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PHYSICS
Higher

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SCOTTISH QUALIFICATIONS AUTHORITY

NOTE OF CHANGES TO ARRANGEMENTS

SIXTH EDITION PUBLISHED DECEMBER 2004

COURSE TITLE: Physics (Higher)

COURSE NUMBER: C069 12

National Course Specification

Minor changes have been made to Content Statements to improve the consistency of style across Physics courses at all levels. The requirement to state some of the mathematical relationships has been removed with emphasis moved to carrying out calculations involving the relationships between quantities.
The Physics Data Booklet should be available to all candidates during assessments.
Tables defining the symbols and units used in all SQA Physics courses can be downloaded from the SQA website http://www.sqa.org.uk .

National Course Specification: general information

PHYSICS (HIGHER)

COURSE NUMBER C069 12

COURSE STRUCTURE

The course has three mandatory units as follows:

D383 12	***Mechanics and Properties of Matter (H)***	***1 credit (40 hours)***
D380 12	***Electricity and Electronics (H)***	***1 credit (40 hours)***
D384 12	***Radiation and Matter (H)***	***1 credit (40 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 the following.

- Standard Grade Physics with Knowledge and Understanding and Problem Solving at Grade 1 or 2

or

- Intermediate 2 Physics

and

- Standard Grade Mathematics at 1 or 2 **or** Intermediate 2 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

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National Course Specification: course details

COURSE Physics (Higher)

RATIONALE

The Higher Physics course has been designed to articulate with and provide progression from both the Standard Grade Physics and Intermediate 2 Physics courses. Through a deeper insight into the structure of the subject, the course aims to provide an opportunity for reinforcing and extending the candidate's knowledge and understanding of the concepts of physics and developing both the candidate's ability to solve problems, and to carry out experimental and investigative work. 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. The resulting elements of knowledge and understanding, problem solving and practical activities form the basis of the Higher Physics course.

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

- an increased knowledge and understanding of facts and ideas, of techniques and of the applications of physics in society
- 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 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 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 Higher Physics with a suitable basis for further study.

COURSE CONTENT

The course is made up of three mandatory units: Mechanics and Properties of Matter, Electricity and Electronics, Radiation and Matter. 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 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, a report 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)

Higher Physics: Mechanics and Properties of Matter

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 and Properties of Matter.

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 Vectors	
1 Distinguish between distance and displacement. 2 Distinguish between speed and velocity. 3 Define and classify vector and scalar quantities. 4 Use scale diagrams, or otherwise, to find the magnitude and direction of the resultant of a number of displacements or velocities.	Exercises involving the drawing of scale diagrams: total distance compared with desired displacement, eg in orienteering, sailing, hill walking or flying along air corridors. Computer simulation to study vectors.
5 State what is meant by the resultant of a number of forces.	
6 Carry out calculations to find the rectangular components of a vector. 7 Use scale diagrams, or otherwise, to find the magnitude and direction of the resultant of a number of forces.	Analysis of vehicles on a slope and ski tows, structures in equilibrium, eg television masts.
1.2 Equations of motion	
1 State that acceleration is the change in velocity per unit time.	
2 Describe the principles of a method for measuring acceleration.	Data capture using a microcomputer. The tachograph.
3 Draw an acceleration–time graph using information obtained from a velocity–time graph for motion with a constant acceleration.	Graph plotting and interpretation. Graphs to illustrate the motion of a bouncing ball and a ball thrown vertically upwards.
4 Use the terms 'constant velocity' and 'constant acceleration' to describe motion represented in graphical or tabular form.	*s-t, v-t* and *a-t* graphs. Orders of magnitude of accelerations and speeds, eg in funfair, thrill rides and sport.
5 Show how the following relationships can be derived from basic definitions in kinematics: $v = u + at$, $s = ut + \frac{1}{2}at^2$, $v^2 = u^2 + 2as$.	Derivation of equations of motion.
6 Carry out calculations using the above kinematic relationships.	Distances achieved, eg in long-jumping, ski-jumping and javelin. Trajectories and sighting adjustments. Arrows fired at an angle. Inclined planes.

National Course Specification: course details (cont)

CONTENT STATEMENTS	CONTEXTS, APPLICATIONS, ILLUSTRATIONS AND ACTIVITIES
1.3 Newton's Second Law, energy and power 1 Define the newton 2 Carry out calculations involving the relationship between unbalanced force, mass and acceleration in situations where resolution of forces is not required. 3 Use free body diagrams to analyse the forces on an object. 4 Carry out calculations involving work done, potential energy, kinetic energy and power.	Analysis of situations, involving a number of forces acting on an object. Order of magnitude of forces in rocket motion, jet engine, pile driving, and sport. Analysis of skydiving and parachuting, falling raindrops, scuba diving, lift and haulage systems. Discuss energy conservation.
1.4 Momentum and impulse 1 State that momentum is the product of mass and velocity. 2 State that the law of conservation of linear momentum can be applied to the interaction of two objects moving in one dimension, in the absence of net external forces. 3 State that an elastic collision is one in which both momentum and kinetic energy are conserved. 4 State that in an inelastic collision momentum is conserved but kinetic energy is not. 5 Carry out calculations concerned with collisions in which the objects move in only one dimension. 6 Carry out calculations concerned with explosions in one dimension. 7 Apply the law of conservation of momentum to the interaction of two objects moving in one dimension to show that: a) the changes in momentum of each object are equal in size and opposite in direction. b) the forces acting on each object are equal in size and opposite in direction.	Experiments involving collisions and explosions of vehicles on a linear air track. Analysis of interactions between colliding vehicles, snooker balls, motion in space, manned manoeuvring units. Discuss rebound and the vector nature of momentum.
8 State that *impulse = force × time*. 9 State that *impulse = change of momentum*. 10 Carry out calculations involving the relationships between impulse, force, time and momentum.	Sensor and force-time graphs using a computer. Computer simulations for momentum and impulse. Application of momentum and impulse to car safety design, crumple zones, golf, hockey, football and racquet sports.

