GCSE (9-1)

Separate

Physics 1

### Topics common to Paper 1 and Paper 2

#### Topic 1 – Key concepts of physics

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| **Students should:** | | **Maths skills** |
| 1.1 | Recall and use the SI unit for physical quantities:  *M metre (distance), kg kilogram (mass), s second (time),*  *A ampere (current), K Kelvin (absolute temperature), mol mole (amount of chemical substance), Hz Hertz (frequency), N Newton (Force and weight), J Joule (energy), W Watts (power), Pa Pascal (pressure), C Coulomb (electrical charge), V Volts (Voltage/potential difference), T Tesla (magnetic flux density), Ω Ohm (electrical resistance)* |  |
| 1.2 | Recall and use multiples and sub-multiples of units, including giga (G), mega (M), kilo (k), centi (c), milli (m), micro (μ) and nano (n). This often involves multiplying or dividing by 1000. *For example, 1 kilogram is 1000 grams. 100 micrometres is 0.1 millimetres. Careful with centi as centimetres are a hundredth of a metre.* | 3c |
| 1.3 | Be able to convert between different units, including hours to seconds | 1c |
| 1.4 | Use significant figures and standard form where appropriate  *Remember 1.23 is 3 significant figures and so is 0.123.*  *100000 is 1 x 105* | 1b |

### Topics for Paper 1

#### Topic 2 – Motion and forces

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| **Students should:** | | **Maths skills** |
| 2.1 | Explain that a scalar quantity has magnitude (size) but no specific direction |  |
| 2.2 | Explain that a vector quantity has both magnitude (size) and a specific direction | 5b |
| 2.3 | Explain the difference between vector and scalar quantities | 5b |
| 2.4 | Recall vector and scalar quantities, including: a displacement/distance  b velocity/speed  c acceleration   1. force 2. weight/mass f momentum g energy |  |
| 2.5 | Recall that velocity is speed in a stated direction | 5b |
| 2.6 | Recall and use the equations:   1. (average) speed (metre per second, m/s) = distance (metre, m) ÷ time (s) 2. distance travelled (metre, m) = average speed (metre per second, m/s) × time (s) | 1a, 1c, 1d 2a  3a, 3c, 3d |
| 2.7 | Analyse distance/time graphs including determination of speed from the gradient.  *Gradient is rise over run between 2 points using the numbers on a graph scale.* | 2a  4a, 4b, 4d, 4e |
| 2.8 | **Recall** and use the equation:  acceleration (metre per second squared, m/s2) = change in velocity (metre per second, m/s) ÷ time taken (second, s)  *v* *u*  *a*   *t* | 1a, 1c, 1d 2a  3a, 3b, 3c, 3d |
| 2.9 | Use the equation:  *v*2 *u* 2 2 *a* *x*.  *v is final velocity, u is start velocity, a is acceleration and x is distance travelled.* | 1a, 1c, 1d 2a  3a, 3c, 3d |

