Higher
Course Assessment
Specification

Higher Physics Course Assessment Specification (C757 76)

Valid from August 2014

This edition: April 2014, version 2.0

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
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- 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

- Equations of motion for objects moving with constant acceleration in a straight line.
- Motion-time graphs for motion with constant acceleration in a straight line.
- Displacement, velocity and acceleration-time graphs and their interrelationship.
- Graphs for bouncing objects and objects thrown vertically upwards.
- All graphs restricted to constant acceleration in one dimension, inclusive of change of direction.

Forces, energy and power

- Balanced and unbalanced forces. The effects of friction. Terminal velocity.
- Forces acting in one plane only.
- Analysis of motion using Newton’s First and Second Laws. Frictional force as a negative vector quantity. No reference to static and dynamic friction.
- Tension as a pulling force exerted by a string or cable on another object.
- Velocity-time graph of a falling object when air resistance is taken into account, including the effect of changing the surface area of the falling object.
- Resolving a force into two perpendicular components.
- Forces acting at an angle to the direction of movement.

- Resolving the weight of an object on a slope into a component acting down the slope and a component acting normal to the slope.
- Systems of balanced forces with forces acting in two dimensions.
- Work done, potential energy, kinetic energy and power in familiar and unfamiliar situations.
- Conservation of energy.

Collisions, explosions and impulse
- Conservation of momentum in one dimension and in cases where the objects may move in opposite directions.
- Kinetic energy in elastic and inelastic collisions.
- Explosions and Newton‘s Third Law.
- Conservation of momentum in explosions in one dimension only.
- Force-time graphs during contact of colliding objects.
- Impulse found from the area under a force-time graph.
- Equivalence of change in momentum and impulse.
- Newton’s Third Law of motion.

Gravitation
- Projectiles and satellites.
- Resolving the motion of a projectile with an initial velocity into horizontal and vertical components and their use in calculations.
- Comparison of projectiles with objects in free fall.
  Gravitational Field Strength of planets, natural satellites and stars. Calculating the force exerted on objects placed in a gravity field.
- Newton’s Universal Law of Gravitation.

Special relativity
- The speed of light in a vacuum is the same for all observers.
- The constancy of the speed of light led Einstein to postulate that measurements of space and time for a moving observer are changed relative to those for a stationary observer.
- Length contraction and time dilation.

The Expanding Universe
- The Doppler Effect is observed in sound and light.
- The Doppler Effect causes shifts in wavelengths of sound and light. The light from objects moving away from us is shifted to longer (more red) wavelengths.
- 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.
  Hubble’s Law shows the relationship between the recession velocity of a galaxy and its distance from us.
- Hubble’s Law allows us to estimate of the age of the universe.
- Evidence for the expanding universe.
- We can estimate the mass of a galaxy by the orbital speed of stars within it.
- Evidence for dark matter from observations of the mass of galaxies.
- Evidence for dark energy from the accelerating rate of expansion of the universe.
- The temperature of stellar objects is related to the distribution of emitted radiation

over a wide range of wavelengths. The wavelength of the peak of this distribution is shorter for hotter objects than for cooler objects.

- Qualitative relationship between radiation per unit surface area and temperature of a star.
- Cosmic microwave background radiation as evidence for the big bang and subsequent expansion of the universe.

Particles and Waves

The Standard Model

- Orders of magnitude — the range of orders of magnitude of length from the very small (sub-nuclear) to the very large (distance to furthest known celestial objects).
- The standard model of fundamental particles and interactions.
- Evidence for the sub-nuclear particles and the existence of antimatter.
- Fermions, the matter particles, consist of quarks (6 types) and leptons (electron, muon and tau, together with their neutrinos).
- Hadrons are composite particles made of quarks. Baryons are made of three quarks and mesons are made of two quarks.
- 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

- Fields exist around charged particles and between charged parallel plates.
- Examples of electric field patterns for single point charges, systems of two point charges and between parallel plates.
- Movement of charged particles in an electric field.
- The relationship between potential difference, work and charge gives the definition of the volt.
- Calculation of the speed of a charged particle accelerated by an electric field.
- A moving charge produces a magnetic field.
- The determination of the direction of the force on a charged particle moving in a magnetic field for negative and positive charges (right hand rule for negative charges).
- Basic operation of particle accelerators in terms of acceleration, deflection and collision of charged particles.

Nuclear reactions

- Nuclear equations to describe radioactive decay, fission and fusion reactions with reference to mass and energy equivalence, including calculations.
- Coolant and containment issues in nuclear fission and fusion reactors.