National Course Specification: course details (cont)

CONTENT STATEMENTS	CONTEXTS, APPLICATIONS, ILLUSTRATIONS AND ACTIVITIES
1.5 Density and pressure	
1 State that density is mass per unit volume.	Measure the densities of solids and liquids and compare the results.
2 Carry out calculations involving density, mass and volume.	
3 Describe the principles of a method for measuring the density of air.	Measure the density of air and consider any safety precautions.
4 State and explain the relative magnitudes of the densities of solids, liquids and gases.	Compare the values of densities of solids, liquids and gases.
5 State that pressure is the force per unit area, when the force acts normal to the surface.	
6 State that one pascal is one newton per square metre.	
7 Carry out calculations involving pressure, force and area.	
8 State that the pressure at a point in a fluid at rest depends on the depth, density of liquid and gravitational field strength.	Pressure gauge and liquid-filled tubing to investigate pressure variations.
9 Carry out calculations involving pressure, density and depth.	Observations of upthrust on a submerged object.
10 Explain buoyancy force (upthrust) in terms of the pressure difference between the top and bottom of an object.	Hot-air balloons, semi-submersible rigs, submarines, hydrometer.
1.6 Gas laws	
1 Describe how the kinetic model accounts for the pressure of a gas.	Use computer simulations and mechanical models to promote discussion of the behaviour of gases.
2 State that the pressure of a fixed mass of gas at constant temperature is inversely proportional to its volume.	
3 State that the pressure of a fixed mass of gas at constant volume is directly proportional to its temperature measured in kelvins (K).	Experiments to investigate the relationships between the pressure, volume and temperature of a gas.
4 State that the volume of a fixed mass of gas at constant pressure is directly proportional to its temperature measured in kelvins (K).	Application of the gas laws to diving equipment, vacuum pile drivers, pressure gauges, vacuum brakes, breathing and respirators.
5 Carry out calculations to convert temperatures in ^{o}C to K and vice versa.	
6 Carry out calculations involving pressure, volume and temperature of a fixed mass of gas using the general gas equation.	
7 Explain what is meant by absolute zero of temperature.	
8 Explain the pressure-volume, pressure-temperature and volume-temperature laws qualitatively in terms of a kinetic model.	

National Course Specification: course details (cont)

Higher Physics: Electricity and Electronics

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 order to demonstrate knowledge and understanding associated with Electricity and Electronics.

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 and resistors in circuits	
1 State that, in an electric field, an electric charge experiences a force.	Examine electric field lines in non-conducting fluids.
2 State that an electric field applied to a conductor causes the free electric charges in it to move.	Hazards, eg lightning, static electricity on microchips. Precipitators. Xerography. Paint spraying. Accelerators.
3 State that work W is done when a charge Q is moved in an electric field.	Ink jet printing. Electrostatic propulsion.
4 State that the potential difference between two points is a measure of the work done in moving one coulomb of charge between the two points.	Discuss work on energy transformation in a gravitational field and compare this with energy transformation in an electric field.
5 State that if one joule of work is done moving one coulomb of charge between two points, the potential difference between the two points is one volt.	Discuss use of terms voltage and potential difference.
6 Carry out calculations involving the relationship between potential difference, work and charge.	Electron gun.
7 State that the e.m.f. of a source is the electrical potential energy supplied to each coulomb of charge which passes through the source.	Measure voltage across source and current drawn from source, and graph V against I. Sources of e.m.f. eg cells, thermocouple.
8 State that an electrical source is equivalent to a source of e.m.f. with a resistor in series, the internal resistance.	
9 Describe the principles of a method for measuring the e.m.f. and internal resistance of a source.	Determine the e.m.f. and internal resistance of a source.
10 Explain why the e.m.f. of a source is equal to the open circuit p.d. across the terminals of the source.	Internal resistance and load matching. Internal resistance << load for maximum voltage transfer.
11 Explain how the conservation of energy leads to the sum of the e.m.f.s round a closed circuit being equal to the sum of the p.d.s round the circuit.	

