95-7, 217 |
| P5.1f show how changes, in velocity, frequency and wavelength, in transmission of sound waves from one medium to another, are inter-related | 98-9 | 79-80 | 100-1, 217-9 |
| P5.1g describe the effects of reflection, transmission, and absorption of waves at material interface examples such as ultrasound and sonar | 98-9 | 82-4 | 100-1, 220-2 |
| **P5.1h describe, with examples, processes which convert wave disturbances between sound waves and vibrations in solids**  **To include knowledge of a simple structure of the parts of the ear is expected** | 98-9 | 83-4 | 100-1, 221-2 |
| **P5.1i explain why such processes only work over a limited frequency range, and the relevance of this to human hearing**  **To include why hearing (audition) changes due to ageing** | 98-9 | 83-4 | 100-1, 221-2 |
| P5.1j describe how ripples on water surfaces are used to model transverse waves whilst sound waves in air are longitudinal waves, and how the speed of each may be measured | 95 | 79 | 97, 217 |
| P5.1k describe evidence that in both cases it is the wave and not the water or air itself that travels | 95 | 79 | 97, 217 |
| P5.2 The electromagnetic spectrum | | | |
| P5.2a recall that electromagnetic waves are transverse and are transmitted through space where all have the same velocity | 100-2 | 85-6 | 102-4, 223-4 |
| P5.2b explain that electromagnetic waves transfer energy from source to absorber  To include examples from a range of electromagnetic waves | 100-2 | 85-6 | 102-4, 223-4 |
| P5.2c apply the relationships between frequency and wavelength across the electromagnetic spectrum | 100-2 | 85-6 | 102-4, 223-4 |
| P5.2d describe the main groupings of the electromagnetic spectrum and that these groupings range from long to short wavelengths and from low to high frequencies  To include radio, microwave, infra-red, visible (red to violet), ultraviolet, X-rays and gamma-rays | 100-2 | 85-6 | 102-4, 223-4 |
| P5.2e describe that our eyes can only detect a limited range of the electromagnetic spectrum | 100-2 | 85-6 | 102-4, 223-4 |
| P5.2f recall that light is an electromagnetic wave | 100-2 | 85-6 | 102-4, 223-4 |
| P5.2g give examples of some practical uses of electromagnetic waves in the radio, micro-wave, infra-red, visible, ultra-violet, X-ray and gamma-ray regions | 100-2 | 85-6 | 102-4, 223-4 |
| P5.2h describe how ultra-violet waves, X-rays and gamma-rays can have hazardous effects, notably on human bodily tissues | 100-2 | 85-6 | 102-4, 223-4 |
| **P5.2i explain, in qualitative terms, how the differences in velocity, absorption and reflection between different types of waves in solids and liquids can be used both for detection and for exploration of structures which are hidden from direct observation, notably in our bodies**  **To include the use of infra-red, X-rays, gamma rays and ultrasound as an alternative in medical imaging** | 100-2 | 85-6 | 102-4, 223-4 |
| **P5.2j recall that radio waves can be produced by, or can themselves induce, oscillations in electrical circuits** | 101 | 85 | 103, 223 |
| P5.3 Wave interactions | | | |
| **P5.3a recall that different substances may absorb, transmit, refract, or reflect electromagnetic waves in ways that vary with wavelength** | 100-2 | 85-6 | 102-4, 223-4 |
| **P5.3b explain how some effects are related to differences in the velocity of electromagnetic waves in different substances** | 100-2 | 85-6 | 102-4, 223-4 |
| P5.3c use ray diagrams to illustrate reflection, refraction and the similarities and differences between convex and concave lenses (qualitative only)  To include how the behaviour of convex and concave lenses determine how they may be used, for example, to correct vision | 96-7 | 82 | 98-9, 220 |
| P5.3d construct two-dimensional ray diagrams to illustrate reflection and refraction (qualitative only –equations not needed) | 96-7 | 82 | 98-9, 220 |
| P5.3e explain how colour is related to differential absorption, transmission and reflection  To include specular reflection and scattering | 106-7 | 89-90 | 108-9, 227-8 |
| Topic P6: Radioactivity | | | |
| P6.1 Radioactive emissions | | | |
| P6.1a recall that atomic nuclei are composed of both protons and neutrons, that the nucleus of each element has a characteristic positive charge | 49-50 | 42-3 | 51-2, 180-1 |
| P6.1b recall that atoms of the same elements can differ in nuclear mass by having different numbers of neutrons | 49-50 | 42-3 | 51-2, 180-1 |
| P6.1c Use the conventional representation for nuclei to relate the differences between isotopes  To include identities, charges and masses | 49-50 | 42-3 | 51-2, 180-1 |
| P6.1d recall that some nuclei are unstable and may emit alpha particles, beta particles, or neutrons, and electromagnetic radiation as gamma rays | 52-3 | 46 | 54-5, 184 |
| P6.1e relate these emissions to possible changes in the mass or the charge of the nucleus, or both | 52-3 | 46 | 54-5, 184 |
| P6.1f use names and symbols of common nuclei and particles to write balanced equations that represent radioactive decay | 52-3 | 46-7 | 54-5, 184-5 |
| P6.1g balance equations representing the emission of alpha-, beta- or gamma-radiation in terms of the masses, and charges of the atoms involved | 54 | 47 | 56, 185 |
