SCOTTISH
QUALIFICATIONS
AUTHORITY

PHYSICS
Advanced Higher

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SCOTTISH QUALIFICATIONS AUTHORITY

NOTE OF CHANGES TO ARRANGEMENTS
THIRD EDITION PUBLISHED JUNE 2002

COURSE TITLE:	Physics (Advanced Higher)
COURSE NUMBER:	C069 13

National Course Specification

Course Details:

Content Statements	minor change	1.1.3, 1.2.6, 1.2.9, 1.3.4, 1.3.5, 1.3.9, 1.3.10, 1.3.11,1.4.14,1.5.2, 1.5.4, 1.5.5, 1.5.6, 3.1.5, 3.1.11, 3.1.12, 3.2.7, 3.3.3, 3.4.1, 3.4.3, 3.4.9

Details of instruments for external assessment:

Investigation report	Reference to visiting external assessor deleted marks for management of resources deleted assessment categories and mark allocations included
Grade descriptions at ‘A’	final bullet point modified

National Unit Specification:

D385 13 Mechanics

General information	Outcome 3 modified
Statement of standards	Outcome 3 and associated Evidence requirements modified
Support notes	advice regarding Outcome 3 modified

D386 13 Electrical Phenomena

General information	Outcome 3 modified
Statement of standards	Outcome 3 and associated Evidence requirements modified
Support notes	advice regarding Outcome 3 modified

D387 13 Wave Phenomena

General information	Outcome 3 modified
Statement of standards	Outcome 3 and associated Evidence requirements modified
Support notes	advice regarding Outcome 3 modified

D388 13 Physics Investigation

General information	Outcome 1 modified
Statement of standards	Outcome 1, associated performance criteria and evidence requirements modified
Support notes	“day book” replaced by “record”.

National Course Specification: general information

PHYSICS (ADVANCED HIGHER)

COURSE NUMBER C069 13

COURSE STRUCTURE

This course has four mandatory units as follows:

D385 13	***Mechanics (AH)***	***1 credit (40 hours)***
D386 13	***Electrical Phenomena (AH)***	***1 credit (40 hours)***
D387 13	***Wave Phenomena (AH)***	***0.5 credit (20 hours)***
D388 13	***Physics Investigation (AH)***	***0.5 credit (20 hours)***

This course includes 40 hours over and above the 120 hours for the component units. This may be used for induction, extending the range of learning and teaching approaches, support, consolidation, integration of learning and preparation for external assessment.

RECOMMENDED ENTRY

While entry is at the discretion of the centre, candidates will normally be expected to have attained the following:

- Higher Physics
- Higher Mathematics

CORE SKILLS

Core skills for this qualification remain subject to confirmation and details will be available at a later date.

Additional information about core skills is published in the *Catalogue of Core Skills in National Qualifications* (SQA, 2001).

Administrative Information

Publication date: June 2002

Source: Scottish Qualifications Authority

Version: 03

Additional copies of this course specification (including unit specifications) can be purchased from the Scottish Qualifications Authority for £7.50. **Note:** Unit specifications can be purchased individually for £2.50 (minimum order £5).

National Course Specification: course details

COURSE Physics (Advanced Higher)

RATIONALE

The Advanced Higher Physics course has been designed to articulate with and provide a progression from the Higher Physics course. Through a deeper insight into the structure of the subject, the course aims to provide a challenging experience for those who wish to study the subject to a greater depth and to assist candidates towards an understanding of the use of mathematical models and techniques for describing the behaviour of nature. The course seeks to illustrate and emphasise situations where the principles of physics are used and applied, thus promoting the candidate's awareness that physics involves interaction between theory and practice. An opportunity for engaging in some independent research is provided. The resulting elements of knowledge and understanding, problem solving and practical activities form the basis of the Advanced Higher Physics course.

As a result of following an Advanced Higher Physics course, candidates should acquire:

- a deeper knowledge and understanding of the nature of physics and its applications
- skill in applying their knowledge and understanding in a wide variety of theoretical and practical problem solving contexts
- skills associated with carrying out experimental and investigative work in physics and analysing the information obtained.

The study of Advanced Higher Physics should also foster an interest in current developments in, and applications of physics, the willingness to make critical and evaluative comment and the acceptance that physics is a changing subject. Positive attitudes, such as being self-reliant, open-minded and willing to recognise alternative points of view, are promoted.

The course endeavours to provide learning experiences leading to the acquisition of worthwhile knowledge, skills and attitudes which will assist candidates to make their own reasoned decisions on many issues within a modern society increasingly dependent on science and technology. The course will also provide those who wish to proceed beyond Advanced Higher Physics with a suitable basis for further study.

COURSE CONTENT

The course is made up of four mandatory units: Mechanics, Electrical Phenomena, Wave Phenomena, and Physics Investigation. While these units are valuable in their own right, candidates will gain considerable additional benefit from completing this course, since there will be opportunities for the integration of skills developed through the study of the units, and for tackling problem solving of a more complex nature than that required for attainment of the performance criteria of the units. Evidence of achievement of the problem solving core skill will be provided by end of Unit assessments, reports on practical work and the external examination. The following Content Statements describe in detail what the candidate should be able to do in order to demonstrate the knowledge and understanding associated with the course. External assessment will sample from across all of the Content Statements.

National Course Specification: course details (cont)

Advanced Higher Physics: Mechanics

The Content Statements given in the left-hand column of the table below describe in detail what the candidate should be able to do in demonstrating knowledge and understanding associated with Mechanics.

The right-hand column gives suggested contexts, applications, illustrations and activities associated with the Content Statements.

CONTENT STATEMENTS	CONTEXTS, APPLICATIONS, ILLUSTRATIONS AND ACTIVITIES
1.1 Kinematic relationships and relativistic motion	
1 Derive from $a = \frac{dv}{dt}$ ie $a = \frac{d^2s}{dt^2}$ the kinematic relationships:	Use calculus methods to derive the equations of motion. Applications of Newtonian dynamics.
$v = u + at$, $s = ut + ½at^2$ and $v^2 = u^2 + 2as$ where a is a constant acceleration.	
2 Carry out calculations involving constant accelerations.	
3 State that the greatest possible speed of any object is always less than the speed of light in vacuo.	
4 State that the relativistic mass m of a moving object is not constant, but increases with its speed.	
5 Carry out calculations involving mass and speed, given the formula:	View a video on special relativity. Relativistic dynamics.
$m = \frac{m_o}{\sqrt{1 - v^2/c^2}}$ where m_o is the rest mass.	
6 State that the relativistic energy E of an object is mc^2.	Time dilation, length contraction, twin paradox.
1.2 Angular motion	
1 State that angular velocity ω is the rate of change of angular displacement,	Carry out an experiment to measure an angular velocity.
ie $\omega = \frac{d\theta}{dt}$.	Discuss definition of the radian.

National Course Specification: course details (cont)

CONTENT STATEMENTS	CONTEXTS, APPLICATIONS, ILLUSTRATIONS AND ACTIVITIES
1.2 Angular motion (cont)	
2 State that angular acceleration $\alpha = \frac{d\omega}{dt}$ ie $\alpha = \frac{d^2\theta}{dt^2}$.	
3 State the following relationships: $\omega = \omega_o + \alpha t$; $\theta = \omega_o t + ½\alpha t^2$; $\omega^2 = \omega_o^2 + 2\alpha\theta$ where α is a constant angular acceleration.	Use calculus methods to derive the equations of angular motion.
4 Carry out calculations involving the relationships in 3 above.	
5 State and derive the expression $v = r\omega$ for a particle in circular motion.	
6 State that tangential acceleration $a_t = r\alpha$	Qualitative discussion of angular and tangential acceleration
7 Explain that a central force is required to maintain circular motion.	Carry out experiments using a central force.
8 State that the central force required depends on mass, speed and radius of rotation.	
9 State and derive the expressions $a_r = \frac{v^2}{r}$ and $a_r = r\omega^2$ for the radial acceleration.	Carry out experiments to verify the expression $F = \frac{mv^2}{r}$ for central force.
10 Carry out calculations using $F = \frac{mv^2}{r} = mr\omega^2$.	Centrifuge, fun fair, thrill rides. Use computer simulations to study angular motion.
1.3 Rotational dynamics	
1 State what is meant by the moment of a force.	
2 State that torque $T = Fr$.	Torque wrench.
3 State that an unbalanced torque produces an angular acceleration.	Engine torque.
4 State that the angular acceleration produced by an unbalanced torque depends on the moment of inertia of the object.	Discuss comparison of mass and moment of inertia.
5 Explain that the moment of inertia of an object depends on the mass of the object and the distribution of the mass about a fixed axis.	Obtain information on moments of inertia of different objects and compare I about different axes for a given object. Skaters, trampoliners and high divers.
6 State that the moment of inertia of a mass m at a distance r from a fixed axis is mr^2.	

