1.2 Assessment information

This unit is assessed by means of a written examination paper of 1 hour 30 minutes duration. The paper will consist of objective, short-answer and long-answer questions. Students may be required to apply their knowledge and understanding of physics to situations that they have not encountered before. The total number of marks available for this examination paper is 80. It contributes 40% to IAS and 20% to the IAL in Physics.

It is recommended that students have access to a scientific calculator for this paper.

Students will be provided with the formulae sheet shown in *Appendix 5*. Any other physics formulae that are required will be stated in the question paper.

The quality of written communication will be assessed in the context of this unit through questions which are labelled with an asterisk (*). Students should take particular care with spelling, punctuation and grammar, as well as the clarity of expression, on these questions.

1.3 Mechanics

This topic leads on from the Key Stage 4 programme of study and covers rectilinear motion, forces, energy and power. It may be studied using applications that relate to mechanics, for example, sports.

Students will be assessed on their ability to:		Suggested experiments
1	use the equations for uniformly accelerated motion in one dimension, $v = u + at$, $s = ut + \frac{1}{2}at^2$, $v^2 = u^2 + 2as$	
2	demonstrate an understanding of how ICT can be used to collect data for, and display, displacement/time and velocity/time graphs for uniformly accelerated motion and compare this with traditional methods in terms of reliability and validity of data	Determine speed and acceleration, for example use light gates
3	identify and use the physical quantities derived from the slopes and areas of displacement/time and velocity/time graphs, including cases of non-uniform acceleration	
4	investigate, using primary data, recognise and make use of the independence of vertical and horizontal motion of a projectile moving freely under gravity	Strobe photography or video camera to analyse motion
5	distinguish between scalar and vector quantities and give examples of each	
6	resolve a vector into two components at right angles to each other by drawing and by calculation	
7	combine two coplanar vectors at any angle to each other by drawing, and at right angles to each other by calculation	
8	draw and interpret free-body force diagrams to represent forces on a particle or on an extended but rigid body, using the concept of *centre of gravity* of an extended body	Find the *centre of gravity* of an irregular rod
9	investigate, by collecting primary data, and use $\Sigma F = ma$ in situations where m is constant (Newton's first law of motion ($a = 0$) and second law of motion)	Use an air track to investigate factors affecting acceleration

Students will be assessed on their ability to:	Suggested experiments
10 use the expressions for gravitational field strength $g = F/m$ and weight $W = mg$	Measure g using, for example, light gates Estimate, and then measure, the weight of familiar objects
11 identify pairs of forces constituting an interaction between two bodies (Newton's third law of motion)	
12 use the relationship $E_k = \frac{1}{2}mv^2$ for the kinetic energy of a body	
13 use the relationship $\Delta E_{grav} = mg\Delta h$ for the gravitational potential energy transferred near the Earth's surface	
14 investigate and apply the principle of conservation of energy including use of work done, gravitational potential energy and kinetic energy	Use, for example, light gates to investigate the speed of a falling object
15 use the expression for work $\Delta W = F\Delta s$ including calculations when the force is not along the line of motion	
16 understand some applications of mechanics, for example, to safety or to sports	
17 investigate and calculate power from the rate at which work is done or energy transferred	Estimate power output of electric motor (see 53)

1.4 Materials

This topic covers flow of liquids, viscosity, Stokes' law, properties of materials, Hooke's law, Young's modulus and elastic strain energy.

This topic may be taught using, for example, a case study of the production of sweets and biscuits. It could also be taught using the physics associated with spare part surgery for joint replacements and lens implants.

Content 18–27 should be studied using variety of applications, for example, making and testing food, engineering materials, spare part surgery. This unit includes many opportunities to develop experimental skills and techniques.