| P6.1h recall that in each atom its electrons are arranged at different distances from the nucleus, that such arrangements may change with absorption or emission of electromagnetic radiation and that atoms can become ions by loss of outer electrons  To include knowledge that inner electrons can be ‘excited’ when they absorb energy from radiation and rise to a higher energy level. When this energy is lost by the electron it is emitted as radiation. When outer electrons are lost this is called ionisation | 49-50 | 42-3 | 51-2, 180-1 |
| P6.1i recall that changes in atoms and nuclei can also generate and absorb radiations over a wide frequency range  To include an understanding that these types of radiation may be from any part of the electromagnetic spectrum which includes gamma rays | 52-3 | 46 | 54-5, 184 |
| P6.1j explain the concept of half-life and how this is related to the random nature of radioactive decay | 56-8 | 48 | 58-60, 186 |
| **P6.1k calculate the net decline, expressed as a ratio, during radioactive emission after a given (integral) number of half-lives** | 56-8 | 48 | 58-60, 186 |
| P6.1l recall the differences in the penetration properties of alpha-particles, beta-particles and gamma-rays | 52-3 | 46 | 54-5, 184 |
| P6.2 Uses and hazards | | | |
| P6.2a recall the differences between contamination and irradiation effects and compare the hazards associated with these two | 59-60 | 49-52 | 61-2, 187-190 |
| P6.2b explain why the hazards associated with radioactive material differ according to the half-life involved | 59-60 | 49-52 | 61-2, 187-190 |
| P6.2c describe the different uses of nuclear radiations for exploration of internal organs, and for control or destruction of unwanted tissue | 59-60 | 49-52 | 61-2, 187-190 |
| P6.2d recall that some nuclei are unstable and may split, and relate such effects to radiation which might emerge, to transfer of energy to other particles and to the possibility of chain reactions  To include knowledge of the term nuclear fission | 61-2 | 53 | 63-4, 191 |
| P6.2e describe the process of nuclear fusion  To include knowledge that mass may be converted into the energy of radiation | 61-2 | 53 | 63-4, 191 |
| Topic P7: Energy | | | |
| P7.1 Work done | | | |
| P7.1a describe for situations where there are energy transfers in a system, that there is no net change to the total energy of a closed system (qualitative only)  To include the law of conservation of energy | 17-8 | 16 | 19-20, 154 |
| P7.1b describe all the changes involved in the way energy is stored when a system changes for common situations  To include 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 | 10-2, 17-8 | 8-12, 16 | 12-3, 19-20, 146-150, 154 |
| P7.1c describe the changes in energy involved when a system is changed by heating (in terms of temperature change and specific heat capacity), by work done by forces, and by work done when a current flows | 13-5 | 13 | 15-7, 151 |
| P7.1d make calculations of the energy changes associated with changes in a system, recalling or selecting the relevant equations for mechanical, electrical, and thermal processes; thereby express in quantitative form and on a common scale the overall redistribution of energy in the system  To include work done by forces, current flow, through heating and the use of kWh to measure energy use in electrical appliances in the home | 10-2, 17-8 | 8-12, 16 | 12-4, 19-20, 146-150, 154 |
| P7.1e calculate the amounts of energy associated with a moving body, a stretched spring and an object raised above ground level | 8-12 | 8-12 | 10-4, 146-150 |
| P7.2 Power and efficiency | | | |
| P7.2a describe, with examples, the process by which energy is dissipated, so that it is stored in less useful ways | 19 | 17 | 21, 155 |
| P7.2b describe how, in different domestic devices, energy is transferred from batteries or the a.c. from the mains  To include how energy may be wasted in the transfer to and within motors and heating devices | 19, 35-7 | 17, 28 | 21, 37-9, 155, 166 |
| P7.2c describe, with examples, the relationship between the power ratings for domestic electrical appliances and how this is linked to the changes in stored energy when they are in use | 35-7 | 28 | 37-9, 166 |
| P7.2d calculate energy efficiency for any energy transfer | 19 | 17 | 21, 155 |
| **P7.2e describe ways to increase efficiency** | 19 | 17 | 21, 155 |
| P7.2f explain ways of reducing unwanted energy transfer  To include lubrication and thermal insulation | 19 | 17 | 21, 155 |
| P7.2g describe how the rate of cooling of a building is affected by the thickness and thermal conductivity of its walls (qualitative only) | 17-8 | 16 | 19-20, 154 |
| Topic P8: Global challenges | | | |
| P8.1a recall typical speeds encountered in everyday experience for wind and sound, and for walking, running, cycling and other transportation systems | 78-9 | 65-6 | 80-1, 203-4 |
| P8.1b estimate the magnitudes of everyday accelerations | 82-4 | 67 | 84-6, 205 |
| P8.1c make calculations using ratios and proportional reasoning to convert units and to compute rates  To include conversion from non-SI to SI units | 80-2 | 65-8 | 82-4, 203-6 |
