

1.1 Physical quantities

Physical quantities

Can you explain that a physical quantity is a numerical magnitude multiplied by a unit?	☐	☐	☐
Can you state the SI base units of mass, length, time, current, temperature and amount of substance (kg, m, s, A, K, mol)?	☐	☐	☐
Can you express derived units (e.g. N, J, W, Pa, V, Ω) in terms of SI base units?	☐	☐	☐
Can you recall and use the prefixes T, G, M, k, c, m, μ , n, p and f?	☐	☐	☐
Can you present values in standard form with an appropriate number of significant figures?	☐	☐	☐

1.2 Scalars and vectors

Scalars and vectors

Can you distinguish between scalar and vector quantities and give examples of each?	☐	☐	☐
Can you resolve a vector into two perpendicular components (e.g. $F \cos \theta$ and $F \sin \theta$)?	☐	☐	☐
Can you find the resultant of two coplanar perpendicular vectors by calculation (Pythagoras and trigonometry)?	☐	☐	☐
Can you find the resultant of two coplanar perpendicular vectors by scale drawing?	☐	☐	☐
Can you solve problems with two or three coplanar forces acting at a point in equilibrium (e.g. using a closed triangle of forces or resolving)?	☐	☐	☐

1.3 Principle of moments

Principle of moments

Can you define the moment of a force about a point as force multiplied by the perpendicular distance from the point to the line of action of the force?	☐	☐	☐
Can you explain and use the concept of centre of gravity?	☐	☐	☐
Can you state the principle of moments for a body in equilibrium?	☐	☐	☐
Can you use the principle of moments to solve problems, including finding an unknown mass or the mass of a uniform rule?	☐	☐	☐

1.4 Linear motion

Linear motion

Can you define displacement, velocity, average velocity and acceleration?	☐	☐	☐
Can you recall and use the equations of motion for uniform acceleration ($v = u + at$, $s = ut + \frac{1}{2}at^2$, $v^2 = u^2 + 2as$, $s = \frac{1}{2}(u + v)t$)?	☐	☐	☐
Can you describe an experiment using light gates and computer software to measure the acceleration of free fall, g ?	☐	☐	☐
Can you interpret displacement-time graphs qualitatively and quantitatively, using the gradient to find velocity?	☐	☐	☐
Can you interpret velocity-time graphs qualitatively and quantitatively, using the gradient to find acceleration and the area to find displacement?	☐	☐	☐
Can you interpret motion graphs for both uniform and non-uniform acceleration?	☐	☐	☐

1.5 Dynamics

Projectile motion

Can you describe the motion of a projectile?	☐	☐	☐
Can you explain projectile motion as uniform velocity in one direction combined with uniform acceleration in a perpendicular direction?	☐	☐	☐
Can you apply the equations of motion to projectiles, ignoring air resistance, to find time of flight, range and maximum height?	☐	☐	☐
Can you treat the horizontal and vertical components of a projectile's motion independently?	☐	☐	☐

1.6 Newton's laws of motion

Newton's laws of motion

Can you state Newton's first, second and third laws of motion?	☐	☐	☐
Can you apply Newton's laws to simple situations, including identifying third law force pairs?	☐	☐	☐
Can you recall and use $F = ma$ for situations where the mass is constant?	☐	☐	☐
Can you explain that friction is a force that opposes motion?	☐	☐	☐

1.7

Linear momentum and impulse

Momentum

Can you define linear momentum as the product of mass and velocity?	☐	☐	☐
Can you calculate the momentum of a body, including its direction?	☐	☐	☐
Can you state and apply the principle of conservation of linear momentum?	☐	☐	☐
Can you perform calculations involving collisions in one dimension?	☐	☐	☐
Can you describe the difference between elastic and inelastic collisions and confirm by calculation which type a collision is?	☐	☐	☐

Impulse

Can you define impulse as the product of force and time, $F \times t$?	☐	☐	☐
Can you recall and use $Ft = mv - mu$?	☐	☐	☐
Can you apply the impulse-momentum relationship to impact situations (e.g. car safety features, sports)?	☐	☐	☐
Can you state Newton's second law in terms of momentum, that force equals rate of change of momentum?	☐	☐	☐
Can you find the impulse from the area under a force-time graph?	☐	☐	☐

