**OCR A - AS Physics Checklist**

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| Unit |  |  |
| **Module 1: Development of Practical Skills in Physics** | | |
| 1 | Can you design experiments, including ones to solve problems set in a practical context? |  |
|  | Can you identify the variables that must be controlled in an experiment? |  |
|  | Can you evaluate whether an experimental method is appropriate to meet expected outcomes? |  |
|  | Can you use a wide range of practical apparatus and techniques correctly? |  |
|  | Can you use appropriate units to take measurements? |  |
|  | Can you present observations and data in an appropriate format? |  |
|  | Can you process, analyse and interpret qualitative and quantitative experimental results? |  |
|  | Can you use appropriate mathematical skills for analysis of quantitative data? |  |
|  | Can you use significant figures appropriately? |  |
|  | Can you plot and interpret suitable graphs from experimental results? |  |
|  | Can you select and label axes with appropriate scales, quantities, and units? |  |
|  | Can you measure gradients? |  |
|  | Can you evaluate results and draw conclusions? |  |
|  | Can you identify anomalies in experimental measurements? |  |
|  | Can you explain the limitations in experimental procedures? |  |
|  | Can you be precise and accurate with measurements and data, including margins of error, percentage errors and uncertainties in apparatus? |  |
|  | Can you refine experimental design by suggesting improvements to the procedures and apparatus? |  |
| **Module 2: Foundations of Physics** | | |
| 2 | Can you explain that physical quantities have a numerical value and a unit? |  |
|  | Can you estimate physical quantities? |  |
|  | Can you describe the Système Internationale (S.I.) base quantities and their units – mass (kg), length (m), time (s), current (A), temperature (K), amount of substance (mol)? |  |
|  | Can you use derived units of S.I. base units? |  |
|  | Can you use the all the units you have encountered in the course? |  |
|  | Can you check the homogeneity of physical equations using S.I. base units? |  |
|  | Can you use prefixes and their symbols to indicate decimal submultiples or multiples of units – pico (p), nano (n), micro (μ), milli (m), centi (c), deci (d), kilo (k), mega (M), giga (G), tera (T)? |  |
|  | Can you use conventions for labelling graph axes and table columns? |  |
|  | Can you identify systematic errors (including zero errors) and random errors in measurements? |  |
|  | Can state the difference between precision and accuracy? |  |
|  | Can you explain absolute and percentage uncertainties when data are combined by addition, subtraction, multiplication, division and raising to powers? |  |
|  | Can you identify graphical treatment of errors and uncertainties; line of best fit; worst line; absolute and percentage uncertainties; percentage difference? |  |
|  | Can you use scalar and vector quantities? |  |
|  | Can you use vector addition and subtraction? |  |
|  | Can you use a vector triangle to determine the resultant of any two coplanar vectors? |  |
|  | Can you resolve a vector into two perpendicular components;  *F*x = *F* cos *θ* and *F*y = *F* sin *θ*? |  |
| **Module 3: Forces and Motion** | | |
| 3 | Can you define displacement, instantaneous speed, average speed, velocity, and acceleration? |  |
|  | Can you interpret graphical representations of displacement, speed, velocity, and acceleration? |  |
|  | Can you draw displacement–time graphs and calculate velocity from the gradient? |  |
|  | Can you interpret velocity–time graphs, where acceleration is the gradient and displacement is the area under the graph? |  |
|  | Can you use the equations of motion for constant acceleration in a straight line, including motion of bodies falling in a uniform gravitational field without air resistance? |  |
|  | Can you list and describe techniques and procedures used to investigate the motion and collisions of objects? |  |
|  | Can you define acceleration *g* of free fall? |  |
|  | Can you list and describe techniques and procedures used to determine the acceleration of free fall using a trapdoor and electromagnet arrangement or light gates and a timer? |  |
|  | Can you define what is meant by reaction time and thinking distance; and calculate braking distance and stopping distance for a vehicle? |  |
|  | Can you explain the independence of the vertical and horizontal motion of a projectile? |  |
|  | Can you describe the two-dimensional motion of a projectile with constant velocity in one direction and constant acceleration in a perpendicular direction? |  |
