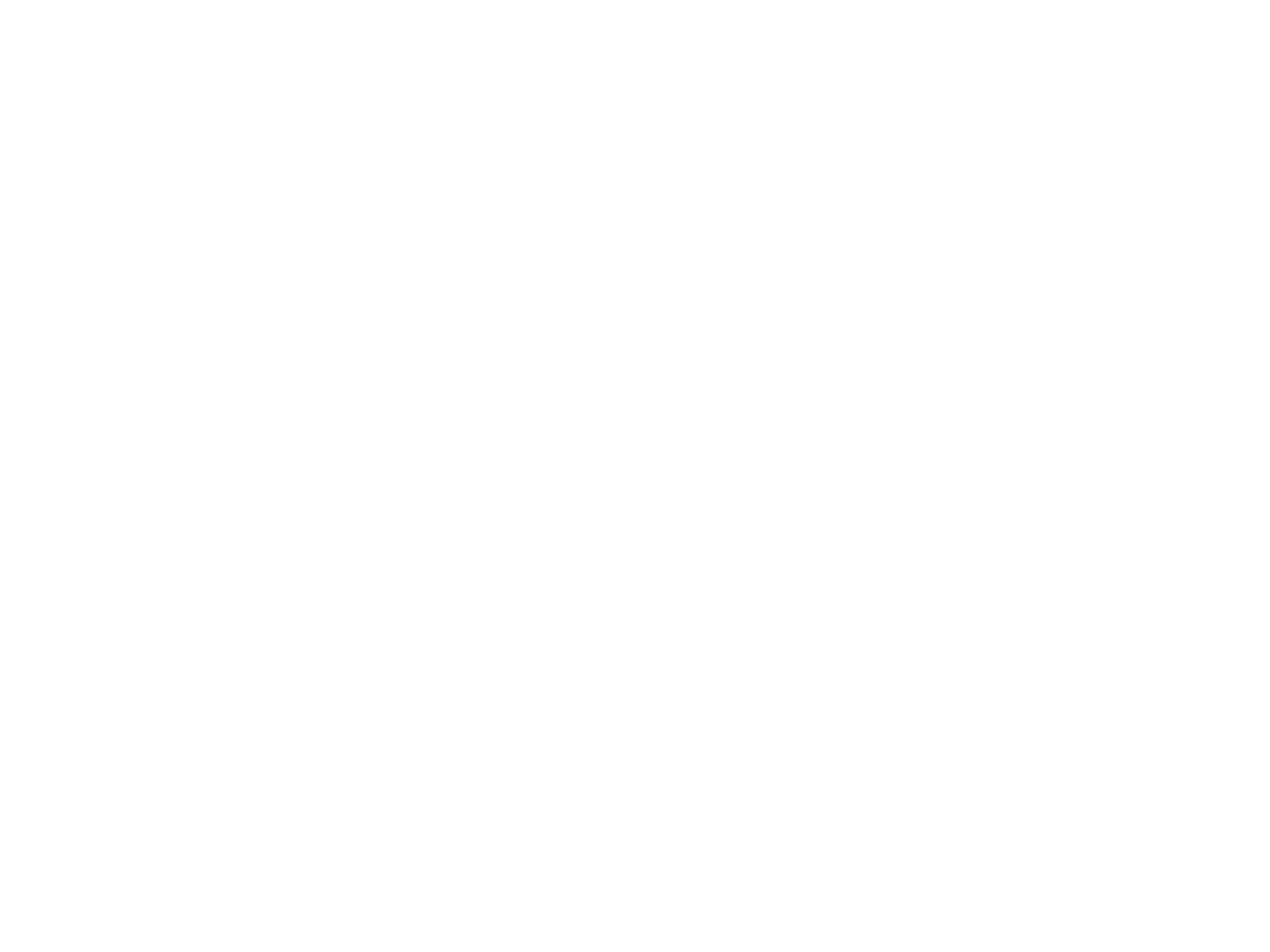
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GCSE (9-1)

***GATEWAY SCIENCE   
PHYSICS A***

**J249**

For first teach in 2016

**Student revision**

**checklist**

Version 1

**[www.ocr.org.uk/physics](http://www.ocr.org.uk/physics)**

# Student revision checklist

## Revision checklists

The tables below can be used as a revision checklist.

