Identification of Core Practicals

Unit 1	**1**: Determine the acceleration of a freely falling object **2**: Use a falling-ball method to determine the viscosity of a liquid **3**: Determine the Young modulus of a material
Unit 2	**4**: Determine the speed of sound in air using a 2-beam oscilloscope, signal generator, speaker and microphone **5**: Investigate the effects of length, tension and mass per unit length on the frequency of a vibrating string or wire **6**: Determine the wavelength of light from a laser or other light source using a diffraction grating **7**: Determine the electrical resistivity of a material **8**: Determine the e.m.f. and internal resistance of an electrical cell
Unit 4	**9**: Investigate the relationship between the force exerted on an object and its change of momentum **10**: Use ICT to analyse collisions between small spheres, e.g. ball bearings on a table top **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
Unit 5	**12**: Calibrate a thermistor in a potential divider circuit as a thermostat **13**: Determine the specific latent heat of a phase change **14**: Investigate the relationship between pressure and volume of a gas at fixed temperature **15**: Investigate the absorption of gamma radiation by lead **16**: Determine the value of an unknown mass using the resonant frequencies of the oscillation of known masses

The core practicals were chosen to give students the opportunity to acquire a wide range of practical skills choosing experiments were apparatus is more readily available for class sets. Hence there is not an even distribution across the units but there are eight at AS and eight at A2.

It is advised that students should carry out other experiments as well but the 16 core practicals could be asked for as recall AO1 on the theory papers.

Notes on the Core Practicals

Core Practical Activity	Link to specification points	Progression toward A level	Practical Skills	Maths Skills C	Notes
1: Determine the acceleration of a freely-falling object	1: suvat 18: $g = F/m$	Uncertainty in measurements against known outcome	Use of light gates to determine speed	0.1, 0.3, 0.5, 1.1, 1.2, 1.5, 3.1-4	This can be done using a light gate to measure the final velocity after an object has fallen through a measured height
2: Use a falling-ball method to determine the viscosity of a liquid.	25: $F = 6\pi\eta rv$ and variation with temperature	Uncertainty in measurements	Measurement of volume, small diameter and timing	0.1, 0.3, 0.5, 1.1, 1.2, 1.5, 3.1-4	Can be part of a wide ranging investigation into viscosity
3: Determine the Young modulus of a material	27: $\Delta F = k\Delta x$ 28: *Young modulus = stress/strain* 29: Force extension graphs	Adapting experimental design to enable measurements	Measurement of small diameter	0.1, 0.3, 0.5, 1.1, 1.2, 1.5, 3.1-4	Use of weight to stretch a wire, might also consider engineer's beam theory to find E for wood by deflection of a metre rule
4: Determine the speed of sound in air using a 2-beam oscilloscope, signal generator, speaker and microphone	33: understand terms 34: $v = f\lambda$	Graphical method and uncertainties	Generating & measuring waves. Use of oscilloscope	0.1, 0.3, 1.1, 1.2, 1.5, 2.2, 3.1-4	Uncertainties contribute to lines of best fit and uncertainty in gradient and final value
5: Investigate the effects of length, tension and mass per unit length on the frequency of a vibrating string or wire	33: understand terms 34: $v = f\lambda$ 41: Standing waves	Judgement of resonance point in dynamic experiment	Generating & measuring waves	0.1, 0.3, 1.1, 1.2, 1.5, 3.1-4	This can be an investigation into any number of the three factors; this is one of the best opportunities at AS for a full student investigation. Opportunity for stroboscopic technique
6: Determine the wavelength of light from a laser or other light source using a diffraction grating	39: Superposition 40: *phase difference* and *path difference* 50: diffraction	Measurement of small angles	Use of laser	0.1, 0.3, 0.6, 1.1, 1.5, 4.5	

