Higher
Course Assessment
Specification

Higher Physics Course Assessment Specification (C757 76)

Valid from August 2014

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Please refer to the note of changes at the end of this Course Assessment Specification for details of changes from previous version (where applicable).

Course outline

Course title:	Higher Physics
SCQF level:	6 (24 SCQF credit points)
Course code:	C757 76
Course assessment code:	X757 76

The purpose of the Course Assessment Specification is to ensure consistent and transparent assessment year on year. It describes the structure of the Course assessment and the mandatory skills, knowledge and understanding that will be assessed.

Course assessment structure

Component 1 — question paper (scaled from 130 marks)	100 marks
Component 2 — assignment	20 marks
Total marks	**120 marks**

This Course includes six SCQF credit points to allow additional time for preparation for Course assessment. The Course assessment covers the added value of the Course.

Equality and inclusion

This Course Assessment Specification has been designed to ensure that there are no unnecessary barriers to assessment. Assessments have been designed to promote equal opportunities while maintaining the integrity of the qualification.

For guidance on assessment arrangements for disabled learners and/or those with additional support needs, please follow the link to the Assessment Arrangements web page: www.sqa.org.uk/sqa/14977.html.

Guidance on inclusive approaches to delivery and assessment of this Course is provided in the *Course Support Notes*.

Assessment

To gain the award of the Course, the learner must pass all of the Units as well as the Course assessment. Course assessment will provide the basis for grading attainment in the Course award.

Course assessment

SQA will produce and give instructions for the production and conduct of Course assessments based on the information provided in this document.

Added value

The purpose of the Course assessment is to assess added value of the Course as well as confirming attainment in the Course and providing a grade. The added value for the Course will address the key purposes and aims of the Course, as defined in the Course Rationale. It will do this by addressing one or more of breadth, challenge, or application.

In this Course assessment, added value will focus on the following:

- breadth — drawing on knowledge and skills from across the Course
- challenge — requiring greater depth or extension of knowledge and/or skills
- application — requiring application of knowledge and/or skills in practical or theoretical contexts as appropriate

This added value consists of:

- a question paper, which requires learners to demonstrate aspects of breadth, challenge and application; learners will apply breadth and depth of skills, knowledge and understanding from across the Course to answer questions in physics
- an assignment, which requires learners to demonstrate aspects of challenge and application; learners will apply skills of scientific inquiry, using related knowledge, to carry out a meaningful and appropriately challenging task in physics and communicate findings

Grading

Course assessment will provide the basis for grading attainment in the Course award.

The Course assessment is graded A–D. The grade is determined on the basis of the total mark for all Course assessments together.

A learner's overall grade will be determined by their performance across the Course assessment.

Grade description for C
For the award of Grade C, learners will have demonstrated successful performance in all of the Units of the Course. In the Course assessment, learners will typically have demonstrated successful performance in relation to the mandatory skills, knowledge and understanding for the Course.

Grade description for A
For the award of Grade A, learners will have demonstrated successful performance in all of the Units of the Course. In the Course assessment, learners will typically have demonstrated a consistently high level of performance in relation to the mandatory skills, knowledge and understanding for the Course.

In addition, learners achieving a Grade A will have demonstrated a high overall level of performance by:

- retaining knowledge and understanding over a long period of time
- showing a deeper level of knowledge and understanding
- integrating and applying skills, knowledge and understanding across the three component Units of the Course
- displaying problem solving skills in less familiar and more complex contexts
- applying skills of scientific inquiry and analytical thinking in complex contexts that involve more complex data

Credit
To take account of the extended range of learning and teaching approaches, remediation, consolidation of learning and integration needed for preparation for external assessment, six SCQF credit points are available in Courses at National 5 and Higher, and eight SCQF credit points in Courses at Advanced Higher. These points will be awarded when a grade D or better is achieved.

Structure and coverage of the Course assessment

The Course assessment will consist of two Components: a question paper and an assignment. The question paper will have two Sections. The assignment will have one Section.

Component 1 — question paper

The purpose of the question paper is to assess breadth and depth of knowledge and understanding from across the Units.

The paper will assess scientific inquiry skills, analytical thinking skills and the impact of applications on society and the environment.