For more information please see the [OCR GCSE Gateway Science Physics A specification.](https://www.ocr.org.uk/Images/234600-specification-accredited-gcse-gateway-science-suite-physics-a-j249.pdf)

The table headings are explained below:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Assessable learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| Here is a list of the learning outcomes for this qualification and the content you need to cover and work on.  **Please note the learning outcomes in bold are for Higher tier only.** | You can use the tick boxes to show when you have revised an item and how confident you feel about it.  R = **RED** means you are really unsure and lack confidence; you might want to focus your revision here and possibly talk to your teacher for help.  A = **AMBER** means you are reasonably confident but need some extra practice.  G = **GREEN** means you are very confident.  As your revision progresses, you can concentrate on the **RED** and **AMBER** items in order to turn them into **GREEN** items.  You might find it helpful to highlight each topic in red, orange or green to help you prioritise. | | | You can use the comments column to:   * add more information about the details for each point * add formulae or notes * include a reference to a useful resource * highlight areas of difficulty or things that you need to talk to your teacher about or look up in a textbook. |

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| **P1 Matter** | | | | |
| **P1.1 The particle model** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| 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 |  |  |  |  |
| 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 |  |  |  |  |
| P1.1c recall the typical size (order of magnitude) of atoms and small molecules  *To include* – knowledge that it is typically 1 × 10–10m |  |  |  |  |
| P1.1d define density |  |  |  |  |

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| **P1.1 The particle model** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| P1.1e explain the differences in density between the different states of matter in terms of the arrangements of the atoms and molecules |  |  |  |  |
| P1.1f apply the relationship between density, mass and volume to changes where mass is conserved |  |  |  |  |
| **P1.2 Changes of state** | | | | |
| P1.2a describe how mass is conserved when substances melt, freeze, evaporate, condense or sublimate |  |  |  |  |
| P1.2b describe that physical changes differ from chemical changes because the material recovers its original properties if the change is reversed |  |  |  |  |
| P1.2c describe how heating a system will change the energy stored within the system and raise its temperature or produce changes of state |  |  |  |  |

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| **P1.2 Changes of state** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| P1.2d define the term specific heat capacity and distinguish between it and the term specific latent heat  *To include* – specific latent heat of fusion and specific latent heat of vaporisation |  |  |  |  |
| 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 |  |  |  |  |
| P1.2f apply the relationship between specific latent heat and mass to calculate the energy change involved in a change of state |  |  |  |  |
| **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 |  |  |  |  |

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| **P1.3 Pressure** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| P1.3b explain the relationship between the temperature of a gas and its pressure at constant volume (qualitative only) |  |  |  |  |
| 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  (*separate science only)* |  |  |  |  |
| P1.3d explain how increasing the volume in which a gas is contained, at constant temperature can lead to a decrease in pressure  (*separate science only)*  *To include* – behaviour regarding particle velocity and collisions |  |  |  |  |
| **P1.3e explain how doing work on a gas can increase its temperature**  **(*separate science only)***    ***To include* – examples such as a bicycle pump** |  |  |  |  |

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| **P1.3 Pressure** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| P1.3f describe a simple model of the Earth’s atmosphere and of atmospheric pressure  (*separate science only)*  *To include* – an assumption of uniform density; knowledge of layers is not expected |  |  |  |  |
| P1.3g explain why atmospheric pressure varies with height above the surface of the planet  (*separate science only)* |  |  |  |  |
| **P1.3h describe the factors which influence floating and sinking**  **(*separate science only)*** |  |  |  |  |
| **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**  **(*separate science only)*** |  |  |  |  |

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| **P1.3 Pressure** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| **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**  **(*separate science only)*** |  |  |  |  |

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| **P2 Forces** | | | | |
| **P2.1 Motion** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| P2.1a describe how to measure distance and time in a range of scenarios |  |  |  |  |
| P2.1b describe how to measure distance and time and use these to calculate speed  *To include* – from graphs |  |  |  |  |
| P2.1c make calculations using ratios and proportional reasoning to convert units and to compute rates  *To include* – conversion from non-Sl to Sl units |  |  |  |  |
| P2.1d explain the vector–scalar distinction as it applies to displacement and distance, velocity and speed |  |  |  |  |
| P2.1e relate changes and differences in motion to appropriate distance–time, and velocity–time graphs; interpret lines and slopes |  |  |  |  |

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| **P2.1 Motion** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| **P2.1f interpret enclosed area in velocity-time graphs** |  |  |  |  |
| P2.1g calculate average speed for non-uniform motion |  |  |  |  |
| P2.1h apply formulae relating distance, time and speed, for uniform motion, and for motion with uniform acceleration |  |  |  |  |
| **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) |  |  |  |  |
| P2.2b describe how such examples involve interactions between pairs of objects which produce a force on each object |  |  |  |  |

