

INTERNATIONAL ADVANCED LEVEL

PHYSICS

SCHEME OF WORK

Pearson Edexcel International Advanced Subsidiary in Physics (XPH11)

Pearson Edexcel International Advanced Level in Physics (YPH11)

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and August 2020 (International Advanced Level)

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IAL Physics 2018: Scheme of Work

This scheme of work is created as an example approach only and is not intended to be prescriptive. It may be adapted to suit your teaching plan. The sample assessment materials can be used for question practice to enable students to build up confidence and skills as part of their revision and exam practice.

Week	Prior Learning	Content of Lessons	Teaching Suggestions	Spec Reference
1	International GCSE/GCSE mechanics – describing motion	SI base and derived units. Measurement & techniques. Sig. figs., scientific notation, standard form and prefixes. Distance, displacement, speed, velocity and acceleration.	The work on SI base and derived units, Sig. figs., standard form and prefixes is required for all topics and needs to be revisited regularly.	
2	describing motion graphically	Displacement/time and velocity/time graphs and their interpretation, for motion with uniform and non-uniform acceleration.	Displacement/time graph for a trolley on a runway with a motion sensor. Mathematical requirement: graph plotting and measuring gradients	2, 3
3	International GCSE/GCSE mechanics – equations for speed and acceleration	Derive equations of motion: $s = \frac{(u + v)t}{2}$ $v = u + at$ $s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$ Practise problems in one dimension. Measurement of the acceleration of free fall. <i>CORE PRACTICAL 1:</i> Determine the acceleration of a freely falling object.	Examples to include positive and negative values of the variables. Mathematical requirement: manipulate of equations. Investigate the motion of a bouncing ball. All students should carry out this experiment.	1, 11

4	International GCSE/GCSE mechanics – Newton's second law as $F = ma$ mass and weight	Free-body force diagrams Newton's second law of motion Acceleration, mass and force. Mass and weight. $\sum F = ma$ $W = mg$ Newton's third law and Newton's first law of motion.	Use of light gates to investigate the effect of force and mass on the acceleration of an object. Motion on a linear air track to demonstrate N1. 2 students on roller skates to demonstrate N3. Examples of free-body force diagrams for N3.	8, 9, 10, 12
5		Introduce vectors and vector addition Practise calculations scale drawing Parallelogram law equivalence to 'nose to tail' – shown using drawings. Bodies in equilibrium: vector forces on body sum to zero, triangle of forces Resolution of vectors into two components at right angles to each other by calculation and scale drawing.	Practise calculations using scale drawing. Investigate the equilibrium of three vertical forces using two pulley wheels. Mathematical requirement: use of trig. functions.	4, 5, 6
6	Resolution of vectors	Work done and energy transfer K.E. & G.P.E. Derivation of $E_k = \frac{1}{2}mv^2$ and $\Delta E_{grav} = mg\Delta h$ $\Delta W = F\Delta s$ and $\Delta W = F\Delta s \cos\theta$ Principle of conservation of energy. Application to mechanical situations, e.g. 'frictionless' rollercoaster: $E_p + E_k = \text{constant}$.	Investigate the transfer of GPE to KE for a trolley rolling down a ramp. Include examples where the direction of the force is different to the direction of motion.	17, 18, 19, 20