The question paper will give learners an opportunity to demonstrate the following skills, knowledge and understanding by:

- demonstrating knowledge and understanding of physics by making statements, describing information, providing explanations and integrating knowledge
- applying knowledge of physics to new situations, interpreting information and solving problems
- planning and designing experiments/practical investigations to test given hypotheses or to illustrate particular effects, including safety measures
- selecting information and presenting information appropriately in a variety of forms
- processing information (using calculations, significant figures and units, where appropriate)
- making predictions from evidence/information
- drawing valid conclusions and giving explanations supported by evidence/justification
- evaluating experimental procedures, identifying sources of uncertainty and suggesting improvements

The mandatory skills and knowledge are specified in the 'Further Mandatory Information on Course Coverage' section at the end of this Course Assessment Specification.

The question paper will have 130 marks and will be scaled to 100 marks.

The question paper will have two Sections.

Section 1 (Objective Test) will have 20 marks.

Section 2 (Paper 2) will contain restricted and extended response questions and will be scaled from 110 to 80 marks.

Marks will be distributed approximately proportionately across the Units. The majority of the marks will be awarded for applying knowledge and understanding. The other marks will be awarded for applying scientific inquiry, scientific analytical thinking and problem solving skills.

A data booklet containing relevant data and formulae will be provided.

Component 2 — assignment
This assignment requires candidates to apply skills, knowledge and understanding to investigate a relevant topic in physics. The topic should draw on one or more of the key areas of the Course, and should be chosen with guidance from the assessor.

The assignment will assess the application of skills of scientific inquiry and related physics knowledge and understanding.

The assignment will give candidates an opportunity to demonstrate the following skills, knowledge and understanding by:

applying physics knowledge to new situations, interpreting information and solving problems
selecting information and presenting information appropriately in a variety of forms
processing information (using calculations, significant figures and units, where appropriate)
drawing valid conclusions and giving explanations supported by evidence/justification
communicating findings/information effectively

The assignment will have 20 marks out of a total of 120 marks.

The majority of the marks will be awarded for applying scientific inquiry and analytical thinking skills. The other marks will be awarded for applying knowledge and understanding related to the topic chosen.

The assignment offers challenge by requiring skills, knowledge and understanding to be applied in a context that is one or more of the following:

unfamiliar
familiar but investigated in greater depth
integrates a number of familiar contexts

This assignment has two stages:

a research stage
a communication stage

For their assignment, candidates are required to:

- choose a relevant topic in physics
- request the assessor to review the appropriateness of the chosen topic
- state appropriate aim(s)
- research the topic by selecting relevant data/information
- process, analyse and present relevant data/information
- state conclusion(s)
- evaluate their investigation
- explain the underlying physics of the topic researched
- present the findings of the research in a report

Setting, conducting and marking of assessment

Question paper

This question paper will be set and marked by SQA, and conducted in centres under conditions specified for external examinations by SQA. Learners will complete this in 2 hours and 30 minutes.

Controlled assessment — assignment

This assignment is:

- set by centres within SQA guidelines
- conducted under a high degree of supervision and control

Evidence will be submitted to SQA for external marking.

All marking will be quality assured by SQA.

Setting the assessment

Set by centres within SQA guidelines.

Conducting the assessment

The **research** stage will be conducted under some supervision and control.

The **communication** stage will be conducted under a high degree of supervision. SQA will provide Assignment General assessment information and Assignment Assessment task documents. SQA will specify the material to be taken into the communication stage of the assignment.

The production of the report will be carried out:

- in time to meet a submission date set by SQA
- independently by the candidate

Further mandatory information on Course coverage

The following gives details of mandatory skills, knowledge and understanding for the Higher Physics Course. Course assessment will involve sampling the skills, knowledge and understanding. This list of skills, knowledge and understanding also provides the basis for the assessment of Units of the Course.

