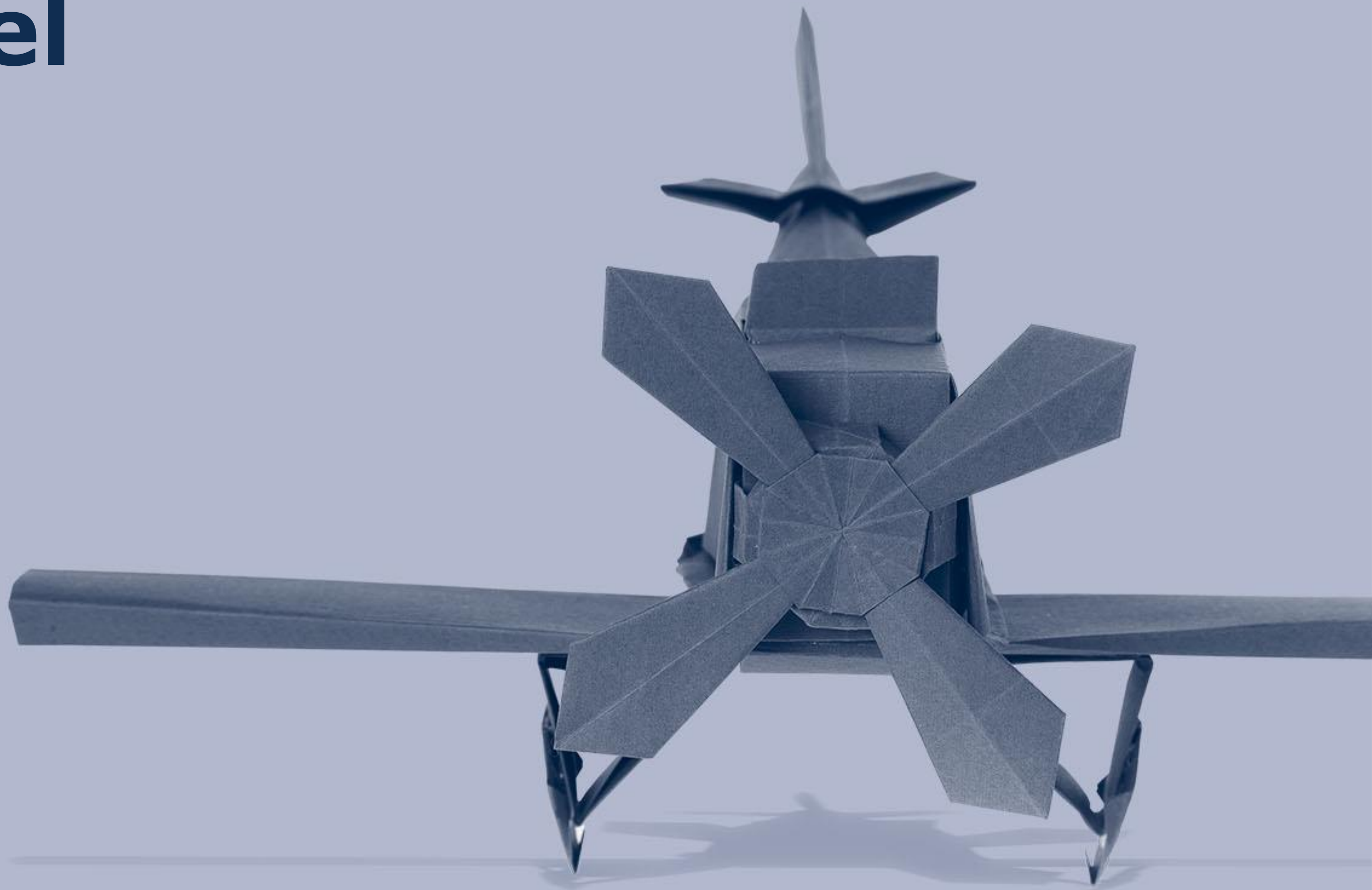
AS and A Level Physics



SCHEME OF WORK

A Level Physics

Pearson Edexcel Level 3 Advanced GCE Physics

Scheme of Work – A level Physics

This is an example and may be adapted.