| 4 | Can you recall and understand the formula net force = mass × acceleration (*F* = *m a*)? |  |
|  | Can you recall the newton as the unit of force? |  |
|  | Can you explain why the weight of an object, *W* = *m g*? |  |
|  | Can you define and use the terms tension, normal contact force, upthrust, and friction? |  |
|  | Can you draw and interpret free-body diagrams? |  |
|  | Can you explain one- and two-dimensional motion under constant force? |  |
|  | Can you explain drag as the frictional force experienced by an object travelling through a fluid? |  |
|  | Can you describe the factors affecting drag for an object travelling through air? |  |
|  | Can you describe the motion of objects falling in a uniform gravitational field in the presence of drag? |  |
|  | Can you define terminal velocity? |  |
|  | Can you list and describe techniques and procedures used to determine terminal velocity in fluids? |  |
|  | Can you define the moment of a force? |  |
|  | Can you describe a couple and the torque of a couple? |  |
|  | Can you define and use the principle of moments? |  |
|  | Can you describe centre of mass/centre of gravity, and describe how to determine the centre of gravity experimentally? |  |
|  | Can you describe the conditions for equilibrium of an object under the action of forces and torques? |  |
|  | Can you explain the conditions for equilibrium of three coplanar forces? |  |
|  | Can you define density? |  |
|  | Can you describe pressure for solids, liquids, and gases? |  |
|  | Can you apply Archimedes’ principle and use the equation *p* = *h ρ g* to calculate the upthrust acting on an object in a fluid? |  |
| 5 | Can you define work done by a force and recall that the unit for work done is the joule? |  |
|  | Can you use *W* = *F x* cos *θ* to calculate the work done by a force? |  |
|  | Can you define and apply the principle of conservation of energy? |  |
|  | Can you describe and carry out calculations for situations involving the transfer of energy between different forms? |  |
|  | Can you explain how transfer of energy is equal to work done? |  |
|  | Can you define and calculate the kinetic energy of an object? |  |
|  | Can you define and calculate the gravitational potential energy of an object in a uniform gravitational field? |  |
|  | Can you describe the exchange between gravitational potential energy and kinetic energy? |  |
|  | Can you define and calculate power, and recall that the unit for power is the watt? |  |
|  | Can you use the equation *P* = *F v*? |  |
|  | Can you calculate the efficiency of a mechanical system? |  |
| 6 | Can you define and describe tensile and compressive deformation, and extension and compression? |  |
|  | Can you state Hooke’s law? |  |
|  | Can you determine the force constant *k* of a spring or wire using *F* = *k x*? |  |
|  | Can you sketch and interpret force–extension (or compression) graphs for springs and wires? |  |
|  | Can you describe techniques and procedures used to investigate force–extension characteristics for arrangements which may include springs, rubber bands, and polythene strips? |  |
|  | Can you use a force–extension (or compression) graph to determine the work done in extending (or compressing) the material? |  |
|  | Can you calculate elastic potential energy using *E* = *F x* and *E* = *k x*2? |  |
|  | Can you define stress, strain, and ultimate tensile strength? |  |
|  | Can you calculate the Young modulus of a material using tensile stress and tensile strain? |  |
|  | Can you describe techniques and procedures used to determine the Young modulus for a metal? |  |
|  | Can you interpret and sketch stress–strain graphs for typical ductile, brittle, and polymeric materials? |  |
|  | Can you describe elastic and plastic deformations of materials? |  |
| 7 | Can you use the equations of motion for constant acceleration in a straight line, including motion of bodies falling in a uniform gravitational field without air resistance? |  |
|  | Can you explain Newton’s three laws of motion? |  |
|  | Can you calculate linear momentum and understand the vector nature of momentum? |  |
|  | Can you understand that net force = rate of change of momentum? |  |
|  | Can you describe and calculate the impulse of a force? |  |
|  | Can you recall that impulse is equal to the area under a force–time graph? |  |
|  | Can you define the principle of conservation of momentum? |  |
|  | Can you describe and carry out calculations for collisions and interactions of bodies in one dimension and in two dimensions? |  |