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| **P2.2 Newton’s laws** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| P2.2c represent forces as vectors  *To include* - drawing free body force diagrams to demonstrate understanding of forces acting as vectors |  |  |  |  |
| 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) |  |  |  |  |
| **P2.2e use vector diagrams to illustrate resolution of forces, a net force (resultant force), and equilibrium situations**  ***To include* – scale drawings limited to parallel and perpendicular vectors only** |  |  |  |  |
| **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** |  |  |  |  |
| **P2.2 Newton’s laws** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| **P2.2g describe, using free body diagrams, examples where two or more forces lead to a resultant force on an object** |  |  |  |  |
| **P2.2h describe, using free body diagrams, examples of the special case where forces balance to produce a resultant force of zero (qualitative only)** |  |  |  |  |
| P2.2i apply Newton’s second law in calculations relating forces, masses and accelerations |  |  |  |  |
| **P2.2j explain that inertia is a measure of how difficult it is to change the velocity of an object and that the inertial mass is defined as the ratio of force over acceleration** |  |  |  |  |
| **P2.2k define momentum and describe examples of momentum in collisions**  ***To include* – an idea of the law of conservation of momentum in collisions** |  |  |  |  |

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| **P2.2 Newton’s laws** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| P2.2l apply formulae relating force, mass, velocity and acceleration to explain how the changes involved are inter-related  (*separate science only)* |  |  |  |  |
| 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 |  |  |  |  |
| P2.2n calculate relevant values of stored energy and energy transfers; convert between newton- metres and joules |  |  |  |  |
| P2.2o explain, with reference to examples, the definition of power as the rate at which energy is transferred |  |  |  |  |
| P2.2p recall and apply Newton’s third law  *To include* – application to situations of equilibrium and non-equilibrium |  |  |  |  |
| **P2.2q explain why an object moving in a circle with a constant speed has a changing velocity (qualitative only)** |  |  |  |  |
| **P2.3 Forces in action** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| 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 |  |  |  |  |
| P2.3b describe the difference between elastic and plastic deformation (distortions) caused by stretching forces |  |  |  |  |
| 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 |  |  |  |  |
| P2.3d describe the difference between linear and non-linear relationships between force and extension |  |  |  |  |
| P2.3e calculate a spring constant in linear cases |  |  |  |  |
| P2.3f calculate the work done in stretching |  |  |  |  |
| **P2.3 Forces in action** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| P2.3g describe that all matter has a gravitational field that causes attraction, and the field strength is much greater for massive objects |  |  |  |  |
| 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*  *To include* - knowledge that the gravitational field strength is known as g and has a value of 10N/kg at the earth’s surface |  |  |  |  |
| P2.3i recall the acceleration in free fall |  |  |  |  |
| 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  (*separate science only)* |  |  |  |  |

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| **P2.3 Forces in action** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| P2.3k describe examples in which forces cause rotation  (*separate science only)*  *To include* - location of pivot points and whether a resultant turning force will be in a clockwise or anticlockwise direction |  |  |  |  |
| P2.3l define and calculate the moment of a force  (*separate science only)*  *To include* – application of the principle of moments for objects which are balanced |  |  |  |  |
| P2.3m explain how levers and gears transmit the rotational effects of forces  (*separate science only)*  *To include* – an understanding of ratios and how this enables gears and levers to work as force multipliers |  |  |  |  |
| P2.3n recall that the pressure in fluids (gases and liquids) causes a net force at right angles to any surface  (*separate science only)* |  |  |  |  |

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| **P2.3 Forces in action** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| P2.3o use the relationship between the force, the pressure and the area in contact.  (*separate science only)*  *To include* – an understanding of how simple hydraulic systems work |  |  |  |  |

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| **P3 Electricity** | | | | |
| **P3.1 Static and charge** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| P3.1a describe that charge is a property of all matter and that there are positive and negative charges  *To include* – the understanding that in most bodies there are an equal number of positive and negative charges resulting in the body having zero net charge |  |  |  |  |
| 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 |  |  |  |  |
| P3.1c explain how transfer of electrons between objects can explain the phenomena of static electricity |  |  |  |  |

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| **P3.1 Static and charge** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| P3.1d explain the concept of an electric field and how it helps to explain the phenomena of static electricity  (*separate science only)*  *To include* – how electric fields relate to the forces of attraction and repulsion |  |  |  |  |
| P3.1e recall that current is a rate of flow of charge (electrons) and the conditions needed for charge to flow  *To include* – how electric fields relate to the forces of attraction and repulsion |  |  |  |  |
| P3.1f recall that current has the same value as any point in a single closed loop |  |  |  |  |
| P3.1g recall and use the relationship between quantity of charge, current and time |  |  |  |  |

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| **P3.2 Simple circuits** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| 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 |  |  |  |  |
| P3.2b represent d.c. circuits with the conventions of positive and negative terminals, and the symbols that represent common circuit elements    *To include* – cells, power supply, diodes, LDRs, NTC thermistors, filament lamps, ammeter, voltmeter, fixed and variable resistors and switch |  |  |  |  |
| 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 |  |  |  |  |

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| **P3.2 Simple circuits** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| 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 |  |  |  |  |
| P3.2e explain that for some resistors the value of *R* remains constant but that in others it can change as the current changes |  |  |  |  |
| 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 |  |  |  |  |
| P3.2g use graphs to explore whether circuit elements are linear or non-linear |  |  |  |  |
| 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 |  |  |  |  |