1.8

Work done, potential energy and kinetic energy

Work and energy

Can you define work done, potential energy and kinetic energy?	☐	☐	☐
Can you explain that when work is done, energy is transferred from one form to another?	☐	☐	☐
Can you calculate the work done by a constant force, including a force not along the line of motion ($W = Fs \cos \theta$)?	☐	☐	☐
Can you recall and use $\Delta PE = mg\Delta h$ and $KE = \frac{1}{2}mv^2$?	☐	☐	☐
Can you state the principle of conservation of energy?	☐	☐	☐
Can you use conservation of energy to calculate exchanges between gravitational potential energy and kinetic energy?	☐	☐	☐
Can you use $\frac{1}{2}mv^2 - \frac{1}{2}mu^2 = Fs$ for a constant force?	☐	☐	☐

Power and efficiency

Can you recall and use power = work done / time taken?

Can you recall and use $P = Fv$?

Can you recall and use efficiency = useful energy (or power) output / total energy (or power) input?



Can you explain the importance to society of energy conservation and energy efficiency?

**1.9****Electric current, charge, potential difference and electromotive force****Current, charge and voltage**Can you recall and use $I = Q/t$?Can you recall and use $V = W/q$?Can you recall and use $V = P/I$?

Can you define the volt as one joule per coulomb?

Can you define electromotive force (e.m.f.), E , as the energy converted into electrical energy per unit charge by a source?

Can you distinguish between e.m.f. and potential difference in terms of energy transfers?

**1.10****Resistance and resistivity****Series and parallel circuits**

Can you perform and describe experiments to confirm the current, voltage and resistance relationships in series and parallel circuits?

Can you recall and use $R = R_1 + R_2 + R_3$ for resistors in series?Can you recall and use $1/R = 1/R_1 + 1/R_2 + 1/R_3$ for resistors in parallel?Can you recall and use $R = V/I$?Can you recall and use $P = I^2R$ (and $P = IV$, $P = V^2/R$)?**Resistivity and superconductivity**

Can you define resistivity?



Can you recall and use $R = \rho l/A$?



Can you perform and describe an experiment to measure the resistivity of a metal?



Can you demonstrate a basic knowledge and understanding of superconductivity, including critical temperature and uses?



I-V characteristics

Can you state Ohm's law?



Can you distinguish between ohmic and non-ohmic behaviour?



Can you perform experiments to find the I-V characteristics of a metallic conductor at constant temperature and of a filament bulb?



Can you sketch and describe the I-V characteristics of a metallic conductor, a diode and an ntc thermistor?



Can you sketch and explain how the resistance of a metallic conductor varies with temperature?



Can you sketch and explain how the resistance of an ntc thermistor varies with temperature?



Can you perform an experiment to show how the resistance of an ntc thermistor varies with temperature?



1.11

Internal resistance and electromotive force

Internal resistance

Can you explain the simple consequences of the internal resistance of a source for external circuits (e.g. lost volts, terminal p.d. falling as current increases)?



Can you use $V = E - Ir$?



Can you perform and describe an experiment to measure the internal resistance and e.m.f. of a source?



Can you find E and r from a graph of terminal p.d. against current?



1.12

Potential divider circuits

Potential dividers

Can you explain how a potential divider provides a variable p.d. from a fixed power supply?



Can you explain the use of potential dividers with LDRs and thermistors in lighting and heating control circuits?



Can you calculate the output voltage of a potential divider using $V_{out} = R_1 V_{in} / (R_1 + R_2)$?



Can you calculate output voltages in loaded potential divider circuits?



2.1 Waves

Wave properties

- | | |
|--|---|
| Can you describe the difference between transverse and longitudinal waves? | ☐ ☐ ☐ |
| Can you classify waves as transverse or longitudinal? | ☐ ☐ ☐ |
| Can you read wave graphs to find amplitude, period, frequency, wavelength and phase? | ☐ ☐ ☐ |
| Can you explain that polarisation is a property of transverse waves only? | ☐ ☐ ☐ |
| Can you use $f = 1/T$ and $v = f\lambda$? | ☐ ☐ ☐ |

Electromagnetic spectrum

- | | |
|---|---|
| Can you name the regions of the electromagnetic spectrum (radio, microwave, infrared, visible, ultraviolet, X-ray, gamma) in order? | ☐ ☐ ☐ |
| Can you state typical wavelengths for each region of the electromagnetic spectrum? | ☐ ☐ ☐ |
| Can you recall the approximate wavelengths of violet light (400 nm) and red light (700 nm)? | ☐ ☐ ☐ |