CONTENT STATEMENTS	CONTEXTS, APPLICATIONS, ILLUSTRATIONS AND ACTIVITIES
1.3 Rotational dynamics (cont)	
7 State the relationship $T = I\alpha$.	Carry out experiments to investigate the relationship between T, I and α.
8 Carry out calculations using $T = I\alpha$, given I where required.	Spin of Earth (precession of equinoxes), spin stabilising of satellites, Foucault pendulum, wind patterns, spinning tops, electron orbits.
9 State that the angular momentum of a rigid object is $I\omega$.	Discuss angular momentum of a particle as mvr or $mr^2\omega$.
10 State that in the absence of external torques, the angular momentum of a rotating rigid object is conserved.	Carry out experiments to show that angular momentum is conserved. Investigate the linear and rotational motion of objects rolling down inclined planes. Compare linear and angular kinetic energy equations.
11 State the expression $E_{rot} = \frac{1}{2}I\omega^2$ for the rotational kinetic energy of a rigid object.	
12 Carry out calculations using the above relationship.	
1.4 Gravitation	
1 State the inverse square law of gravitation $F = \frac{Gm_1m_2}{r^2}$ where G is the gravitational constant.	Obtain, present and discuss information on Newton's work on gravitation.
2 Carry out calculations using the relationship in 1 above.	Planetary motion, tides.
3 Define gravitational field strength.	View audio/visual presentation to obtain information on the Cavendish/Boys experiments for measuring G.
4 Sketch gravitational field lines for an isolated point mass and for two point masses.	
5 State that the gravitational potential at a point in a gravitational field is the work done by external forces in bringing unit mass from infinity to that point.	Discuss gravitational fields and gravitational potential energy. View video on forces, potentials and fields.
6 State that the zero of gravitational potential is taken to be at infinity.	
7 State the expression for the gravitational potential $-\frac{Gm}{r}$ at a distance r from a mass m.	
8 Carry out calculations involving the gravitational potential energy of a mass in gravitational field.	
9 Explain what is meant by a conservative field.	Discuss equipotentials and potential wells.

National Course Specification: course details (cont)

CONTENT STATEMENTS	CONTEXTS, APPLICATIONS, ILLUSTRATIONS AND ACTIVITIES
1.4 Gravitation (cont)	
10 State that a gravitational field is a conservative field.	Use computer simulations to study gravitational fields.
11 Explain the term 'escape velocity'.	
12 Derive the expression $v = \sqrt{\frac{2GM}{r}}$ for the escape velocity.	Space flight. View video on stellar evolution.
13 State that the motion of photons is affected by gravitational fields.	Cosmology.
14 State that, within a certain distance from a sufficiently dense object, the escape velocity is greater than *c*, hence nothing can escape from such an object – a black hole.	
15 Carry out calculations involving orbital speed, period of rotation and radius of orbit of satellites.	Discuss satellite communications. Use computer simulations to study orbital motion. Kepler's work on planetary motion.
1.5 Simple harmonic motion	
1 Describe examples of simple harmonic motion (SHM).	Investigate SHM using: pendulum, mass on a spring, loaded test tube, liquid in a U-tube, ultrasonic motion detector.
2 State that in SHM the unbalanced force is proportional to the displacement of the object and acts in the opposite direction.	Body mass measuring device, car engine pistons, vehicle springs, roly-poly toys, loudspeaker cones, eardrums, vibrating crystals.
3 State and explain the equation $\frac{d^2y}{dt^2} = -\omega^2 y$ for SHM.	
4 Show that $y = A \cos \omega t$ and $y = A \sin \omega t$ are solutions of the equation for SHM.	Mechanical and electrical oscillating systems.
5 Show that $v = \pm \omega \sqrt{(A^2 - y^2)}$ for the relationships in 4.	Wave motion, alternating current, link with circular motion.
6 Derive the expressions $\frac{1}{2}m\omega^2(A^2 - y^2)$ and $\frac{1}{2}m\omega^2 y^2$ for the kinetic and potential energies of a particle executing SHM.	
7 State that damping on an oscillatory system causes the amplitude of oscillation to decay.	Observations of damping, critical damping and overdamping. Car shock absorbers.

National Course Specification: course details (cont)

CONTENT STATEMENTS		CONTEXTS, APPLICATIONS, ILLUSTRATIONS AND ACTIVITIES
1.6	**Wave-particle duality**	
1	State that electrons can behave like waves.	Obtain, present and discuss information on electron diffraction.
2	Describe evidence which shows that electrons and electromagnetic radiation exhibit wave–particle duality.	Obtain, present and discuss information on wave particle duality, photoelectric effect, Compton scattering, line spectra.
3	State that the wave and particle models are related by the expression: $\lambda = h/p$ where p is the associated momentum.	G. P. Thomson's, Davisson's and Germer's work on electron diffraction.
4	State that the wavelength found for a particle using $\lambda = h/p$ is small compared with the dimensions of any physical system (except on the atomic or sub-atomic scale).	Electron microscopy.
5	Carry out calculations using the relationship in 3 above.	
6	State that the angular momentum of an electron about the nucleus is quantised.	Discuss work on spectra and angular momentum.
7	Describe qualitatively the Bohr model of the atom.	Discuss the standing wave model for the Bohr atom.
8	State that the quantisation of angular momentum is given by $mvr = \frac{nh}{2\pi}$.	Measure the wavelength of the visible lines of the Balmer series in hydrogen.
9	Carry out calculations using the relationship in 8 above.	Use computer simulations to study atomic spectra.
10	State that a more far-reaching model of atomic and nuclear structure interprets waves in terms of probabilities.	Obtain, present and discuss information on the contribution made by Bohr, de Broglie, Einstein, Schrodinger, etc to the development of modern physics.
11	State that quantum mechanics provides methods to determine probabilities.	Quantum mechanics, nuclear, atomic and molecular structure. Philosophical implications: probability versus determinism.

National Course Specification: course details (cont)

Advanced Higher Physics: Electrical Phenomena

The Content Statements given in the left-hand column of the table below describe in detail what the candidate should be able to do in demonstrating knowledge and understanding associated with Electrical Phenomena.

The right-hand column gives suggested contexts, applications, illustrations and activities associated with the Content Statements.

	CONTENT STATEMENTS	CONTEXTS, APPLICATIONS, ILLUSTRATIONS AND ACTIVITIES
2.1	**Electric fields**	
1	State Coulomb's inverse square law for the force between two point charges ie $F = \frac{Q_1Q_2}{4\pi\varepsilon_0 r^2}$ where ε_0 is the permittivity of free space.	Carry out an experiment to verify Coulomb's law, or use a computer simulation. Electrostatic forces and structure of matter.
2	Carry out calculations involving the electrostatic force between point charges.	
3	Describe how the concept of an electric field is used to explain the forces that charged particles at rest exert on each other.	Discuss and compare electrostatic and gravitational forces between atomic and nuclear particles.
4	State that the electric field strength *E* at any point is the force per unit positive charge placed at that point.	Discuss and compare gravitational and electric fields.
5	State that the expression for the electric field strength *E* at a distance *r* from a point charge *Q* is $E = \frac{Q}{4\pi\varepsilon_0 r^2}$.	
6	State that the units of electric field strength are newton per coulomb.	
7	Carry out calculations involving the electric fields due to point charges.	
8	State and derive the expression $V = Ed$ for a uniform electric field.	Discuss definition and meaning of potential difference.
9	Carry out calculations using the above relationship.	
10	Describe what happens during the process of charging by induction.	Carry out experiments on induction, eg charging gold leaf electroscope, spheres in contact.