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| **P3.2 Simple circuits** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| 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) |  |  |  |  |
| 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 |  |  |  |  |
| P3.2k explain the design and use of d.c. circuits for measurement and testing purposes |  |  |  |  |
| 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 |  |  |  |  |
| 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 |  |  |  |  |

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| **P4 Magnetism and magnetic fields** | | | | |
| **P4.1 Magnets and magnetic fields** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| 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 |  |  |  |  |
| P4.1b describe the difference between permanent and induced magnets |  |  |  |  |
| 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 |  |  |  |  |
| P4.1d explain how the behaviour of a magnetic (dipping) compass is related to evidence that the core of the Earth must be magnetic |  |  |  |  |

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| **P4.1 Magnets and magnetic fields** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| 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 |  |  |  |  |
| P4.1f recall that the strength of the field depends on the current and the distance from the conductor |  |  |  |  |
| P4.1g explain how solenoid arrangements can enhance the magnetic effect |  |  |  |  |
| **P4.2 Uses of magnetism** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| **P4.2a describe how a magnet and a current-carrying conductor exert a force on one another** |  |  |  |  |
| **P4.2b show that Fleming’s left-hand rule represents the relative orientations of the force, the current and the magnetic field** |  |  |  |  |

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| **P4.2 Uses of magnetism** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| **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** |  |  |  |  |
| **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** |  |  |  |  |
| **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**  **(*separate science only)*** |  |  |  |  |
| **P4.2f explain how this effect is used in an alternator to generate a.c., and in a dynamo to generate d.c.**  **(*separate science only)*** |  |  |  |  |
| **P4.2 Uses of magnetism** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| **P4.2g explain how the effect of an alternating current in one circuit, in inducing a current in another, is used in transformers**  **(*separate science only)*** |  |  |  |  |
| **P4.2h explain how the ratio of the potential differences across the two circuits in a transformer depends on the ratio of the numbers of turns in each**  **(*separate science only)*** |  |  |  |  |
| **P4.2i apply the equations linking the potential differences and numbers of turns in the two coils of a transformer**  **(*separate science only)*** |  |  |  |  |
| **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**  **(*separate science only)***  ***To include* - an understanding of how dynamic microphones work using electromagnetic induction** |  |  |  |  |

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| **P5 Waves in matter** | | | | |
| **P5.1 Wave behaviour** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| P5.1a describe wave motion in terms of amplitude, wavelength, frequency and period |  |  |  |  |
| P5.1b define wavelength and frequency |  |  |  |  |
| P5.1c describe and apply the relationship between wavelength, frequency and wave velocity |  |  |  |  |
| P5.1d apply formulae relating velocity, frequency and wavelength |  |  |  |  |
| P5.1e describe differences between transverse and longitudinal waves  *To include* – direction of travel and direction of vibration |  |  |  |  |
| P5.1f show how changes, in velocity, frequency and wavelength, in transmission of sound waves from one medium to another, are inter-related  (*separate science only)* |  |  |  |  |

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| **P5.1 Wave behaviour** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| P5.1g describe the effects of reflection, transmission and absorption of waves at material interface  (*separate science only)*  *To include* – examples such as ultrasound and sonar |  |  |  |  |
| **P5.1h describe, with examples, processes which convert wave disturbances between sound waves and vibrations in solids**  **(*separate science only)***  ***To include* - knowledge of a simple structure of the parts of the ear is expected** |  |  |  |  |
| **P5.1i explain why such processes only work over a limited frequency range, and the relevance of this to human hearing**  **(*separate science only)***  ***To include* - why hearing (audition) changes due to ageing** |  |  |  |  |
| 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 |  |  |  |  |
| **P5.1 Wave behaviour** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| P5.1k describe evidence for the cases of ripples on water surfaces and for sound waves in air that it is the wave that travels and not the water or the air |  |  |  |  |
| **P5.2 The electromagnetic spectrum** | | | | |
| P5.2a recall that electromagnetic waves are transverse and are transmitted through space where all have the same velocity |  |  |  |  |
| P5.2b explain that electromagnetic waves transfer energy from source to absorber  *To include* – examples from a range of electromagnetic waves |  |  |  |  |
| P5.2c apply the relationships between frequency and wavelength across the electromagnetic spectrum |  |  |  |  |

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| **P5.2 The electromagnetic spectrum** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| 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, infrared, visible (red to violet), ultraviolet, X-rays and gamma rays |  |  |  |  |
| P5.2e describe that our eyes can only detect a limited range of the electromagnetic spectrum |  |  |  |  |
| P5.2f recall that light is an electromagnetic wave |  |  |  |  |
| P5.2g give examples of some practical uses of electromagnetic waves in the radio, microwave, infrared, visible, ultraviolet, X-ray and gamma ray regions |  |  |  |  |
| P5.2h describe how ultraviolet waves, X-rays and gamma rays can have hazardous effects, notably on human bodily tissues |  |  |  |  |