National Course Specification: course details (cont)

CONTENT STATEMENTS		CONTEXTS, APPLICATIONS, ILLUSTRATIONS AND ACTIVITIES
2.1	**Electric fields and resistors in circuits (cont)**	
12	Derive the expression for the total resistance of any number of resistors in series, by consideration of the conservation of energy.	Use ohmmeter to determine total resistance for: a) two resistors in series, and b) two resistors in parallel.
13	Derive the expression for the total resistance of any number of resistors in parallel by consideration of the conservation of charge.	Resistive heating. Conservation of charge and current.
14	Carry out calculations involving the resistances in a balanced Wheatstone bridge.	Investigate the relationship among the four resistors in a balanced Wheatstone bridge.
15	State that for an initially balanced Wheatstone bridge, as the value of one resistor is changed by a small amount, the out-of-balance p.d. is directly proportional to the change in resistance.	For a balanced bridge with resistance box in one arm, plot V versus ΔR for out-of-balance Wheatstone bridge.
16	Carry out calculations involving potential differences, currents and resistances in circuits containing resistors.	Use of Wheatstone bridge in measuring strain (eg digital balance and pressure sensors), temperature, light intensity.
17	Use the following terms correctly in context: charge, current, p.d., resistance, terminal p.d., load resistor, bridge circuit, e.m.f., lost volts, short circuit current.	
2.2	**Alternating current and voltage**	
1	Describe how to measure frequency using an oscilloscope.	Use a calibrated oscilloscope to measure the frequency of a low-voltage a.c. supply. Compare peak and r.m.s. values. National Grid and a.c.
2	Carry out calculations involving peak and r.m.s. values of voltage and current.	Use oscilloscope to measure voltage across lamps with a.c. and d.c. sources-adjust to equal brightness.
3	State the relationship between current and frequency in a resistive circuit.	Use graphical method to derive relationship between peak and r.m.s. values. Investigate the relationship between current and frequency in a resistive circuit.
2.3	**Capacitance**	
1	State that the charge Q on two parallel conducting plates is directly proportional to the p.d. V between the plates.	
2	Describe the principles of a method to show that the charge on a capacitor is directly proportional to the p.d. across the capacitor.	Investigate the relationship between the charge on and the p.d. across a capacitor.
3	State that capacitance is the ratio of charge to p.d.	

National Course Specification: course details (cont)

CONTENT STATEMENTS	CONTEXTS, APPLICATIONS, ILLUSTRATIONS AND ACTIVITIES
2.3 Capacitance (cont)	
4 State that the unit of capacitance is the farad and that one farad is one coulomb per volt.	
5 Carry out calculations involving the relationship between capacitance, charge and potential difference.	
6 Explain why work must be done to charge a capacitor.	Energy storage. Flash photography.
7 State that the work done to charge a capacitor is given by the area under the graph of charge against p.d.	Charge capacitor then discharge through a lamp or low-voltage d.c. motor.
8 Carry out calculations involving the relationships between capacitance, charge, potential difference and energy stored in a capacitor.	
9 Draw qualitative graphs of current against time and of p.d. against time for the charge and discharge of a capacitor in a d.c. circuit containing a resistor and capacitor in series.	Use computer and interface to plot charge–discharge graphs for a capacitor. Timing.
10 Carry out calculations involving p.d. and current in *CR* circuits (calculus methods are not required).	
11 State the relationship between current and frequency in a capacitive circuit.	Investigate the relationship between current and frequency in a capacitive circuit.
12 Describe the principles of a method to show how the current varies with frequency in a capacitive circuit.	
13 Describe and explain the possible functions of a capacitor: storing energy, storing charge, blocking d.c. while passing a.c.	Smoothing, filtering, coupling, suppressing.
2.4 Analogue electronics	
1 State that an op-amp can be used to increase the voltage of a signal.	Use an op-amp in inverting mode to amplify a.c. and d.c. voltages. Amplifiers, attenuators.
2 State that for the ideal op-amp: a) input current is zero, ie it has infinite input resistance. b) there is no potential difference between the inverting and non-inverting inputs: ie both input pins are at the same potential.	
3 Identify circuits where the op-amp is being used in the inverting mode.	
4 State that an op-amp connected in the inverting mode will invert the input signal.	

National Course Specification: course details (cont)

CONTENT STATEMENTS	CONTEXTS, APPLICATIONS, ILLUSTRATIONS AND ACTIVITIES
2.4 Analogue electronics (cont)	
5 Carry out calculations involving the relationship between input voltage, output voltage, resistances and gain in inverting mode op-amp circuits.	Verify the inverting mode gain expression for a.c. and d.c. signals. Multiplication, division, addition and D to A converter.
6 State that an op-amp cannot produce an output voltage greater than the positive supply voltage or less than the negative supply voltage.	Observe the effects of saturation in an inverting-mode amplifier by: a) increasing the gain of the amplifier and increasing the magnitude of the input signal b) square wave generation.
7 Identify circuits where the op-amp is being used in the differential mode.	
8 State that a differential amplifier amplifies the potential difference between its two inputs.	Obtain information on op-amp in differential mode.
9 Carry out calculations involving the relationship between input voltages, output voltage, resistances and gain in differential mode op-amp circuits.	Verify the differential mode gain expression for d.c. signals.
10 Describe how to use the differential amplifier with resistive sensors connected in a Wheatstone bridge arrangement.	Use a differential amplifier to amplify the output produced by a range of resistive sensors connected in a Wheatstone bridge arrangement. Monitoring and control applications.
11 Describe how an op-amp can be used to control external devices via a transistor.	Use a transistor connected to the output of an op-amp as a power amplifier.