7: Determine the electrical resistivity of a material	71: $R = \rho l/A$	Use of ohmmeter & uncertainties	Planning Measurement of small diameter	0.1, 0.3, 0.5, 1.1, 1.5, 3.1-4	Might use 2 meter method, choice of methods means this is suitable to encourage investigation early in Year 1
8: Determine the e.m.f. and internal resistance of an electrical cell	75: Potential divider 77: emf & internal resistance	Use of graphs. Selection of method	Planning, circuit design & construction	0.1, 1.1, 1.5, 3.1-4	Variety of methods using known resistors or unknown values again make this suitable as a limited and early investigation
9: Investigate the relationship between the force exerted on an object and its change of momentum	81: $F\Delta t = \Delta p$ recalls suvat & $p = mv$ from unit 1	Control of variables – total mass to remain the same	Use of light gates to determine speed	0.1, 0.3, 1.1, 1.2, 1.5, 3.1-4	Can use trolleys and ticker tape or light gates
10: Use ICT to analyse collisions between small spheres, e.g. ball bearings on a table top	82: momentum in two dimensions 85: Elastic & inelastic collisions	Appreciation of calibration & scale	Use of ICT to measure speed and angle	0.1, 0.6, 1.1, 2.3, 4.1, 4.2, 4.5	As an investigation this might go a long way but need only be fairly simple. Can start in one dimension using curtain track or similar
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	102: RC curves and time constants 104: $V = V_0 e^{-t/RC}$ and $\ln V = \ln V_0 - t/RC$	Adapting experimental design to enable measurements	Use of ICT to measure p.d.	0.1, 0.3, 0.5, 1.1, 1.2, 1.5, 2.3, 2.5, 3.1-4, 3.10, 3.11	The wide variety of techniques available make this a good topic for investigation. There are options for a variety of graphical techniques to determine a value for the time constant
12: Calibrate a thermistor in a potential divider circuit as a thermostat	Recalls 75 & 76 from unit 2 and combines with ideas about temperature	Complex planning required with little analysis beyond use of Ohm's law	Designs and uses electric circuits. Measures temperature and resistance. Planning	0.1, 0.3, 0.4, 1.1, 1.5	Requires some research on the thermistor and use of data to construct thermometer which can then be tested at melting point of ice and against other thermometers. An investigation.

13: Determine the specific latent heat of a phase change	125: $\Delta E = L\Delta m$	Allowance for thermal energy loss.	Planning	0.1, 1.1, 1.5, 2.2, 2.3	Since this activity does not specify the phase change and there is little analysis required this is an ideal planning investigation with a measurable outcome
14: Investigate the relationship between pressure and volume of a gas at fixed temperature	130: $pV = NkT$	Control of variables	Measurement of pressure and volume	0.1, 1.1, 1.5, 3.1-4	
15: Investigate the absorption of gamma radiation by lead	137: background radiation 138: range 141: random & spontaneous	Detailed safety procedures required. Analysis requires use of logarithms	Use of ionising radiation and detector	0.1, 0.5, 1.1, 1.2, 1.3, 1.5, 3.1-4, 3.10, 3.11	The analysis requires use of $C = C_0\, e^{-\mu x}$ analogous to $A = A_0\, e^{-\lambda t}$
16: Determine the value of an unknown mass using the resonant frequencies of the oscillation of known masses	143: $F = -kx$ 145: $T = 2\,\pi\,\sqrt{(m/k)}$ 148: Resonance	Use of generated data to make testable predictions	Use of timing markers to measure period	0.1, 0.3, 0.5, 1.1, 1.2, 1.5, 2.3, 3.1-4,	This is a good experiment for uncertainties, since the outcome is numerical

Notes:

The link to specification points gives an indication of where the practical could be used as part of the scheme of work

The progression column is indicative only of the strands representing progression and there will be more in each practical than there is room to list here.