The following gives details of the skills:

- demonstrating knowledge and understanding of physics by making statements, describing information, providing explanations and integrating knowledge
- applying physics knowledge to new situations, interpreting information and solving problems
- planning and designing experiments/practical investigations to test given hypothesis or to illustrate particular effects including safety measures
- carrying out /experiments/practical investigations safely, recording detailed observations and collecting data
- selecting information and presenting information appropriately in a variety of forms
- processing information using calculations, significant figures and units, where appropriate
- making predictions from evidence/information
- drawing valid conclusions and giving explanations supported by evidence/justification
- evaluating experimental procedures, identifying sources of error and suggesting improvements
- communicating findings/information effectively

These skills will be assessed, across the Course, in the context of the mandatory knowledge

The following table specifies the mandatory knowledge for the Higher Physics Course.

Our Dynamic Universe

Motion — equations and graphs

Use of appropriate relationships to solve problems involving displacement, velocity and acceleration for objects moving with constant acceleration in a straight line.
Interpretation and drawing of motion-time graphs for motion with constant acceleration in a straight line, including graphs for bouncing objects and objects thrown vertically upwards.
Awareness of the interrelationship of displacement, velocity and acceleration-time graphs.
Calculation of displacement, velocity and acceleration from appropriate graphs.
All graphs restricted to constant acceleration in one dimension, inclusive of change of direction.

Forces, energy and power

Use of appropriate relationships to solve problems involving balanced and unbalanced forces, mass, acceleration, and gravitational field strength.
Awareness of the effects of friction on a moving object (no reference to static and dynamic friction).
Explanation, in terms of forces, of an object moving with terminal velocity.
Interpretation of velocity-time graphs for a falling object when air resistance is

taken into account.
Use on Newton’s first and second laws to explain the motion of an object.
Use of free body diagrams and appropriate relationships to solve problems involving friction and tension (as a pulling force exerted by a string or cable).
Resolution of a force into two perpendicular components, including the resolution of the weight of an object on a slope into component forces parallel and normal to the surface of the slope.
Use of the principle of conservation of energy and appropriate relationships to solve problems involving work done, potential energy, kinetic energy and power.

Collisions, explosions and impulse
Use of the principle of conservation of momentum and an appropriate relationship to solve problems involving the momentum, mass and velocity of objects interacting in one dimension.
Knowledge of energy interactions involving the total kinetic energy of systems of objects undergoing inelastic collisions, elastic collisions and explosions.
Use of appropriate relationships to solve problems involving the total kinetic energy of systems of interacting objects.
Use of Newton’s third law to explain the motion of objects involved in interactions.
Interpretation of force-time graphs during contact of interacting objects.
Knowledge that the impulse of a force is equal to the area under a force-time graph and is equal to the change in momentum of an object involved in the interaction.
Use data from a force-time graph to solve problems involving the impulse of a force, the average force and its duration.
Use of an appropriate relationship to solve problems involving the mass, change in velocity, average acting force and the duration of the force for an object involved in an interaction.

Gravitation
Knowledge that satellites are in free fall around a planet/star.
Resolution of the initial velocity of a projectile into horizontal and vertical components and their use in calculations.
Use of appropriate relationships to solve problems involving projectiles.
Knowledge that the horizontal motion and vertical motion of a projectile are independent of each other.
Use of Newton’s Universal law of Gravitation to solve problems involving, force, masses and their separation.

Special relativity
Knowledge that the speed of light in a vacuum is the same for all observers.
Knowledge that measurements of space and time for a moving observer are changed relative to those for a stationary observer, giving rise to time dilation.
Use of appropriate relationships to solve problems involving length contraction, time dilation and speed.

The Expanding Universe
Knowledge that the Doppler effect causes shifts in wavelengths of sound and light.
Use of an appropriate relationship to solve problems involving the observed frequency, source frequency, source speed and wave speed.
Knowledge that the light from objects moving away from us is shifted to longer (more red) wavelengths.
Knowledge that the redshift of a galaxy is the change in wavelength divided by the emitted wavelength. For slowly moving galaxies, redshift is the ratio of the velocity of