National Course Specification: course details (cont)

Higher Physics: Radiation and Matter

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 order to demonstrate knowledge and understanding associated with Radiation and Matter.

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 the frequency of a wave is the same as the frequency of the source producing it.	
2 Carry out calculations involving the relationship between period and frequency.	
3 State that the energy of a wave depends on its amplitude.	
4 Use correctly in context the terms: 'in phase', 'out of phase' and 'coherent', when applied to waves.	
5 Explain the meaning of: 'constructive interference' and 'destructive interference', in terms of superposition of waves.	Demonstrate the interference pattern produced by two coherent sources. Use computer simulations to study interference.
6 State that interference is the test for a wave.	Cancellation of sound resonances using out-of-phase speakers.
7 State that reflection, refraction, diffraction and interference are characteristic behaviours of all types of waves.	Discuss reflection, refraction and diffraction. Reception problems with TV and radio aerials.
8 Describe the conditions for maxima and minima in an interference pattern formed by two coherent sources.	Investigate the effect of path difference on the irradiance of radiation in the interference pattern produced by two coherent sources of microwaves.
9 Carry out calculations involving the relationships for maxima and minima in an interference pattern formed by two coherent sources.	Holography. Industrial imaging of surfaces-curvature and stress analysis. Lens blooming.
10 Describe the effect of a grating on a monochromatic light beam.	Interference colours (jewellery, petrol films, soap bubbles).
11 Carry out calculations involving the relationship between wavelength, order, slit separation and angle for gratings.	Investigate the effect of a grating on monochromatic light. Interferometers to measure small changes in path difference.
12 Describe the principles of a method for measuring the wavelength of a monochromatic light source, using a grating.	Use a grating to measure wavelength.
13 State approximate values for the wavelengths of red, green and blue light.	
14 Describe and compare the white light spectra produced by: a grating and a prism.	Use a prism and a grating to produce white light spectra, then make a comparison.

National Course Specification: course details (cont)

CONTENT STATEMENTS	CONTEXTS, APPLICATIONS, ILLUSTRATIONS AND ACTIVITIES
3.2 Refraction of light	
1 State that the ratio $\sin\theta_1 / \sin\theta_2$ is a constant when light passes obliquely from medium 1 to medium 2.	Investigate the ratio $\sin\theta_1 / \sin\theta_2$ using rayboxes and glass or plastic blocks. Use computer simulations to study refraction.
2 State that the absolute refractive index, n, of a medium is the ratio $\sin\theta_1 / \sin\theta_2$ where θ_1 is in a vacuum (or air as an approximation) and θ_2 is in the medium.	Mirages, fish-eye view, Schlieren photography. Dispersion of high power laser beams due to hot centre with lower refractive index.
3 Describe the principles of a method for measuring the absolute refractive index of glass for monochromatic light.	
4 State that the refractive index depends on the frequency of the incident light.	Measure refractive index for red and blue light.
5 State that the frequency of a wave is unaltered by a change in medium.	Design of lenses, dispersion of signals in optical fibres, colours seen in cut diamonds.
6 Carry out calculations involving the relationships between refractive index, angle, wavelength, speed and frequency.	Observe incident, reflected and transmitted rays for a light ray from a dense to a less dense medium at increasing angles of incidence.
7 Explain what is meant by total internal reflection.	
8 Explain what is meant by critical angle θ_C.	Measure critical angle.
9 Describe the principles of a method for measuring a critical angle.	Reflective road signs, prism reflectors (binoculars, periscopes, SLR cameras).
10 Derive the relationship between critical angle and absolute refractive index of a medium.	Optical fibres for communications, medicine and sensors.
11 Carry out calculations involving the relationship between critical angle and absolute refractive index of a medium.	
3.3 Optoelectronics and semiconductors	
1 State that the irradiance at a surface on which radiation is incident is the power per unit area.	Measure irradiance as a function of distance.
2 Describe the principles of a method for showing that the irradiance is inversely proportional to the square of the distance from a point source.	
3 Carry out calculations involving the relationship between irradiance and distance.	

National Course Specification: course details (cont)