Students will be assessed on their ability to:		Suggested experiments
18	understand and use the terms *density, laminar flow, streamline flow, terminal velocity, turbulent flow, upthrust* and *viscous drag*, for example, in transport design or in manufacturing	
19	recall, and use primary or secondary data to show that the rate of flow of a fluid is related to its viscosity	
20	recognise and use the expression for Stokes' Law, $F = 6\pi\eta rv$ and upthrust = weight of fluid displaced	
21	investigate, using primary or secondary data, and recall that the viscosities of most fluids change with temperature. Explain the importance of this for industrial applications	
22	obtain and draw force-extension, force-compression, and tensile/compressive stress-strain graphs. Identify the *limit of proportionality, elastic limit* and *yield point*	Obtain graphs for, for example, copper wire, nylon and rubber
23	investigate and use Hooke's law, $F = k\Delta x$, and know that it applies only to some materials	
24	explain the meaning and use of, and calculate, *tensile/compressive stress, tensile/compressive strain, strength, breaking stress, stiffness* and *Young Modulus*. Obtain the *Young modulus* for a material	Investigations could include, for example, copper and rubber
25	investigate elastic and plastic deformation of a material and distinguish between them	

2.1 Unit description

Concept approach

This unit covers waves, electricity and the nature of light. The unit may be taught using either a concept approach or a context approach. The concept approach begins with a study of the laws, theories and models of physics and then explores their practical applications. This section of the specification is presented in a format for teachers who wish to use the concept approach.

Context approach

This unit is presented in a different format on page 53 for teachers who wish to use a context approach. The context approach begins with the consideration of an application that draws on many different areas of physics, and then the laws, theories and models of physics that apply to this application are studied. The context approach for this unit uses three contexts for teaching: music, technology in space and archaeology.

How Science Works

How Science Works – Appendix 3 should be integrated with the teaching and learning of this unit.

It is expected that students will be given opportunities to use spreadsheets and computer models to analyse and present data, and to make predictions while studying this unit.

The word 'investigate' indicates where students should develop their practical skills for *How Science Works*, numbers 1–6 as detailed in *Appendix 3*.

Students should communicate the outcomes of their investigations using appropriate scientific, technical and mathematical language, conventions and symbols.

Applications of physics should be studied using a range of contemporary contexts that relate to this unit.

Concept approach

3.4 Electric and Magnetic Fields

This topic covers Coulomb's law, capacitors, magnetic flux density and the laws of electromagnetic induction. This topic may be studied using applications that relate to, for example, communications and display techniques.

Students will be assessed on their ability to:		Suggested experiments
83	explain what is meant by an electric field and recognise and use the expression electric field strength $E = F/Q$	
84	draw and interpret diagrams using lines of force to describe radial and uniform electric fields qualitatively	Demonstration of electric lines of force between electrodes
85	use the expression $F = kQ_1Q_2/r^2$, where $k = 1/4\pi\varepsilon_0$ and derive and use the expression $E = kQ/r^2$ for the electric field due to a point charge	Use electronic balance to measure the force between two charges
86	investigate and recall that applying a potential difference to two parallel plates produces a uniform electric field in the central region between them and recognise and use the expression $E = V/d$	
87	investigate and use the expression $C = Q/V$	Use a Coulometer to measure charge stored
88	recognise and use the expression $W = \frac{1}{2}QV$ for the energy stored by a capacitor, derive the expression from the area under a graph of potential difference against charge stored, and derive and use related expressions, for example, $W = \frac{1}{2}CV^2$	Investigate energy stored by discharging through series/parallel combination of light bulbs
89	investigate and recall that the growth and decay curves for resistor–capacitor circuits are exponential, and know the significance of the time constant RC	
90	recognise and use the expression $Q = Q_0e^{-t/RC}$ and derive and use related expressions, for exponential discharge in RC circuits, for example, $I = I_0 e^{-t\backslash RC}$	Use of data logger to obtain I–t graph
91	explore and use the terms magnetic flux density B, flux Φ and flux linkage $N\Phi$	
92	investigate, recognise and use the expression $F = BIl \sin\theta$ and apply Fleming's left hand rule to currents	Electronic balance to measure effect of I and l on force