National Course Specification: course details (cont)

CONTENT STATEMENTS		CONTEXTS, APPLICATIONS, ILLUSTRATIONS AND ACTIVITIES
2.1	**Electric fields (cont)**	
11	Describe the effect of placing a conducting shape in an electric field: the induced charge resides on the surface of the conductor, inside the shape *E* is zero, and outside the shape *E* is perpendicular to the surface of the conductor.	Carry out an experiment to show that the field inside a conductor is zero, eg Faraday's ice pail experiment. Shielding.
12	State that the electrostatic potential at a point is the work done by external forces in bringing unit positive charge from infinity to that point.	Compare electrostatic and gravitational fields and potentials.
13	State that the expression for the electrostatic potential *V* at a distance *r* from a point charge *Q* is $V = \frac{Q}{4\pi\varepsilon_0 r}$.	Use computer simulations to study electrostatic fields and potentials. Use a flame probe to find points of equipotential and draw the shapes of equipotential surfaces for charged objects.
14	Carry out calculations involving potentials due to point charges.	
15	Describe the energy transformation associated with the movement of a charge in an electric field.	Photocopying, fog formation, lightning conductors, electrostatic generators. Investigate the deflection of an electron beam in an electric field.
16	Describe the motion of charged particles in uniform electric fields.	Cosmic rays, Compton scattering.
17	Carry out calculations concerning the motion of charged particles in uniform electric fields.	Use computer simulations to study deflections in a cathode ray tube. Electron gun, oscilloscope deflecting plates, particle accelerators.
18	State that relativistic effects must be considered when the velocity of a charged particle is more than 10% of the velocity of light.	Carry out illustrative calculations. Discuss the importance of relativistic effects for charged particle accelerators and cosmic rays.
19	Carry out calculations involving the head-on collision of a charged particle with a fixed nucleus.	Rutherford scattering.
20	Explain how the results of Millikan's experiment lead to the idea of quantisation of charge.	Carry out, or use computer simulation, to study Millikan's oil drop experiment.

National Course Specification: course details (cont)

CONTENT STATEMENTS	CONTEXTS, APPLICATIONS, ILLUSTRATIONS AND ACTIVITIES
2.2 Electromagnetism	
1 State that a magnetic field exists around a moving charge in addition to its electric field.	Compare gravitational, electrostatic and magnetic fields.
2 State that a charged particle moving across a magnetic field experiences a force.	Unification of electricity and magnetism by J. C. Maxwell.
3 Describe how the concept of a magnetic field is used to explain the magnetic force exerted by current-carrying conductors on each other.	
4 State that one tesla is the magnetic induction of a magnetic field in which a conductor of length one metre, carrying a current of one ampere perpendicular to the field is acted on by a force of one Newton.	Electric motors, analogue meters, electromagnetic pump.
5 State the relationship $F = IlB\sin\theta$.	Carry out experiments to investigate the force on a current-carrying conductor and how it depends on *I* and *l*.
6 Carry out calculations involving the relationship in 5 above.	
7 State the relative directions of current, magnetic field and force for a current-carrying conductor in a magnetic field.	Hall effect (measurement of magnetic induction, nature of charge carriers in extrinsic semiconductors).
8 State that the magnetic induction at a perpendicular distance *r* from an 'infinite' straight conductor carrying a current *I* is $\frac{\mu_0 I}{2\pi r}$ where μ_0 is the permeability of free space.	Carry out an experiment to measure *B* using a force-on-a-conductor balance. Carry out experiments using a Hall probe to investigate how *B* varies with the current *I* and perpendicular distance *r* for a long straight current-carrying conductor. ε_0, μ_0 and the speed of light.
9 Derive the expression $\frac{F}{l} = \frac{\mu_0 I_1 I_2}{2\pi r}$ for the force per unit length between two parallel current carrying wires a distance *r* apart, using the above relationships.	The ampere. National Physical Laboratory Standards.

National Course Specification: course details (cont)

CONTENT STATEMENTS	CONTEXTS, APPLICATIONS, ILLUSTRATIONS AND ACTIVITIES
2.3 Motion in a magnetic field	
1 State and derive the relationship $F = qvB$ for the magnitude of the force acting on a charge q moving with speed v perpendicular to a magnetic field B, using the relationship $F = IlB\sin\theta$.	Carry out experiments to show the effect on an electron beam moving: a) parallel, b) at right angles, c) obliquely, to magnetic field lines.
2 State that if the charge's velocity vector is not perpendicular to the field, then the component of v perpendicular to the field $v_\perp$ must be used in the above equation.	TV tubes, fusion plasma confinement.
3 State the relative directions of magnetic field, velocity and force for positive and negative charges.	Use computer simulations to study the motion of charged particles in electric and magnetic fields.
4 Explain how the helical movement of a charged particle in a magnetic field arises.	View video on fusion plasma confinement.
5 Carry out calculations on the motion of charged particles moving with non-relativistic velocities in uniform magnetic fields.	Charged particles in Earth's magnetic field, aurora.
6 Describe the principles of J. J. Thomson's method for measuring the charge to mass ratio (specific charge) of the electron.	Mass spectrometer, bubble chambers, cloud chambers, charged particle accelerators, magnetrons.
2.4 Self-inductance	
1 Sketch qualitative graphs of the growth and decay of current in a d.c. circuit containing an inductor.	Carry out experiments to investigate self-inductance of a coil, ie growth and decay of a current. R and L in parallel - time delay.
2 Describe the principles of a method to illustrate the growth of current in a d.c. circuit.	
3 State that an e.m.f. is induced across a coil when the current through the coil is varying.	Observe the direction of induced currents in simple circuits.
4 Explain the production of the induced e.m.f. across a coil.	Carry out an experiment to find the self-inductance of a coil.
5 Explain the direction of the induced e.m.f. in terms of energy.	Lenz, Faraday. Discuss terms: choke, back e.m.f. magnetic flux and magnetic induction.
6 State that the self-induced e.m.f. in a coil is $e = -L\frac{dI}{dt}$, where L is the self-inductance of the coil.	

National Course Specification: course details (cont)

CONTENT STATEMENTS	CONTEXTS, APPLICATIONS, ILLUSTRATIONS AND ACTIVITIES
2.4 Self-inductance (cont)	
7 State that the inductance of an inductor is one henry if an e.m.f. of one volt is induced when the current changes at a rate of one ampere per second.	
8 Explain that the work done in building up the current in an inductor is stored in the magnetic field of the inductor.	
9 Explain that the energy stored in the magnetic field of an inductor may be a source of e.m.f.	Neon bulb lit from 1.5V cell, linear induction motor, magnetic levitation. Car ignition coil, mutual inductance, transformers, xenon flashlamp circuits.
10 State that the energy stored in an inductor is $\frac{1}{2}LI^2$	Eddy currents, electromagnetic braking, induction heating.
11 Carry out calculations involving the above relationship.	
12 Describe the principles of a method to show how the current varies with frequency in an inductive circuit.	Investigate the relationship between current and frequency in an inductive circuit.
13 Describe and explain the possible functions of an inductor - sources of high e.m.f., blocking a.c. signals while transmitting d.c. signals.	
14 Compare the dependence on frequency of the capacitive and inductive reactances. (No numerical calculations required.)	Discuss capacitive circuits. Compare the functions of a capacitor and inductor in an a.c. circuit. Filter circuits for hi-fi.
2.5 Forces of nature	
1 State that nuclear particles attract each other with a force called the strong force.	Obtain, present and discuss information on fundamental forces: gravitational, electromagnetic, strong, weak.
2 State that the strong force has a short range $< 10^{-14}$ m.	
3 State that the weak force is associated with beta decay.	Grand Unified Theory. Neutron decay.
4 State that there are a number of ‘elementary’ particles.	Present and discuss the elementary particle families and their interactions.
5 State that neutrons and protons can be considered to be composed of quarks.	Introduce the idea of quarks.

National Course Specification: course details (cont)

Advanced Higher Physics: Wave Phenomena

The Content Statements given in the left-hand column of the table below describe in detail what the candidate should be able to do in demonstrating knowledge and understanding associated with Wave Phenomena.

The right-hand column gives suggested contexts, applications, illustrations and activities associated with the Content Statements.

CONTENT STATEMENTS	CONTEXTS, APPLICATIONS, ILLUSTRATIONS AND ACTIVITIES
3.1 Waves	
1 State that in wave motion energy is transferred with no net mass transport.	Discuss work on waves – look at graphs and waveforms for their composition and analysis. Discuss phase difference.
2 State that the intensity of a wave is directly proportional to $(\text{amplitude})^2$.	
3 State that the sine or cosine variation is the simplest mathematical form of a wave.	
4 State that all waveforms can be described by the superposition of sine or cosine waves.	Obtain information on the principle of superposition. Use a 'Slinky' to show the superposition of wave pulses. Use computer simulations to study superposition of waves. Fourier analysis, synthesisers.
5 Explain that the relationship $y = A \sin 2\pi (ft - \frac{x}{\lambda})$, represents a travelling wave.	Use the wave profile to derive the travelling wave equation.
6 Carry out calculations on travelling waves using the above relationship.	
7 Explain the meaning of phase difference.	
8 Explain what is meant by a stationary wave. 9 Define the terms 'node' and 'antinode'.	Carry out experiments on stationary waves using: a stretched string; a sound wave; microwaves. Use these waves to find the wavelength. Resonant systems, musical instruments.
10 State that the Doppler effect is the change in frequency observed when a source of sound waves is moving relative to an observer. 11 State and derive the expression for the apparent frequency detected when a source of sound waves moves relative to a stationary observer.	Change of pitch of a train whistle or aeroplane. Moving source and wavefront diagrams. Doppler ultrasound in medicine.