CONTENT STATEMENTS	CONTEXTS, APPLICATIONS, ILLUSTRATIONS AND ACTIVITIES
3.3 Optoelectronics and semiconductors (cont)	
4 State that photoelectric emission from a surface occurs only if the frequency of the incident radiation is greater than some threshold frequency f_0 which depends on the nature of the surface.	Study photoelectric emission from a zinc plate placed on the cap of a charge detector, eg gold leaf electroscope, coulombmeter. Channel plate image intensifiers, photomultipliers.
5 State that for frequencies smaller than the threshold value, an increase in the irradiance of the radiation at the surface will not cause photoelectric emission.	
6 State that for frequencies greater than the threshold value, the photoelectric current produced by monochromatic radiation is directly proportional to the irradiance of the radiation at the surface.	
7 State that a beam of radiation can be regarded as a stream of individual energy bundles called photons, each having an energy dependent on the frequency of the radiation.	Discuss wave–particle duality.
8 Carry out calculations involving the relationship between energy and frequency of photons.	
9 Explain that if N photons per second are incident per unit area on a surface, the irradiance at the surface is $I = Nhf$.	
10 State that photoelectrons are ejected with a maximum kinetic energy which is given by the difference between the energy of the incident photon and the work function of the surface.	
11 State that electrons in a free atom occupy discrete energy levels.	
12 Draw a diagram which represents qualitatively the energy levels of a hydrogen atom.	
13 Use the following terms correctly in context: ground state, excited state, ionisation level.	
14 State that an emission line in a spectrum occurs when an electron makes a transition between an excited energy level and a lower level.	Examine line and continuous spectra, eg from tungsten filament lamp, electric heater element, fluorescent tube, burning a salt in a Bunsen flame.
15 State that an absorption line in a spectrum occurs when an electron in a lower energy level absorbs radiation and is excited to a higher energy level.	Use computer simulations to study atomic spectra. Discharge lighting, laboratory and extraterrestrial spectroscopy, the standard of time. View absorption spectrum.
16 Carry out calculations involving energy level transitions, photon energy and photon frequency.	

National Course Specification: course details (cont)

CONTENT STATEMENTS	CONTEXTS, APPLICATIONS, ILLUSTRATIONS AND ACTIVITIES
3.3 Optoelectronics and semiconductors (cont)	
17 Explain the occurrence of absorption lines in the spectrum of sunlight.	Observe spectrum of scattered sunlight with hand spectrometer. (**Do not view the sun directly or by specular reflections**.)
18 State that spontaneous emission of radiation is a random process analogous to the radioactive decay of nucleus.	Obtain, present and discuss information on lasers.
19 State that when radiation of energy hf is incident on an excited atom the atom may be stimulated to emit its excess energy hf.	View video on lasers – any discussions limited to two energy levels.
20 State that in stimulated emission the incident radiation and the emitted radiation are in phase and travel in the same direction.	Optical alignment and component testing, distance and velocity measurements, spectroscopy, communications, pattern recognition, scribing, cutting, welding, surface hardening, semiconductor processing, opthalmology, dermatology, general and specialised surgery, laser induced nuclear fusion.
21 State that the conditions in a laser are such that a light beam gains more energy by stimulated emission that it loses by absorption – hence Light Amplification by the Stimulated Emission of Radiation.	
22 Explain the function of the mirrors in a laser.	Measure beam diameter at various distances from laser **(do not look directly into beam and avoid specular reflections)**. Compare irradiance at the eye from a 100 W lamp and a 0.1 mW laser.
23 Explain why a beam of laser light having a power even as low as 0.1 mW may cause eye damage.	
24 State that materials can be divided into three broad categories according to their electrical properties – conductors, insulators and semiconductors.	Measure and compare the resistance of various conductors, insulators and semiconductors.
25 Give examples of conductors, insulators and semiconductors.	
26 State that the addition of impurity atoms to a pure semiconductor (a process called doping) decreases its resistance.	
27 Explain how doping can form an n-type semiconductor in which the majority of the charge carriers are negative, or a p-type semiconductor in which the majority of the charge carriers are positive.	Electronic devices.
28 Describe the movement of the charge carriers in a forward/reverse-biased p–n junction diode.	Measure variation of current with applied p.d. for a forward and reverse-biased p–n junction. Rectification and smoothing of a.c.
29 State that in the junction region of a forward-biased p–n junction diode, positive and negative charge carriers may recombine to give quanta of radiation.	Estimate the recombination energy in an LED from the wavelength of light emitted. Digital displays.
30 State that a photodiode is a solid-state device in which positive and negative charges are produced by the action of light on a p–n junction.	Study photodiode connected to an oscilloscope and illuminated with a light source connected to an a.c. supply.
31 State that in the photovoltaic mode, a photodiode may be used to supply power to a load.	Solar cells.

National Course Specification: course details (cont)

CONTENT STATEMENTS	CONTEXTS, APPLICATIONS, ILLUSTRATIONS AND ACTIVITIES
3.3 Optoelectronics and semiconductors (cont)	
32 State that in the photoconductive mode, a photodiode may be used as a light sensor.	
33 State that the leakage current of a reverse-biased photodiode is directly proportional to the light irradiance and fairly independent of the reverse-biasing voltage, below the breakdown voltage.	Measure variation of current with applied p.d. for a forward-biased and a reversed-bias photodiode under a constant fixed level of illumination. Measurement of light irradiance.
34 State that the switching action of a reverse-biased photodiode is extremely fast.	Show that the switching action of a photodiode is extremely fast. Electronic ignition circuits. Optical isolators.
35 Describe the structure of an n-channel enhancement MOSFET using the terms: gate, source, drain, substrate, channel, implant and oxide layer.	Obtain information on an n-channel enhancement MOSFET.
36 Explain the electrical ON and OFF states of an n-channel enhancement MOSFET.	
37 State that an n-channel enhancement MOSFET can be used as an amplifier.	
3.4 Nuclear reactions	
1 Describe how Rutherford showed that: a) the nucleus has a relatively small diameter compared with that of the atom b) most of the mass of the atom is concentrated in the nucleus.	Analogue of alpha particle scattering. Use computer simulations to study Rutherford scattering.
2 State what is meant by alpha, beta and gamma decay of radionuclides.	Diagnosis in medicine, radiotherapy, tracers, smoke detectors.
3 Identify the processes occurring in nuclear reactions written in symbolic form.	Dating of rocks, carbon dating of archaeological specimens.
4 State that in fission a nucleus of large mass number splits into two nuclei of smaller mass numbers, usually with the release of neutrons.	
5 State that fission may be spontaneous or induced by neutron bombardment.	View video, slide and/or computer simulation on nuclear reactors.
6 State that in fusion two nuclei combine to form a nucleus of larger mass number.	Nuclear reactors and electricity generation, stellar evolution.
7 Explain, using $E = mc^2$, how the products of fission and fusion acquire large amounts of kinetic energy.	
8 Carry out calculations involving the relationship between energy and mass loss for fission and fusion reactions.	