|  | Can you describe perfectly elastic collisions and inelastic collisions? |  |
| **Module 4: Electrons, Waves and Photons** | | |
| 8 | Can you define electric current as rate of flow of charge? |  |
|  | Can you describe the coulomb as the unit of charge? |  |
|  | Can you recall the elementary charge *e* equals 1.6 × 10−19C? |  |
|  | Can you explain why the net charge on a particle or an object is quantised and a multiple of *e*? |  |
|  | Can you explain current as the movement of electrons in metals and movement of ions in electrolytes? |  |
|  | Can you describe the difference between conventional current and electron flow? |  |
|  | Can you recall and apply Kirchhoff’s first law? |  |
|  | Can you describe what is meant by mean drift velocity of charge carriers? |  |
|  | Can you carry out calculations using *I* = *A n e v*, where *n* is the number density of charge carriers? |  |
|  | Can you explain the distinction between conductors, semiconductors, and insulators in terms of *n*? |  |
| 9 | Can you recognise and draw circuit symbols? |  |
|  | Can you draw circuit diagrams using circuit symbols? |  |
|  | Can you define potential difference (p.d.) and the unit volt? |  |
|  | Can you describe the electromotive force (e.m.f.) of a source such as a cell or a power supply? |  |
|  | Can you explain the distinction between e.m.f. and p.d. in terms of energy transfer? |  |
|  | Can you describe and calculate energy transfer using *W* = *V Q* and  *W* = *E Q*? |  |
|  | Can you describe and calculate energy transfer using *eV* = *m v*2 for electrons and other charged particles? |  |
|  | Can you define resistance and the unit ohm? |  |
|  | Can you explain Ohm's law? |  |
|  | Can you describe the *I*–*V* characteristics of the resistor, filament lamp, thermistor, diode, and light-emitting diode (LED)? |  |
|  | Can you list and describe techniques and procedures used to investigate the electrical characteristics for a range of ohmic and non-ohmic components? |  |
|  | Can you explain the variation of resistance with light intensity for a light-dependent resistor (LDR)? |  |
|  | Can you explain the resistivity of a material and use the equation ? |  |
|  | Can you list and describe techniques and procedures used to determine the resistivity of a metal? |  |
|  | Can you explain how resistivity varies with temperature for metals and semiconductors? |  |
|  | Can you explain how resistance varies with temperature for a negative temperature coefficient (NTC) thermistor? |  |
|  | Can you use the equations *P* = *V I*, *P* = *I*2*R* and ? |  |
|  | Can you describe energy transfer using the equation *W* = *V I t*? |  |
|  | Can you describe the kilowatt-hour (kW h) as a unit of energy and calculate the cost of energy? |  |
| 10 | Can you explain Kirchhoff’s second law and the conservation of energy? |  |
|  | Can you describe Kirchhoff’s first and second laws applied to electrical circuits? |  |
|  | Can you determine the total resistance of two or more resistors in series using *R* = *R*1 + *R*2 + …? |  |
|  | Can you determine the total resistance of two or more resistors in parallel using ? |  |
|  | Can you analyse circuits with components both in series and in parallel? |  |
|  | Can you analyse circuits with more than one source of e.m.f.? |  |
|  | Can you define source of e.m.f. and internal resistance? |  |
|  | Can you define terminal p.d. and ‘lost volts’? |  |
|  | Can you use the equations *Ɛ* = *I* (*R* + *r*) and *Ɛ* = *V* + *I r*? |  |
|  | Can you list and describe techniques and procedures used to determine the internal resistance of a chemical cell or other source of e.m.f.? |  |
|  | Can you analyse a potential divider circuit with components? |  |
|  | Can you use potential divider circuits with variable components, e.g., LDRs and thermistors? |  |
|  | Can you use potential divider equations  and ? |  |
|  | Can you list and describe techniques and procedures used to investigate potential divider circuits which may include a sensor such as a thermistor or a LDR? |  |
| 11 | Can you describe progressive waves, both longitudinal and transverse? |  |
|  | Can you define displacement, amplitude, wavelength, period, phase difference, frequency, and speed of a wave? |  |
|  | Can you list and describe techniques and procedures used to use an oscilloscope to determine frequency? |  |
|  | Can you use the equation ? |  |
|  | Can you use the wave equation *v* = *f λ*? |  |
|  | Can you produce graphical representations of transverse and longitudinal waves? |  |