Specification points 1–8 need to be considered and incorporated throughout the course, as they apply to all topics.

Week	Prior Learning	Content of Lessons	Teaching Suggestions	Spec Reference	Student Book page numbers
1	GCSE mechanics – describing motion graphically	SI base and derived units. Measurement and techniques. Sig. figs., scientific notation, standard form and prefixes. Distance, displacement, speed, velocity and acceleration. Displacement/time and velocity/time graphs and their interpretation, for motion with uniform and non-uniform 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. Displacement/time graph for a trolley on a runway with a motion sensor.	1, Introduce 2, 10, 11	
2	GCSE mechanics – equations for speed and acceleration	Derive equations of motion:	Examples to include positive and negative values of the variables. Mathematical requirement: manipulate of equations.	9, 19	

		$s = \frac{(u+v)t}{2}$ $v = u + at$ $s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$ Practise problems in one dimension. Measurement of the acceleration of free fall. • *CORE PRACTICAL 1:* Determine the acceleration of a freely falling object.	Investigate the motion of a bouncing ball. All students should carry out this experiment.		

3	GCSE mechanics – Newton's second law as $\sum F = ma$ mass and weight	Free-body force diagrams Newton's second law of motion Mass and weight. $W = mg$ Newton's third law and Newton's first law of motion. $g = \frac{F}{m}$	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.	16, 17, 18, 20	
4		Introduce vectors and vector addition 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.	12, 13, 14	
5	Resolution of	Work done and energy transfer	Investigate the transfer of	25, 26, 27, 28	

	vectors (Week 4)	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, eg 'frictionless' rollercoaster: $E_p + E_k = constant$	G.P.E. to K.E. for a trolley rolling down a ramp. Include examples where the direction of the force is different to the direction of motion..		

6	GCSE – equations for power and efficiency	$P = \frac{W}{t}$ Derive $P = Fv$ using $\frac{\Delta W}{\Delta t} = \frac{F\Delta s}{\Delta t}$ $P = \frac{W}{t}$ and $P = \frac{E}{t}$ Discuss useful work done → efficiency. efficiency = [useful power output]/[total power) input	Measure the output power of an electric motor. Efficiency of HEP stations Mathematical requirement: dealing with percentages	29, 30	
7	GCSE mechanics – momentum = mass × velocity	Linear momentum, $p = mv$. Principle of conservation of linear momentum as a consequence of Newton's laws of motion. Collision problems in one dimension.	Discuss and calculate values for, eg car and truck with different speeds. Examples of conservation of momentum could include: Newton's cradle, stepping off a boat, trolley 'explosions'.	21, 22	
8	Equations of motion (Week 2)	Projectiles. Independence of vertical and horizontal motion.	Use of strobe light to illuminate objects falling vertically and projected horizontally.	15	

			'Monkey and hunter' demonstration.		
9	Free-body force diagrams (Week 3)	Centre of gravity Moment of a force; the principle of moments.	'Lorry on a bridge' model, using spring balances to support a metre ruler with weights (lorry) that move along the ruler. Include examples where the forces are not all parallel to each other.	16, 23, 24	

10	GCSE wave properties and wave equation, $v = f\lambda$	Mechanical progressive wave properties. Introduce wave types: transverse, longitudinal Graphs representing transverse and longitudinal waves. $v = f\lambda$ • *CORE PRACTICAL 6:* 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.	59, 60, 61, 62, 63, 64	
11		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.	65, 66, 67	
12		Patterns of nodes and antinodes for stretched strings and open and closed air columns Speed of a transverse wave on a string: $v = \sqrt{\frac{T}{\mu}}$ • *CORE PRACTICAL 7:* Investigate the effects of length, tension and mass per unit length on the	Demonstrate standing waves on strings. Mathematical requirement: manipulation of an equation with a square root in it. All students should carry	67, 68, 69	