the galaxy to the velocity of light.
Use of an appropriate relationship to solve problems involving the Hubble constant, the recession velocity of a galaxy and its distance from us.
Knowledge that Hubble's law allows us to estimate the age of the Universe.
Awareness of evidence supporting the expanding Universe theory.
Knowledge that the mass of a galaxy can be estimated by the orbital speed of stars within it.
Knowledge that evidence supporting the existence of dark matter comes from estimations of the mass of galaxies.
Knowledge that evidence supporting the existence of dark energy comes from the accelerating rate of expansion of the Universe.
Knowledge that the temperature of stellar objects is related to the distribution of emitted radiation over a wide range of wavelengths.
Knowledge that the wavelength of the peak wavelength of this distribution is shorter for hotter objects than for cooler objects.
Awareness of the qualitative relationship between radiation emitted per unit surface area per unit time and the temperature of a star.
Awareness of evidence supporting the big bang theory and subsequent expansion of the universe, for example cosmic microwave background radiation, the abundance of the elements hydrogen and helium, the darkness of the sky (Olbers' paradox) and the large number of galaxies showing redshift, rather than blueshift.

Particles and Waves

The Standard Model

Use of orders of magnitude and awareness of the range of orders of magnitude of length from the very small (sub-nuclear) to the very large (distance to furthest known celestial objects).
Knowledge of the standard model of fundamental particles and interactions.
Awareness of evidence supporting the existence of sub-nuclear particles and the existence of antimatter.
Knowledge that fermions, the matter particles, consist of quarks (six types) and leptons (electron, muon and tau, together with their neutrinos).
Knowledge that hadrons are composite particles made of quarks that baryons are made of three quarks, and that mesons are made of quark-antiquark pairs.
Knowledge that the force-mediating particles are bosons (photons, W- and Z-bosons, and gluons).
Description of beta decay as the first evidence for the neutrino.

Forces on charged particles

Awareness that charged particles experience a force in an electric field.
Knowledge that fields exist around charged particles and between charged parallel plates.
Sketch of electric field patterns for single-point charges, systems of two-point charges and between two charged parallel plates.
Knowledge of the direction of movement of charged particles in an electric field.
Knowledge that the relationship between potential difference, work and charge gives the definition of the volt.
Use of appropriate relationships to solve problems involving the charge, mass, speed and energy of a charges particle in an electric field and the potential difference through which it moves.
Knowledge that a moving charge produces a magnetic field.
Determination of the direction of the force on a charged particle moving in a magnetic field for negative and positive charges (for example, by using the right-hand rule for

negative charges).
Awareness of the basic operation of particle accelerators in terms of acceleration, deflection and collision of charged particles.

Nuclear reactions
Use of nuclear equations to describe radioactive decay, fission and fusion reactions with reference to mass and energy equivalence.
Use of an appropriate relationship to solve problems involving the mass loss and the energy released by a nuclear reaction.
Awareness of coolant and containment issues in nuclear fusion reactors.

Wave particle duality
Awareness of the photoelectric effect as evidence supporting the particulate model of light.
Knowledge that photons of sufficient energy can eject electrons from the surface of materials.
Use of an appropriate relationship to solve problems involving the frequency and energy of a photon.
Knowledge that the threshold frequency is the minimum frequency of a photon required for photoemission.
Knowledge that the work function of a material is the minimum energy required to cause photoemission.
Use of an appropriate relationship to solve problems involving the maximum kinetic energy of photoelectrons, the threshold frequency of the material and the frequency of the photon.

Interference and diffraction
Knowledge that coherent waves have a constant phase relationship and have the same frequency, wavelength and velocity.
Description of the conditions for constructive and destructive interference in terms of the phase difference between two waves.
Knowledge that maxima and minima are produced when the path difference between waves is a whole number of wavelengths or an odd number of half-wavelengths respectively.
Use of an appropriate relationship to solve problems involving the path difference between waves, wavelength and order number.
Use of an appropriate relationship to solve problems involving grating spacing, wavelength, order number and angle to the maximum.

Refraction of light
Definition of absolute refractive index of a medium as the ratio of the speed of light in a vacuum to the speed of light in the medium.
Use of an appropriate relationship to solve problems involving absolute refractive index, the angle of incidence and the angle of refraction.
Use of an appropriate relationship to solve problems involving the angles of incidence and refraction, the wavelength of radiation in each medium and the speed of the radiation in each medium (including situations where light is travelling from a more dense to a less dense medium).
Awareness of the variation of refractive index with frequency.
Knowledge of critical angle and of total internal reflection.
Use of an appropriate relationship to solve problems involving critical angle and refractive index.