2.2 Refraction

Refraction

- | | |
|--|---|
| Can you carry out and describe an experiment to verify Snell's law and measure the refractive index of a material? | ☐ ☐ ☐ |
| Can you use $n = \sin i / \sin r$ and $n_1 \sin \theta_1 = n_2 \sin \theta_2$? | ☐ ☐ ☐ |
| Can you use $n = c/v$ (speed of light in vacuum over speed in medium)? | ☐ ☐ ☐ |
| Can you explain total internal reflection and the conditions needed for it? | ☐ ☐ ☐ |
| Can you use $\sin c = 1/n$ for the critical angle? | ☐ ☐ ☐ |

Optical fibres and endoscopes

- | | |
|---|---|
| Can you explain how step-index optical fibres work, including total internal reflection at the core/cladding boundary? | ☐ ☐ ☐ |
| Can you calculate the speed of light in an optical fibre core and the time for a signal to travel along it? | ☐ ☐ ☐ |
| Can you describe the structure of a flexible endoscope (coherent and incoherent bundles) and its medical and industrial uses? | ☐ ☐ ☐ |

2.3

Lenses

Lenses

Can you draw ray diagrams to locate images formed by converging and diverging lenses?



Can you use the lens equation $1/u + 1/v = 1/f$ for converging and diverging lenses, using the real is positive sign convention?



Can you verify the lens equation experimentally and determine the focal length of a converging lens (real images only)?



Can you define linear magnification as image height divided by object height?



Can you use $m = v/u$?



Defects of vision

Can you describe how lenses are used to correct myopia (short sight) and hypermetropia (long sight)?



Can you calculate the focal length of a lens needed to correct long or short sight?



Can you calculate the new range of vision when a corrective lens is worn?



Can you calculate lens power using $P = 1/f$ (in dioptres, f in metres)?



2.4

Superposition, interference and diffraction

Superposition and standing waves

Can you illustrate the principle of superposition by graphically adding two sinusoidal waves?



Can you state the conditions needed to produce a standing wave?



Can you represent standing waves graphically for stretched strings and for air in pipes closed at one end?



Can you identify modes of vibration graphically for stretched strings and closed pipes (without the terms overtone or harmonic)?



Can you identify the positions of nodes and antinodes?



Can you use a resonance tube to measure the speed of sound in air (end correction not required)?



Interference

- | | |
|---|---|
| Can you state the conditions needed for observable interference (coherent sources)? | ☐ ☐ ☐ |
| Can you explain interference effects in terms of path difference and phase difference? | ☐ ☐ ☐ |
| Can you describe Young's double-slit experiment to measure the wavelength of monochromatic light? | ☐ ☐ ☐ |
| Can you use $\lambda = ay/d$ for the double-slit fringe spacing? | ☐ ☐ ☐ |

Diffraction

- | | |
|--|---|
| Can you describe and explain single-slit diffraction? | ☐ ☐ ☐ |
| Can you describe qualitatively, with diagrams, how the size of the aperture affects the amount of diffraction? | ☐ ☐ ☐ |
| Can you use the diffraction grating equation $d \sin \theta = n\lambda$? | ☐ ☐ ☐ |
| Can you describe how to use a diffraction grating and a laser to measure wavelength? | ☐ ☐ ☐ |

2.5 Quantum physics**Photons and the photoelectric effect**

- | | |
|---|---|
| Can you use $E = hf$ for the energy of a photon? | ☐ ☐ ☐ |
| Can you use the photon model to explain the photoelectric effect qualitatively in terms of photon energy and work function? | ☐ ☐ ☐ |
| Can you explain why there is a threshold frequency for photoemission? | ☐ ☐ ☐ |
| Can you use Einstein's photoelectric equation $hf = \phi + KE_{\max}$? | ☐ ☐ ☐ |

Energy levels, lasers and X-rays

- | | |
|---|---|
| Can you explain that electrons in atoms occupy discrete energy levels? | ☐ ☐ ☐ |
| Can you use $hf = E_1 - E_2$ for transitions between energy levels? | ☐ ☐ ☐ |
| Can you explain laser action in terms of population inversion, stimulated emission and metastable states? | ☐ ☐ ☐ |
| Can you explain that X-rays are produced by electron transitions between energy levels? | ☐ ☐ ☐ |
| Can you describe the physical principles of conventional X-ray imaging? | ☐ ☐ ☐ |
| Can you describe the physical principles of CT scanning and compare it with conventional X-ray imaging? | ☐ ☐ ☐ |

2.6 Wave-particle duality

Wave-particle duality

Can you classify electromagnetic phenomena as explained by the wave model, the photon model or both?



