Physics Advanced Subsidiary (AS) and Advanced Level (AS + A2)

The New Advanced-Level Scene

Following the Dearing 'Review of Qualifications for 16-19 Year Olds', there was a significant change in the pattern of provision in the school curriculum at sixth form level. From September 2000, the traditional advanced level courses were replaced by the Advanced Subsidiary (AS) and Advanced Level (AS + A2) programmes. The Centre commissioned a paper describing the changes and this was published in 2005. There are to be further changes which take effect from September 2008 (first teaching) with assessments at AS level in 2009 followed by those at A2 level in 2010. The original document is relevant until the first intake under the new system; this is an update which keeps to the same format and applies to students entering University from 2010 onwards.

An A level qualification consists of advanced subsidiary (AS) and A2 units[1]. The AS is a stand-alone qualification and is worth half a full A level qualification. It normally consists of two units (assessed at the standard expected for a learner half way through an A level course) that together contribute 50 per cent towards the full A level.

The A2 is the second half of a full A level qualification. It normally consists of two units (assessed at the standard expected for a learner at the end of a full A level course) that together are worth 50 per cent of the full A level qualification. For A level qualifications started before September 2008, the qualification structure will normally comprise three AS units and three A2 units. Although most A levels have been revised from a six unit structure to a four unit structure, this does not apply to the sciences which retain the six module constitution.

Most units are assessed by examination but some are assessed by internal assessment. The AS covers the less demanding material in an A level course. The A2 covers the more demanding material. For example in the A2 learners might:

- Specialise in an area they studied at AS.
- Extend their knowledge and understanding of the subject by studying new topics.

Improve their skills.

The introduction of 'stretch and challenge' at A2 should better prepare students for higher education and employment. Changes to the assessments include:

- A broad range of question types to ensure that a wide range of skills is assessed.
- An extended writing requirement to give students the opportunity to demonstrate the full breadth and depth of their knowledge and understanding.

Synoptic assessment that will test students' understanding of the subject as a whole and their ability to make links between different areas of the subject.
The amount of extended writing required will vary depending on the nature of the subject. There will be an assessment of quality of written communication in all subjects and this will be integrated into mark schemes.

Synoptic assessment will be part of all A2 assessments, requiring students to demonstrate that they can:

- Effectively use the techniques, concepts and theories relevant to the particular subject.
- Identify from across the study programme the knowledge, understanding and skills that are required to address a particular task.

Demonstrate a high level of independent performance across a range of contexts, some of which may be new and unfamiliar.

An additional A* grade will be introduced to the grading of A level (not AS level or individual units) to recognise and reward exceptional performance. It will be awarded to students who achieve a grade A overall at A level and also achieve 90% or more on the uniform mark scale across their A2 units. The current standards of AS/A level will be maintained. This means that, for example, the level of performance awarded a grade B on the old specification will also be awarded a grade B on the new specification.

How Science Works

The new science programme of study is based on 'How science works'[2]. This is sometimes referred to as 'science process'. It includes scientific method and the way scientific knowledge develops. Developing ideas and theories lies at the heart of science. 'How science works' focuses on the evidence to support or refute these ideas and theories. The evidence comes from the collection and creative interpretation of data, both of which need to be considered. Consequently, in order to understand how science works, learners need skills such as practical collection of data, working safely, presenting scientific information; they need to understand the power of science to explain phenomena, the way understanding of science changes over time and the applications of contemporary scientific developments.

Basing the new science curriculum on a more appropriate balance between science process and factual knowledge is a clear signal that science teaching needs to change to match the needs of learners today and in the future.

How Science Works requires that students explore how scientific knowledge is developed, validated and communicated by the scientific community. It also requires that students consider the risks, benefits, ethical and environmental implications of science and that students appreciate ways in which society uses science to inform decision making. In the table below the first column lists the criteria for How Science Works. The second column provides some guidance on How Science Works may be applied in schools to the GCE Physics programme of study.