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| **Students should:** | | **Maths skills** |
| 2.10 | Analyse velocity/time graphs to:   1. compare acceleration from gradients qualitatively. *This means a steeper line shows a larger acceleration.* 2. calculate the acceleration from the gradient (for uniform acceleration only). *Gradient is rise over run between 2 points using the numbers on a graph scale.* 3. determine the distance travelled using the area between the graph line and the time axis (for uniform acceleration only). *This means the area under the graph. It will be a triangle, square/rectangle or a combination of both.* | 1a, 1c, 1d 2a  4a, 4b, 4c, 4d, 4e, 4f  5c |
| 2.11 | Describe a range of laboratory methods for determining the speeds of objects such as the use of light gates  *You can measure the distance between 2 points and time an object between them. Then s = d/t.*  *Light gates and a computer will do all the calculations of time and distance for you* | 1a, 1d  2a, 2b, 2c, 2f, 2h  3a, 3c, 3d  4a, 4c |
| 2.12 | Recall some typical speeds encountered in everyday experience.  *Wind (5-20m/s) and sound (340m/s), and for walking (1-2 m/s), running (3m/s), cycling (5-6m/s) and other transportation systems. E.g. cars typically 13m/s in towns or 30m/s on a motorway)* |  |
| 2.13 | Recall that the acceleration, *g*, in free fall is 10 m/s2  *Estimate the magnitudes of everyday accelerations by finding their change in velocity and estimating how many seconds they take to speed up or slow down and then use the acceleration equations.* | 1d  2h |
| 2.14 | Recall Newton’s first law and use it in the following situations:  The first law says a resultant force on an object will change its speed or direction.   1. where the resultant force on a body is zero, i.e. *the body is moving at a constant velocity or is at rest. Here the object will continue doing what it was doing before either constant velocity or stationary.* 2. where the resultant force is not zero, i.e. *the speed and/or direction of the body change(s). The resultant force will make the object speed up if the force is in the direction of movement or it will slow down if the force is against the direction of movement.* | 1a, 1d 2a  3a, 3c, 3d |
| 2.15 | **Recall** and use Newton’s second law as:  The force on an object is directly proportional to the acceleration. Force (newton, N) = mass (kilogram, kg) × acceleration (metre per second squared, m/s2)  *F* *m* *a* | 1a, 1c, 1d 2a  3a, 3b, 3c, 3d |
| 2.16 | Define weight, **recall** and use the equation:  Weight is the force on an object due to gravity/  weight (newton, N) = mass (kilogram, kg) × gravitational field strength (newton per kilogram, N/kg)  *W* *m* *g* | 1a, 1c, 1d 2a  3a, 3b, 3c, 3d |
| 2.17 | Describe how weight is measured.  *Use a Newton meter.* |  |
| 2.18 | Describe the relationship between the weight of a body and the gravitational field strength.  *If the gravitational field that an object is in changes then its weight will change.* | 1c |
| 2.19 | *Core Practical: Investigate the relationship between force, mass and acceleration by varying the masses added to trolleys. Revise this from your practical book! As the trolley became heavier than it had a smaller acceleration with the same force.* | 1a, 1c,1d 2a, 2b, 2f  3a, 3b, 3c, 3d  4a, 4b, 4c, 4d |

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| **Students should:** | | **Maths skills** |
| 2.20 | **Explain that an object moving in a circular orbit at constant speed has a changing velocity.**  *Direction is changing so velocity must be changing as velocity is linked to direction* | 5b |
| 2.21 | **Explain that for motion in a circle there must be a resultant force known as a centripetal force that acts towards the centre of the circle.**  *If an object is changing velocity then a force must be involved.* | 5b |
| 2.22 | **Explain that inertial mass is a measure of how difficult it is to change the velocity of an object (including from rest) and know that it is defined as the ratio of force over acceleration.**  *Inertial mass (kg) = force (N)/ acceleration (m/s2)* | 1c, |
| 2.23 | Recall and apply Newton’s third law both to equilibrium situations and to collision interactions and relate it to the conservation of momentum in collisions.  *The law says that when two objects interact the forces on each of them are equal and opposite)*  *Use the inertia and third law page on your revision guide for a bit of clarity.* | 1a, 1c, 1d 2a  3a, 3b, 3c, 3d |
| 2.24 | **Define momentum, recall and use the equation:**  **momentum (kilogram metre per second, kg m/s) = mass (kilogram, kg) × velocity (metre per second, m/s)**  ***p*** ***m*** ***v*** | 1a, 1c, 1d 2a  3a, 3b, 3c, 3d |
| 2.25 | **Describe examples of momentum in collisions.**  *You may be asked to explain things like the movement of pool balls hitting each other or train carriages hitting each other. Use the momentum page in your revision guide.* | 1a, 1c, 1d 2a  3a, 3b, 3c, 3d |
| 2.26 | **Use Newton’s second law as:**  **force (newton, N) = change in momentum (kilogram metre per second, kg m/s) ÷ time (second, s)**  ***mv*** ***mu***  ***F***   ***t*** | 1a, 1c, 1d 2a  3a, 3b, 3c, 3d |
| 2.27 | Explain methods of measuring human reaction times and recall typical results.  *You could use a computer program or the ruler stick drop.* | 2a, 2b, 2c, 2g |
| 2.28 | Recall that the stopping distance of a vehicle is made up of the sum of the thinking distance and the braking distance | 1a |
| 2.29 | Explain that the stopping distance of a vehicle is affected by a range of factors including:  a the mass of the vehicle.  b the speed of the vehicle   1. the driver’s reaction time 2. the state of the vehicle’s brakes e the state of the road   f the amount of friction between the tyre and the road surface  *More mass gives a larger stopping distance, more speed more distance, slower reactions more distance, bad brakes more distance, icy road or gravel on the road more distance, more friction gives less distance.* | 1c, 1d 2b, 2c, 2h 3b, 3c |