Can you describe electron diffraction as evidence for the wave nature of particles?



Can you use the de Broglie equation $\lambda = h/p = h/mv$?



2.7 Astronomy

Red shift and the expanding universe

Can you apply the classical Doppler shift equations to find the wavelength received by a stationary observer from a moving source?



Can you distinguish between cosmological red shift and Doppler red shift?



Can you calculate the red shift parameter $z = \Delta\lambda/\lambda$ for a receding galaxy?



Can you use $z = v/c$ to find the recession speed of a galaxy when $v \ll c$?



Can you use Hubble's law $v = H_0 d$ to estimate the distance to a galaxy, given $H_0 \approx 2.4 \times 10^{-18} \text{ s}^{-1}$?



Can you recall and use $t = 1/H_0$ to estimate the age of the universe?



3.1 Implementing

Implementing

Can you use measuring apparatus correctly, skilfully and safely, including balances, rules, micrometers, calipers, graduated cylinders, clocks, thermometers, ammeters, voltmeters, multimeters and protractors?



Can you make and record sufficient relevant, reliable and valid measurements to an appropriate precision?



Can you use data loggers where appropriate?



Can you read analogue and digital displays correctly?



3.2 Analysis

Analysis

Can you present your work appropriately in written, tabular, graphical or other forms?



Can you analyse, interpret and explain the results of your own and others' experiments, using ICT and other methods?



Can you recognise the limitations of measurements when commenting on trends and patterns?



Can you draw valid conclusions by applying your knowledge of physics?



3.3 Evaluation

Evaluation

Can you assess the reliability of data, results and conclusions?



Can you evaluate an experimental method and its impact, and appreciate its limitations?



Can you calculate absolute and percentage uncertainties?



3.4 Refinement

Refinement

Can you suggest improved, effective and safe procedures for an experiment?



Can you modify procedures to reduce serious systematic errors?



Can you modify procedures to reduce serious random errors?

**3.5**

Communication

Communication

Can you communicate observations, measurements, results and conclusions appropriately and effectively?



4.1 Deformation of solids

A-LEVEL ONLY

Deformation of solids

Can you state Hooke's law, $F = kx$, and use it in simple problems?	☐	☐	☐
Can you explain elastic and plastic deformation and the elastic limit?	☐	☐	☐
Can you distinguish between the limit of proportionality and the elastic limit?	☐	☐	☐
Can you define stress, strain and the Young modulus?	☐	☐	☐
Can you perform and describe an experiment to determine the Young modulus of a material (e.g. a metal wire)?	☐	☐	☐
Can you use $E = \frac{1}{2}Fx = \frac{1}{2}kx^2$ for strain energy?	☐	☐	☐
Can you find strain energy from the area under a force-extension graph?	☐	☐	☐
Can you explain how knowledge of stress, strain and the Young modulus informs design and economic decisions about materials?	☐	☐	☐

4.2 Thermal physics

A-LEVEL ONLY

Gas laws

Can you describe an experiment to show that $pV = \text{constant}$ for a fixed mass of gas at constant temperature (Boyle's law)?	☐	☐	☐
Can you describe an experiment to show that $p/T = \text{constant}$ for a fixed mass of gas at constant volume?	☐	☐	☐
Can you describe an experiment to show that $V/T = \text{constant}$ for a fixed mass of gas at constant pressure?	☐	☐	☐
Can you combine the gas laws to give $pV/T = \text{constant}$?	☐	☐	☐
Can you use the ideal gas equation $pV = nRT$?	☐	☐	☐
Can you use the ideal gas equation in the form $pV = NkT$?	☐	☐	☐

Kinetic theory and internal energy

Can you explain internal energy as the sum of the randomly distributed kinetic and potential energies of the molecules?	☐	☐	☐
Can you use $pV = \frac{1}{3}Nm\langle c^2 \rangle$?	☐	☐	☐
Can you use $\frac{1}{2}m\langle c^2 \rangle = \frac{3}{2}kT$ for the average kinetic energy of a molecule?	☐	☐	☐
Can you explain the concept of absolute zero?	☐	☐	☐

Specific heat capacity

Can you perform and describe an electrical method to determine the specific heat capacity of a solid or liquid?