		frequency of a vibrating string or wire.	out this experiment.		
13		Diffraction: single slit water wave diffraction demonstration. Width of central maximum linked to relative sizes of wavelength and slit. and the diffraction grating $n\lambda = d sin\theta$ • *CORE PRACTICAL 8:* Determine the wavelength of light from a laser or other light source using a diffraction grating.	Ripple tank demonstration for water wave diffraction. Diffraction grating and laser for light diffraction. Mathematical requirement: use of trig. functions. Use of polaroid filters Effect of concentration of sugar solution on the plane of polarisation. All students should carry out this experiment.	82, 83, 84	
14	GCSE light – reflection and refraction	Waves meeting an interface between two media, pulse echo techniques Refraction, refractive index and Snell's law Critical angle and total internal reflection.	Ripple tank to demonstrate refraction of wavefronts. Ray tracing through a glass block. Use of semi-circular block to demonstrate critical angle. Fibre optics as an example.	71, 72, 73, 74, 88, 89	
16	GCSE light – simple ray diagrams	An understanding that image formation in lenses is due to refraction. Definition of focal length of a lens Ray diagrams for converging and diverging lenses. Real and virtual images and their properties Simple lens equation, $\frac{1}{u}+\frac{1}{v}=\frac{1}{f}$.	Demonstration of image formation by converging and diverging lenses. Ray diagrams to locate the image position Experimental verification of lens formula	75, 78, 79, 80	

16		Focal length and power of a lens, $P = \frac{1}{f}$ $P = P_1 + P_2 + P_3 + \ldots$ for thin lenses in combination Linear magnification, $m = \frac{h_i}{h_o} = \frac{v}{u}$ Understand what is meant by plane polarisation.	Measure the focal length of a lens. Experimental verification that *m* = *v*/*u* Use of polaroid filters Effect of concentration of sugar solution on the plane of polarisation.	77, 80, 81, 82	
17	GCSE materials - density = mass/ volume	Density $\rho = \frac{m}{V}$ Flotation: upthrust = weight of fluid displaced Laminar and turbulent flow, viscosity and Stokes' law, $F = 6\pi\eta rv$. • *CORE PRACTICAL 4:* Use a falling-ball method to determine the viscosity of a liquid.	Measure the density of air Demonstration of floating objects sinking further as their weight increases. All students should carry out this experiment individually.	49, 50, 51, 52	
18	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.	53, 54, 55	
19		Tensile/compressive stress-strain graphs, and		56, 57, 58	

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		understand the term breaking stress. Calculate the elastic strain energy E_{el} in a deformed material sample, using the equation $\Delta E_{el} = \frac{1}{2} F\Delta x$, and from the area under the force/extension graph. • *CORE PRACTICAL 5:* Determine the Young modulus of a material.	All students should carry out this experiment.		
20	GCSE current electricity Standard prefixes (Week 1)	Current as rate of flow of charge: $I = \frac{\Delta Q}{\Delta t}$ P.d. as work done per unit charge: $V = \frac{W}{Q}$. Define resistance, $R = \frac{V}{I}$ Ohm's law.	Use of ammeters and voltmeters to measure current and potential difference. I-V graph for an ohmic conductor.	31, 32, 33, 38	
21	GCSE electricity – series and parallel circuits	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).	Experiments to investigate series and parallel circuits. Mathematical requirement: derivation of formulae for series and parallel resistors.	34, 35, 36	
22	Power (Week 7)	I-V characteristics of: ohmic conductors, filament bulbs, thermistors and diodes Electrical working $\Delta W = IV\Delta t$ Electrical power, $P = \frac{\Delta W}{\Delta t} = IV$	Plot I-V graphs for a range of components. Plot P-V graphs.	37, 38	