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| **Students should:** | **Maths skills** |
| 2.30 Describe the factors affecting a driver’s reaction time including drugs and distractions.  *Tiredness, alcohol, drugs and distractions like kids in the car all increase reaction time and increase stopping distance as thinking distance will go up.* | 1d 2b, 2h  3c |
| 2.31 Explain the dangers caused by large decelerations and estimate the forces involved in typical situations on a public road.  *If momentum changes very quickly like in a car crash that can give large forces on a person which can cause injury and death. Car crash forces can be into the several thousands of Newtons.* | 1c, 1d,  2c, 2h, 3b, 3c |
| 2.32P Estimate how the distance required for a road vehicle to stop in an emergency varies over a range of typical speeds.  *Remember the typical speeds of a car in various situations and appreciate that faster cars need a much larger distance to stop than when moving slowly. See point below.* | 1a, 1c, 1d 2a  3a, 3b, 3c, 3d |
| 2.33P Carry out calculations on work done to show the dependence of braking distance for a vehicle on initial velocity squared (work done to bring a vehicle to rest equals its initial kinetic energy).  *The kinetic energy a car has needs to be reduced when a car stops. The brakes need to do work that equals the kinetic energy. If a cars speed doubles then the work and distance needed to stop goes up by a factor of 4!* | 1c, 1d  2b, 2h 3b, 3c |

#### Topic 3 – Conservation of energy

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| **Students should:** | | **Maths skills** |
| 3.1 | **Recall** and use the equation to calculate the change in gravitational PE when an object is raised above the ground:  change in gravitational potential energy (joule, J) = mass (kilogram, kg) × gravitational field strength (newton per kilogram, N/kg) × change in vertical height (metre, m)  *GPE* *m* *g* *h* | 1a, 1c, 1d 2a  3a, 3b, 3c, 3d |
| 3.2 | **Recall** and use the equation to calculate the amounts of energy associated with a moving object:  *KE* 1 *m* *v* 2  2 | 1a, 1c, 1d 2a  3a, 3b, 3c, 3d |
| 3.3 | Draw and interpret diagrams to represent energy transfers.  Screen Clipping | 1c  2c |
| 3.4 | Explain what is meant by conservation of energy.  *Energy cannot be created or destroyed it is changed from one form to another by machines.* |  |
| 3.5 | Analyse the changes involved in the way energy is stored when a system changes, *this means what are the starting energies and what energies are they transferred into*  a an object projected upwards or up a slope b a moving object hitting an obstacle  c an object being accelerated by a constant force d a vehicle slowing down  e bringing water to a boil in an electric kettle |  |
| 3.6 | Explain that where there are energy transfers in a closed system there is no net change to the total energy in that system**.**  *i.e. Amount of energy at the start equals energy at the end.* |  |
| 3.7 | Explain that mechanical processes become wasteful when they cause a rise in temperature so dissipating energy in heating the surroundings.  *Dissipate means to spread out.* |  |
| 3.8 | Explain, using examples, how in all system changes energy is dissipated so that it is stored in less useful ways.  *e.g. In a kettle electrical energy is transferred to the water (useful) but quite a lot heats the air and the material of the kettle. (spread out and wasted)* |  |
| 3.9 | Explain ways of reducing unwanted energy transfer including through lubrication, thermal insulation.  *You would lubricate the moving parts of an engine to avoid friction wasting thermal energy. Also a heating system will be insulated to slow down unwanted heat loss.* |  |
| 3.10 | Describe the effects of the thickness and thermal conductivity of the walls of a building on its rate of cooling.  *Thicker insulating materials will reduce the rate that heat is transferred and material with a low thermal conductivity will reduce the rate of heat transfer.* |  |
| 3.11 | **Recall and use the equation:**  useful energy transferred by the device  efficiency  total energy sup plied to the device  *In other words, useful energy out divided by total energy into a machine.* | 1a, 1c, 1d 2a  3a, 3b, 3c, 3d |

