N5 National 5 Course Specification

SQA

National 5 Physics

Course code:	C857 75
Course assessment code:	X857 75
SCQF:	level 5 (24 SCQF credit points)
Valid from:	session 2017–18

The course specification provides detailed information about the course and course assessment to ensure consistent and transparent assessment year on year. It describes the structure of the course and the course assessment in terms of the skills, knowledge and understanding that are assessed.

This document is for teachers and lecturers and contains all the mandatory information you need to deliver the course.

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Course overview

The course consists of 24 SCQF credit points which includes time for preparation for course assessment. The notional length of time for a candidate to complete the course is 160 hours.

The course assessment has two components.

Component	Marks	Scaled mark	Duration
Component 1: question paper	135	100	2 hours and 30 minutes
Component 2: assignment	20	25	8 hours, of which a maximum of 1 hour and 30 minutes is allocated to the report stage — see course assessment section

Recommended entry	Progression
Entry to this course is at the discretion of the centre. Candidates should have achieved the fourth curriculum level or the National 4 Physics course or equivalent qualifications and/or experience prior to starting this course. Candidates may also progress from relevant biology, chemistry, environmental science or science courses.	♦ other qualifications in physics or related areas ♦ further study, employment or training

Conditions of award

The grade awarded is based on the total marks achieved across all course assessment components.

Course rationale

National Courses reflect Curriculum for Excellence values, purposes and principles. They offer flexibility, provide more time for learning, more focus on skills and applying learning, and scope for personalisation and choice.

Every course provides opportunities for candidates to develop breadth, challenge and application. The focus and balance of assessment is tailored to each subject area.

Physics is the study of matter, energy and the interaction between them. This entails asking fundamental questions and trying to answer them by observing and experimenting. The answers to such questions can lead to advances in our understanding of the world around us and often result in technological improvements which enhance the lives of all. The study of physics is of benefit, not only to those intending to pursue a career in science, but also to those intending to work in areas such as the health, energy, leisure and computing industries.

An experimental and investigative approach is used to develop knowledge and understanding of concepts in physics.

Purpose and aims

The purpose of the course is to develop candidates' interest and enthusiasm for physics in a range of contexts. The skills of scientific inquiry are integrated and developed, throughout the course, by investigating the applications of physics. This enables candidates to become scientifically literate citizens, able to review the science-based claims they will meet.

Physics gives candidates an insight into the underlying nature of our world and its place in the universe. From the sources of the energy we use, to the exploration of space, it covers a range of applications of the relationships that have been discovered through experiment and calculation, including those used in modern technology. An experimental and investigative approach is used to develop knowledge and understanding of physics concepts.

This course enables candidates to develop a deeper understanding of physics concepts and the ability to describe and interpret physical phenomena using mathematical skills. They develop scientific methods of research in which issues in physics are explored and conclusions drawn.

The aims of the course are for candidates to:

- develop and apply knowledge and understanding of physics
- develop an understanding of the impact of physics on everyday life
- develop an understanding of the role of physics in scientific issues and relevant applications of physics, including the impact these could make on society and the environment
- develop scientific inquiry and investigative skills
- develop scientific analytical thinking skills in a physics context

- develop the skills to use technology, equipment and materials, safely, in practical scientific activities
- develop planning skills
- develop problem-solving skills in a physics context
- use and understand scientific literacy, in everyday contexts, to communicate ideas and issues and to make scientifically informed choices
- develop the knowledge and skills for more advanced learning in physics
- develop skills of independent working

The course enables candidates to make their own decisions on issues within a modern society, where the body of scientific knowledge and its applications and implications are ever developing.

Who is this course for?

The course is suitable for learners who have experienced learning across the sciences experiences and outcomes. The course may be suitable for those wishing to study physics for the first time.

This course has a skills-based approach to learning. It takes account of the needs of all learners and provides sufficient flexibility to enable learners to achieve in different ways.

Course content

Candidates gain an understanding of physics and develop this through a variety of approaches, including practical activities, investigations and problem solving. Candidates research topics, apply scientific skills and communicate information related to their findings, which develops skills of scientific literacy.

The course content includes the following areas of physics:

Dynamics
In this area, the topics covered are: vectors and scalars; velocity–time graphs; acceleration; Newton’s laws; energy; projectile motion.

Space
In this area, the topics covered are: space exploration; cosmology.

Electricity
In this area, the topics covered are: electrical charge carriers; potential difference (voltage); Ohm’s law; practical electrical and electronic circuits; electrical power.