Students will be assessed on their ability to:		Suggested experiments
104	use the non-SI units MeV and GeV (energy) and MeV/c^2, GeV/c^2 (mass) and atomic mass unit u, and convert between these and SI units	
105	be aware of relativistic effects and that these need to be taken into account at speeds near to that of light (use of relativistic equations not required)	
106	recall that in the standard quark-lepton model each particle has a corresponding antiparticle, that baryons (e.g. neutrons and protons) are made from three quarks, and mesons (e.g. pions) from a quark and an antiquark, and that the symmetry of the model predicted the top and bottom quark	
107	write and interpret equations using standard nuclear notation and standard particle symbols (e.g. π^+, e^-)	
108	use de Broglie's wave equation $\lambda = h/p$	

5.1 Unit description

Context approach

This unit covers mechanics and materials. The unit may be taught using either a concept approach or a context approach. This section of the specification is presented in a format for teachers who wish to use the context approach. The context approach begins with the consideration of an application that draws on many different areas of physics, and then the laws, theories and models of physics that apply to this application are studied. The context approach for this unit uses three different contexts: sports, the production of sweets and biscuits and spare part surgery.

Concept approach

This unit is presented in a different format on page 15 for teachers who wish to use a concept approach. The concept approach begins with a study of the laws, theories and models of physics and then explores their practical applications. The concept approach is split into two topics: mechanics and materials.

How Science Works

How Science Works – Appendix 3 should be integrated with the teaching and learning of this unit.

It is expected that students will be given opportunities to use spreadsheets and computer models to analyse and present data, and to make predictions while studying this unit.

The word 'investigate' indicates where students should develop their practical skills for *How Science Works*, numbers 1–6 as detailed in Appendix 3.

Students should communicate the outcomes of their investigations using appropriate scientific, technical and mathematical language, conventions and symbols.

Applications of physics should be studied using a range of contemporary contexts that relate to this unit.

8.3 Reach for the Stars (STA)

The focus of this unit is on the physical interpretation of astronomical observations, the formation and evolution of stars, and the history and future of the universe:

- distances of stars
- masses of stars
- energy sources in stars
- star formation
- star death and the creation of chemical elements
- the history and future of the universe.

This topic uses the molecular kinetic theory model of matter and includes a study of the 'Big Bang' model of the universe. It also involves mathematical modelling of gravitational force and radioactive decay.

There are opportunities for students to develop ICT skills using the internet, data-logging and simulations.

There are several case studies that show how scientific knowledge and understanding have changed over time, providing students with opportunities to consider the provisional nature of scientific ideas.

Students will be assessed on their ability to:	Suggested experiments
109 investigate, recognise and use the expression $\Delta E = mc\Delta\theta$	Measure specific heat capacity of a solid and a liquid using, for example, temperature sensor and data logger
110 explain the concept of internal energy as the random distribution of potential and kinetic energy amongst molecules	
111 explain the concept of absolute zero and how the average kinetic energy of molecules is related to the absolute temperature	
112 recognise and use the expression $\frac{1}{2}m\langle c^2\rangle = \frac{3}{2}kT$	

Unit 6 Experimental Physics

IA2 compulsory unit — **Externally assessed**

10.1 Unit description

Introduction

Students are expected to further develop the experimental skills that they acquired in Units 1 and 2.

Students are expected to develop these skills, and a knowledge and understanding of experimental techniques, by carrying out a range of practical experiments and investigations while they study Units 4 and 5.

This unit will assess students' knowledge and understanding of experimental procedures and techniques that were developed when they conducted these experiments.

Development of practical skills, knowledge and understanding

Students should do a variety of practical work during the IA2 course to develop their practical skills.

Centres should provide opportunities for students to plan experiments, implement their plans, collect data, analyse their data and draw conclusions in order to prepare them for the assessment of this unit.

Experiments should cover a range of different topic areas and use of a variety of practical techniques. The specification for Units 4 and 5 contain suggestions for practical work, although these suggestions do not constitute an exhaustive list. This should help students to gain an understanding and knowledge of the practical techniques that are used in experimental work.

Students should gain experience of using log graphs to determine the relationship between two variables. The graphs do not always need to be obtained for variables that are related by the exponential function.

For example, students could investigate how the pressure of a fixed mass of gas varies with its volume at constant temperature and plot an appropriate log/log graph to determine the relationship between the pressure and volume of the gas.