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| **Students should:** | | **Maths skills** | |
| 3.12 | Explain how efficiency can be increased. For a particular system describe how the waste energy can be reduced, thus improving the efficiency. |  | |
| 3.13 | Describe the main energy sources available for use on Earth  *(including fossil fuels, nuclear fuel, bio-fuel, wind, hydro- electricity, the tides and the Sun), and compare the ways in which both renewable and non-renewable sources are used. Basically explain why renewables are used more and non-renewables are used less. Also what are the limitations of the renewables? Why aren’t they used all the time? It’s usually down to efficiency.* | 2c, | 2g |
| 3.14 | Explain patterns and trends in the use of energy resources.   * *More people = more electricity BUT appliances are becoming more efficient = using less electricity* * *Pressure from other countries and the public = government introduced targets for using renewables* * *Renewables - Protests over wind farm locations, Unreliable, Research into making them better = TIME and MONEY, Hybrid cars are more expensive than petrol cars* | 2c, | 2g |

#### Topic 4 – Waves

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| **Students should:** | | **Maths skills** |
| 4.1 | Recall that waves transfer energy and information without transferring matter |  |
| 4.2 | Describe evidence that with water and sound waves it is the wave and not the water or air itself that travels. |  |
| 4.3 | Define and use the terms frequency and wavelength as applied to waves.  *Frequency = number of cycles per second*  *wavelength = the distance from one point of a wave to the next identical point.* |  |
| 4.4 | Use the terms amplitude, period, wave velocity and wavefront as applied to waves.  *Frequency =no. complete cycles passing a point each second*  *Amplitude = displacement from rest to crest*  *Period = time taken for 1 cycle (1/f)*  *Wave velocity= speed of the wave*  *Wavefront = front of the wave* |  |
| 4.5 | Describe the difference between longitudinal and transverse waves by referring to sound, electromagnetic, seismic and water waves.  *Sound is longitudinal, electromagnetic waves are transverse and seismic waves can be both.* |  |
| 4.6 | **Recall** and use both the equations below for all waves:  wave speed (metre/second, m/s) = frequency (hertz, Hz)   wavelength (metre, m)  *v* *f* **  wave speed (metre/second, m/s) = distance (metre, m) ÷ time (second, s)  *v* *x t* | 1a, 1b, 1c, 1d 2a  3a, 3b, 3c, 3d |
| 4.7 | Describe how to measure the velocity of sound in air and ripples on water surfaces.  *How to measure speed of waves in* ***water:***  *speed = frequency x wavelength*  *Frequency = count no waves in 10 seconds THEN divide by 10*  *Wavelength = measured on frozen screen*  *How to measure speed of sound in* ***air:***  *speed = frequency (of signal generator) x wavelength (distance between microphone)* | 2g |
| 4.8P | **Calculate depth or distance from time and wave velocity.**  *If a sound wave is sent out an object will reflect it. If you time the reflection, then half it. Multiply this by the speed of the wave and you will have the distance from the source of the wave to the object.* | 1a, 1b, 1c, 1d 2a  3a, 3b, 3c, 3d |
| 4.9P | Describe the effects of a reflection   1. refraction 2. transmission d absorption   of waves at material interfaces (where one material meets another).  *See the wave behavior section in the rev guide.* | 5b |
| 4.10 | Explain how waves will be refracted at a boundary in terms of the change of direction and speed.  *If a wave enters a more dense material at an angle then one edge of the wavefront hits the dense material first and is slowed down, this throws the wave off course.* | 1c 3c  5b |
| 4.11 | **Recall that different substances may absorb, transmit, refract or reflect waves in ways that vary with wavelength.**  *Reflection – wave sent back*  *Refraction – wave changes direction*  *Transmitted – wave travels through*  *Absorbed – wave transfer energy to material* |  |