National Course Specification: course details (cont)

CONTENT STATEMENTS	CONTEXTS, APPLICATIONS, ILLUSTRATIONS AND ACTIVITIES
3.5 Dosimetry and safety	
1 State that the activity of a radioactive source is the number of decays per second and is measured in becquerels (Bq), where one becquerel is one decay per second.	
2 Carry out calculations involving the relationship between activity, number of decays and time.	
3 State that the absorbed dose is the energy absorbed per unit mass of the absorbing material.	View video on radiological protection.
4 State that the gray (Gy) is the unit of absorbed dose and that one gray is one joule per kilogram.	
5 State that a radiation weighting factor is given to each kind of radiation as a measure of its biological effect.	
6 State that the equivalent dose is the product of absorbed dose and radiation weighting factor and is measured in sieverts (Sv).	
7 Carry out calculations, for a single tissue, involving the relationship between equivalent dose, absorbed dose and radiation weighting factor.	
8 State that equivalent dose rate is the equivalent dose per unit time..	
9 State that the risk of biological harm from an exposure to radiation depends on: a) the absorbed dose. b) the kind of radiations, eg α, β, γ, slow neutron. c) the body organs or tissues exposed.	Biological effects of ionising radiations (Hiroshima, Chernobyl).
10 Describe the factors affecting the background radiation level.	Monitor the radon background by measuring the count rate from dust collected on filter paper.
11 State that the average annual effective dose that a person in the UK receives due to natural sources (cosmic, terrestrial and internal radiation) is approximately 2 mSv.	
12 State that annual effective dose limits have been set for exposure to radiation for the general public, and higher limits for workers in certain occupations.	Ionising radiations safety legislation.

National Course Specification: course details (cont)

CONTENT STATEMENTS	CONTEXTS, APPLICATIONS, ILLUSTRATIONS AND ACTIVITIES
3.5 Dosimetry and safety (cont)	
13 Sketch a graph to show how the intensity of a beam of gamma radiation varies with the thickness of an absorber.	Thickness measurement, level detection, weld radiography.
14 Describe the principles of a method for measuring the half-value thickness of an absorber.	Measure the irradiance of gamma radiation transmitted by different thickness of absorber and establish a relationship between irradiance and thickness of absorber.
15 Carry out calculations involving half-value thickness.	
16 State that the equivalent dose rate is reduced by shielding or by increasing the distance from a source.	Measure the count rate at different distances from a gamma ray source and establish relationship between count rate and distance; compare with $I = k/d^2$ for light. Nuclear radiation safety.

National Course Specification: course details (cont)

Content Statements – 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 measurement of any physical quantity is liable to uncertainty.	
2 Distinguish between random uncertainties and recognised systematic effects.	Discuss systematic effects due to limitations of apparatus or experimental design or technique. Parallax.
3 State that the scale-reading uncertainty is a measure of how well an instrument scale can be read.	
4 Explain why repeated measurements of a physical quantity are desirable.	
5 Calculate the mean value of a number of measurements of the same physical quantity.	
6 State that this mean is the best estimate of a 'true' value of the quantity being measured.	
7 State that where a systematic effect is present the mean value of the measurements will be offset from a 'true' value of the physical quantity being measured.	
8 Calculate the approximate random uncertainty in the mean value of a set of measurements using the relationship: $\text{approximate random uncertainty in the mean} = \dfrac{\text{maximum value} - \text{minimum value}}{\text{number of measurements taken}}$	

National Course Specification: course details (cont)

CONTENT STATEMENTS	CONTEXTS, APPLICATIONS, ILLUSTRATIONS AND ACTIVITIES
4.2 Uncertainties (cont)	
9 Estimate the scale-reading uncertainty incurred when using an analogue display and a digital display.	Discuss ability to interpret between scale divisions.
10 Express uncertainties in absolute or percentage form.	Discuss the scale-reading uncertainty for digital displays as ± 1.
11 Identify, in an experiment where more than one physical quantity has been measured, the quantity with the largest percentage uncertainty.	
12 State that this percentage uncertainty is often a good estimate of the percentage uncertainty in the final numerical result of the experiment.	
13 Express the numerical result of an experiment in the form: final value ± uncertainty.	