Use theories, models and ideas to develop and modify scientific explanations.	Explain how the development of scientific theories involves collecting and interpreting data and using creative thinking. Explain the importance of using models to develop scientific understanding.
Use knowledge and understanding to pose scientific questions, define scientific problems, present scientific arguments and scientific ideas.	Distinguish between questions that science can address, and those which science can't address. Identify scientific questions or problems within a given context. Use scientific theories to answer scientific questions or address scientific problems.
Use appropriate methodology, including ICT, to answer scientific questions and solve scientific problems.	Justify methods, techniques and processes used during scientific investigations, including the use of ICT, to collect valid and reliable data and produce scientific theories for a chosen question or problem. Use, for example, spreadsheets to develop scientific models.
Carry out experimental and investigative activities, including appropriate risk management, in a range of contexts.	Produce a risk assessment before carrying out a range of practical work.
Analyse and interpret data to provide evidence, recognising correlations and causal relationships.	Analyse data, including the use of graphs, to identify patterns and relationships (for example, correlation and cause). Interpret data with reference to the analytical methods used.
Evaluate methodology, evidence and data, and resolve conflicting evidence.	Evaluate the validity of conclusions derived from primary and secondary data in terms of the methods, techniques and processes used to collect and analyse the data. Recognise any systematic or random errors present. Recognise conflicting evidence.
Appreciate the tentative nature of scientific knowledge.	Explain how scientific theories are developed, refined, supported or refuted as new data or new interpretations of data become available.
Communicate information and ideas in appropriate ways using appropriate terminology.	Present scientific information: using text, graphics and other media as appropriate using scientific terminology with reference to data and credible sources.
Consider applications and implications of science and appreciate their associated benefits and risks.	Evaluate activities in terms of their associated benefits and risks to humans and the environment. Discuss the risk associated with an activity in terms of the actual level of the risk and its potential consequences, associated uncertainties and the factors affecting people's perception of the risk.
Consider ethical issues in the treatment of humans, other organisms and the environment.	Identify ethical issues arising from the application of science as it impacts on humans and the environment. Discuss scientific solutions from a range of ethical viewpoints.
Appreciate the role of the scientific community in validating new knowledge and ensuring integrity.	Discuss the importance of critical evaluation of new data or new interpretations of data which challenge established scientific theories or propose new theories. Describe how the process of communication through journals and conferences, and peer review contribute to validation of new scientific theories by the scientific community.
Appreciate the ways in which society uses science to inform decision making.	Discuss how science influences decisions on an individual, local, national or international level.

Examination Boards and their Specifications

There are three principal examination boards which, although adhering to the general principles laid down by the qualifications and curriculum authority[3], produce somewhat different examination syllabuses. For the full specification it is necessary to read the individual documents[4-7]. The rest of this document provides a short summary of each.

EDEXCEL

AS Unit 1: Physics on the go

The study of mechanics (rectilinear motion, forces, energy and power) and materials (flow of liquids, viscosity, Stokes' Law, properties of materials, Young's modulus and elastic strain energy). Part of this topic may be taught using applications that relate to, for example, sports. The other part of this topic may be taught using, for example, a case study of the production of sweets and biscuits. It may also be taught using the physics associated with spare part surgery for joint replacements and lens implants.

***Assessment*:**
The unit is assessed by means of a written examination paper of 1 hour 20 minutes duration, which will consist of objective questions, short questions and long questions.

AS Unit 2: Physics at Work

The study of waves (including refraction, polarisation, diffraction and standing (stationary) waves), electricity (current and resistance, Ohm's law and non-ohmic materials, potential dividers, emf and internal resistance of cells, and negative temperature coefficient thermistors) and the wave/particle nature of light. Several different contexts may be used to teach parts of this unit including music, medical physics, technology in space, solar cells and an historical study of the nature of light.

***Assessment*:**
The unit is assessed by means of a written examination paper of 1 hour 20 minutes duration, which will consist of objective questions, short questions and long questions.

AS Unit 3: Exploring Physics

This unit involves an experiment that is based on a physics-based visit or a case study of an application of physics.

***Assessment*:**
This unit is assessed by means of an experiment that is founded on either a physics based visit or a case study of an application of physics. Students write a report that is either internally marked and externally moderated or externally marked by Edexcel.

A2 Unit 4: Physics on the Move

The study of further mechanics (momentum and circular motion), electric and magnetic fields, and particle physics. Several different contexts may be used to teach parts of this unit including a modern rail transport system, communications and display techniques.
Particle physics is the subject of current research, involving the acceleration and detection of high-energy particles. This area of the specification may be taught by exploring a range of contemporary experiments.

***Assessment*:**
This unit is assessed by means of a written examination paper of 1 hour 35 minutes duration, which will consist of objective questions, short questions and long questions.

A2 Unit 5: Physics from Creation to Collapse

The study of thermal energy, nuclear decay, oscillations, astrophysics and cosmology. Several different contexts may be used to teach parts of this unit including space technology, medical physics and the construction of buildings in earthquake zones.
The astrophysics and cosmology section of this specification may be taught using the physical interpretation of astronomical observations, the formation and evolution of stars, and the history and future of the universe.

***Assessment*:**
This unit is assessed by means of a written examination paper of 1 hour 35 minutes duration, which will consist of objective questions, short questions and long questions.