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| **Students should:** | **Maths skills** |
| P Describe the processes which convert wave disturbances between sound waves and vibrations in solids *(sound in air causes pressure changes and this makes the solid vibrate, the amount of vibration depends on the density and flexibility of the material),* and  * + 1. **explain why such processes only work over a limited frequency range.** *Some are too low or too high to be sensed by the ear or create a sound*     2. **use this to explain the way the human ear works** |  |
| 4.13P **Recall that sound with frequencies greater than 20 000 hertz, Hz, is known as ultrasound** |  |
| 4.14P **Recall that sound with frequencies less than 20 hertz, Hz, is known as infrasound** |  |
| * 1. P **Explain uses of ultrasound and infrasound, including a sonar**      1. **foetal scanning**      2. **exploration of the Earth’s core**   *These are covered in the revision guide!* | 1a, 1b, 1c, 2a  3a, 3b, 3c, 3d  5b |
| 4.16P Describe how changes, if any, in velocity, frequency and wavelength, in the transmission of sound waves from one medium to another are inter-related.  *For an electromagnetic wave the frequency always remains the same no matter what material the wave travels through. So if the speed changes the wavelength will have to change.* | 1a, 1c, 1d 2a  3a, 3c, 3d |
| *4.17 Core Practical: Investigate the suitability of equipment to measure the speed, frequency and wavelength of a wave in a solid and a fluid*  *How to measure speed of waves in* ***water (fluid):***  *speed = frequency x wavelength*  *Frequency = count no waves in 10 seconds THEN divide by 10*  *Wavelength = measured on frozen screen*  *How to measure speed of sound in* ***solids:***  *speed = frequency x wavelength*  *Frequency = computer*  *Wavelength = 2 x rod length* | 2g |

#### Topic 5 – Light and the electromagnetic spectrum

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| **Students should:** | **Maths skills** |
| 5.1P Explain, with the aid of ray diagrams, reflection, refraction and total internal reflection (TIR), including the law of reflection and critical angle | 5a, 5b |
| 5.2P Explain the difference between specular (**from smooth surfaces)** and diffuse reflection (**from rough surfaces**) | 5b |
| 5.3P Explain how colour of light is related to a differential absorption at surfaces.  *E.g. Objects are green because they absorb other colours and reflect green*  b transmission of light through filters.  *Green light passes through green filters. All other light would make filter look black.* |  |
| 5.4P Relate the power of a lens to its focal length and shape. *Powerful means short focal length or fatter lens.* | 5b |
| 5.5P Use ray diagrams to show the similarities and differences in the refraction of light by converging and diverging lenses. *Practise from your revision guide.* | 5b |
| 5.6P Explain the effects of different types of lens in producing real and virtual images.  *Revise which combination of lenses and object position creates these types of image.* | 5b |
| 5.7 Recall that all electromagnetic waves are transverse, that they travel at the same speed in a vacuum |  |
| 5.8 Explain, with examples, that all electromagnetic waves transfer energy from source to observer.  *Infra-red transfers heat etc.* |  |
| 5.9 *Investigate refraction in rectangular glass blocks in terms of the interaction of electromagnetic waves with matter* |  |
| 5.10 Recall the main groupings of the continuous electromagnetic spectrum including (in order) radio waves, microwaves, infrared, visible (including the colours of the visible spectrum), ultraviolet, x-rays and gamma rays |  |
| 5.11 Describe the electromagnetic spectrum as continuous from radio waves to gamma rays and that the radiations within it can be grouped in order of decreasing wavelength and increasing frequency.  *Gamma is high frequency and low wavelength and radio waves are the opposite.* | 1a, 1c 3c |
| 5.12 Recall that our eyes can only detect a limited range of frequencies of electromagnetic radiation.  *I.e. The visible spectrum part of the electromagnetic spectrum.* |  |
| 5.13 **Recall that different substances may absorb, transmit, refract or reflect electromagnetic waves in ways that vary with wavelength** |  |
| 5.14 Explain the effects of differences in the velocities of electromagnetic waves in different substances | 1a, 1c  3c |
| 5.15P Explain that all bodies emit radiation, that the intensity and wavelength distribution of any emission depends on their temperature.  *I.e. very hot objects are white and*  *Slightly cooler objects glow red and all objects emit IR* | 5c |
| 5.16P **Explain that for a body to be at a constant temperature it needs to radiate the same average power that it absorbs** |  |