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| **P5.2 The electromagnetic spectrum** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| **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**  **(*separate science only)***  ***To include* – the use of infrared, X- rays, gamma rays and ultrasound as an alternative in medical imaging** |  |  |  |  |
| **P5.2j recall that radio waves can be produced by, or can themselves induce, oscillations in electrical circuits** |  |  |  |  |
| **P5.3 Wave interactions** | | | | |
| **P5.3a recall that different substances may absorb, transmit, refract, or reflect electromagnetic waves in ways that vary with wavelength** |  |  |  |  |
| **P5.3b explain how some effects are related to differences in the velocity of electromagnetic waves in different substances** |  |  |  |  |
| **P5.3 Wave interactions** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| P5.3c use ray diagrams to illustrate reflection, refraction and the similarities and differences between convex and concave lenses (qualitative only)  (*separate science only)*  *To include* - how the behaviour of convex and concave lenses determine how they may be used, for example, to correct vision |  |  |  |  |
| P5.3d construct two-dimensional ray diagrams to illustrate reflection and refraction (qualitative only – equations not needed)  (*separate science only)* |  |  |  |  |
| P5.3e explain how colour is related to differential absorption, transmission and reflection  (*separate science only)*  *To include* – specular reflection and scattering |  |  |  |  |

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| **P6 Radioactivity** | | | | |
| **P6.1 Radioactive emissions** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| P6.1a recall that atomic nuclei are composed of both protons and neutrons, that the nucleus of each element has a characteristic positive charge |  |  |  |  |
| P6.1b recall that atoms of the same elements can differ in nuclear mass by having different numbers of neutrons |  |  |  |  |
| P6.1c Use the conventional representation for nuclei to relate the differences between isotopes  *To include* – identities, charges and masses |  |  |  |  |
| P6.1d recall that some nuclei are unstable and may emit alpha particles, beta particles, or neutrons, and electromagnetic radiation as gamma rays |  |  |  |  |
| P6.1e relate the emission of alpha particles, beta particles, gamma radiation and neutrons to possible changes in the mass or the charge of the nucleus, or both |  |  |  |  |
| **P6.1 Radioactive emissions** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| P6.1f use names and symbols of common nuclei and particles to write balanced equations that represent radioactive decay |  |  |  |  |
| P6.1g balance equations representing the emission of alpha-, beta- or gamma radiation in terms of the masses, and charges of the atoms involved |  |  |  |  |
| 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 |  |  |  |  |

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| **P6.1 Radioactive emissions** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| 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 |  |  |  |  |
| P6.1j explain the concept of half-life and how this is related to the random nature of radioactive decay |  |  |  |  |
| **P6.1k calculate the net decline, expressed as a ratio, during radioactive emission after a given (integral) number of half-lives**  *To include* – half-life graphs |  |  |  |  |
| P6.1l recall the differences in the penetration properties of alpha particles, beta particles and gamma rays |  |  |  |  |

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| **P6.2 Uses and hazards** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| P6.2a recall the differences between contamination and irradiation effects and compare the hazards associated with these two |  |  |  |  |
| P6.2b explain why the hazards associated with radioactive material differ according to the half-life involved  (*separate science only)* |  |  |  |  |
| P6.2c describe the different uses of nuclear radiations for exploration of internal organs, and for control or destruction of unwanted tissue  (*separate science only)* |  |  |  |  |
| 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  (*separate science only)*  *To include* – knowledge of the term nuclear fission. for fission to occur the unstable nucleus must usually first absorb a neutron |  |  |  |  |
| **P6.2 Uses and hazards** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| P6.2e describe the process of nuclear fusion  (*separate science only)*  *To include* – knowledge that mass may be converted into the energy of radiation |  |  |  |  |

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| **P7 Energy** | | | | |
| **P7.1 Work done** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| 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 |  |  |  |  |
| 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 |  |  |  |  |
| 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 |  |  |  |  |

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| **P7.1 Work done** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| 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 |  |  |  |  |
| P7.1e calculate the amounts of energy associated with a moving body, a stretched spring and an object raised above ground level |  |  |  |  |
| **P7.2 Power and efficiency** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| P7.2a describe, with examples, the process by which energy is dissipated, so that it is stored in less useful ways |  |  |  |  |

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| **P7.2 Power and efficiency** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| 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 |  |  |  |  |
| 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 |  |  |  |  |
| P7.2d calculate energy efficiency for any energy transfer |  |  |  |  |
| **P7.2e describe ways to increase efficiency** |  |  |  |  |
| P7.2f explain ways of reducing unwanted energy transfer  *To include* – lubrication and thermal insulation |  |  |  |  |
| **P7.2 Power and efficiency** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| P7.2g describe how the rate of cooling of a building is affected by the thickness and thermal conductivity of its walls (qualitative only) |  |  |  |  |