		$P = I^2R$ and $P = \frac{V^2}{R}$			
23		Potential divider $V_1 = \frac{VR_1}{(R_1 + R_2)}$. Analyse potential divider circuit where one resistor is variable, such as a thermistor or LDR.	Demonstration of a potential divider circuit. Demonstration of variation of resistance of thermistor with change of temperature and LDR with change of light level.	42, 43, 44	
24		e.m.f. as work done per unit charge: $V = \frac{W}{Q}$ e.m.f. and internal resistance • *CORE PRACTICAL 3:* Determine the e.m.f. and internal resistance of an electrical cell.	Demonstrate the effect on the terminal potential difference of a cell of altering the load across the cell. Mathematical requirement: dealing with a negative gradient. All students should carry out this experiment.	45, 46	

25		Resistivity, $R = \frac{\rho l}{A}$ Conduction mechanisms, distinction between metals, semiconductors and insulators. $I = nqvA$ • *CORE PRACTICAL 2:* Measure the electrical resistivity of a material.	Investigate the effect of temperature on the résistance of a thermistor. All students should carry out this experiment.	39, 40, 41, 47, 48	
26	GCSE light - photons	Photon model: $E = hf$	Flame tests with diffraction gratings.	90, 91, 94, 96	

		Small energy unit; *1eV = 1.6 x* 10^{-19}*J.* Optical line spectra. Energy level 'ladder' diagrams. Ground and 'excited' states, choice of routes back → photons emitted, $hf = E_1 - E_2$.			
27		The photoelectric effect Work function and the photoelectric equation $hf = \phi + \frac{1}{2}mv_{max}^2$.	Demonstration using UV and a zinc plate on a coulombmeter. Use of a phototube to investigate how max KE of photoelectrons varies with frequency of incident radiation.	92, 93	
28	Diffraction (Week 14)	Wave-particle duality Wave properties of free electrons. Electron diffraction demonstration.		86, 87, 95	
29	Newton's second law (Week 5)	Impulse momentum theorem • *CORE PRACTICAL 9:* 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.	97, 98	
30	Conservation of momentum (Week 8)	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. • *CORE PRACTICAL 10:* Use ICT to analyse collisions	Computer simulations of two dimensional collisions. Investigate elastic and inelastic collision between trolleys All students should carry	99, 100, 101, 102	

		between small spheres, eg ball bearings on a table top.	out this experiment.		
31		Radian measure, $2\pi\ rad = 360^o$ Angular displacement, $\theta = s / r$ and angular velocity, $\omega = \Delta\theta/\Delta t = v/r$ Angular frequency, $\omega = 2\pi f$ Circular motion.		103, 104, 106	
32		Centripetal acceleration $a = \frac{v^2}{r} = r\omega^2$ Centripetal force as a resultant force $F = ma = \frac{mv^2}{r} = mr\omega^2$.	Mathematical requirement: use of vector diagrams to derive equations for centripetal acceleration. Horizontal circles; banked tracks Simple vertical circles.	105, 107	
33		Concept of a field. Radial gravitational field of the Earth Inverse square law Newton's law of gravitation $F = \frac{Gm_1m_2}{r^2}$ Derive and use the equation $g = \frac{Gm}{r^2}$ for the gravitational field due to a point mass $V_{grav} = \frac{-GM}{r}$ for a radial gravitational field	Mathematical requirement: Inverse square law Equipotential surfaces – compare to map 'contour lines'. No work done moving on an equipotential surface.	174, 176,177, 178, 180	

34	Circular motion (Week 32)	Application to satellite orbits	Planets orbiting the sun, moons orbiting planets, artificial satellites around the Earth.	180	
35	Gravitational field strength (Week 3)	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. Electric field strength, $E = \frac{F}{Q}$ [compare with gravitational field strength].	Radial fields due to point charges and parallel fields due to parallel plates.	108, 109, 115	
36		Force between point charges. Coulomb's Law: F = kQ_1Q_2 / r^2 Electric field strength due to a point charge: $E = \frac{Q}{4\pi\varepsilon_0 r^2}$	Experimental verification of Coulomb's law	110, 111	
37	P.d. (Week 20) Projectiles (Week 9)	Electric potential, $V = \frac{W}{Q}$ Uniform field (between parallel plates): $E = \frac{V}{d}$ Force on charge q entering this field is: $F = qE = \frac{qV}{d}$ (compare with projectiles) $V = \frac{Q}{4\pi\varepsilon_0 r}$ for a radial field	Investigate equipotentials across an electric field.	112, 113, 114, 179	