National Course Specification: course details (cont)

COURSE Physics (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 THE INSTRUMENTS FOR EXTERNAL ASSESSMENT

The instrument of assessment will be an externally set question paper of 2 hours 30 minutes duration. The question paper will sample the Content Statements of all three component units. The question paper will consist of 20 objective questions (each worth 1 mark) and 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 90 marks for the paper.

Approximately 36 marks will be allocated to questions that require candidates to demonstrate achievement of a sample of the performance criteria associated with Outcome 1 for the three component units.

Approximately 54 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 component units;
- integrate knowledge and understanding, problem solving and analytical skills acquired through 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.

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	36 ± 4	54 ± 4	90
each component unit (40 hour)	12 ± 3	18 ± 4	30 ± 4

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 associated with 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
- apply knowledge and understanding set in contexts similar to those associated with the component units
- demonstrate the ability to integrate skills acquired in component units to solve problems
- apply knowledge and understanding to solve problems set in less familiar contexts.

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 are set in more complex contexts.

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.

National Course Specification: course details (cont)

COURSE Physics (Higher)

Practical activities provide opportunities to develop a wide range of skills associated with scientific enquiry and practical problem solving.

Suggested practical activities could include the following.

1. Measuring a physical quantity, eg after a class discussion, candidates could be asked to design a circuit to measure the internal resistance of a cell. After completion of the experiment the readings and results could be analysed, the uncertainties discussed and the method evaluated.
2. Demonstrating a physical law, eg candidates could be involved in the design of an experiment using a linear air track to illustrate the law of conservation of momentum.
3. Testing a hypothesis, eg class discussion of the charging and discharging of a capacitor could lead to the hypothesis that increasing the frequency of the supply voltage in a capacitive circuit increases the current in the circuit. Candidates can then design a suitable circuit to test this hypothesis.

The use of microcomputers is a powerful aid to learning and experimenting. When interfaced to suitable sensors, the microcomputer can assist investigations 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.

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 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 Assessment Arrangements for Candidates with Disabilities and/or Additional Support Needs* (SQA, 2004).

National Unit Specification: general information

UNIT Mechanics and Properties of Matter (Higher)

NUMBER D383 12

COURSE Physics (Higher)

SUMMARY

The unit seeks to develop the candidate's knowledge and understanding of concepts and principles related to mechanics and properties of matter. It also provides an opportunity for developing the ability to apply these concepts and principles in the analysis of a wide variety of motion, and interpreting of the macroscopic and microscopic behaviour of matter.

OUTCOMES

1 Demonstrate knowledge and understanding related to mechanics and properties of matter.
2 Solve problems related to mechanics and properties of matter.
3 Collect and analyse information related to 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.

- Standard Grade Physics with Knowledge and Understanding and Problem Solving at grade 1 or 2

or

- Intermediate 2 Physics **or** the unit Mechanics and Heat (Intermediate 2)

and

- Standard Grade Mathematics at 1 or 2 **or** Intermediate 2 Mathematics

CREDIT VALUE

1 credit at Higher.

Administrative Information

Superclass: RC

Publication date: December 2004

Source: Scottish Qualifications Authority

Version: 06

Additional copies of this unit specification can be purchased from the Scottish Qualifications Authority. The cost for each unit specification is £2.50 (minimum order £5).

National Unit Specification: general information (cont)

UNIT Mechanics and Properties of Matter (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).

National Unit Specification: statement of standards

UNIT Mechanics and Properties of Matter (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 and properties of matter.

Performance criteria

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

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 (Higher) Course Content) in each of the following areas:

- Vectors
- Equations of motion
- Newton's Second Law, energy and power
- Momentum and impulse
- Density and pressure
- Gas laws.

OUTCOME 2
Solve problems related to mechanics and properties of matter.

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.

- Vectors
- Equations of motion
- Newton's Second Law, energy and power
- Momentum and impulse
- Density and pressure
- Gas laws.

National Unit Specification: statement of standards (cont)

UNIT Mechanics and Properties of Matter

OUTCOME 3

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

Performance criteria

(a) The information is collected by active participation in the experiment.
(b) The 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) The experimental procedures are evaluated with supporting argument.

Evidence requirements

A report of one experimental activity related to 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 (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 Higher Physics units D380 12 Electricity and Electronics and D384 12 Radiation and Matter. An Outcome 3 report of practical work in the Higher Physics unit D380 12 Electricity and Electronics or D384 12 Radiation and Matter may be used as evidence of the achievement of Outcome 3 of this unit.

National Unit Specification: support notes

UNIT Mechanics and Properties of Matter

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

While the exact 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 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 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 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 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:

- uncertainties in individual readings
- a mean value and an approximate random uncertainty in the mean
- uncertainties expressed in absolute or percentage form.

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 Mechanics and Properties of Matter (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 Assessment Arrangements for Candidates with Disabilities and/or Additional Support Needs* (SQA, 2004).

SCOTTISH QUALIFICATIONS AUTHORITY

National Unit Specification: general information

UNIT Electricity and Electronics (Higher)

NUMBER D380 12

COURSE Physics (Higher)

SUMMARY

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

OUTCOMES

1 Demonstrate knowledge and understanding related to electricity and electronics.
2 Solve problems related to electricity and electronics.
3 Collect and analyse information related to 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.