7	International GCSE/GCSE – equations for power and efficiency	$P = \frac{W}{t}$ <p>Derive $P = Fv$ using $\frac{\Delta W}{\Delta t} = \frac{F\Delta s}{\Delta t}$</p> $P = \frac{W}{t} \text{ and } P = \frac{E}{t}$ <p>Discuss useful work done → efficiency. Efficiency = [useful power output]/[total power) input.</p>	<p>Measure the output power of an electric motor.</p> <p>Efficiency of HEP stations Mathematical requirement: dealing with percentages</p>	21, 22
8	International GCSE/GCSE mechanics – momentum = mass × velocity	<p>Linear momentum, $p = mv$.</p> <p>Discuss and calculate values for, e.g. car and truck with different speeds.</p> <p>Principle of conservation of linear momentum as a consequence of Newton’s laws of motion.</p> <p>Collision problems in one dimension.</p>	<p>Discuss and calculate values for, eg car and truck with different speeds.</p> <p>Examples of conservation of momentum could include: Newton’s cradle, stepping off a boat, trolley ‘explosions’.</p>	13, 14
9	Equations of motion (Week 3)	<p>Projectiles.</p> <p>Independence of vertical and horizontal motion</p> <p>‘Monkey and hunter’ demonstration.</p>	<p>Use of strobe light to illuminate objects falling vertically and projected horizontally.</p> <p>‘Monkey and Hunter’ demonstration</p>	7
10	Free-body force diagrams (Week 6)	<p>Centre of gravity</p> <p>Moment of a force; the principle of moments</p>	<p>‘Lorry on a bridge’ model, using spring balances to support a metre ruler with weights (lorry) that move along the ruler.</p> <p>Include examples where the forces are not all parallel to each other.</p>	8, 15, 16
11	International GCSE/GCSE materials - density = mass/ volume	<p>Density $\rho = \frac{m}{V}$</p> <p>Flotation: upthrust = weight of fluid displaced</p> <p>Laminar and turbulent flow, viscosity and Stokes’ law, $F = 6\pi\eta rv$.</p> <p>CORE PRACTICAL 2: Use a falling-ball method to determine the viscosity of a liquid.</p>	<p>Measure the density of air</p> <p>Demonstration of floating objects sinking further as their weight increases.</p> <p>All students should carry out this experiment.</p>	23, 24, 25, 26

12	International GCSE/GCSE materials – Hooke's law, $F = kx$	Hooke's law, $\Delta F = k\Delta x$ Force-extension and force-compression graphs. Idea of limit of proportionality, elastic limit, yield point, elastic deformation and plastic deformation (including relation to graphs) Stress, strain, the Young modulus	Loading and unloading of springs and rubber bands. Measuring the effect of compression on a range of materials. Measurement of Young modulus for different materials.	27, 28, 29
13		Tensile/compressive stress-strain graphs and understanding the term breaking stress. Elastic strain energy in a deformed material sample from the area under the force/extension graph and $\Delta E_{el} = \frac{1}{2} F\Delta x$ <i>CORE PRACTICAL 3:</i> Determine the Young modulus of a material.	All students should carry out this experiment.	30, 31, 32
14	International GCSE/GCSE wave properties and wave equation, $v = f\lambda$	Mechanical progressive wave properties. Introduce wave types: transverse, longitudinal Graphs representing transverse and longitudinal waves plane polarisation <i>CORE PRACTICAL 4:</i> Determine the speed of sound in air using a 2-beam oscilloscope, signal generator, speaker and microphone.	Expectation of more precise definitions for transverse and longitudinal waves. All students should carry out this experiment.	33, 34, 35, 36, 37, 38, 49
15		Wavefronts, coherence, path difference and phase Principle of superposition and interference Stationary wave demonstrations.	Demonstrate interference of sound waves with loudspeakers and signal generator. Ripple tank demonstration.	39, 40, 41

16		<p>Patterns of nodes and antinodes for stretched strings and open and closed air columns</p> <p>Speed of a transverse wave on a string: $v = \sqrt{\frac{T}{\mu}}$</p> <p><i>CORE PRACTICAL 5:</i> Investigate the effects of length, tension and mass per unit length on the frequency of a vibrating string or wire.</p>	<p>Demonstrate standing waves on strings.</p> <p>Mathematical requirement: manipulation of an equation with a square root in it.</p> <p>All students should carry out this experiment.</p>	41, 42, 43
17	International GCSE/GCSE light – reflection and refraction	<p>Intensity, $I = \frac{P}{A}$</p> <p>Waves meeting an interface between two media, pulse echo techniques</p> <p>Refraction, refractive index and Snell's law</p> <p>Critical angle and total internal reflection.</p>	<p>Ripple tank to demonstrate refraction of wavefronts.</p> <p>Ray tracing through a glass block.</p> <p>Use of semi-circular block to demonstrate critical angle.</p> <p>Fibre optics as an example.</p>	44, 45, 46, 47, 48, 55, 56
18		<p>Diffraction: single slit water wave diffraction demonstration. Width of central maximum linked to relative sizes of wavelength and slit.</p> <p>The diffraction grating, $n\lambda = d\sin\theta$.</p> <p><i>CORE PRACTICAL 6:</i> Determine the wavelength of light from a laser or other light source using a diffraction grating.</p>	<p>Ripple tank demonstration for water wave diffraction.</p> <p>Diffraction grating and laser for light diffraction.</p> <p>Mathematical requirement: use of trig functions.</p> <p>All students should carry out this experiment.</p>	50, 51, 52