National Course Specification: course details (cont)

CONTENT STATEMENTS	CONTEXTS, APPLICATIONS, ILLUSTRATIONS AND ACTIVITIES
3.1 Waves (cont)	
12 State and derive the expression for the apparent frequency detected when an observer moves relative to a stationary source of sound waves.	Discuss Doppler 'red shift' when a star moves away from the Earth. Use of 'red shift' to determine the velocity of a star relative to the Earth. Doppler radar.
13 Carry out calculations using the above relationships.	
3.2 Interference – division of amplitude	
1 State in simple terms the condition for two light beams to be coherent.	
2 State the reasons why the conditions for coherence are usually more difficult to satisfy for light than for sound and microwaves.	
3 Define the term 'optical path difference' and relate it to phase difference.	
4 State what is meant by the principle of interference by division of amplitude.	
5 Describe how the division of amplitude enables an extended source to be used.	
6 State that there is a phase change of π on reflection at an interface where there is an increase in optical density and that there is no change in phase on reflection at an interface where there is a decrease in optical density.	
7 State the expressions for maxima and minima in the fringes formed by reflection and transmission of normally incident monochromatic light or microwaves in a 'thin film'.	Discuss derivation of the expressions for fringes formed in a 'thin film'.
8 Carry out calculations using the above expressions.	
9 Derive the expression for the distance between the fringes which are formed by reflection of light at normal incidence from a 'thin wedge'.	Length measurement. Changes in length of a crystal.
10 Carry out calculations using the above expression.	
11 Explain how lenses are made non-reflecting for a specific wavelength of light.	Clarity of image formation in optical instruments.
12 Derive the expression $d = \lambda/4n$ for the thickness of a non-reflecting coating.	

National Course Specification: course details (cont)

CONTENT STATEMENTS	CONTEXTS, APPLICATIONS, ILLUSTRATIONS AND ACTIVITIES
3.2 Interference – division of amplitude (cont)	
13 Carry out calculations using the above expression.	
14 Explain why coated (bloomed) lenses have a coloured hue when viewed in reflected light.	Discuss the reflection of white light from coated lenses. Coated mirrors and filters.
15 Explain the formation of coloured fringes in a thin film illuminated by white light.	Colours in films of oil or glass.
3.3 Interference – division of wavefront	
1 State what is meant by the principle of interference by division of a wavefront.	
2 Explain why the principle of division of a wavefront requires the use of a 'point' or 'line' source.	
3 State and derive the expression $\Delta x = \lambda D/d$ for the fringe spacing in the Young's slit experiment for $\Delta x << D$.	Carry out an experiment to measure wavelength using the Young's slit experiment.
4 Carry out calculations using the above expression.	Discuss importance of θ being a small angle.
3.4 Polarisation	
1 Explain the difference between linearly (plane) polarised and unpolarised waves.	Carry out experiments to show polarisation using light waves and microwaves.
2 State that only transverse waves can be polarised.	
3 State that light can be linearly (plane) polarised using a polarising filter.	
4 Explain how a combination of a 'polariser' and 'analyser' can prevent the transmission of light.	Malus' Law. Polarisation of rainbows, scattered sunlight, photography.
5 State that light reflected from any electrical insulator may be polarised.	
6 Explain what is meant by the polarising angle i_p (Brewster's angle).	
7 Derive the expression $n = \tan i_p$.	
8 Carry out calculations using the above expression.	Maximum polarisation, Brewster's law.
9 Explain how polarising sunglasses can remove glare.	Discuss applications of polarisation, eg polarising lenses, photoelasticity, optical activity, saccharimetry.

National Course Specification: course details (cont)

Advanced Higher Physics

The following Content Statements apply to all units in the course.

CONTENT STATEMENTS	CONTEXTS, APPLICATIONS, ILLUSTRATIONS AND ACTIVITIES
4.1 Units, prefixes and scientific notation	
1 Use SI units of all physical quantities appearing in the Content Statements.	
2 Give answers to calculations to an appropriate number of significant figures.	
3 Check answers to calculations.	Check answers in relation to context – reject impossible solutions, use a checking procedure.
4 Use prefixes (p, n, μ, m, k, M, G).	
5 Use scientific notation.	
4.2 Uncertainties	
1 State that all instruments are subject to calibration uncertainty.	
2 Express the numerical result of an experiment and its uncertainty, making appropriate use of significant figures.	
3 Combine the calibration uncertainty, reading uncertainty, and random uncertainty to obtain the total uncertainty.	
4 Calculate the uncertainty in a quantity raised to a power.	
5 Calculate the uncertainty in a product or quotient of quantities.	
6 Calculate the uncertainty in a sum or difference of quantities.	
7 Estimate the uncertainty in the gradient and intercept of a straight-line graph.	
8 Represent, in graphical analysis, the uncertainties in readings as error bars for points on the graph representing the readings.	Discuss the term error bars as a representation of the uncertainties in individual points. Discuss the use of error bars as a guide when considering the best fit curve or line through points on a graph. Use of error bars to indicate a trend.
9 Compare critically the numerical result of one experiment with that of another experiment.	

National Course Specification: course details (cont)

COURSE Physics (Advanced Higher)

ASSESSMENT

To gain the award of the course, the candidate must achieve all the component units as well as the external assessment. External assessment will provide the basis for grading attainment.

When units are taken as component parts of a course, candidates will have the opportunity to demonstrate achievement beyond that required to attain each of the units. This attainment may, where appropriate, be recorded and used to contribute towards course estimates, and to provide evidence for appeals.

Further information on the key principles of assessment is provided in the paper, *Assessment* (HSDU, 1996) and in *Managing Assessment* (HSDU, 1998).

Each unit specification gives information on unit assessment.

DETAILS OF INSTRUMENTS FOR EXTERNAL ASSESSMENT

The instruments of assessment will be an externally set question paper of 2 hours 30 minutes duration and a completed investigation report.

Question Paper

The question paper will sample the Content Statements of three component units: *Mechanics; Electrical Phenomena; Wave Phenomena*. The question paper will consist of questions requiring a short answer (a few words); a response in the form of a numerical calculation; a restricted response (a few sentences or a paragraph). Candidates will be expected to answer all of the questions.

There will be a total of 100 marks for the paper.

Approximately 40 marks will be allocated to questions which require candidates to demonstrate achievement of a sample of the performance criteria associated with Outcome 1 for the three component units.

Approximately 60 marks will be allocated to questions that require candidates to:

- demonstrate achievement of a sample of the performance criteria associated with Outcome 2 and Outcome 3 for the three units;
- integrate knowledge and understanding, problem solving and analytic skills acquired through a study of the component units;
- apply knowledge and understanding to solve problems in contexts which are less familiar than those associated with a study of the component units;
- solve problems which are less structured or are set in more complex contexts;
- demonstrate knowledge and understanding of uncertainties within the context of any of the component units.

National Course Specification: course details (cont)

COURSE Physics (Advanced Higher)

A summary of the breakdown of the marks allocation across the outcomes and component units is as follows.

	Outcomes 1	*Outcomes 2 and 3*	*Total*
Mark allocation for:			
whole paper	*40 ± 4*	*60 ± 4*	*100*
each component unit (40 hour)	*16 ± 3*	*24 ± 4*	*40 ± 4*
component unit (20 hour)	*8 ± 2*	*12 ± 3*	*20 ± 3*

Investigation report

The investigation report will be based on the work carried out in the component unit, *Physics Investigation (AH).* It is expected that approximately 10 hours of the 'additional 40 hours' will be required for the candidate to complete the report for the course award.

A total of 25 marks will be allocated to the investigation report. The investigation report will be externally assessed using the following assessment categories and mark allocations:

(a) Introduction (4 marks)
(b) Procedures (6 marks)
(c) Results (5 marks)
(d) Discussion (7 marks)
(e) Presentation (3 marks).