		Comparison of electric and gravitational fields.			
38		Define capacitance, $C = \frac{Q}{V}$ Energy stored by a capacitor derived from the area under a graph of potential difference against charge stored $W = \frac{1}{2}QV$ $W = \frac{1}{2}CV^2$ and $W = \frac{\frac{1}{2}Q^2}{C}$.	Use a coulombmeter to investigate the relationship *C = QV.*	116, 117	
39		Charge and discharge capacitor through fixed resistor to obtain exponential decay curve $Q = Q_0 e^{-t/RC}$ for capacitor discharge Derive and use related equations for discharge in a resistor-capacitor circuit: $I = I_0\, e^{-t/RC}$, *and* $V = V_0\, e^{-t/RC}$ and the corresponding log equations Time constant, *RC* as the time taken for charge to fall to 37 per cent of initial value. • *CORE PRACTICAL 11:* 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.	Investigate how the current through a capacitor varies over time. Investigate both charging and discharging circuits. Investigate the effect of the time constant on the discharge/charging of a capacitor. Mathematical requirement: Use of the exponential equation and logs. All students should carry out this experiment.	118, 119, 120	
40	GCSE permanent magnetism	Magnetic field line patterns Right hand grip rule Demonstrate motor effect Fleming's left hand rule	U-shaped magnet and current in wire to demonstrate Fleming's LH rule. Investigate the force on a current carrying wire in a	121,122, 123	

		Magnitude of B defined by $F = BIl$ (for wire, $F = Bqv$ for charged particles). Application to motors, moving coil meters and loudspeakers.	magnetic field.		
41		Magnetic flux density B, flux φ and flux linkage Nφ Origins of EM induction Faraday's law, $\varepsilon = \frac{-\mathrm{d}(N\phi)}{\mathrm{d}t}$. Lenz's law and energy conservation.	Demonstrations of EM induction, such as magnet falling through coil of wire, or magnet on a spring oscillating though a coil of wires.	121, 124, 126, 127	
42	GCSE Transformer	Transformer effect Effect of turns-ratio on transformer output Explain $\frac{V_p}{V_s} = \frac{N_p}{N_s}$ using Faraday's law Lenz's law and energy conservation laminated core → eddy currents.	Simple transformer demonstration Demonstrate Eddy current braking.	125, 126, 127	
43		Simple a.c. theory Peak and root-mean-square values of current and voltage. $V_{rms} = \frac{V_0}{\sqrt{2}}$ and $I_{rms} = \frac{I_0}{\sqrt{2}}$.		128, 129	
44	Electric potential (Week 20 and Week 37)	The thermionic effect LINAC principles $W = QV$.	Demonstrate Van de Graaff generator Use of the CERN website to	,132, 133, 134, 139	

		Cyclotron principles $BQv = \frac{mv^2}{r}$ $r = \frac{p}{BQ}$ for a charged particle in a magnetic field Mass increase as speed increases; particles can never reach the speed of light.	illustrate the LINAC and Cyclotron.		
45	GCSE atomic Physics	Structure of the atom Rutherford scattering experiments High energy scattering experiments.	Computer simulation of Rutherford's experiment.	130, 131, 136	
46		Creation and annihilation of matter and antimatter particles $\Delta E = c^2 \Delta m$ Non-SI units of MeV and GeV (energy) and MeV/c^2, GeV/c^2 (mass) Principles of cloud, bubble & spark chambers, ionisation detectors.		133, 137, 138	
47	Conservation of momentum (Week 8 and week 30)	The standard model Particle collisions: interpretation in terms of conservation laws.	Use bubble chamber images and a variety of interactions to illustrate particle collisions.	135, 140,141, 142, 143	·
48	Angular motion (Week 31)	Conditions for simple harmonic motion Equations of shm: $a = -\omega^2 x$, $x = A\cos\omega t$, $v = A\omega \sin\omega t$,		181, 182	