Properties of matter
In this area, the topics covered are: specific heat capacity; specific latent heat; gas laws and the kinetic model.

Waves
In this area, the topics covered are: wave parameters and behaviours; electromagnetic spectrum; refraction of light.

Radiation
In this area, the topic covered is nuclear radiation.

Skills, knowledge and understanding

Skills, knowledge and understanding for the course

The following provides a broad overview of the subject skills, knowledge and understanding developed in the course:

- demonstrating knowledge and understanding of physics by making accurate statements
- demonstrating knowledge and understanding of physics by describing information and providing explanations and integrating knowledge
- applying knowledge of physics to new situations, interpreting information and solving problems
- planning or designing experiments to test given hypotheses or to illustrate particular effects, including safety measures
- carrying out experimental procedures safely
- selecting information from a variety of sources

- presenting information appropriately in a variety of forms
- processing information (using calculations and units, where appropriate)
- making predictions based on evidence/information
- drawing valid conclusions and giving explanations supported by evidence/justification
- evaluating experimental procedures
- suggesting improvements to experiments/practical investigations
- communicating findings/information

Skills, knowledge and understanding for the course assessment

The following provides details of skills, knowledge and understanding sampled in the course assessment:

Dynamics
Vectors and scalars
Definition of vector and scalar quantities. Identification of force, speed, velocity, distance, displacement, acceleration, mass, time and energy as vector or scalar quantities. Calculation of the resultant of two vector quantities in one dimension or at right angles. Determination of displacement and/or distance using scale diagram or calculation. Determination of velocity and/or speed using scale diagram or calculation. Use of appropriate relationships to solve problems involving velocity, speed, displacement, distance and time. $s = vt$ $s = \bar{v}t$ $d = \bar{v}t$ Description of experiments to measure average and instantaneous speed.
Velocity–time graphs
Drawing or sketching of velocity–time or speed–time graphs from data. Interpretation of a velocity–time graph to describe the motion of an object. Determination of displacement from a velocity–time graph. $s = \text{area under } v\text{-}t \text{ graph.}$
Acceleration
Definition of acceleration in terms of initial velocity, final velocity and time. Use of an appropriate relationship to solve problems involving acceleration, initial velocity (or speed), final velocity (or speed) and time. $a = \dfrac{v-u}{t}$ Determination of acceleration from a velocity–time graph. $a = \text{gradient of the line on a } v\text{-}t \text{ graph.}$ Description of an experiment to measure acceleration.

Dynamics

Newton's laws

Application of Newton's laws and balanced forces to explain constant velocity (or speed), making reference to frictional forces.
Application of Newton's laws and unbalanced forces to explain and/or determine acceleration for situations where more than one force is acting.
Use of an appropriate relationship to solve problems involving unbalanced force, mass and acceleration for situations where one or more forces are acting in one dimension or at right angles.

$$F = ma$$

Use of an appropriate relationship to solve problems involving weight, mass and gravitational field strength.

$$W = mg$$

Explanation of motion resulting from a 'reaction' force in terms of Newton's third law.
Explanation of free-fall and terminal velocity in terms of Newton's laws.

Energy

Explanation of energy conservation and of energy conversion and transfer.
Use of an appropriate relationship to solve problems involving work done, unbalanced force and distance/displacement.

$$E_w = Fd, \text{ or } W = Fd$$

Definition of gravitational potential energy.
Use of an appropriate relationship to solve problems involving gravitational potential energy, mass, gravitational field strength and height.

$$E_p = mgh$$

Definition of kinetic energy.
Use of an appropriate relationship to solve problems involving kinetic energy, mass and speed.

$$E_k = \frac{1}{2}mv^2$$

Use of appropriate relationships to solve problems involving conservation of energy.

$$E_w = Fd, \; W = Fd$$

$$E_p = mgh$$

$$E_k = \frac{1}{2}mv^2$$

Dynamics
Projectile motion
Explanation of projectile motion in terms of constant vertical acceleration and constant horizontal velocity. Use of appropriate relationships to solve problems involving projectile motion from a horizontal launch, including the use of motion graphs. area under v_h-t graphs (horizontal range) area under v_v-t graphs (vertical height) $v_h = \frac{s}{t}$ (constant horizontal velocity) $v_v = u_v + at$ (constant vertical acceleration) Explanation of satellite orbits in terms of projectile motion, horizontal velocity and weight.