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| **P8 Global challenges** | | | | |
| **P8.1 Physics on the move** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| P8.1a recall typical speeds encountered in everyday experience for wind and sound, and for walking, running, cycling and other transportation systems |  |  |  |  |
| P8.1b estimate the magnitudes of everyday accelerations |  |  |  |  |
| P8.1c make calculations using ratios and proportional reasoning to convert units and to compute rates  *To include* – conversion from non-Sl to Sl units |  |  |  |  |
| P8.1d explain methods of measuring human reaction times and recall typical results |  |  |  |  |

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| **P8.1 Physics on the move** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| 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 |  |  |  |  |
| P8.1f estimate how the distances required for road vehicles to stop in an emergency, varies over a range of typical speeds  (*separate science only)* |  |  |  |  |
| P8.1g explain the dangers caused by large decelerations |  |  |  |  |
| **P8.1h estimate the forces involved in typical situations on a public road**  **(*separate science only)*** |  |  |  |  |
| P8.1i estimate, for everyday road transport, the speed, accelerations and forces involved in large accelerations  (*separate science only)* |  |  |  |  |

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| **P8.2 Powering Earth** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| 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, biofuel, wind, hydroelectricity, tides and the Sun |  |  |  |  |
| P8.2b explain patterns and trends in the use of energy resources    *To include* – the changing use of different resources over time |  |  |  |  |
| 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 |  |  |  |  |
| P8.2d recall that step-up and step-down transformers are used to change the potential difference as power is transferred from power stations |  |  |  |  |

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| **P8.2 Powering Earth** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| P8.2e explain how the national grid is an efficient way to transfer energy |  |  |  |  |
| **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**  **(*separate science only)*** |  |  |  |  |
| P8.2g recall that the domestic supply in the UK is a.c. at 50Hz and about 230 volts |  |  |  |  |
| P8.2h explain the difference between direct and alternating voltage |  |  |  |  |
| P8.2i recall the differences in function between the live, neutral and earth mains wires, and the potential differences between these wires |  |  |  |  |
| 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  *To include* – the protection offered by insulation of devices |  |  |  |  |
| **P8.3 Beyond Earth** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| 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.  (*separate science only)*  *To include* – understanding of changes in frequency and wavelength |  |  |  |  |
| P8.3b explain how red shift and other evidence can be linked to the Big-Bang model  (*separate science only)*  *To include* – CMBR |  |  |  |  |
| 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  (*separate science only)*  *To include* – lifecycle of a star |  |  |  |  |

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| **P8.3 Beyond Earth** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| P8.3d explain that all bodies emit radiation, and that the intensity and wavelength distribution of any emission depends on their temperatures  (*separate science only)*  *To include* – an understanding that hot objects can emit a continuous range of electromagnetic radiation at different energy values and therefore frequencies and wavelengths |  |  |  |  |
| P8.3e recall the main features of our solar system, including the similarities and distinctions between the planets, their moons, and artificial satellites  (*separate science only)*  *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 |  |  |  |  |

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| **P8.3 Beyond Earth** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| **P8.3f explain for circular orbits, how the force of gravity can lead to changing velocity of a planet but unchanged speed (qualitative only)**  **(*separate science only)*** |  |  |  |  |
| **P8.3g explain how, for a stable orbit, the radius must change if this speed changes (qualitative only)**  **(*separate science only)*** |  |  |  |  |
| **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**  **(*separate science only)***  ***To include* – an understanding that Earth’s atmosphere affects the electromagnetic radiation from the Sun that passes through it** |  |  |  |  |

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| **P8.3 Beyond Earth** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |
| **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**  **(*separate science only)***  ***To include* – P and S waves, use of sonar** |  |  |  |  |

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| **WS1 Working scientifically assessed in written examinations** | | | | |
| **WS1.1 Development of scientific thinking** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |

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| 1.1a understand how scientific methods and theories develop over time  *To include* – new technology allowing new evidence to be collected and changing explanations as new evidence is found |  |  |  |  |
| 1.1b use models to solve problems, make predictions and to develop scientific explanations and understanding of familiar and unfamiliar facts  *To include* – representational, spatial, descriptive, computational and mathematical models |  |  |  |  |
| 1.1c understand the power and limitations of science  *To include* – perception how developments in science have led to increased understanding and improved quality of life and questions and problems that science cannot currently answer |  |  |  |  |

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| **WS1 Working scientifically assessed in written examinations** | | | | |
| **WS1.1 Development of scientific thinking** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |

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| 1.1d discuss ethical issues arising from developments in science |  |  |  |  |
| 1.1e explain every day and technological applications of science |  |  |  |  |
| 1.1f evaluate associated personal, social, economic and environmental implications |  |  |  |  |
| 1.1g make decisions based on the evaluation of evidence and arguments |  |  |  |  |
| 1.1h evaluate risks both in practical science and the wider societal context  *To include* – perception of risk in relation to data and consequences |  |  |  |  |
| 1.1i recognise the importance of peer review of results and of communicating results to a range of audiences |  |  |  |  |

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| **WS1 Working scientifically assessed in written examinations** | | | | |
| **WS1.2 Experimental skills and strategies** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |

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| 1.2a use scientific theories and explanations to develop hypotheses |  |  |  |  |
| 1.2b plan experiments or devise procedures to make observations, produce or characterise a substance, test hypotheses, check data or explore phenomena |  |  |  |  |
| 1.2c apply a knowledge of a range of techniques, instruments, apparatus, and materials to select those appropriate to the experiment |  |  |  |  |
| 1.2d recognise when to apply a knowledge of sampling techniques to ensure any samples collected are representative |  |  |  |  |
| 1.2e evaluate methods and suggest possible improvements and further investigations |  |  |  |  |

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| **WS1 Working scientifically assessed in written examinations** | | | | |
| **WS1.3 Analysis and evaluation** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |

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| 1.3a presenting observations and other data using appropriate methods  *To include –* methods to include descriptive, tabular diagrammatic and graphically |  |  |  |  |
| 1.3b translating data from one form to another |  |  |  |  |
| 1.3c carrying out and representing mathematical and statistical analysis  *To include* – statistical analysis to include arithmetic means, mode, median |  |  |  |  |
| 1.3d representing distributions of results and make estimations of uncertainty |  |  |  |  |

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| **WS1 Working scientifically assessed in written examinations** | | | | |
| **WS1.3 Analysis and evaluation** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |

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| 1.3e interpreting observations and other data  *To include* – data presentations to include verbal, diagrammatic, graphical, symbolic or numerical form interpretations to include identifying patterns and trends, making inferences and drawing conclusions |  |  |  |  |
| 1.3f presenting reasoned explanations  *To include* – relating data to hypotheses |  |  |  |  |
| 1.3g being objective, evaluating data in terms of accuracy, precision, repeatability and reproducibility |  |  |  |  |
| 1.3h identifying potential sources of random and systematic error |  |  |  |  |

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| **WS1 Working scientifically assessed in written examinations** | | | | |
| **WS1.3 Analysis and evaluation** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |

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| 1.3i communicating the scientific rationale for investigations, methods used, findings and reasoned conclusions  *To include* – presentations through paper- based presentations using diagrammatic, graphical, numerical and symbolic forms |  |  |  |  |

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| **WS1 Working scientifically assessed in written examinations** | | | | |
| **WS1.4 Scientific vocabulary, quantities, units, symbols and nomenclature** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |

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| 1.4a use scientific vocabulary, terminology and definitions |  |  |  |  |
| 1.4b recognise the importance of scientific quantities and understand how they are determined |  |  |  |  |
| 1.4c use SI units and IUPAC chemical nomenclature unless inappropriate  *To include* – base units & derived units |  |  |  |  |
| 1.4d use prefixes and powers of ten for orders of magnitude  *To include* – tera, giga, mega, kilo, deci, centi, milli, micro and nano |  |  |  |  |
| 1.4e interconvert units |  |  |  |  |
| 1.4f use an appropriate number of significant figures in calculation |  |  |  |  |

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| **WS2 Working scientifically skills demonstrated** | | | | |
| **Practical skills to be developed** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |

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| 2a carry out experiments  *To include* – due regard to the correct manipulation of apparatus, the accuracy of measurements and health and safety considerations, and following written instructions. |  |  |  |  |
| 2b make and record observations and measurements using a range of apparatus and methods  *To include* – keeping appropriate records |  |  |  |  |
| 2c presenting observations using appropriate methods  *To include* – methods to include descriptive, tabular diagrammatic and graphically |  |  |  |  |

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| **WS2 Working scientifically skills demonstrated** | | | | |
| **Practical skills to be developed** | | | | |
| **Learning outcomes**  You will be required to: | **R** | **A** | **G** | **Comments** |

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| 2d communicating the scientific rationale for investigations, methods used, findings and reasoned conclusions    *To include* – presentations through paper- based and electronic reports and presentations using verbal, diagrammatic, graphical, numerical and symbolic forms |  |  |  |  |