Can you use $Q = mc\Delta\theta$?

**4.3 Uniform circular motion****A-LEVEL ONLY****Circular motion**

Can you explain the concept of angular velocity, ω ?



Can you use $v = r\omega$ (and $\omega = 2\pi/T = 2\pi f$)?



Can you apply $F = ma = mv^2/r$ to motion in a circle at constant speed?



Can you identify the force providing the centripetal force in a given situation?

**4.4 Simple harmonic motion****A-LEVEL ONLY****SHM**

Can you define simple harmonic motion using $a = -\omega^2 x$, where $\omega = 2\pi f$?



Can you perform calculations using $x = A \cos \omega t$?



Can you investigate experimentally and graphically the motion of a simple pendulum and a loaded spiral spring?



Can you use $T = 2\pi\sqrt{l/g}$ for a simple pendulum?



Can you use $T = 2\pi\sqrt{m/k}$ for a mass on a spring?



Can you interpret graphs of SHM, including finding velocity from the gradient of a displacement-time graph?

**Damping and resonance**

Can you use the terms free vibrations, forced vibrations, resonance and damping?



Can you describe light damping, critical damping and overdamping?



Can you describe mechanical examples of resonance and damping (e.g. bridges, car suspension)?



4.5 The nucleus

A-LEVEL ONLY

The nucleus

Can you describe alpha-particle scattering as evidence for the existence of atomic nuclei?



Can you interpret how nuclear radius varies with nucleon number?



Can you use $r = r_0 A^{1/3}$ to estimate the density of nuclear matter?



Can you explain why the density of nuclear matter is constant for all nuclei?



4.6 Nuclear decay

A-LEVEL ONLY

Radiation

Can you explain how the nature of alpha, beta and gamma radiation determines their penetration and range?



Can you calculate changes in nucleon number and proton number caused by alpha, beta and gamma emission?



Decay law and half-life

Can you explain the random and exponential nature of radioactive decay?



Can you use $A = -\lambda N$, where λ is the fraction of atoms decaying per second?



Can you use $A = A_0 e^{-\lambda t}$ (and $N = N_0 e^{-\lambda t}$)?



Can you define half-life?



Can you use $t_{1/2} = 0.693/\lambda$ ($\ln 2/\lambda$)?



Can you describe an experiment to measure the half-life of a radioactive source?



4.7 Nuclear energy

A-LEVEL ONLY

Mass-energy and binding energy

Can you explain the equivalence of mass and energy?



Can you use $E = \Delta mc^2$ and explain that it applies to all energy changes?



Can you calculate mass defect and binding energy of a nucleus?



Can you describe how binding energy per nucleon varies with mass number?



Can you use the binding energy per nucleon curve to describe the principles of fission and fusion?



4.8

Nuclear fission and fusion

A-LEVEL ONLY

Fission reactors

Can you explain chain reaction and critical size in a fission reactor?



Can you explain the roles of the moderator, control rods, coolant and shielding in a fission reactor?



Can you discuss the social, environmental, security and economic issues of nuclear power?



Fusion

Can you describe the D-T fusion reaction used in the ITER tokamak, including the fuel and the required temperature?



Can you describe the plasma, heating methods, vacuum vessel, blanket and magnetic confinement in the ITER (tokamak) reactor?



Can you describe the practical difficulties of fusion and its advantages and disadvantages?



Can you describe gravitational, inertial and magnetic confinement of plasma?