19	International GCSE/GCSE light – photons	<p>Photon model: $E = hf$</p> <p>Small energy unit, $1eV = 1.6 \times 10^{-19}J$.</p> <p>Atomicline spectra.</p> <p>Energy level 'ladder' diagrams. Ground & 'excited' states, choice of routes back → photons emitted,</p> $hf = E_1 - E_2.$	Flame tests with diffraction gratings.	57, 58, 61, 63
20		<p>The photoelectric effect</p> <p>Work function and the photoelectric equation</p> $hf = \phi + \frac{1}{2}mv_{\max}^2 .$	<p>Demonstration using UV and a zinc plate on a coulombmeter.</p> <p>Use of a phototube to investigate how max KE of photoelectrons varies with frequency of incident radiation.</p>	59, 60
21	Diffraction (Week 18)	<p>Wave-particle duality</p> <p>Wave properties of free electrons</p> <p>Electron diffraction demonstration.</p>		53, 54, 62
22	<p>International GCSE/GCSE current electricity</p> <p>Standard prefixes (Week 1)</p>	<p>Current as rate of flow of charge:</p> $I = \frac{\Delta Q}{\Delta t}$ <p>P.d. as work done per unit charge:</p> $V = \frac{W}{Q} .$ <p>Define resistance, $R = \frac{V}{I}$</p> <p>Ohm's law.</p>	Use of ammeters and voltmeters to measure current and potential difference. I-V graph for an ohmic conductor.	64, 65, 66, 70

23	International GCSE/GCSE electricity – series and parallel circuits	<p>Series and parallel circuits Kirchhoff's laws. Resistor combinations: $R = R_1 + R_2 + R_3$ (series resistors) $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$ (parallel resistors).</p>	<p>Experiments to investigate series and parallel circuits. Mathematical requirement: derivation of formulae for series and parallel resistors.</p>	67, 68, 69
24	Power (Week 22)	<p>I-V characteristics of: ohmic conductors, filament bulbs, thermistors and diodes Electrical working $\Delta W = IV\Delta t$ Electrical power, $P = \frac{\Delta W}{\Delta t} = IV$ $P = I^2R$ and $P = \frac{V^2}{R}$.</p>	<p>Plot I-V graphs for a range of components. Plot P-V graphs.</p>	69, 70
25		<p>Potential divider Demonstration of variation of resistance of thermistor with change of temperature and LDR with change of light level. $V_1 = \frac{VR_1}{(R_1 + R_2)}$.</p>	<p>Demonstration of a potential divider circuit. Demonstration of variation of resistance of thermistor with change of temperature and LDR with change of light level.</p>	74, 75, 76
26		<p>e.m.f as work done per unit charge: $V = \frac{W}{Q}$. e.m.f. and internal resistance</p>	<p>Demonstrate the effect on the terminal potential difference of a cell of altering the load across the cell.</p>	77

27		<p><i>CORE PRACTICAL 8:</i> Determine the e.m.f. and internal resistance of an electrical cell.</p> <p>Resistivity, $R = \frac{\rho l}{A}$</p>	<p>Mathematical requirement: dealing with a negative gradient.</p> <p>All students should carry out this experiment.</p>	71, 78
28		<p>Conduction mechanisms, distinction between metals, semiconductors and insulators.</p> <p>$I = nqvA$.</p> <p><i>CORE PRACTICAL 7:</i> Measure the electrical resistivity of a material.</p>	<p>Investigate the effect of temperature on the resistance of a thermistor.</p> <p>All students should carry out this experiment.</p>	71, 72, 73, 79, 80