Section 2

Mathematical Skills

40% of the assessment marks are for mathematical skills at Level 2 or above

The Maths skills codes can be found in Appendix 6 of the specification and fall into the 5 categories

C.0 Arithmetical computation, C.1 Handling data, C.2 Algebra, C.3 Graphs, C.4 Geometry and trigonometry

Further detail on these is given in the Guide to Mathematical Skills but the table below gives some guidance on how these skills are employed in the Core Practicals and other practical situations.

Skill Code	Nature of skill	Core Practicals requiring this skill	Notes
C0.1	Units	All	All physical measurements will have a unit. It is important that the correct form of that is used in calculations. For example a measurement made in centimetres must be converted to metres before it is used in a calculation. Units are also a feature of graphical work C3.1-4.
C0.3	Use of ratios and percentages	All	When considering uncertainties it is necessary to express them as a percentage of the measurement. Further details of how to handle uncertainty in determining physical quantities from measurements can be found in Appendix 10 of the specification
C0.5	Use of calculator for powers and higher functions	1, 2, 5, 11, 15, 16	Most of the practicals require some 'number crunching' but the use of powers, exponents and logarithms is as shown. It should be pointed out that exponents and logarithms are not included in Level 2 mathematics and will need teaching separately so time should be added to the Scheme of Work
C0.6	Use of calculator for trigonometrical functions	6, 10	Use of trigonometrical functions will depend on the exact nature of the work done by the candidate but it is expected that these will occur somewhere in these two practicals.
C1.1	Use of significant figures	All	All instruments have a finite resolution and thus a limit to the number of significant figures (SF) that can be used in quoting the measured value. When combining measurements the final result should have the same number of SF as the measurement with the least number of SF. For example if the temperature is measured to 2 SF then the value for the specific heat capacity should also only have 2 SF. SF are also a feature of graphical work C3.1-4.

			The number of SF in a set of readings of one quantity might change, for example when the reading on a digital multimeter goes from 0.915 to 1.039, the recorded value should always be that showing on the instrument and in this case the quantity is read to 3 SF.
C1.2	Finding mean values	1, 2, 4, 5, 9, 11, 15, 16	Whenever possible readings should be repeated and a mean value found, there are some experiments where repeating the method, such as 14, is either not possible – because some of the oil adheres to the tube - or it is unlikely that the same values can be found exactly.
C1.5	Uncertainties	All	All measurements have an associated uncertainty and A level physicists are expected to note an uncertainty in every reading they take. It will not be useful to combine these rigorously in every practical but candidates should demonstrate that they can do so routinely.
C2.2	Change the subject of an equation	(2), 4, 5, (8),9, 13, 14	This is likely to occur when the student plots a graph which has axes that are not suggested by the standard equation. For example in the speed of sound experiment where frequency and wavelength are measured but one will need to be inverted in order to get the speed as the gradient. A level candidates should not find this demanding.
C2.3	Substituting into an equation using units		This is largely a combination of what has gone before and is a feature of every experiment that has a mathematical model describing the behaviour.
C3.1-4	Use of graphs	All except 6, 10, 12 & 13	Most of the practicals require a graph to determine a value for the outcome and an uncertainty. 8 and 13 are 'single shot' experiments since it is difficult to find a variable. 10 and 12 are more investigations or a design exercise. It is expected that A level candidates are quite at home with graphical methods. Data should be plotted and read using 3 SF and plots should be accurate to 1 mm. Lines of best fit should show data points on either side and not be forced through the origin and when curved should cover only the data points plotted. Graphical work will be part of the written question papers.
C3.10	Interpret logarithmic plots	11, 15, (16)	The mathematics associated with this is beyond Level 2 and may require special teaching. Since the resulting line should be straight the gradient calculations are not demanding but use of scales and units can be, especially if the value of the intercept is required.
C3.11	Test variations using log graphs	11, 15 (16)	The mathematics associated with this is beyond Level 2 and may require special teaching. This is to test a relationship and should not be found demanding.
C4.1, 2 & 5	Use sine and cosine in 2 D representations	10	In order to determine whether momentum has been conserved in 2 dimensions the analysis of diagrams will be done