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| **Students should:** | **Maths skills** |
| 5.17P Explain what happens to a body if the average power it radiates is less or more than the average power that it absorbs.  *Less power radiated then the object heats up and vice versa.* |  |
| 5.18P Explain how the temperature of the Earth is affected by factors controlling the balance between incoming radiation and radiation emitted.  *This is the greenhouse effect so revise it from the rev guide. More CO2 prevents heat being radiated away so warms the earth* |  |
| 5.19P *Core Practical: Investigate how the nature of a surface affects the amount of thermal energy radiated or absorbed* | 1a, 1c, 1d 2a, 2c, 2f 3a, 3c, 3d  4a, 4c |
| 5.20 Recall that the potential danger associated with an electromagnetic wave increases with increasing frequency.  *Gamma is the most dangerous for example. Causes cancer.* |  |
| 5.21 Describe the harmful effects on people of excessive exposure to electromagnetic radiation, including:  a microwaves: internal heating of body cells b infrared: skin burns   1. ultraviolet: damage to surface cells and eyes, leading to skin cancer and eye conditions 2. x-rays and gamma rays: mutation or damage to cells in the body |  |
| * 1. Describe some uses of electromagnetic radiation      1. radio waves: including broadcasting, communications and satellite transmissions      2. microwaves: including cooking, communications and satellite transmissions      3. infrared: including cooking, thermal imaging, short range communications, optical fibres, television remote controls and security systems      4. visible light: including vision, photography and illumination      5. ultraviolet: including security marking, fluorescent lamps, detecting forged bank notes and disinfecting water      6. x-rays: including observing the internal structure of objects, airport security scanners and medical x-rays      7. gamma rays: including sterilising food and medical equipment, and the detection of cancer and its treatment |  |
| 5.23 Recall that radio waves can be produced by, or can themselves induce, oscillations in electrical circuits.*Induce means create.* |  |
| 5.24 Recall that changes in atoms and nuclei can  a generate radiations over a wide frequency range b be caused by absorption of a range of radiations  *Changes could be absorbing light or emitting light or heat, emitting or absorbing particles.* |  |

#### Topic 6 – Radioactivity

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| **Students should:** | | **Maths skills** |
| 6.1 | Describe an atom as a positively charged nucleus, consisting of protons and neutrons, surrounded by negatively charged electrons, with the nuclear radius much smaller than that of the atom and with almost all of the mass in the nucleus | 5b |
| 6.2 | Recall the typical size (order of magnitude) of atoms and small molecules.  *Atoms approx. 10-10m* |  |
| 6.3 | Describe the structure of nuclei of isotopes using the terms atomic (proton) number and mass (nucleon) number and using symbols in the format 13 C | 1a 3a |
| 6.4 | Recall that the nucleus of each element has a characteristic positive charge, but that isotopes of an element differ in mass by having different numbers of neutrons | 2g 5b |
| 6.5 | Recall the relative masses and relative electric charges of protons (1,+1), neutrons (1,0), electrons (virtually 0,-1) and positrons (virtually zero and +1) |  |
| 6.6 | Recall that in an atom the number of protons equals the number of electrons and is therefore neutral |  |
| 6.7 | Recall that in each atom its electrons orbit the nucleus at different set distances from the nucleus,*these are called shells or orbits* | 5b |
| 6.8 | Explain that electrons change orbit when there is absorption or emission of electromagnetic radiation.  *Absorbing energy makes electrons go up levels.* | 5b |
| 6.9 | Explain how atoms may form positive ions by losing outer electrons. | 5b |
| 6.10 | Recall that alpha, β– (beta minus), β+ (positron), gamma rays and neutron radiation are emitted from unstable nuclei in a random process |  |
| 6.11 | Recall that alpha, β– (beta minus), β+ (positron) and gamma  rays are ionising radiations.  *Ionising means to knock electrons completely out of the shell.* |  |
| 6.12 | Explain what is meant by background radiation.  *This is radiation all around us in the atmosphere, e.g. from rocks, the sun or nuclear testing etc.* |  |
| 6.13 | Describe the origins of background radiation from Earth and space |  |
| 6.14 | Describe methods for measuring and detecting radioactivity limited to photographic film and a Geiger–Müller tube.  Radiation blackens a photo film, radiation ionizes the air inside a GM tube causing a small current to flow that can be counted. |  |
| 6.15 | Recall that an alpha particle is equivalent to a helium nucleus (e.g. 2 protons and 2 neutrons), a beta particle is an electron emitted from the nucleus (a neutron splits into a proton and an electron) and a gamma ray is electromagnetic radiation |  |
| 6.16 | Compare alpha, beta and gamma radiations in terms of their abilities to penetrate and ionize.  *Which is most penetrating etc. and which is most ionizing etc.* |  |