IAL Physics 2018: Scheme of Work – A2 units

Week	Prior Learning	Content of Lessons	Teaching Suggestions	Spec Reference
1	Newton's second law (AS)	Impulse momentum theorem <i>CORE PRACTICAL 9</i> : Investigate the relationship between the force exerted on an object and its change of momentum.	Applications such as sport and crumple zones on cars. All students should carry out this experiment.	81, 82
2	Conservation of momentum (AS)	Conservation of linear momentum. Collision problems in two dimensions. Elastic and inelastic collisions. $E_k = \frac{p^2}{2m}$ for the kinetic energy of a non-relativistic particle. <i>CORE PRACTICAL 10</i> : Use ICT to analyse collisions between small spheres, eg ball bearings on a table top.	Computer simulations of two dimensional collisions. Investigate elastic and inelastic collision between trolleys All students should carry out this experiment.	83, 84, 85, 86
3		Radian measure, $2\pi \text{ rad} = 360^\circ$ Angular displacement, $\theta = s / r$ and angular velocity, $\omega = \Delta\theta/\Delta t = v/r$ Angular frequency, $\omega = 2\pi f$ Circular motion.		87, 88, 90

4		<p>Centripetal acceleration</p> $a = \frac{v^2}{r} = r\omega^2$ <p>Centripetal force as a resultant force</p> $F = ma = \frac{mv^2}{r} = mr\omega^2 .$	<p>Mathematical requirement: use of vector diagrams to derive equations for centripetal acceleration.</p> <p>Horizontal circles; banked tracks Simple vertical circles.</p>	89, 91
5		<p>Electrostatic phenomena and electric charge. Radial and uniform electric fields (field lines and equipotentials) [compare with gravitational fields] A charge experiences a force in an electric field.</p> <p>Electric field strength, $E = \frac{F}{Q}$</p>	Radial fields due to point charges and parallel fields due to parallel plates.	92, 93,
6		<p>Force between point charges. Coulomb's Law: $F = kQ_1Q_2 / r^2$ Electric field strength due to a point charge:</p> $E = \frac{Q}{4\pi\epsilon_0 r^2}$	Experimental verification of Coulomb's law	94, 95
7	P.d. (AS) Projectiles (AS)	<p>Electric potential, $V = \frac{W}{Q}$</p> <p>Uniform field (between parallel plates):</p> $E = \frac{V}{d}$ <p>Force on charge q entering this field is:</p> $F = qE = \frac{qV}{d} \text{ (compare with projectiles)}$ <p>$V = \frac{Q}{4\pi\epsilon_0 r}$ for a radial field</p>	Investigate equipotentials across an electric field.	96, 97, 98, 99

8		<p>Define capacitance, $C = \frac{Q}{V}$</p> <p>Energy stored by a capacitor derived from the area under a graph of potential difference against charge stored</p> $W = \frac{1}{2}QV$ $W = \frac{1}{2}CV^2 \text{ and } W = \frac{1}{2}\frac{Q^2}{C}.$	<p>Use a coulombmeter to investigate the relationship $C = QV$.</p>	100, 101
9		<p>Charge and discharge capacitor through fixed resistor to obtain exponential decay curve</p> $Q = Q_0 e^{-t/RC}$ <p>Derive and use related equations for discharge in a resistor-capacitor circuit:</p> $I = I_0 e^{-t/RC}, \text{ and } V = V_0 e^{-t/RC}$ <p>and the corresponding log equations</p> <p>Time constant, RC as the time taken for charge to fall to 37 per cent of initial value.</p> <p><i>CORE PRACTICAL 11:</i> Use an oscilloscope or data-logger to display and analyse the potential difference (p.d.) across a capacitor as it charges and discharges through a resistor.</p>	<p>Investigate how the current through a capacitor varies over time.</p> <p>Investigate both charging and discharging circuits.</p> <p>Investigate the effect of the time constant on the discharge/charging of a capacitor.</p> <p>Mathematical requirement:</p> <p>Use of the exponential equation and logs.</p> <p>All students should carry out this experiment.</p>	102, 103, 104
10	International GCSE/GCSE permanent magnetism	<p>Magnetic field line patterns</p> <p>Right hand grip rule</p> <p>Demonstrate motor effect</p> <p>Fleming's left hand rule</p> <p>Magnitude of B defined by $F = BIl$ (for wire, $F = Bqv$ for charged particles).</p> <p>Application to motors, moving coil meters and loudspeakers.</p>	<p>U-shaped magnet and current in wire to demonstrate Fleming's LH rule.</p> <p>Investigate the force on a current carrying wire in a magnetic field.</p>	106, 107, 108