|  | Can you describe reflection, refraction, polarisation, and diffraction of all waves? |  |
|  | Can you list and describe techniques and procedures used to demonstrate wave effects using a ripple tank? |  |
|  | Can you list and describe techniques and procedures used to observe polarising effects using microwaves and light? |  |
|  | Can you describe and determine the intensity of a progressive wave using  and intensity ∝ (amplitude)2? |  |
|  | Can you describe the electromagnetic spectrum and the properties of electromagnetic waves? |  |
|  | Can you describe the orders of magnitude of wavelengths of the principal radiations from radio waves to gamma rays? |  |
|  | Can you describe plane polarised waves and polarisation of electromagnetic waves? |  |
|  | Can you describe refraction of light with reference to the refractive index? |  |
|  | Can you carry out calculations using the refraction law *n* sin *θ* = *k*? |  |
|  | Can you list and describe techniques and procedures used to investigate refraction and total internal reflection of light using ray boxes, and transparent rectangular and semi-circular blocks? |  |
|  | Can you define and calculate the critical angle using ? |  |
|  | Can you describe the conditions needed for total internal reflection to occur? |  |
| 12 | Can you explain the principle of superposition of waves? |  |
|  | Can you list and describe techniques and procedures used for superposition experiments using sound, light, and microwaves? |  |
|  | Can you use graphical methods to illustrate the principle of superposition? |  |
|  | Can you define interference, coherence, path difference, and phase difference? |  |
|  | Can you describe constructive interference and destructive interference in terms of path difference and phase difference? |  |
|  | Can you describe two-source interference for sound and microwaves? |  |
|  | Can you explain the Young double-slit experiment using visible light? |  |
|  | Can you use for all waves where *a* << *D*? |  |
|  | Can you list and describe techniques and procedures used to determine the wavelength of light using a double-slit and a diffraction grating? |  |
|  | Can you describe stationary (standing) waves using microwaves, stretched strings, and air columns? |  |
|  | Can you interpret and produce graphical representations of a stationary wave? |  |
|  | Can you describe the similarities and the differences between stationary and progressive waves? |  |
|  | Can you describe nodes and antinodes? |  |
|  | Can you describe stationary wave patterns for a stretched string, and air columns in closed and open tubes? |  |
|  | Can you list and explain techniques and procedures used to determine the speed of sound in air by formation of stationary waves in a resonance tube? |  |
|  | Can you explain the idea that the separation between adjacent nodes (or antinodes) is equal to , where *λ* is the wavelength of the progressive wave? |  |
|  | Can you define the fundamental mode of vibration (1st harmonic) and describe different harmonics? |  |
| 13 | Can you explain the particulate nature (photon model) of electromagnetic radiation? |  |
|  | Can you define a photon as a quantum of energy of electromagnetic radiation? |  |
|  | Can you describe and calculate the energy of a photon using *E* = *h f* and ? |  |
|  | Can you define the electronvolt (eV) as a unit of energy? |  |
|  | Can you use LEDs and the equation to estimate the value of the Planck constant *h*? |  |
|  | Can you determine the Planck constant using different coloured LEDs? |  |
|  | Can you explain the photoelectric effect, including a simple experiment to demonstrate this effect? |  |
|  | Can you demonstrate the photoelectric effect using, for example, a gold-leaf electroscope and zinc plate? |  |
|  | Can you describe the one-to-one interaction between a photon and a surface electron? |  |
|  | Can you explain Einstein’s photoelectric equation *h f* = *ɸ* + *KE*max? |  |
|  | Can you define work function and threshold frequency? |  |
|  | Can you explain the idea that the maximum kinetic energy of the photoelectrons is independent of the intensity of the incident radiation? |  |
|  | Can you explain the idea that a rate of emission of photoelectrons above the threshold frequency is directly proportional to the intensity of the incident radiation? |  |
|  | Can you explain electron diffraction, including experimental evidence of this effect? |  |
|  | Can you describe diffraction of electrons travelling through a thin slice of polycrystalline graphite? |  |
|  | Can you use the de Broglie equation ? |  |