- Standard Grade Physics with Knowledge and Understanding and Problem Solving at grade 1 or 2

or

- Intermediate 2 Physics **or** the unit Electricity and Electronics (Intermediate 2)

and

- Standard Grade Mathematics at 1 or 2 **or** Intermediate 2 Mathematics

CREDIT VALUE

1 credit at Higher.

Administrative Information

Superclass: RC

Publication date: December 2004

Source: Scottish Qualifications Authority

Version: 06

National Unit Specification: general information (cont)

UNIT Electricity and Electronics (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).

National Unit Specification: statement of standards

UNIT Electricity and Electronics (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 electricity and electronics.

Performance criteria

(a) Quantities, units and symbols are used correctly in relation to electricity and electronics.
(b) Relationships and mathematical techniques are used correctly in relation to electricity and electronics.
(c) Principles are used correctly in relation to electricity and electronics.

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 (Higher) Course Content) in each of the following areas:

- Electric fields and resistors in circuits
- Alternating current and voltage
- Capacitance
- Analogue electronics.

OUTCOME 2

Solve problems related to electricity and electronics.

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 and resistors in circuits
- Alternating current and voltage
- Capacitance
- Analogue electronics.

National Unit Specification: statement of standards (cont)

UNIT Electricity and Electronics (Higher)

OUTCOME 3

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

Performance criteria

(a) The information is collected by active participation in the experiment.
(b) The 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) The experimental procedures are evaluated with supporting argument.

Evidence requirements

A report of one experimental activity related to 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 (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 Higher Physics units D383 12 Mechanics and Properties of Matter and D384 12 Radiation and Matter. An Outcome 3 report of practical work in the Higher Physics unit D383 12 Mechanics and Properties of Matter or D384 12 Radiation and Matter may be used as evidence of the achievement of Outcome 3 of this unit.

National Unit Specification: support notes

UNIT Electricity and Electronics (Higher)

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

While the exact 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, application, 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 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 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 should 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:

- uncertainties in individual readings
- a mean value and an approximate random uncertainty in the mean
- uncertainties expressed in absolute or percentage form.

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 Electricity and Electronics (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 to meet the performance criteria. 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 Assessment Arrangements for Candidates with Disabilities and/or Additional Support Needs* (SQA, 2004).

SCOTTISH QUALIFICATIONS AUTHORITY

National Unit Specification: general information

UNIT Radiation and Matter (Higher)

NUMBER D384 12

COURSE Physics (Higher)

SUMMARY

The unit seeks to develop the candidate's knowledge and understanding of concepts in radiation and optoelectronics. It 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 radiation and matter.
2 Solve problems related to radiation and matter.
3 Collect and analyse information related to 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.

- Standard Grade Physics with Knowledge and Understanding and Problem Solving at grade 1 or 2

or

- Intermediate 2 Physics **or** the units Waves and Optics (Intermediate 2) **and** Radioactivity (Intermediate 2)

and

- Standard Grade Mathematics at 1 or 2 **or** Intermediate 2 Mathematics

CREDIT VALUE

1 credit at Higher.

Administrative Information

Superclass: RC

Publication date: December 2004

Source: Scottish Qualifications Authority

Version: 06

National Unit Specification: general information (cont)

UNIT Radiation and Matter (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).

National Unit Specification: statement of standards

UNIT Radiation and Matter (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 radiation and matter.

Performance criteria

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

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 (Higher), Course Content) in each of the following areas:

- Waves
- Refraction of light
- Optoelectronics and semiconductors
- Nuclear reactions
- Dosimetry and safety.

OUTCOME 2

Solve problems related to radiation and matter.

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
- Refraction of light
- Optoelectronics and semiconductors
- Nuclear reactions
- Dosimetry and safety.

National Unit Specification: statement of standards (cont)

UNIT Radiation and Matter (Higher)

OUTCOME 3

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

Performance criteria

(a) The information is collected by active participation in the experiment.
(b) The 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) The experimental procedures are evaluated with supporting argument.

Evidence requirements

A report of one experimental activity related to Higher Physics covering the above performance criteria is required. Evidence submitted in support of attainment 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 Contents Statements for uncertainties (see Physics (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 Higher Physics units D383 12 Mechanics and Properties of Matter and D380 12 Electricity and Electronics. An Outcome 3 report of practical work in the Higher Physics unit D383 12 Mechanics and Properties of Matter or D380 12 Electricity and Electronics may be used as evidence of the achievement of Outcome 3 of this unit.

National Unit Specification: support notes

UNIT Radiation and Matter (Higher)

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

While the exact 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 contents, 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 Higher Physics and must allow opportunity for all 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 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 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.

National Unit Specification: support notes (cont)

UNIT Radiation and Matter (Higher)

PC (b)
Many experiments will follow a given procedure or method hence there is no need for a detailed description. The procedure should 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:

- uncertainties in individual readings
- a mean value and an approximate random uncertainty in the mean
- uncertainties expressed in absolute or percentage form.

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 Radiation and Matter (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 to meet the performance criteria. 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 Assessment Arrangements for Candidates with Disabilities and/or Additional Support Needs* (SQA, 2004).