		$T=\frac{1}{f}=\frac{2\pi}{\omega}$ and $\omega = 2\pi f$.			
49	Hooke's law (Week 18)	Displacement-time and velocity-time graphical variations for an oscillating object Equation for a simple harmonic oscillator $T=2\pi\sqrt{\frac{m}{k}}$ and a simple pendulum $T=2\pi\sqrt{\frac{l}{g}}$.	Use of motion sensor to obtain displacement-time graphs and velocity time graphs. Oscillating mass on a spring and simple pendulum experiments.	183, 184, 185	
50	Materials (Week 18)	Resonance Free and forced oscillations Damping • *CORE PRACTICAL 16*: Determine the value of an unknown mass using the resonant frequencies of the oscillation of known masses.	Demonstration: Barton's pendulums Investigate damped oscillations using a long pendulum with a paper cone around the bob. All students should carry out this experiment.	186, 187, 188, 189, 190, 191	
51	Pressure from GCSE	Ideal gases Equation of state $pV = NkT$ Concept of absolute zero, $T= \theta + 273$ • *CORE PRACTICAL 14:* Investigate the relationship between pressure and volume of a gas at fixed temperature.	Investigate the relationship between pressure and temperature of a gas at fixed volume. All students should carry out this experiment.	148, 150, 151	
52	Conservation of momentum (Week 8) Potential dividers (Week 23)	Kinetic theory: derive $pV=\frac{1}{3}Nm<c^2>$ Temperature and molecular kinetic energy $\frac{1}{2}m<c^2>=\frac{3}{2}kT$ Concept of internal energy	Mathematical requirement: Derivation of both equations. All students should carry	145,, 147, 148, 149, 152	

		• *CORE PRACTICAL 12:* Calibrate a thermistor in a potential divider circuit as a thermostat.	out this experiment.		
53	Electrical power (Week 22)	Specific heat capacity, $\Delta E = mc\Delta\theta$ Specific latent heat, $\Delta E = L\Delta m$ • *CORE PRACTICAL 13*: 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.	144, 146	
54		Black bodies Stefan-Boltzmann law, $L = \sigma AT^4$ Wien's law, $\lambda_{max}T = 2.90 \times 10^{-3}$ m K Intensity, $I = \frac{P}{A}$		153, 154, 155, 156	
55		Trignometric 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, white dwarfs and red giants.	Investigate the inverse square law with lamps and LDR	156, 157, 158, 159, 160	
56	Mass-energy equation (Week 46)	Gravitational collapse and hydrogen 'burning' 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.	Measure background radiation with GM tube. Measure range of radiation in air and other materials. All students should carry	164, 165, 168, 169, 170, 171	

		• *CORE PRACTICAL 15*: Investigate the absorption of gamma radiation by lead.	out this experiment,		
57	GCSE Radioactivity	Radioactivity as a random process (eg dice simulation). Activity, $A = \frac{dn}{df} = -\lambda N$ Meaning of λ, $ln2 = \lambda t_{1/2}$ Exponential decay equations $N = N_0e^{-\lambda t}$ and $A = A_0e^{-\lambda t}$ and the corresponding log. Equations.	Model radioactivity with dice. Computer simulation to produce a radioactive decay curve.	172, 173	
58	GCSE Fission	Processes of fission and fusion Mechanism of nuclear fusion Extreme condition required for fusion.		166, 167	
59		Doppler effect for em-radiation Redshift, $z = \frac{\Delta\lambda}{\lambda} \approx \frac{\Delta f}{f} \approx \frac{v}{c}$ Hubble's law, $v = H_0d$.	Use of spectra from different galaxies.	161, 162	
60		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.		163	