How Science Works

Students should be given the opportunity to develop their practical skills for *How Science Works*, numbers 2–6, as detailed in *Appendix 3*, by completing a range of different experiments that require a variety of different practical techniques throughout the International Advanced Level course.

Students should produce laboratory reports on their experimental work using appropriate scientific, technical and mathematical language, conventions and symbols in order to meet the requirements of *How Science Works*, number 8.

D Assessment and additional information

Assessment information

Assessment requirements

For a summary of assessment requirements and assessment objectives, see *Section B: Specification overview*.

Entering candidates for the examinations for this qualification

Details of how to enter candidates for the examinations for this qualification can be found in the International Information Manual, copies of which are sent to all examinations officers. The information can also be found at: www.edexcel.com/international

Resitting of units

There is one resit opportunity allowed for each unit prior to claiming certification for the qualification. The best available result for each contributing unit will count towards the final grade.

After certification all unit results may be reused to count towards a new award. Students may re-enter for certification only if they have retaken at least one unit.

Results of units are held in the Pearson unit bank and have a shelf life limited only by the shelf life of this specification.

Awarding and reporting

The IAS qualification will be graded and certificated on a five-grade scale from A to E. The full International Advanced Level will be graded on a six-point scale A* to E. Individual unit results will be reported.

A pass in an International Advanced Subsidiary subject is indicated by one of the five grades A, B, C, D, E of which grade A is the highest and grade E the lowest. A pass in an International Advanced Level subject is indicated by one of the six grades A*, A, B, C, D, E of which grade A* is the highest and grade E the lowest. To be awarded an A* students will need to achieve an A on the full International Advanced Level qualification and an A* aggregate of the IA2 units. Students whose level of achievement is below the minimum judged by Pearson to be of sufficient standard to be recorded on a certificate will receive an unclassified U result.

Performance descriptions

Performance descriptions give the minimum acceptable level for a grade. See *Appendix 1* for the performance descriptions for this subject.

Unit results

The minimum uniform marks required for each grade for each unit:

Unit 1

Unit grade	A	B	C	D	E
Maximum uniform mark = 120	**96**	**84**	**72**	**60**	**48**

Students who do not achieve the standard required for a grade E will receive a uniform mark in the range 0–47.

Unit 2

Unit grade	A	B	C	D	E
Maximum uniform mark = 120	**96**	**84**	**72**	**60**	**48**

Students who do not achieve the standard required for a grade E will receive a uniform mark in the range 0–47.

Unit 3

Unit grade	A	B	C	D	E
Maximum uniform mark = 60	**48**	**42**	**36**	**30**	**24**

Students who do not achieve the standard required for a grade E will receive a uniform mark in the range 0–23.

Unit 4

Unit grade	A	B	C	D	E
Maximum uniform mark = 120	**96**	**84**	**72**	**60**	**48**

Students who do not achieve the standard required for a grade E will receive a uniform mark in the range 0–47.

E Support, training and resources

Support

Pearson aim to provide the most comprehensive support for our qualifications. Here are just a few of the support services we offer:

- Subject Advisor – subject experts are on-hand to offer their expertise to answer any questions you may have on delivering the qualification and assessment.
- Subject Page – written by our Subject Advisors, the subject pages keep you up to date with the latest information on your subject.
- Subject Communities – exchange views and share information about your subject with other teachers.
- Training – see 'Training' below for full details.

For full details of all the teacher and student support provided by Pearson to help you deliver our qualifications, please visit:
www.edexcel.com/ial/physics/support

Training

Our programme of professional development and training courses, covering various aspects of the specification and examinations, are arranged each year on a regional basis. Pearson training is designed to fit you, with an option of face-to-face, online or customised training so you can choose where, when and how you want to be trained.

Face-to-face training
Our programmes of face-to-face training have been designed to help anyone who is interested in, or currently teaching, a Pearson Edexcel qualification. We run a schedule of events throughout the academic year to support you and help you to deliver our qualifications.