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| **Students should:** | **Maths skills** |
| 6.17 Describe how and why the atomic model has changed over time including reference to the plum pudding model and Rutherford alpha particle scattering leading to the Bohr model.  *Check the revision guide for the models of the atoms.* | 5b |
| 6.18 Describe the process of β– decay **(a neutron becomes a proton plus an electron).** Atomic number goes up by one but the mass number stays the same. | 1b, 1c,  3c |
| 6.19 Describe the process of β+ decay **(a proton becomes a**  **neutron plus a positron).** The atomic number goes down by one but the mass number stays the same. | 1b, 1c,  3c |
| 6.20 Explain the effects on the atomic (proton) number and mass (nucleon) number of radioactive decays (α, β, γ and neutron emission) | 1b, 1c, 3c |
| 6.21 Recall that nuclei that have undergone radioactive decay often undergo nuclear rearrangement with a loss of energy as gamma radiation |  |
| 6.22 Use given data to balance nuclear equations in terms of mass and charge see 6.18 and 6.;19.  *Also if alpha is emitted the mass goes down by 4 and the atomic number goes down by 2* | 1b, 1c,  3c |
| 6.23 Describe how the activity of a radioactive source decreases over a period of time.  *Decreases rapidly at first then the rate slows. Learn the shape of the graph.* | 2g  4c |
| 6.24 Recall that the unit of activity of a radioactive isotope is the Becquerel, Bq |  |
| 6.25 Explain that the half-life of a radioactive isotope is the time taken for half the undecayed nuclei to decay or the activity of a source to decay by half | 1c, 1d 2a |
| 6.26 Explain that it cannot be predicted when a particular nucleus will decay but half-life enables the activity of a very large number of nuclei to be predicted during the decay process | 1c, 3d |
| 6.27 Use the concept of half-life to carry out simple calculations on the decay of a radioactive isotope, including graphical representations | 1a, 1b, 1c, 1d 2a, 2g  3a, 3b, 3c, 3d |
| * 1. P Describe uses of radioactivity, including: a household fire (smoke) alarms. *alpha*      1. irradiating food. *gamma*      2. sterilisation of equipment *gamma*      3. tracing and gauging thicknesses *beta*      4. diagnosis and treatment of cancer ***gamma*** |  |
| 6.29 Describe the dangers of ionising radiation in terms of tissue damage and possible mutations and relate this to the precautions needed.  *E.g. radiation can ionize the cells in the body. DNA can be damaged and cells can multiply out of control. CANCER. Precautions, lead shields, limiting x rays etc* |  |
| 6.30P Explain how the dangers of ionising radiation depend on half- life and relate this to the precautions needed.  *A long half-life substance will need precautions as it stays radioactive for a long time.* |  |

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| **Students should:** | **Maths skills** |
| 6.31 Explain the precautions taken to ensure the safety of people exposed to radiation, including limiting the dose for patients and the risks to medical personnel(radiation badges and shields for x rays etc. |  |
| 6.32 Describe the differences between contamination *(radioactive substances on you or in you)* and irradiation (emissions from a radioactive source directed at you)effects and compare the hazards associated with these two. |  |
| 6.33P Compare and contrast the treatment of tumours using radiation applied internally or externally | 5b |
| 6.34P Explain some of the uses of radioactive substances in diagnosis of medical conditions, including PET scanners and tracers |  |
| 6.35P Explain why isotopes used in PET scanners have to be produced nearby.  *They have a very short half-life so are only useful for a short period.* |  |
| 6.36P Evaluate the advantages and disadvantages of nuclear power for generating electricity, including the lack of carbon dioxide emissions, risks, public perception, waste disposal and safety issues |  |
| 6.37P Recall that nuclear reactions, including fission, fusion and radioactive decay, can be a source of energy |  |
| 6.38P Explain how the fission of U-235 produces two daughter nuclei and the emission of two or more neutrons, accompanied by a release of energy.  *Diagram in the revision guide* | 1b, 1c, 3c |
| 6.39P Explain the principle of a controlled nuclear chain reaction |  |
| 6.40P Explain how the chain reaction is controlled in a nuclear reactor, including the action of moderators and control rods *(these are made of Boron and absorb the neutrons)* | 5b |
| 6.41P Describe how thermal (heat) energy from the chain reaction is used in the generation of electricity in a nuclear power station. *Heat boils water into steam and the steam turns a turbine linked to a generator* |  |
| 6.42P Recall that the products of nuclear fission are radioactive |  |
| 6.43P Describe nuclear fusion as the creation of larger nuclei resulting in a loss of mass from smaller nuclei, accompanied by a release of energy, and recognise fusion as the energy source for stars | 1b, 1c, 3c |
| 6.44P Explain the difference between nuclear fusion and nuclear fission. *Comparison in the revision guide* |  |
| 6.45P Explain why nuclear fusion does not happen at low temperatures and pressures, due to electrostatic repulsion of protons *so nuclei cannot easily be brought together* |  |
| 6.46P Relate the conditions for fusion to the difficulty of making a practical and economic form of power station.  *Need to supply lots of energy and a strong magnetic field.* |  |