Spectra
Knowledge that irradiance is the power per unit area incident on a surface.
Use of an appropriate relationship to solve problems involving irradiance, the power of radiation incident on a surface and the area of the surface.
Knowledge that irradiance is inversely proportional to the square of the distance from a point source.
Use of an appropriate relationship to solve problems involving irradiance and distance from a point light source.
Knowledge of the Bohr model of the atom.
Awareness of the terms *ground state*, *energy levels*, *ionisation* and *zero potential energy* in relation to the Bohr model of the atom.
Knowledge of the mechanism of production of line emission spectra, continuous emission spectra and absorption spectra in terms of electron energy level transitions.
Use of appropriate relationships to solve problems involving energy levels and the frequency of the radiation emitted/absorbed.
Awareness that the absorption lines in the spectrum of sunlight provide evidence for the composition of the Sun’s upper atmosphere.

Electricity

Monitoring and measuring a.c.
Knowledge that a.c. is a current which changes direction and instantaneous value with time.
Use of appropriate relationships to solve problems involving peak and r.m.s. values.
Determination of frequency, peak voltage and r.m.s. values from graphical data.

Current, potential difference, power and resistance
Use of appropriate relationships to solve problems involving potential difference, current, resistance and power. Solutions may involve several steps.
Use of appropriate relationships to solve problems involving potential divider circuits.

Electrical sources and internal resistance
Knowledge of the terms *electromotive force (e.m.f.)*, *internal resistance* and *terminal potential difference (t.p.d.)*, *ideal supplies*, *short circuit* and *open circuit*.
Use of an appropriate relationship to solve problems involving e.m.f., t.p.d., current and internal resistance.
Determination of internal resistance and e.m.f. using graphical analysis.

Capacitors
Definition of capacitance.
Use of an appropriate relationship to solve problems involving capacitance, charge and potential difference.
Knowledge that the total energy stored in a charged capacitor is the area under the charge against potential difference graph.
Use of data from a charge against potential difference graph.
Use of appropriate relationships to solve problems involving energy, charge, capacitance and potential difference.
Awareness of the variation of current and potential difference with time for both charging and discharging cycles of a capacitor in a CR circuit (charging and discharging curves).
Awareness of the effect of resistance and capacitance on charging and discharging curves in a CR circuit.

Conductors, semiconductors and insulators
Knowledge that solids can be categorised into conductors, semiconductors or insulators by their ability to conduct electricity.
Awareness of the terms *conduction band* and *valance band*.
Qualitative explanation of the electrical properties of conductors, insulators and semiconductors using the electron population of the conduction and valance bands and the energy difference between the conduction and valance bands.

p-n junctions
Awareness that, during manufacture, the conductivity of semiconductors can be controlled, resulting in two types: p-type and n-type.
Knowledge that, when p-type and n-type materials are joined, a layer is formed at the junction. The electrical properties of this layer are used in a number of devices.
Awareness of the terms *forward bias* and *reverse bias*.
Knowledge that solar cells are p-n junctions designed so that a potential difference is produced when photons enter the layer. (This is known as the photovoltaic effect.)
Knowledge that LEDs are forward biased p-n junction diodes that emit photons when electrons 'fall' from the conduction band into the valence band of the p-type semiconductor.

Throughout the Course, appropriate attention should be given to:

- units, prefixes and scientific notation
- uncertainties

Administrative information

Published: April 2015 (version 3.0)

History of changes to Course Assessment Specification

Course details	Version	Description of change	Authorised by	Date
	2.0	The number of marks awarded for the assignment has changed. The descriptions of the skills to be assessed have been rewritten to better explain what is required. Conducting the assessment: this has been rewritten to clarify how stages will be assessed. Suggested timings for each stage have been removed. The details of the skills to be assessed have been rewritten for clarity. Further mandatory knowledge: these tables have been revised to aid understanding.	Qualifications Development Manager	April 2014
	3.0	Significant changes to clarify mandatory knowledge — table revised in 'Further mandatory information on Course coverage' section.	Qualifications Manager	April 2015

Note: You are advised to check SQA's website (**www.sqa.org.uk**) to ensure you are using the most up-to-date version of the Course Assessment Specification.