5.1 Force fields**A-LEVEL ONLY****Force fields**

- | | | | |
|---|-----------------------|-----------------------|-----------------------|
| Can you explain the concept of a field of force? | ☐ | ☐ | ☐ |
| Can you use field lines to show the direction of a field? | ☐ | ☐ | ☐ |
| Can you use the spacing of field lines to show field strength? | ☐ | ☐ | ☐ |
| Can you draw field patterns for point masses, point charges and uniform fields? | ☐ | ☐ | ☐ |

5.2 Gravitational fields**A-LEVEL ONLY****Gravitational fields**

- | | | | |
|--|-----------------------|-----------------------|-----------------------|
| Can you define gravitational field strength as force per unit mass? | ☐ | ☐ | ☐ |
| Can you recall and use $g = F/m$? | ☐ | ☐ | ☐ |
| Can you state Newton's law of universal gravitation? | ☐ | ☐ | ☐ |
| Can you recall and use $F = GMm/r^2$ for the force between point masses? | ☐ | ☐ | ☐ |
| Can you recall and use $g = GM/r^2$, including to calculate the mass of a planet or star? | ☐ | ☐ | ☐ |

Orbits

- | | | | |
|---|-----------------------|-----------------------|-----------------------|
| Can you apply circular motion to planetary and satellite orbits? | ☐ | ☐ | ☐ |
| Can you show that $T^2 \propto r^3$ (Kepler's third law) is consistent with Newton's law of gravitation? | ☐ | ☐ | ☐ |
| Can you state the conditions of period, position and direction of rotation for a geostationary satellite? | ☐ | ☐ | ☐ |

5.3 Electric fields**A-LEVEL ONLY****Electric fields**

- | | | | |
|---|-----------------------|-----------------------|-----------------------|
| Can you define electric field strength as force per unit positive charge? | ☐ | ☐ | ☐ |
| Can you recall and use $E = F/q$? | ☐ | ☐ | ☐ |
| Can you state Coulomb's law for point charges? | ☐ | ☐ | ☐ |
| Can you recall and use $F = q_1q_2/(4\pi\epsilon_0 r^2) = kq_1q_2/r^2$, where $k = 1/(4\pi\epsilon_0)$? | ☐ | ☐ | ☐ |

Can you recall and use $E = q/(4\pi\epsilon_0 r^2) = kq/r^2$ for a point charge?



Can you recall that field strength is constant in a uniform field and use $E = V/d$?



Can you state similarities and differences between gravitational and electric fields?



5.4 Capacitors

A-LEVEL ONLY

Capacitance

Can you define capacitance?



Can you recall and use $C = Q/V$?



Can you define the farad?



Can you recall and use energy stored $= \frac{1}{2}QV = \frac{1}{2}CV^2 = \frac{1}{2}Q^2/C$?



Can you recall and use $C = C_1 + C_2 + C_3$ for capacitors in parallel?



Can you recall and use $1/C = 1/C_1 + 1/C_2 + 1/C_3$ for capacitors in series?



Charging and discharging

Can you perform and describe experiments to investigate charging and discharging a capacitor?



Can you confirm the exponential nature of capacitor discharge using voltage or current curves?



Can you use $Q = Q_0 e^{-t/CR}$, $V = V_0 e^{-t/CR}$ and $I = I_0 e^{-t/CR}$?



Can you define the time constant and use $\tau = CR$?



Can you perform and describe an experiment to determine the time constant of an RC circuit?



Can you apply time constants and stored energy to electronic flash guns and defibrillators?



5.5 Magnetic fields

A-LEVEL ONLY

Magnetic force

Can you describe the shape and direction of the magnetic field around a current-carrying coil and a long straight wire?



Can you explain the force on a current-carrying conductor in a perpendicular magnetic field and predict its direction (Fleming's left-hand rule)?



Can you explain that the force on a current-carrying coil in a magnetic field is the principle of the electric motor?



Can you recall and use $F = BIl$?



Can you define magnetic flux density and the tesla?



Electromagnetic induction

Can you explain magnetic flux and magnetic flux linkage?



Can you recall and use $\Phi = BA$ and $N\Phi = NBA$?



Can you state and use Faraday's law and Lenz's law?



Can you demonstrate Faraday's and Lenz's laws experimentally?



Can you calculate the average induced e.m.f. as the rate of change of flux linkage?



Can you explain the simple a.c. generator and use $E = BAN\omega \sin \omega t$?



Transformers

Can you describe how a transformer works?



Can you recall and use $V_s/V_p = N_s/N_p$?



Can you explain the causes of power losses in transformers and how they are reduced?



Can you explain the advantages of transmitting electrical power at high voltage?



5.6

Deflection of charged particles in electric and magnetic fields

A-LEVEL ONLY

Charged particles in fields

Can you explain that a charge in a uniform electric field experiences a force?



Can you recall and use $F = qE$ and determine the direction of the force?