11		<p>Magnetic flux density B, flux ϕ and flux linkage $N\phi$</p> <p>Origins of EM induction</p> <p>Faraday's law, $\mathcal{E} = -\frac{d(N\phi)}{dt}$.</p> <p>Lenz's law and energy conservation.</p>	Demonstrations of EM induction, such as magnet falling through coil of wire, or magnet on a spring oscillating through a coil of wires.	105, 110
12	International GCSE/GCSE Transformer	<p>Transformer effect</p> <p>Effect of turns-ratio on transformer output</p> <p>Explain $\frac{V_p}{V_s} = \frac{N_p}{N_s}$ using Faraday's law</p>	Simple transformer demonstration	109
13	Electric potential (Week 7)	<p>The thermionic effect</p> <p>LINAC principles</p> <p>$W = QV$.</p> <p>Cyclotron principles</p> $BQv = \frac{mv^2}{r}$ <p>$r = \frac{p}{BQ}$ for a charged particle in a magnetic field</p> <p>Mass increase as speed increases; particles can never reach the speed of light.</p>	<p>Demonstrate Van de Graaff generator</p> <p>Use of the CERN website to illustrate the LINAC and Cyclotron.</p>	113, 114, 115, 120
14	International GCSE/GCSE atomic Physics	<p>Structure of the atom</p> <p>Rutherford scattering experiments</p> <p>High energy scattering experiments.</p>	Computer simulation of Rutherford's experiment.	111, 112, 117

15		<p>Creation and annihilation of matter and antimatter particles</p> $\Delta E = c^2 \Delta m$ <p>Non-SI units of MeV and GeV (energy) and MeV/c², GeV/c² (mass)</p> <p>Principles of cloud, bubble & spark chambers, ionisation detectors.</p>		118, 119
16	Conservation of momentum (AS and week 2)	<p>The standard model</p> <p>Particle collisions: interpretation in terms of conservation laws.</p>	Use bubble chamber images and a variety of interactions to illustrate particle collisions.	116, 121, 122, 123, 124
17	Pressure from International GCSE/GCSE	<p>Ideal gases</p> <p>Equation of state $pV = NkT$</p> <p>Concept of absolute zero, $T = \theta + 273$</p> <p><i>CORE PRACTICAL 14</i>: Investigate the relationship between pressure and volume of a gas at fixed temperature.</p>	<p>Investigate the relationship between pressure and temperature of a gas at fixed volume.</p> <p>All students should carry out this experiment.</p>	129, 130, 131
18	Conservation of momentum (AS) Potential dividers (AS)	<p>Temperature and molecular kinetic energy</p> $\frac{1}{2} m \langle c^2 \rangle = \frac{3}{2} kT$ <p>Concept of internal energy</p> <p><i>CORE PRACTICAL 12</i>: Calibrate a thermistor in a potential divider circuit as a thermostat.</p>	<p>Mathematical requirement: Derivation of both equations.</p> <p>All students should carry out this experiment.</p>	126, 128, 129, 131