| P8.1d explain methods of measuring human reaction times and recall typical results | 88-9 | 74-5 | 90-1, 212-3 |
| P8.1e explain the factors which affect the distance required for road transport vehicles to come to rest in emergencies and the implications for safety  To include factors that affect thinking and braking distance and overall stopping distance | 88-9 | 74-5 | 90-1, 212-3 |
| P8.1f estimate how the distances required for road vehicles to stop in an emergency, varies over a range of typical speeds | 88-9 | 74-5 | 90-1, 212-3 |
| P8.1g explain the dangers caused by large decelerations | 88-9 | 74-5 | 90-1, 212-3 |
| **P8.1h estimate the forces involved in typical situations on a public road** | 88-9 | 74-5 | 90-1, 212-3 |
| P8.1i estimate, for everyday road transport, the speed, accelerations and forces involved in large accelerations | 88-9 | 74-5 | 90-1, 212-3 |
| P8.2 Powering Earth | | | |
| P8.2a describe the main energy sources available for use on Earth, compare the ways in which they are used and distinguish between renewable and non-renewable sources  To include fossil fuels, nuclear fuel, bio-fuel, wind, hydro-electricity, tides and the Sun | 21-3 | 18-9 | 23-5, 156-7 |
| P8.2b explain patterns and trends in the use of energy resources  To include the changing use of different resources over time | 21-3 | 18-9 | 23-5, 156-7 |
| P8.2c recall that, in the national grid, electrical power is transferred at high voltages from power stations, and then transferred at lower voltages in each locality for domestic use | 37 | 32 | 39, 170 |
| P8.2d recall that step-up and step-down transformers are used to change the potential difference as power is transferred from power stations | 37 | 32 | 39, 170 |
| P8.2e explain how the national grid is an efficient way to transfer energy | 37 | 32 | 39, 170 |
| **P8.2f link the potential differences and numbers of turns of a transformer to the power transfer involved; relate this to the advantages of power transmission at high voltages** | 37 | 32 | 39, 170 |
| P8.2g recall that the domestic supply in the UK is a.c. at 50Hz and about 230 volts | 35-7 | 32 | 37-9, 170 |
| P8.2h explain the difference between direct and alternating voltage | 34 | 29 | 36, 167 |
| P8.2i recall the differences in function between the live, neutral and earth mains wires, and the potential differences between these wires | 34 | 29 | 36, 167 |
| P8.2j explain that a live wire may be dangerous even when a switch in a mains circuit is open, and explain the dangers of providing any connection between the live wire and earth | 34 | 29 | 36, 167 |
| P8.3 Beyond Earth | | | |
| P8.3a explain the red-shift of light as seen from galaxies which are receding (qualitative only). The change with distance of each galaxy’s speed is evidence of an expanding universe  To include understanding of changes in frequency and wavelength | 128-9 | 107-8 | 130-1, 245-6 |
| P8.3b explain how red shift and other evidence can be linked to the Big-Bang model | 128-9 | 107-8 | 130-1, 245-6 |
| P8.3c recall that our Sun was formed from dust and gas drawn together by gravity and explain how this caused fusion reactions, leading to equilibrium between gravitational collapse and expansion due to the energy released during fusion  To include lifecycle of a star | 127 | 104 | 129, 242 |
| P8.3d explain that all bodies emit radiation, and that the intensity and wavelength distribution of any emission depends on their temperatures  To include an understanding that hot objects can emit a continuous range of electromagnetic radiation at different energy values and therefore frequencies and wavelengths | 108-9, 128 | 91-2, 107-8 | 110-1, 130, 229-230, 245-6 |
| P8.3e recall the main features of our solar system, including the similarities and distinctions between the planets, their moons, and artificial satellites  To include the 8 planets and knowledge of minor planets, geostationary and polar orbits for artificial satellites and how these may be similar to or differ from natural satellites | 125-6 | 102 | 127-8, 240 |
| **P8.3f explain for circular orbits, how the force of gravity can lead to changing velocity of a planet but unchanged speed (qualitative only)** | 126 | 105 | 128, 243 |
| **P8.3g explain how, for a stable orbit, the radius must change if this speed changes (qualitative only)** | 126 | 105 | 128, 243 |
| **P8.3h explain how the temperature of a body is related to the balance between incoming radiation absorbed and radiation emitted; illustrate this balance using everyday examples and the example of the factors which determine the temperature of the Earth**  **To include an understanding that Earth’s atmosphere affects the electromagnetic radiation from the Sun that passes through it** | 108-9 | 91-2 | 110-1, 229-230 |
| **P8.3i explain, in qualitative terms, how the differences in velocity, absorption and reflection between different types of waves in solids and liquids can be used both for detection and for exploration of structures which are hidden from direct observation, notably in the Earth’s core and in deep water**  **To include P and S waves, use of sonar** | 98-9 | 83-4 | 100-1, 221-2 |