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| **Equations in Physics** | | | | | | | | | |
| ***recall and apply the following relationships using standard SI units (units given in brackets)*** | | **R** | | **A** | | **G** | | **Comments** | |
| PM1.1i | density (kg/m3) = mass (kg)/volume (m3) |  | |  | |  | |  | |
| PM2.1i | distance travelled (m) = speed (m/s) × time (s) |  | |  | |  | |  | |
| PM2.1ii | acceleration (m/s2) = change in velocity (m/s)/time (s) |  | |  | |  | |  | |
| PM2.1iv | kinetic energy (J) = 0.5 × mass (kg) × (speed (m/s))2 |  | |  | |  | |  | |
| PM2.2i | force (N) = mass (kg) × acceleration (m/s2) |  | |  | |  | |  | |
| **PM2.2ii** | **momentum (kg m/s) = mass (kg) × velocity (m/s)** |  | |  | |  | |  | |
| PM2.2iii | work done (J) = force (N) × distance (m) (along the line of action of the force) |  | |  | |  | |  | |
| PM2.2iv | power (W) = work done (J)/time(s) |  | |  | |  | |  | |
| **Equations in Physics** | | | | | | | | | |
| ***recall and apply the following relationships using standard SI units (units given in brackets)*** | | **R** | | **A** | | **G** | | **Comments** | |
| PM2.3i | force exerted by a spring (N) = extension (m) × spring constant (N/m) |  | |  | |  | |  | |
| PM2.3iii | gravitational force (N) = mass (kg) × gravitational field strength, g (N/kg) |  | |  | |  | |  | |
| PM2.3iv | (in a gravitational field) potential energy (J) = mass (kg)  × height (m) × gravitational field strength, *g* (N/kg) |  | |  | |  | |  | |
| PM2.3v | pressure (Pa) = force normal to a surface (N) / area of that surface (m2)  (*separate science only)* |  | |  | |  | |  | |
| PM2.3vi | moment of a force (N m) = force (N) × distance (m) (normal to direction of the force)  (*separate science only)* |  | |  | |  | |  | |
| PM3.1i | charge flow (C) = current (A) × time (s) |  | |  | |  | |  | |
| PM3.2i | potential difference (V) = current (A) × resistance (Ω) |  | |  | |  | |  | |
| PM3.2ii | energy transferred (J) = charge (C) × potential difference (V) |  | |  | |  | |  | |
| **Equations in Physics** | | | | | | | | | |
| ***recall and apply the following relationships using standard SI units (units given in brackets)*** | | **R** | | **A** | | **G** | | **Comments** | |
| PM3.2iii | power (W) = potential difference (V) × current (A) = (current (A))2 × resistance (Ω) |  | |  | |  | |  | |
| PM3.2iv | energy transferred (J, kW h) = power (W, kW) × time (s, h) |  | |  | |  | |  | |
| PM5.1i | wave speed (m/s) = frequency (Hz) × wavelength (m) |  | |  | |  | |  | |
| PM7.2i | efficiency = useful output energy transfer (J) / input energy transfer (J) |  | |  | |  | |  | |
| **Equations in Physics** | | | | | | | | | |
| ***select and apply from a list the following relationships using standard SI units:*** | | | **R** | | **A** | | **G** | | **Comments** |
| PM1.2i | change in thermal energy (J) = mass (kg) × specific heat capacity (J/kg°C) × change in temperature (°C) | |  | |  | |  | |  |
| PM1.2ii | thermal energy for a change in state (J) = mass (kg) × specific latent heat (J/kg) | |  | |  | |  | |  |
| PM1.3i | for gases: pressure (Pa) × volume (m3) = constant (for a given mass of gas and at a constant temperature)  (*separate science only)* | |  | |  | |  | |  |
| **Equations in Physics** | | | | | | | | | |
| ***select and apply from a list the following relationships using standard SI units:*** | | | **R** | | **A** | | **G** | | **Comments** |
| **PM1.3ii** | **pressure due to a column of liquid (Pa) = height of column (m) × density of liquid (kg/m3) × g (N/kg)**  (*separate science only)* | |  | |  | |  | |  |
| PM2.1iii | (final velocity (m/s))2 – (initial velocity (m/s))2 = 2 × acceleration (m/s2) × distance (m) | |  | |  | |  | |  |
| PM2.3ii | energy transferred in stretching (J) = 0.5 × spring constant (N/m)  × (extension (m))2 | |  | |  | |  | |  |
| **PM4.2i** | **force on a conductor (at right angles to a magnetic field) carrying a current (N) = magnetic flux density (T) × current (A) × length (m)** | |  | |  | |  | |  |
| **PM4.2ii** | **potential difference across primary coil (V) / potential difference across secondary coil (V) = number of turns in primary coil/number of turns in secondary coil**  (*separate science only)* | |  | |  | |  | |  |
| PM8.2i | potential difference across primary coil (V) × current in primary coil (A) = potential difference across secondary coil (V) × current in secondary coil (A) | |  | |  | |  | |  |

A screenshot of text

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[resources.feedback@ocr.org.uk](mailto:resources.feedback@ocr.org.uk)

[resources.feedback@ocr.org.uk](mailto:resources.feedback@ocr.org.uk)

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