Online training
Online training is available for international centres who are interested in, or currently delivering our qualifications. This delivery method helps us run training courses more frequently to a wider audience.

To find out more information or to book a place please visit:
www.edexcel.com/training

Alternatively, email internationaltfp@pearson.com
or telephone +44 (0) 44 844 576 0025

Appendix 2 Codes

Type of code	Use of code	Code number
Unit codes	Each unit is assigned a unit code. This unit code is used as an entry code to indicate that a student wishes to take the assessment for that unit. Centres will need to use the entry codes only when entering students for their examination.	Unit 1 – WPH01 Unit 2 – WPH02 Unit 3 – WPH03 Unit 4 – WPH04 Unit 5 – WPH05 Unit 6 – WPH06
Cash-in codes	The cash-in code is used as an entry code to aggregate the student's unit scores to obtain the overall grade for the qualification. Centres will need to use the entry codes only when entering students for their qualification.	IAS – XPH01 IAL – YPH01
Entry codes	The entry codes are used to: 1 enter a student for the assessment of a unit 2 aggregate the student's unit scores to obtain the overall grade for the qualification.	Please refer to the Pearson *Information Manual*, available on our website (www.edexcel.com).

Unit 2

Waves

Wave speed	$v = f\lambda$
Refractive index	${}_1\mu_2 = \sin i / \sin r = v_1 / v_2$

Electricity

Potential difference	$V = W/Q$
Resistance	$R = V/I$
Electrical power, energy and efficiency	$P = VI$
	$P = I^2R$
	$P = V^2/R$
	$W = VIt$
	% efficiency = [useful energy (or power) output / [total energy (or power) input] × 100%
Resistivity	$R = \rho l/A$
Current	$I = \Delta Q/\Delta t$
	$I = nqvA$

Quantum physics

Photon model	$E = hf$
Einstein's photoelectric equation	$hf = \phi + \frac{1}{2}mv^2_{max}$

Arithmetic and computation

Recognise and use expressions in decimal and standard form (scientific) notation.

Use ratios, fractions and percentages.

Recognise and use SI prefixes for 10^{-12}, 10^{-9}, 10^{-6}, 10^{-3}, 10^{3}, 10^{6} and 10^{9}.

Use a calculator for:

- addition, subtraction, multiplication and division
- finding arithmetic means
- manipulating degrees **and radians**
- finding and using arithmetic means and reciprocals, and squares, sin θ, cos θ, tan θ, x^n and e^x, and their inverses (square roots, $\sin^{-1}\theta$, $\cos^{-1}\theta$, $\tan^{-1}\theta$, $\log_{10} x$ and $\ln x$)
- finding and using x^n, $1/x$ and $\sqrt{x}$.

Be aware of the precision of data, take account of accuracy in numerical work and handle calculations so that significant figures are neither lost unnecessarily nor carried beyond what is justified.

Use the terms *accuracy, precision* and *sensitivity* appropriately

Estimate the uncertainty (random error) in a single measurement and express it as an absolute value and as a percentage.

Estimate the uncertainty (random error) in a quantity derived by processing a set of experimental data, and express it as an absolute value and as a percentage.

Algebra

Change the subject of an equation by manipulation of the terms, including positive, negative, integer and fractional indices, and square roots.

Solve algebraic equations including those involving inverse and inverse square relationships.

Substitute numerical values into algebraic equations using appropriate units for physical quantities.

Formulate and use simple equations as mathematical models of physical situations, and identify inadequacies of such models.

Express quantities with a very large range, e.g. resistivities of materials, using $\log_{10}$ of those quantities

Recognise and use the logarithmic forms of expressions such as *ab*, *a/b*, x^n and e^{kx}

Understand and use the symbols $=$, $<$, $>$, $\ll$, $\gg$, $\approx$, α, $\sim$, Σx and Δx.

Geometry and trigonometry

Calculate the areas of triangles, the circumferences and areas of circles, and the surface areas and volumes of rectangular blocks, cylinders and spheres.

Use Pythagoras' theorem, similarity of triangles and the angle sum of a triangle.

Use sines, cosines and tangents in physical problems.