A2 Unit 6: Experimental Physics

This unit involves planning an experiment, carrying out an experiment and analysing experimental results.

***Assessment*:**
Students must plan an experiment and then carry out a plan of an experiment which may be their own plan, a plan provided by Edexcel or a plan devised by the centre. Students write a report that is either marked by the teacher and externally moderated or externally marked by Edexcel.

AQA: Assessment and Qualifications Alliance

AS Unit 1: Particles, quantum phenomena and electricity

Constituents of the atom, stable and unstable nuclei, particles, antiparticles and photons, particle interactions, classification of particles, quarks and antiquarks. The photoelectric effect, collisions of electrons with atoms, energy levels and photon emission. wave-particle duality. Charge, current and potential difference, current / voltage characteristics, resistivity, circuits, potential divider, electromotive force and internal resistance, alternating currents, oscilloscope.

***Assessment*:**
Written Examination – 6 or 7 structured questions
1¼ hours 40% of the total AS marks. 20% of the total A Level marks.

AS Unit 2: Mechanics, materials and waves

Scalars and vectors, moments, motion along a straight line, projectile motion, Newton's laws of motion, work, energy and power, conservation of energy. Bulk properties of solids, Young modulus. Progressive Waves, longitudinal and transverse waves, refraction at a plane surface, superposition of waves, stationary waves, interference, diffraction.

***Assessment*:**
Written Examination – 6 or 7 structured questions
1¼ hours 40% of the total AS marks. 20% of the total A Level marks

AS Unit 3: Investigative and practical skills in AS Physics

Either
Centre Marked Route T – 50 marks
Practical Skills Assignment (9 raw marks), Investigative Skills Assignment (41 raw marks)
Or
Externally Marked Route X – 55 marks
Practical Skills Verification (teacher verification)
Externally Marked Practical Assignment (55 raw marks)
20% of the total AS marks. 10% of the total A Level marks. Available June only

A2 Unit 4: Fields and further mechanics

Momentum concepts, circular motion, simple harmonic motion, forced vibrations and resonance. Newton's law of Gravitation, gravitational field strength, gravitational potential, orbits of planets and satellites. Coulomb's law, electric field strength, electric potential, electric and gravitational fields. Capacitance, energy stored by capacitor, capacitor discharge. Magnetic flux density, moving charges, induction.

***Assessment*:**
Written Examination – (75 marks)
1¾ hours
Section A is 25 multiple choice questions, each worth one mark.
Section B is a written paper of 4/5 structured questions and consists of 50 marks.
20% of the total A Level marks.

A2 Unit 5 – One of 5 Optional Units

Section A: Nuclear and Thermal Physics – 40 marks
Evidence for the nucleus, α, β ,γ radiation, radioactive decay, nuclear instability, nuclear radius. Mass and energy, induced fission, safety. Thermal energy, ideal gases, kinetic theory.

***Assessment*:**
Written Examination – (75 marks)
1¾ hours
Compulsory section. 4/5 structured questions

Section B: one of the following options.
Options:
A – Astrophysics
Lenses, astronomical telescope, reflecting telescopes, resolving power, charge coupled device. Radio, IR, UV, X-ray telescopes. Star luminosity, apparent and absolute magnitude, temperature, black body radiation, spectral classes, Hertzsprung-Russell, supernovae, black holes, neutron stars. Doppler effect, Hubble's law, quasars.

B – Medical Physics
Vision, eye sensitivity, spatial resolution, persistence of vision, lenses, ray diagrams, defects. Ear, sensitivity and frequency response, relative intensity of sounds, threshold of hearing, defects. Heart, electrical signals, ECG. Ultrasound imaging, fibre optics, MR scanner. X-rays and production, differential tissue absorption, attenuation, contrast enhancement, radiographic images, CT scanner.

C – Applied Physics
Moment of inertia, rotational KE, angular velocity, torque, angular momentum, power. First law of thermodynamics, non-flow processes, p-V diagram, engine cycles, second law, heat engines.

D – Turning Points in Physics
Cathode rays, thermionic emission, e/m, Millikan. Corpuscular theory, Young's double slit, electromagnetic waves, photoelectricity, wave particle duality, electron microscopes. Michelson-Morley, special relativity, time dilation, length contraction, mass and energy.
Assessment
Each paper has 4/5 structured questions and 35 marks.
20% of the total A Level marks (Section A 10%, Section B 10%).