The grade awarded for the course will depend on the marks obtained by the candidate (out of 125) for the question paper and the investigation report. The certificate will record an award for overall attainment.

GRADE DESCRIPTIONS

Course assessment will be based on achievement of the outcomes for the component units but will differ from the unit assessment in a number of regards. In undertaking the course assessment, candidates will be expected to demonstrate that the knowledge and understanding, problem solving and practical skills, which they acquired through their study of the component units, have been retained, and can be integrated and applied in contexts which are less familiar and more complex than those required by a study of the units.

The descriptions below indicate the nature of the achievement which is required for the award of a grade C and a grade A in the course assessment.

Grade Descriptions at 'C'

Candidates can:

- use the appropriate knowledge and understanding acquired through the study of the component units
- integrate skills acquired in component units to solve problems
- apply knowledge and understanding to solve problems set in less familiar contexts
- select, analyse and present information obtained through experimental and observational work in the investigation
- write in a scientific manner which reveals the significance of the physics relating to the investigation.

National Course Specification: course details (cont)

COURSE Physics (Advanced Higher)

Grade Descriptions at 'A'

Candidates can:

- solve problems in which the concepts and given information may not be specified in the Content Statements
- apply knowledge and understanding to solve problems which are less structured or set in more complex contexts
- show particular proficiency in selecting, analysing and presenting information obtained through experimental and observational work in the investigation
- show particular proficiency in writing in a scientific manner which reveals the significance of the findings of the investigation by interpreting the results in a critical and scientific manner and demonstrating depth of knowledge and understanding of physics relating to the investigation.

The above descriptions indicate the value of the course award over achievement of the individual units.

The overall assessment for the course, ie the combination of internal and external assessment, will provide the necessary evidence for the core skills where an automatic award is made.

APPROACHES TO LEARNING AND TEACHING

The learning and teaching of physics are most effective when the concepts, principles and theories are set in a relevant context, eg by making reference to applications of physics and to real-world situations. Appropriate contexts, applications, illustrations and activities relating to the Content Statements are provided.

Practical activities provide opportunities to develop a wide range of skills associated with scientific enquiry and practical problem solving. The practical activities should be designed to assist in the understanding of the concepts being studied.

The use of microcomputers is a powerful aid to learning and experimenting. When interfaced to suitable sensors, the microcomputer can assist the investigation of systems where readings have to be taken very rapidly or over a long time, or where several different variables have to be recorded simultaneously. Data obtained can be analysed and presented in graphical displays.

The units may be taught in any order. However, some of the concepts from the Mechanics unit are useful for the other units, hence it is suggested that this unit should be covered first.

The investigation allows freedom for candidates to pursue their own interests, and provides a valuable exercise in self-motivation, organisation and experimental design.

National Course Specification: course details (cont)

COURSE Physics (Advanced Higher)

Use of the additional 40 hours

This time may be used:

- to provide an introduction to the course and assessment methods
- to allow candidates to develop their ability to integrate knowledge and understanding, problem solving and practical skills acquired through the study of the different component units
- to allow some more practical work, on an individual basis if appropriate, within the units to enhance skills and understanding
- for completion of the investigation report
- for consolidation and integration of learning
- for remediation
- for practice in examination techniques and preparation for the external examination.

SPECIAL NEEDS

This course specification is intended to ensure that there are no artificial barriers to learning or assessment. Special needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments or considering alternative outcomes for units. For information on these, please refer to the SQA document *Guidance on Special Assessment Arrangements* (SQA, 2001).

National Unit Specification: general information

UNIT Mechanics (Advanced Higher)

NUMBER D385 13

COURSE Physics (Advanced Higher)

SUMMARY

The unit seeks to develop the theoretical basis for the candidate's knowledge and understanding of concepts and principles in mechanics. The unit also provides an opportunity for developing the ability to apply these concepts and principles in the analysis of a wide variety of applications.

OUTCOMES

1 Demonstrate knowledge and understanding related to mechanics.
2 Solve problems related to mechanics.
3 Collect and analyse information related to Advanced Higher Physics obtained by experiment.

RECOMMENDED ENTRY

While entry is at the discretion of the centre, candidates will normally be expected to have attained the following.

- Higher Physics or the unit *Mechanics and Properties of Matter* (Higher)

and

- Higher Mathematics

CREDIT VALUE

1 credit at Advanced Higher.

CORE SKILLS

Core skills for this qualification remain subject to confirmation and details will be available at a later date.

Additional information about core skills is published in the *Catalogue of Core Skills in National Qualifications* (SQA, 2001).

Administrative Information

Superclass: RC

Publication date: June 2002

Source: Scottish Qualifications Authority

Version: 03

National Unit Specification: statement of standards

UNIT Mechanics (Advanced Higher)

Acceptable performance in this unit will be the satisfactory achievement of the standards set out in this part of the unit specification. All sections of the statement of standards are mandatory and cannot be altered without reference to the Scottish Qualifications Authority.

OUTCOME 1

Demonstrate knowledge and understanding related to mechanics.

Performance criteria

(a) Quantities and their units are used correctly in relation to mechanics.
(b) Relationships and mathematical techniques are used correctly in relation to mechanics.
(c) Principles are used correctly in relation to mechanics.
(d) Models are described correctly in relation to mechanics.

Evidence requirements

Evidence of an appropriate level of achievement must be generated from a closed book test with items covering all the above performance criteria. The test must sample the Content Statements (See Physics (Advanced Higher), Course Content) in each of the following areas:

- Kinematic relationships and relativistic motion
- Angular motion
- Rotational dynamics
- Gravitation
- Simple harmonic motion
- Wave-particle duality.

OUTCOME 2

Solve problems related to mechanics.

Performance criteria

(a) Relevant information is selected and presented appropriately.
(b) Information is accurately processed, using calculations, where appropriate.
(c) Conclusions drawn are valid and explanations given are supported by evidence.
(d) Experimental procedures are planned, designed and evaluated appropriately.

Evidence requirements

Evidence of an appropriate level of achievement must be generated from a closed book test with items covering all the above performance criteria. The test must sample the areas shown below.

- Kinematic relationships and relativistic motion
- Angular motion
- Rotational dynamics
- Gravitation
- Simple harmonic motion
- Wave-particle duality.

National Unit Specification: statement of standards (cont)

UNIT Mechanics (Advanced Higher)

OUTCOME 3

Collect and analyse information related to Advanced Higher Physics obtained by experiment.

Performance criteria

(a) The information is collected by active participation in the experiment.
(b) Experimental procedures are described accurately.
(c) Relevant measurements and observations are recorded in an appropriate format.
(d) Recorded information is analysed and presented in an appropriate format.
(e) Uncertainties are treated appropriately.
(f) Conclusions drawn are valid.
(g) Experimental procedures are evaluated with supporting argument.

Evidence requirements

A report of one experimental activity related to Advanced Higher Physics covering the above performance criteria is required. Evidence submitted in support of PC (d) must be in the format of a table or graph as appropriate. The teacher/lecturer responsible must attest that the report is the individual work of the candidate derived from active participation in an experiment involving the candidate in planning the experiment; deciding how it is managed; identifying and obtaining the necessary resources, some of which must be unfamiliar; carrying out the experiment. The report must provide evidence in respect of a sample of the Content Statements for uncertainties (see Physics (Advanced Higher), Course Content). Depending on the activity, the collection of the information may be through group work.

An Outcome 3 report of practical work in this unit may be used as evidence of the achievement of Outcome 3 of the Advanced Higher Physics units D386 13 Electrical Phenomena and D387 13 Wave Phenomena. An Outcome 3 report of practical work in the Advanced Higher Physics unit D386 13 Electrical Phenomena or D387 13 Wave Phenomena may be used as evidence of the achievement of Outcome 3 of this unit.

National Unit Specification: support notes

UNIT Mechanics (Advanced Higher)

This part of the unit specification is offered as guidance. The support notes are not mandatory.

While the time allocated to this unit is at the discretion of the centre, the notional design length is 40 hours.

GUIDANCE ON CONTENT AND CONTEXT FOR THIS UNIT

The content and suggested contexts, applications illustrations and activities for this unit are detailed in the National Course Specification: course details. The subheadings in the tables correspond to the areas mentioned in the evidence requirements for Outcome 1 and Outcome 2. The practical activities chosen for Outcome 3 must relate to the content of Advanced Higher Physics and must allow opportunity for all the performance criteria for this outcome to be demonstrated within any single report.

GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT

The learning and teaching of this unit are most effective when the concepts, principles and theories are set in a relevant context, eg by making reference to applications of physics and to real-world situations. Suitable approaches to learning and teaching are detailed in the National Course Specification.

GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT

Outcomes 1 and 2

It is recommended that a holistic approach is taken for assessment of Outcomes 1 and 2. These outcomes can be assessed by an end of unit test with questions covering all of the associated performance criteria. Within one question, assessment of knowledge and understanding and problem solving can occur. Each question can assess achievement of a number of performance criteria from either Outcome 1 or 2. Assessment items are available from the National Assessment Bank.

Outcome 3

The teacher/lecturer should ensure that the experimental activity to be undertaken in connection with Outcome 3 affords opportunity for the candidate to demonstrate the ability to undertake the planning and organising of an experimental activity at an appropriate level of demand. The activity must relate to the content of Advanced Higher Physics and candidates should be made aware of the range of skills which must be demonstrated to ensure attainment of Outcome 3.

In relation to PC (a), the teacher/lecturer should check by observation that the candidate participates in the collection of the experimental information by playing an active part in planning the experiment, deciding how it will be managed, identifying and obtaining resources (some of which must be unfamiliar to the candidate), and carrying out the experiment.

In relation to PCs (b) to (g) the following provides an indication of what may be included in a candidate’s report.

UNIT Mechanics (Advanced Higher)

PC (b)
Many experiments will follow a given procedure or method hence there is no need for a detailed description. The procedure may be described briefly in outline. The impersonal passive voice should be encouraged. The following should be included, as appropriate:
- aim of the experiment
- a labelled diagram, description of apparatus, instruments used
- how the independent variable was altered
- how measurements were taken or observations made.

PC (c)
Readings or observations should be recorded in a clear table. The table must include:
- correct headings
- appropriate units
- correctly entered readings/observations.

PC (d)
Readings should be analysed/presented using the following, as appropriate:
- a table with suitable headings and units
- a table with ascending or descending independent variable
- a table showing appropriate computations
- a graph with independent and dependent variables plotted
- a graph with suitable scales and axes labelled with quantities and units
- a graph with data correctly plotted with a line or a curve of best fit.

PC (e)
Depending on the activity the following may be included:
- calibration uncertainties, reading uncertainties and random uncertainties
- a combination of individual uncertainties
- an uncertainty in the numerical value of a measured quantity
- uncertainties estimated from a straight line graph.

PC (f)
Conclusions should contain, as appropriate, a statement relating to:
- overall pattern to readings or observations
- trends in analysed information or results
- connection between variables
- measurement of a physical quantity.

PC (g)
The experimental procedures should be evaluated with supporting argument by including a few sentences, as appropriate, commenting on:
- effectiveness of procedures
- control of variables
- limitations of equipment
- possible improvements
- possible sources of error.

National Unit Specification: support notes (cont)

UNIT Mechanics (Advanced Higher)

The references under each performance criterion give an indication of what should be provided as evidence in order to achieve the criterion. The relevance of these will vary according to the experiment. These references are intended to assist the teacher/lecturer in making a judgement of the candidate's achievement against the performance criteria. It is appropriate to give limited support to candidates in producing their reports. Re-drafting of reports after necessary supportive criticism is to be encouraged both as part of the learning and teaching process and to produce evidence for assessment.

SPECIAL NEEDS

This unit specification is intended to ensure that there are no artificial barriers to learning or assessment. Special needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments or considering alternative outcomes for units. For information on these, please refer to the SQA document *Guidance on Special Assessment Arrangements* (SQA, 2001).

SCOTTISH
QUALIFICATIONS
AUTHORITY

National Unit Specification: general information

UNIT Electrical Phenomena (Advanced Higher)

NUMBER D386 13

COURSE Physics (Advanced Higher)

SUMMARY

The unit seeks to develop the theoretical basis for the candidate's knowledge and understanding of concepts and principles relating to electrical phenomena. The unit also provides an opportunity for developing the ability to apply these concepts and principles in the analysis of a wide variety of applications.

OUTCOMES

1 Demonstrate knowledge and understanding related to electrical phenomena.
2 Solve problems related to electrical phenomena.
3 Collect and analyse information related to Advanced Higher Physics obtained by experiment.

RECOMMENDED ENTRY

While entry is at the discretion of the centre, the candidate will normally be expected to have attained the following.

- Higher Physics or the unit *Electricity and Electronics* (Higher)

and

- Higher Mathematics

CREDIT VALUE

1 credit at Advanced Higher.

CORE SKILLS

Core skills for this qualification remain subject to confirmation and details will be available at a later date.

Additional information about core skills is published in the *Catalogue of Core Skills in National Qualifications* (SQA, 2001).

Administrative Information

Superclass: RC

Publication date: June 2002

Source: Scottish Qualifications Authority

Version: 03

National Unit Specification: statement of standards

UNIT Electrical Phenomena (Advanced Higher)

Acceptable performance in this unit will be the satisfactory achievement of the standards set out in this part of the unit specification. All sections of the statement of standards are mandatory and cannot be altered without reference to the Scottish Qualifications Authority.

OUTCOME 1
Demonstrate knowledge and understanding related to electrical phenomena.

Performance criteria

(a) Quantities and their units are used correctly in relation to electrical phenomena.
(b) Relationships and mathematical techniques are used correctly in relation to electrical phenomena.
(c) Principles are used correctly in relation to electrical phenomena.
(d) Models are described correctly in relation to electrical phenomena.

Evidence requirements

Evidence of an appropriate level of achievement must be generated from a closed book test with items covering all the above performance criteria. The test must sample the Content Statements (see Physics (Advanced Higher), Course Content) in each of the following areas:

- Electric fields
- Electromagnetism
- Motion in a magnetic field
- Self-inductance
- Forces of nature.

OUTCOME 2
Solve problems related to electrical phenomena.

Performance criteria

(a) Relevant information is selected and presented appropriately.
(b) Information is accurately processed, using calculations, where appropriate.
(c) Conclusions drawn are valid and explanations given are supported by evidence.
(d) Experimental procedures are planned, designed and evaluated appropriately.

Evidence requirements

Evidence of an appropriate level of achievement must be generated from a closed book test with items covering all the above performance criteria. The test must sample the areas shown below.

- Electric fields
- Electromagnetism
- Motion in a magnetic field
- Self-inductance
- Forces of nature.

National Unit Specification: statement of standards (cont)

UNIT Electrical Phenomena (Advanced Higher)

OUTCOME 3
Collect and analyse information related to Advanced Higher Physics obtained by experiment.

Performance criteria

(a) The information is collected by active participation in the experiment.
(b) Experimental procedures are described accurately.
(c) Relevant measurements and observations are recorded in an appropriate format.
(d) Recorded information is analysed and presented in an appropriate format.
(e) Uncertainties are treated appropriately.
(f) Conclusions drawn are valid.
(g) Experimental procedures are evaluated with supporting argument.

Evidence requirements

A report of one experimental activity related to Advanced Higher Physics covering the above performance criteria is required. Evidence submitted in support of PC (d) must be in the format of a table or graph as appropriate. The teacher/lecturer responsible must attest that the report is the individual work of the candidate derived from active participation in an experiment involving the candidate in planning the experiment; deciding how it is managed; identifying and obtaining the necessary resources, some of which must be unfamiliar; carrying out the experiment. The report must provide evidence in respect of a sample of the Content Statements for uncertainties (see Physics (Advanced Higher), Course Content). Depending on the activity, the collection of the information may be through group work.

An Outcome 3 report of practical work in this unit may be used as evidence of the achievement of Outcome 3 of the Advanced Higher Physics units D385 13 Mechanics and D387 13 Wave Phenomena. An Outcome 3 report of practical work in the Advanced Higher Physics unit D385 13 Mechanics or D387 13 Wave Phenomena may be used as evidence of the achievement of Outcome 3 of this unit.

National Unit Specification: support notes

UNIT Electrical Phenomena (Advanced Higher)

This part of the unit specification is offered as guidance. The support notes are not mandatory.

While the time allocated to this unit is at the discretion of the centre, the notional design length is 40 hours.

GUIDANCE ON CONTENT AND CONTEXT FOR THIS UNIT

The content and suggested contexts, applications, illustrations and activities for this unit are detailed in the National Course Specification: course details. The subheadings in the tables correspond to the areas mentioned in the evidence requirements for Outcome 1 and Outcome 2. The practical activities chosen for Outcome 3 must relate to the content of Advanced Higher Physics and must allow opportunity for all the performance criteria for this outcome to be demonstrated within any single report.

GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT

The learning and teaching of this unit are most effective when the concepts, principles and theories are set in a relevant context, eg by making reference to applications of physics and to real-world situations. Suitable approaches to learning and teaching are detailed in the National Course Specification.

GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT

Outcomes 1 and 2

It is recommended that a holistic approach is taken for assessment of Outcomes 1 and 2. These outcomes can be assessed by an end of unit test with questions covering all of the associated performance criteria. Within one question, assessment of knowledge and understanding and problem solving can occur. Each question can assess achievement of a number of performance criteria from either Outcome 1 or 2. Assessment items are available from the National Assessment Bank.

Outcome 3

The teacher/lecturer should ensure that the experimental activity to be undertaken in connection with Outcome 3 affords opportunity for the candidate to demonstrate the ability to undertake the planning and organising of an experimental activity at an appropriate level of demand. The activity must relate to the content of Advanced Higher Physics and candidates should be made aware of the range of skills which must be demonstrated to ensure attainment of Outcome 3.

In relation to PC (a), the teacher/lecturer should check by observation that the candidate participates in the collection of the experimental information by playing an active part in planning the experiment, deciding how it will be managed, identifying and obtaining resources (some of which must be unfamiliar to the candidate), and carrying out the experiment.

In relation to PCs (b) to (g) the following provides an indication of what may be included in a candidate's report.

PC (b)
Many experiments will follow a given procedure or method hence there is no need for a detailed description. The procedure may be described briefly in outline. The impersonal passive voice should be used. The following should be included, as appropriate:

- aim of the experiment
- a labelled diagram, description of apparatus, instruments used
- how the independent variable was altered
- how measurements were taken or observations made.

PC (c)
Readings or observations should be recorded in a clear table. The table must include:

- correct headings
- appropriate units
- correctly entered readings/observations.

PC (d)
Readings should be analysed/presented using the following, as appropriate:

- a table with suitable headings and units
- a table with ascending or descending independent variable
- a table showing appropriate computations
- a graph with independent and dependent variables plotted
- a graph with suitable scales and axes labelled with quantities and units
- a graph with data correctly plotted with a line or a curve of best fit.

PC (e)
Depending on the activity the following may be included:

- calibration uncertainties, reading uncertainties and random uncertainties
- a combination of individual uncertainties
- an uncertainty in the numerical value of a measured quantity
- uncertainties estimated from a straight line graph.

PC (f)
Conclusions should contain, as appropriate, a statement relating to:

- overall pattern to readings or observations
- trends in analysed information or results
- connection between variables
- measurement of a physical quantity.

PC (g)
The experimental procedures should be evaluated with supporting argument by including a few brief sentences, as appropriate, commenting on:

- effectiveness of procedures
- control of variables
- limitations of equipment
- possible improvements
- possible sources of error.

National Unit Specification: support notes (cont)

UNIT Electrical Phenomena (Advanced Higher)

The references under each performance criterion give an indication of what should be provided as evidence in order to achieve the criterion. The relevance of these will vary according to the experiment. These references are intended to assist the teacher/lecturer in making a judgement of the candidate's achievement against the performance criteria. It is appropriate to give limited support to candidates in producing their reports. Redrafting of reports after necessary supportive criticism is to be encouraged both as part of the learning and teaching process and to produce evidence for assessment.

SPECIAL NEEDS

This unit specification is intended to ensure that there are no artificial barriers to learning or assessment. Special needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments or considering alternative outcomes for units. For information on these, please refer to the SQA document *Guidance on Special Assessment Arrangements* (SQA, 2001).

SCOTTISH QUALIFICATIONS AUTHORITY

National Unit Specification: general information

UNIT Wave Phenomena (Advanced Higher)

NUMBER D387 13

COURSE Physics (Advanced Higher)

SUMMARY

The unit seeks to develop the theoretical basis for the candidate's knowledge and understanding of concepts and principles relating to wave phenomena. The unit also provides an opportunity for developing the ability to apply these concepts and principles in the analysis of a wide variety of applications.

OUTCOMES

1 Demonstrate knowledge and understanding related to wave phenomena.
2 Solve problems related to wave phenomena.
3 Collect and analyse information related to Advanced Higher Physics obtained by experiment.

RECOMMENDED ENTRY

While entry is at the discretion of the centre, candidates will normally be expected to have attained the following:

- Higher Physics or the unit *Radiation and Matter* (Higher)

and

- Higher Mathematics

CREDIT VALUE

0.5 credit at Advanced Higher.

CORE SKILLS

Core skills for this qualification remain subject to confirmation and details will be available at a later date.

Additional information about core skills is published in the *Catalogue of Core Skills in National Qualifications* (SQA, 2001).

Administrative Information

Superclass: RC

Publication date: June 2002

Source: Scottish Qualifications Authority

Version: 03

National Unit Specification: statement of standards

UNIT Wave Phenomena (Advanced Higher)

Acceptable performance in this unit will be the satisfactory achievement of the standards set out in this part of the unit specification. All sections of the statement of standards are mandatory and cannot be altered without reference to the Scottish Qualifications Authority.

OUTCOME 1
Demonstrate knowledge and understanding related to wave phenomena.

Performance criteria

(a) Quantities and their units are used correctly in relation to wave phenomena.
(b) Relationships and mathematical techniques are used correctly in relation to wave phenomena.
(c) Principles are used correctly in relation to wave phenomena.
(d) Models are described correctly in relation to wave phenomena.

Evidence requirements

Evidence of an appropriate level of achievement must be generated from a closed book test with items covering all the above performance criteria. The test must sample the Content Statements (see Physics (Advanced Higher), Course Content) in each of the following areas:

- Waves
- Interference – division of amplitude
- Interference – division of wavefront
- Polarisation.

OUTCOME 2
Solve problems related to wave phenomena.

Performance criteria

(a) Relevant information is selected and presented appropriately.
(b) Information is accurately processed, using calculations, where appropriate.
(c) Conclusions drawn are valid and explanations given are supported by evidence.
(d) Experimental procedures are planned, designed and evaluated appropriately.

Evidence requirements

Evidence of an appropriate level of achievement must be generated from a closed book test with items covering all the above performance criteria. The test must sample the areas shown below:

- Waves
- Interference – division of amplitude
- Interference – division of wavefront
- Polarisation.

National Unit Specification: statement of standards (cont)

UNIT Wave Phenomena (Advanced Higher)

OUTCOME 3

Collect and analyse information related to Advanced Higher Physics obtained by experiment.

Performance criteria

(a) The information is collected by active participation in the experiment.
(b) Experimental procedures are described accurately.
(c) Relevant measurements and observations are recorded in an appropriate format.
(d) Recorded information is analysed and presented in an appropriate format.
(e) Uncertainties are treated appropriately.
(f) Conclusions drawn are valid.
(g) Experimental procedures are evaluated with supporting argument.

Evidence requirements

A report of one experimental activity related to Advanced Higher Physics covering the above performance criteria is required. Evidence submitted in support of PC (d) must be in the format of a table or graph as appropriate. The teacher/lecturer responsible must attest that the report is the individual work of the candidate derived from active participation in an experiment involving the candidate in planning the experiment; deciding how it is managed; identifying and obtaining the necessary resources, some of which must be unfamiliar; carrying out the experiment. The report must provide evidence in respect of a sample of the Content Statements for uncertainties (see Physics (Advanced Higher), Course Content). Depending on the activity, the collection of the information may be through group work.

An Outcome 3 report of practical work in this unit may be used as evidence of the achievement of Outcome 3 of the Advanced Higher Physics units D385 13 Mechanics and D386 13 Electrical Phenomena. An Outcome 3 report of the Advanced Higher Physics unit D385 13 Mechanics or D386 13 Electrical Phenomena may be used as evidence of the achievement of Outcome 3 of this unit.

National Unit Specification: support notes

UNIT Wave Phenomena (Advanced Higher)

This part of the unit specification is offered as guidance. The support notes are not mandatory.

While the time allocated to this unit is at the discretion of the centre, the notional design length is 20 hours.

GUIDANCE ON CONTENT AND CONTEXT FOR THIS UNIT

The content and suggested contexts, applications, illustrations and activities for this unit are detailed in the National Course Specification: course details. The subheadings in the tables correspond to the areas mentioned in the evidence requirements for Outcome 1 and Outcome 2. The practical activities chosen for Outcome 3 must relate to the content of Advanced Higher Physics and must allow all the performance criteria for this outcome to be demonstrated within any single report.

GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT

The learning and teaching of this unit are most effective when the concepts, principles and theories are set in a relevant context, eg by making reference to applications of physics and to real-world situations. Suitable approaches to learning and teaching are detailed in the National Course Specification.

GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT

Outcomes 1 and 2

It is recommended that a holistic approach is taken for assessment of Outcomes 1 and 2. These outcomes can be assessed by an end of unit test with questions covering all of the associated performance criteria. Within one question, assessment of knowledge and understanding and problem solving can occur. Each question can assess achievement of a number of performance criteria from either Outcome 1 or 2. Assessment items are available from the National Assessment Bank.

Outcome 3

The teacher/lecturer should ensure that the experimental activity to be undertaken in connection with Outcome 3 affords opportunity for the candidate to demonstrate the ability to undertake the planning and organising of an experimental activity at an appropriate level of demand. The activity must relate to the content of Advanced Higher Physics and candidates should be made aware of the range of skills which must be demonstrated to ensure attainment of Outcome 3.

In relation to PC (a), the teacher/lecturer should check by observation that the candidate participates in the collection of the experimental information by playing an active part in planning the experiment, deciding how it will be managed, identifying and obtaining resources (some of which must be unfamiliar to the candidate), and carrying out the experiment.

In relation to PCs (b) to (g) the following provides an indication of what may be included in a candidate’s report.

PC (b)
Many experiments will follow a given procedure or method hence there is no need for a detailed description. The procedure may be described briefly in outline. The impersonal passive voice should be used. The following should be included, as appropriate:

- aim of the experiment
- a labelled diagram, description of apparatus, instruments used
- how the independent variable was altered
- how measurements were taken or observations made.

PC (c)
Readings or observations should be recorded in a clear table. The table must include:

- correct headings
- appropriate units
- correctly entered readings/observations.

PC (d)
Readings should be analysed/presented using the following, as appropriate:

- a table with suitable headings and units
- a table with ascending or descending independent variable
- a table showing appropriate computations
- a graph with independent and dependent variables plotted
- a graph with suitable scales and axes labelled with quantities and units
- a graph with data correctly plotted with a line or a curve of best fit.

PC (e)
Depending on the activity the following may be included:

- calibration uncertainties, reading uncertainties and random uncertainties
- a combination of individual uncertainties
- an uncertainty in the numerical value of a measured quantity
- uncertainties estimated from a straight line graph.

PC (f)
Conclusions should contain, as appropriate, a statement relating to:

- overall pattern to readings or observations
- trends in analysed information or results
- connection between variables
- measurement of a physical quantity.

PC (g)
The experimental procedures should be evaluated with supporting argument by including a few sentences, as appropriate, commenting on:

- effectiveness of procedures
- control of variables
- limitations of equipment
- possible improvements
- possible sources of error.

National Unit Specification: support notes (cont)

UNIT Wave Phenomena (Advanced Higher)

The references under each performance criterion give an indication of what should be provided as evidence in order to achieve the criterion. The relevance of these will vary according to the experiment. These references are intended to assist the teacher/lecturer in making a judgement of the candidate's achievement against the performance criteria. It is appropriate to give limited support to candidates in producing their reports. Redrafting of reports after necessary supportive criticism is to be encouraged both as part of the learning and teaching process and to produce evidence for assessment.

SPECIAL NEEDS

This unit specification is intended to ensure that there are no artificial barriers to learning or assessment. Special needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments or considering alternative outcomes for units. For information on these, please refer to the SQA document *Guidance on Special Assessment Arrangements* (SQA, 2001).

SCOTTISH QUALIFICATIONS AUTHORITY

National Unit Specification: general information

UNIT Physics Investigation (Advanced Higher)

NUMBER D388 13

COURSE Physics (Advanced Higher)

SUMMARY

The unit seeks to provide opportunities for the candidate to further develop investigative skills through the completion of a investigation. It also provides the opportunity for self-motivation and organisation.

OUTCOMES

1 Develop a plan for a Physics investigation at the level of Advanced Higher Physics.
2 Collect and analyse information obtained from the investigation.

RECOMMENDED ENTRY

While entry is at the discretion of the centre, candidates will normally be expected to have attained the following:

- Higher Physics

and

- Higher Mathematics

CREDIT VALUE

0.5 credit at Advanced Higher.

CORE SKILLS

Core skills for this qualification remain subject to confirmation and details will be available at a later date.

Additional information about core skills is published in the *Catalogue of Core Skills in National Qualifications* (SQA, 2001).

Administrative Information

Superclass: RC

Publication date: June 2002

Source: Scottish Qualifications Authority

Version: 03

National Unit Specification: statement of standards

UNIT Physics Investigation (Advanced Higher)

Acceptable performance in this unit will be the satisfactory achievement of the standards set out in this part of the unit specification. All sections of the statement of standards are mandatory and cannot be altered without reference to the Scottish Qualifications Authority.

OUTCOME 1

Develop a plan for a Physics investigation at the level of Advanced Higher Physics.

Performance criteria

(a) A record is maintained in a regular manner.
(b) Experimental and observational techniques and apparatus are appropriate for the investigation.

Evidence requirements

A completed record giving brief summaries to indicate the planning stage is required. Ideas rejected and important contributions made by the teacher/lecturer or other individuals must be included. The topic chosen must be at a standard commensurate with the demands of Advanced Higher Physics.

OUTCOME 2

Collect and analyse information obtained from the investigation.

Performance criteria

(a) The collection of the experimental information is carried out with due accuracy.
(b) Relevant measurements and observations are recorded in an appropriate format.
(c) Recorded experimental information is analysed and presented in an appropriate format.
(d) Uncertainties are treated appropriately.

Evidence requirements

A record of the collection and analysis of the information, both of which must be the individual work of the candidate is required. The record must provide evidence in respect of a sample of the Content Statements for uncertainties (see Physics (Advanced Higher), Course Content).

National Unit Specification: support notes

UNIT Physics Investigation (Advanced Higher)

This part of the unit specification is offered as guidance. The support notes are not mandatory.

While the time allocated to this unit is at the discretion of the centre, the notional design length is 20 hours.

GUIDANCE ON CONTENT AND CONTEXT FOR THIS UNIT

Candidates can select any suitable topic for investigation provided the physics is at an appropriate level of demand. The topic chosen may be outwith the physics covered in the other units of the Advanced Higher Physics course, eg an investigation into a topic in electronics or bulk properties of matter.

GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT

The candidate should be allowed to consider a variety of approaches. Independent management of both time and resources should be encouraged. Suitable approaches to learning and teaching are detailed in the National Course Specification.

GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT

Outcome 1

Candidates should provide a completed record with:

- regular entries during the investigation
- notes/comments on ideas rejected
- notes/comments on planning and design
- contributions made by other individuals
- notes/comments on selection of method used.

Outcome 2

In relation to PC (a), the teacher/lecturer should check by observation that the collection of information has been carried out accurately and is the individual work of the candidate.

In relation to PCs (b) to (d) the following provides an indication of what may be included in the candidate's record.

PC (b)
Readings or observations should be recorded in a clear table. The table must include:

- correct headings
- appropriate units
- correctly entered readings/observations.

National Unit Specification: support notes (cont)

UNIT Physics Investigation (Advanced Higher)

PC (c)
Readings should be analysed/presented using the following, as appropriate:

- a table with suitable headings and units
- a table with ascending or descending independent variable
- a table showing appropriate computations
- a graph with independent and dependent variables plotted
- a graph with suitable scales and axes labelled with quantities and units
- a graph with data correctly plotted with a line or a curve of best fit.

PC (d)
Depending on the activity the following may be included:

- calibration uncertainties, reading uncertainties and random uncertainties
- a combination of individual uncertainties
- an uncertainty in the numerical value of a measured quantity
- uncertainties estimated from a straight line graph.

The references under each performance criterion give an indication of what should be provided as evidence in order to achieve the criterion. The relevance of these will vary according to the investigation. These references are intended to assist the teacher/lecturer in making a judgement of the candidate's achievement against the performance criteria. It is appropriate to give limited support to the candidate in order to facilitate the progress of the investigation. The extent of the support should be documented briefly in the candidate's record.

SPECIAL NEEDS

This unit specification is intended to ensure that there are no artificial barriers to learning or assessment. Special needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments or considering alternative outcomes for units. For information on these, please refer to the SQA document *Guidance on Special Assessment Arrangements* (SQA, 2001).