Wave particle duality

- Photoelectric effect as evidence for the particulate nature of light.
- Photons of sufficient energy can eject electrons from the surface of materials.
- The threshold frequency is the minimum frequency of a photon required for photoemission.
- The work function of the material is the minimum energy required to cause photoemission.
- Determination of the maximum kinetic energy of photoelectrons.

Interference and diffraction

- Conditions for constructive and destructive interference.
- Coherent waves have a constant phase relationship and have the same frequency, wavelength and velocity. Constructive and destructive interference in terms of phase between two waves.
- Interference of waves using two coherent sources.
- 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.
- The relationship between the wavelength, distance between the sources, distance from the sources and the spacing between maxima or minima.
- The relationship between the grating spacing, wavelength and angle to the maxima.

Refraction of light

- Absolute refractive index of a material is the ratio of the sine of angle of incidence in vacuum (air) to the sine of angle of refraction in the material. Refractive index of air treated as the same as that of a vacuum.
- Situations where light travels from a more dense to a less dense medium/material.
- Refractive index can also be found from the ratio of speed of light in vacuum (air) to the speed in the material and the ratio of the wavelengths.
- Variation of refractive index with frequency.
- Critical angle and total internal reflection.

Spectra

- Irradiance and the inverse square law.
- Irradiance is power per unit area.
- The relationship between irradiance and distance from a point light source.
- Line and continuous emission spectra, absorption spectra and energy level transitions.
- The Bohr model of the atom.
- Movement of electrons between energy levels.
- The terms ground state, energy levels, ionisation and zero potential energy for the Bohr model of the atom.
- Emission of photons due to movement of electrons between energy levels and dependence of photon frequency on energy difference between levels.
- The relationship between photon energy, Planck's constant and photon frequency.
- Absorption lines in the spectrum of sunlight provides evidence for the composition of the Sun's upper atmosphere.

Electricity

Monitoring and measuring a.c.

- a.c. as a current which changes direction and instantaneous value with time.
- Calculations involving peak and r.m.s. values.
- Determination of frequency from graphical data.

Current, potential difference, power and resistance

- Use relationships involving potential difference, current, resistance and power to

analyse circuits. Calculations may involve several steps.
- Calculations involving potential dividers circuits

Electrical sources and internal resistance.
- Electromotive force, internal resistance and terminal potential difference. Ideal supplies, short circuits and open circuits.
- Determining internal resistance and electromotive force using graphical analysis.

Capacitors
- Capacitors and the relationship between capacitance, charge and potential difference.
- The total energy stored in a charged capacitor is the area under the charge against potential difference graph. Use the relationships between energy, charge, capacitance and potential difference.
- Variation of current and potential difference against time for both charging and discharging.
- The effect of resistance and capacitance on charging and discharging curves.

Conductors, semiconductors and insulators
- Solids can be categorised into conductors, semiconductors or insulators by their ability to conduct electricity.
- The electrons in atoms are contained in energy levels. When the atoms come together to form solids, the electrons then become contained in energy bands separated by gaps.
- In metals the highest occupied band is not completely full and this allows the electrons to move and therefore conduct. This band is known as the conduction band.
- In an insulator the highest occupied band (called the valence band) is full. The first unfilled band above the valence band is the conduction band. For an insulator the gap between the valence band and the conduction band is large and at room temperature there is not enough energy available to move electrons from the valence band into the conduction band where they would be able to contribute to conduction. There is no electrical conduction in an insulator.
- In a semiconductor the gap between the valence band and conduction band is smaller and at room temperature there is sufficient energy available to move some electrons from the valence band into the conduction band allowing some conduction to take place. An increase in temperature increases the conductivity of a semiconductor.

p-n junctions
- During manufacture, the conductivity of semiconductors can be controlled, resulting in two types: p-type and n-type.
- 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.
- Solar cells are p-n junctions designed so that a potential difference is produced when photons enter the layer. This is the photovoltaic effect.
- LEDs are p-n junctions which emit photons when a current is passed through the junction.

Throughout the Course, appropriate attention should be given to:

- units, prefixes and scientific notation
- uncertainties

Administrative information

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History of changes to Course Assessment Specification

Course details	Version	Description of change	Authorised by	Date
	2.0	Page 2 – the number of marks awarded for the assignment has changed. Pages 5 and 6 – the descriptions of the skills to be assessed have been rewritten to better explain what is required. Page 7 – Conducting the assessment: this has been rewritten to clarify how stages will be assessed. Suggested timings for each stage have been removed. Page 8 –the details of the skills to be assessed have been rewritten for clarity. Page 8 onwards – Further mandatory knowledge: these tables have been revised to aid understanding.	Qualifications Development Manager	April 2014

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.