Can you explain that a moving charge in a uniform perpendicular magnetic field experiences a force?



Can you recall and use $F = Bqv$ and determine the direction of the force?



Can you explain why a charged particle moving perpendicular to a uniform magnetic field follows a circular path?



5.7 Particle accelerators

A-LEVEL ONLY

Particle accelerators

Can you describe the basic operation of a synchrotron?



Can you explain relativistic mass increase as particles approach the speed of light?



Can you explain the concept of antimatter and its production in high-energy collisions in accelerators?



Can you describe annihilation in terms of photon emission and conservation of charge, energy and momentum?



5.8 Fundamental particles

A-LEVEL ONLY

Fundamental particles

Can you explain the concept of a fundamental particle?



Can you identify the four fundamental forces and their exchange particles?



Can you classify particles as gauge bosons, leptons or hadrons (mesons and baryons)?



Can you state examples of each class of particle?



Can you describe the structure of hadrons (e.g. protons, neutrons, pions) in terms of quarks?



Can you apply conservation of charge, lepton number and baryon number to particle interactions?



Can you describe β^- and β^+ decay in terms of the basic quark model?



6.1 Implementing**A-LEVEL ONLY****Implementing**

Can you assemble and use apparatus correctly, skilfully and effectively, with full regard for safety?



Can you use a cathode ray oscilloscope (CRO) to determine voltage and frequency, and describe how this is done?



Can you make and record sufficient relevant, reliable and valid observations to an appropriate precision and accuracy, using data loggers where appropriate?



Can you read analogue and digital displays correctly?

**6.2 Analysis****A-LEVEL ONLY****Analysis**

Can you present your work appropriately in written, tabular, graphical or other forms?



Can you analyse, interpret and explain experimental activities using ICT and other methods?



Can you recognise experimental limitations when commenting on trends and patterns?



Can you draw valid conclusions by applying your knowledge of physics?

**6.3 Evaluation****A-LEVEL ONLY****Evaluation**

Can you assess the reliability of data, results and conclusions?



Can you evaluate the methodology and impact of an experiment and appreciate its limitations?



Can you calculate absolute and percentage uncertainties?

**6.4 Refinement****A-LEVEL ONLY****Refinement**

Can you suggest improved, effective and safe procedures for an experiment?



Can you modify procedures to reduce serious systematic and random errors?



Communication

Can you communicate observations, measurements, results and conclusions appropriately and effectively?



Practical activities

1 Can you determine the density of a solid or a liquid?	☐	☐	☐
2 Can you determine an unknown mass using the principle of moments?	☐	☐	☐
3 Can you determine the mass of a uniform rule using the principle of moments?	☐	☐	☐
4 Can you determine the acceleration of free fall using a falling object and light gates?	☐	☐	☐
5 Can you verify that acceleration is proportional to force ($a \propto F$) for a constant mass?	☐	☐	☐
6 Can you verify that acceleration is inversely proportional to mass ($a \propto 1/m$) for a constant force?	☐	☐	☐
7 Can you investigate the conservation of momentum in a collision?	☐	☐	☐
8 Can you investigate the energy exchange between potential and kinetic energy for a falling body?	☐	☐	☐
9 Can you measure resistance by the ammeter-voltmeter method and with a multimeter (ohmmeter)?	☐	☐	☐
10 Can you investigate resistors in series and in parallel?	☐	☐	☐
11 Can you determine the resistivity of a metal?	☐	☐	☐
12 Can you determine the I-V characteristic of a metallic conductor at constant temperature?	☐	☐	☐
13 Can you determine the I-V characteristic of a filament lamp?	☐	☐	☐
14 Can you determine the resistance-temperature characteristic of an ntc thermistor?	☐	☐	☐
15 Can you determine the e.m.f. and internal resistance of a battery?	☐	☐	☐
16 Can you verify Snell's law?	☐	☐	☐
17 Can you determine the refractive index of a material?	☐	☐	☐
18 Can you determine the critical angle of glass or perspex using a semicircular block?	☐	☐	☐
19 Can you determine the focal length of a converging lens?	☐	☐	☐
20 Can you verify that the magnification of a real image equals image distance divided by object distance?	☐	☐	☐
21 Can you determine the speed of sound in air using a resonance tube?	☐	☐	☐
22 Can you determine the wavelength of light using a double slit and a diffraction grating?	☐	☐	☐