A2 Unit 6 Investigative and practical skills in A2 Physics

Either
Centre Marked Route T – 50 marks
Practical Skills Assessment (9 marks). Investigative Skills Assignment (41 marks)
Or
Externally Marked Route X – 55 marks
Practical Skills Verification (teacher verification)
Externally Marked Practical Assignment (55 raw marks)
10% of the total A Level marks. Available June only

OCR: Oxford, Cambridge & RSA Examinations

AS Unit 1: Mechanics

Module 1: Motion. Physical quantities and units**.** Scalars and vectors**.** Kinematics**.** Linear motion.
Module 2: Forces in action. Force**.** Nonlinear motion**.** Equilibrium**.** Car safety.
Module 3: Work and energy. Work and conservation of energy**.** Kinetic and potential energy. Power. Behaviour of springs and materials.

***Assessment*:**
30% of the total AS GCE marks
1 hour written paper. 60 marks. Candidates answer all questions.

AS Unit 2: Electrons, Waves and Photons

Module 1: Electric current
Module 2: Resistance. Circuit symbols**.** Emf. and pd**.** Resistance**.** Resistivity**.** Power.
Module 3: DC circuits. Series and parallel circuits. Practical circuits.
Module 4: Waves. Wave motion**.** Electromagnetic waves**.** Interference**.** Stationary waves.
Module 5: Quantum physics. Energy of a photon**.** The photoelectric effect**.** Wave-particle duality. Energy levels in atoms.

***Assessment*:**
50% of the total AS GCE marks
1.75 hour written paper. 100 marks. Candidates answer all questions

AS Unit 3: Practical Skills in Physics 1

Candidates are required to carry out three tasks:
1. Qualitative task [10 marks]
2. Quantitative task [20 marks]
3. Evaluative task [10 marks]

Tasks will be chosen from a selection provided by OCR.
The qualitative and quantitative tasks will test skills of observation and measurement. Candidates will carry out these tasks under controlled conditions. Each task will be internally assessed using a mark scheme provided by OCR. Candidates may attempt more than one task from each category with the best mark from each category being used to make up the overall mark.
Centres will supply OCR with a single mark out of 40.

How Science Works
Carry out experimental and investigative activities, including appropriate risk management, in a range of contexts. Analyse and interpret data to provide evidence, recognising correlations and causal relationships. Evaluate methodology, evidence and data, and resolve conflicting evidence.

***Assessment*:**
20% of the total AS GCE marks
Coursework 40 marks
Candidates complete three tasks set by OCR. Tasks are marked by the centre using a mark scheme written by OCR

A2 Unit 4: The Newtonian World

Module 1: Newton's laws and momentum. Newton's laws of motion. Collisions.
Module 2: Circular motion and oscillations. Circular motion. Gravitational Fields. Simple harmonic oscillations
Module 3: Thermal Physics. Solid, liquid and gas. Temperature. Thermal properties of materials.

***Assessment*:**
15% of the total Advanced GCE marks
1 hour written paper 60 marks
Candidates answer all questions. This unit is synoptic.

A2 Unit 5: Fields, Particles and Frontiers of Physics

Module 1: Electric and magnetic fields. Electric fields. Magnetic fields. Electromagnetism.
Module 2: Capacitors and exponential decay.
Module 3: Nuclear physics. The nuclear atom. Fundamental particles, Radioactivity. Nuclear fission and fusion.
Module 4: Medical imaging. X-rays. Diagnostic methods in medicine. Ultrasound.
Module 5: Modelling the universe. Structure of the universe. The evolution of the universe.

***Assessment*:**
25% of the total Advanced GCE marks
1.75 hour written paper 100 marks
Candidates answer all questions. This unit is synoptic.

A2 Unit 6 Practical Skills in Physics 2

Candidates are required to carry out three tasks:
1. Qualitative task [10 marks]
2. Quantitative task [20 marks]
3. Evaluative task [10 marks]

Tasks will be chosen from a selection provided by OCR.
The qualitative and quantitative tasks will test skills of observation and measurement. Candidates will carry out these tasks under controlled conditions.
Each task will be internally assessed using a mark scheme provided by OCR.
Candidates may attempt more than one task from each category with the best mark from each category being used to make up the overall mark.
Centres will supply OCR with a single mark out of 40.

How Science Works
Carry out experimental and investigative activities, including appropriate risk management, in a range of contexts. Analyse and interpret data to provide evidence, recognising correlations and causal relationships. Evaluate methodology, evidence and data, and resolve conflicting evidence

***Assessment*:**
10% of the total Advanced GCE marks
Coursework 40 marks
Candidates complete three tasks set by OCR. Tasks are marked by the centre using a mark scheme written by OCR.

Briefing papers are designed to provide a condensed discussion on issues and topics related to teaching and learning in the physical sciences. Each guide focuses on a particular aspect of higher education and is written by an academic experienced in that field.

References

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