19	Electrical power (AS)	Specific heat capacity, $\Delta E = mc\Delta\theta$ Specific latent heat, $\Delta E = L\Delta m$ <i>CORE PRACTICAL 13</i> : Determine the specific latent heat of a phase change.	Experiments to find the SHC of a solid and a liquid All students should carry out this experiment.	125, 127
20	Mass-energy equation	Nuclear binding energy Mass deficit, $\Delta E = c^2\Delta m$ Background radiation Nature and properties of alpha, beta and gamma radiation Nuclear decay equations. <i>CORE PRACTICAL 15</i> : Investigate the absorption of gamma radiation by lead.	Measure background radiation with GM tube. Measure range of radiation in air and other materials. All students should carry out this experiment,	133, 134, 137, 138, 139, 140
21	International GCSE/GCSE Fission	Processes of fission and fusion Mechanism of nuclear fusion Extreme condition required for fusion.		135, 136
22	International GCSE/GCSE Radioactivity	Radioactivity as a random process (eg dice simulation). Activity, $A = \frac{dn}{df} = -\lambda N$ Meaning of λ , $\ln 2 = \lambda t_{1/2}$ Exponential decay equations $N = N_0 e^{-\lambda t}$ and $A = A_0 e^{-\lambda t}$ and the corresponding log. Equations.	Model radioactivity with dice. Computer simulation to produce a radioactive decay curve.	141, 142
23	Angular motion (Week 3)	Conditions for simple harmonic motion Equations of shm: $a = -\omega^2 x$, $x = A \cos \omega t$, $v = A \omega \sin \omega t$, $T = \frac{1}{f} = \frac{2\pi}{\omega}$ and $\omega = 2\pi f$.		143, 144

24	Hooke's law (AS)	<p>Displacement-time and velocity-time graphical variations for an oscillating object</p> <p>Equation for a simple harmonic oscillator</p> $T = 2\pi\sqrt{\frac{m}{k}} \text{ and a simple pendulum } T = 2\pi\sqrt{\frac{l}{g}}.$	<p>Use of motion sensor to obtain displacement-time graphs and velocity time graphs.</p> <p>Oscillating mass on a spring and simple pendulum experiments.</p>	145, 146, 147
25	Materials (AS)	<p>Resonance</p> <p>Free and forced oscillations</p> <p>Damping</p> <p><i>CORE PRACTICAL 16</i>: Determine the value of an unknown mass using the resonant frequencies of the oscillation of known masses.</p>	<p>Demonstration: Barton's pendulums</p> <p>Investigate damped oscillations using a long pendulum with a paper cone around the bob.</p> <p>All students should carry out this experiment.</p>	148, 149, 150, 151, 152, 153
26		<p>Concept of a gravitational field.</p> <p>Radial gravitational field of the Earth</p> <p>Inverse square law</p> <p>Newton's law of gravitation</p> $F = \frac{Gm_1m_2}{r^2}$ <p>Derive and use the equation $g = \frac{Gm}{r^2}$ for the gravitational field due to a point mass</p>	<p>Mathematical requirement:</p> <p>Inverse square law</p>	154, 145, 156, 157, 158, 160
27	<p>Electric fields (weeks 5-7)</p> <p>Circular motion (Week 4)</p>	<p>$V_{grav} = \frac{-GM}{r}$ for a radial gravitational field</p> <p>Comparison of electric and gravitational fields</p> <p>Application to satellite orbits</p>	<p>Equipotential surfaces – compare to map 'contour lines'. No work done moving on an equipotential surface.</p> <p>Planets orbiting the sun, moons orbiting planets, artificial satellites around the Earth.</p>	158, 159, 160

28		<p>Black bodies Stefan-Boltzmann law, $L = \sigma AT^4$ Wien's law, $\lambda_{max}T = 2.90 \times 10^{-3} m K$ Intensity, $I = \frac{P}{A}$</p>		161, 162, 163, 164
29		<p>Trigonometric parallax (not parsecs) Standard candles Intensity inverse square law, $I = \frac{L}{4\pi d^2}$ A simple Hertzsprung-Russell diagram and its relation to the life cycle of stars Main sequence stars, white dwarfs and red giants.</p>	Investigate the inverse square law with lamps and LDR	165, 167, 168,
30		<p>Doppler effect for em-radiation Redshift, $z = \frac{\Delta\lambda}{\lambda} \approx \frac{\Delta f}{f} \approx \frac{v}{c}$ Hubble's law, $v = H_0 d$. Gravitational attraction slows expansion of Universe. Average mass-energy density of the Universe affects whether indefinite expansion or final contraction. The Hubble constant Dark matter.</p>	Use of spectra from different galaxies.	169, 170, 171