#### Topic 7 – Astronomy

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| **Students should:** | **Maths skills** |
| 7.1P Explain how and why both the weight of any body and the value of *g* differ between the surface of the Earth and the surface of other bodies in space, including the Moon. **The planets and moons have different masses and therefore gravitational forces** |  |
| 7.2P Recall that our Solar System consists of the Sun (our star), eight planets and their natural satellites (such as our Moon); dwarf planets; asteroids and comets | 5b |
| 7.3P Recall the names and order, in terms of distance from the Sun, of the eight planets  *MeVEMaJSUN* |  |
| 7.4P Describe how ideas about the structure of the Solar System have changed over time, *REVISION GUIDE!* | 5b |
| 7.5P Describe the orbits of moons, planets, comets and artificial satellites | 5b |
| 7.6P Explain for circular orbits how the force of gravity can lead to changing velocity of a planet but unchanged speed.  *Gravity is providing a centripetal force and therefore acceleration. See circular motion!* | 5b |
| 7.7P Explain how, for a stable orbit, the radius must change if orbital speed changes (qualitative only).  *A faster orbit has a larger radius* |  |
| 7.8P Compare the Steady State and Big Bang theories  *REV GUIDE* | 5b |
| 7.9P Describe evidence supporting the Big Bang theory, limited to red-shift Increased wavelength of observed light, suggesting galaxies receding. And the cosmic microwave background (CMB) radiation *(red shifted energy from big bang)* |  |
| 7.10P Recall that as there is more evidence supporting the Big Bang theory than the Steady State theory, it is the currently accepted model for the origin of the Universe |  |
| 7.11P Describe that if a wave source is moving relative to an observer there will be a change in the observed frequency and wavelength.  *Movement away increases wavelength and decreases frequency* | 5b |
| 7.12P Describe the red-shift in light received from galaxies at different distances away from the Earth*.*  *Further away bigger red shift* | 2g  5b |
| 7.13P Explain why the red-shift of galaxies provides evidence for the Universe expanding.  *Furthest galaxies have biggest red shift, moving fastest.* | 5b |
| 7.14P Explain how both the Big Bang and Steady State theories of the origin of the Universe both account for red-shift of galaxies |  |
| 7.15P Explain how the discovery of the CMB radiation led to the Big Bang theory becoming the currently accepted model  *It was created as high-energy gamma radiation just after the Big Bang.*  *It has been travelling through space since then.*  *As the Universe has expanded, it stretched out to longer and longer wavelengths and is now microwave radiation.* |  |

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| **Students should:** | **Maths skills** |
| * 1. P Describe the evolution of stars of similar mass to the Sun through the following stages:      1. Nebula, cloud of dust and gas      2. star (main sequence) c red giant   d white dwarf | 2g |
| 7.17P Explain how the balance between thermal expansion and gravity affects the life cycle of stars.  *E.g. lots of fuel burning provides the thermal expansion to match gravity inwards pull. Fuel runs out gravity wins and star collapses.* |  |
| 7.18P Describe the evolution of stars with a mass larger than the Sun, red super giant, supernova, black hole and neutron star. | 2g |
| 7.19P Describe how methods of observing the Universe have changed over time including why some telescopes are located outside the Earth’s atmosphere  *Space telescopes are located outside the atmosphere so are not affected by clouds and the weather but they are difficult to repair.* |  |