Space
Space exploration
Basic awareness of our current understanding of the universe. Use of the following terms correctly and in context: planet, dwarf planet, moon, Sun, asteroid, solar system, star, exoplanet, galaxy, universe. Awareness of the benefits of satellites: GPS, weather forecasting, communications, scientific discovery and space exploration (for example Hubble telescope, ISS). Knowledge that geostationary satellites have a period of 24 hours and orbit at an altitude of 36 000 km. Knowledge that the period of a satellite in a high altitude orbit is greater than the period of a satellite in a lower altitude orbit. Awareness of the challenges of space travel: ♦ travelling large distances with the possible solution of attaining high velocity by using ion drive (producing a small unbalanced force over an extended period of time) ♦ travelling large distances using a ‘catapult’ from a fast moving asteroid, moon or planet ♦ manoeuvring a spacecraft in a zero friction environment, possibly to dock with the ISS ♦ maintaining sufficient energy to operate life support systems in a spacecraft, with the possible solution of using solar cells with area that varies with distance from the Sun Awareness of the risks associated with manned space exploration: ♦ fuel load on take-off ♦ potential exposure to radiation ♦ pressure differential ♦ re-entry through an atmosphere Knowledge of Newton’s second and third laws and their application to space travel, rocket launch and landing. Use of an appropriate relationship to solve problems involving weight, mass and gravitational field strength, in different locations in the universe. $W = mg$
Cosmology
Use of the term ‘light year’ and conversion between light years and metres. Basic description of the ‘Big Bang’ theory of the origin of the universe. Knowledge of the approximate estimated age of the universe. Awareness of the use of the whole electromagnetic spectrum in obtaining information about astronomical objects. Identification of continuous and line spectra. Use of spectral data for known elements, to identify the elements present in stars.

Electricity
Electrical charge carriers
Definition of electrical current as the electric charge transferred per unit time. Use of an appropriate relationship to solve problems involving charge, current and time. $Q = It$ Knowledge of the difference between alternating and direct current. Identification of a source (as a.c. or d.c.) based on oscilloscope trace or image from data logging software.
Potential difference (voltage)
Knowledge that a charged particle experiences a force in an electric field. Knowledge of the path a charged particle follows: between two oppositely charged parallel plates; near a single point charge; between two oppositely charged points; between two like charged points. Knowledge that the potential difference (voltage) of the supply is a measure of the energy given to the charge carriers in a circuit.
Ohm's law
Calculation of the gradient of the line of best fit on a V-I graph to determine resistance. Use of appropriate relationships to solve problems involving potential difference (voltage), current and resistance. $V = IR$ $V_2 = \left(\frac{R_2}{R_1 + R_2}\right)V_s$ $\frac{V_1}{V_2} = \frac{R_1}{R_2}$ Knowledge of the qualitative relationship between the temperature and resistance of a conductor. Description of an experiment to verify Ohm's law.
Practical electrical and electronic circuits
Measurement of current, potential difference (voltage) and resistance, using appropriate meters in simple and complex circuits. Knowledge of the circuit symbol, function and application of standard electrical and electronic components: cell, battery, lamp, switch, resistor, voltmeter, ammeter, LED, motor, microphone, loudspeaker, photovoltaic cell, fuse, diode, capacitor, thermistor, LDR, relay, transistor. For transistors, knowledge of the symbols for an npn transistor and an n-channel enhancement mode MOSFET. Explanation of their function as a switch in transistor switching circuits.

Electricity
Application of the rules for current and potential difference (voltage) in series and parallel circuits. $I_s = I_1 = I_2 = ...$ $V_s = V_1 + V_2 + ...$ $I_p = I_1 + I_2 + ...$ $V_p = V_1 = V_2 = ...$ Knowledge of the effect on the total resistance of a circuit of adding further resistance in series or in parallel. Use of appropriate relationships to solve problems involving the total resistance of resistors in series and in parallel circuits, and in circuits with a combination of series and parallel resistors. $R_T = R_1 + R_2 + ...$ $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + ...$
Electrical power
Definition of electrical power in terms of electrical energy and time. Use of an appropriate relationship to solve problems involving energy, power and time. $P = \frac{E}{t}$ Knowledge of the effect of potential difference (voltage) and resistance on the current in and power developed across components in a circuit. Use of appropriate relationships to solve problems involving power, potential difference (voltage), current and resistance in electrical circuits. $P = IV$ $P = I^2R$ $P = \frac{V^2}{R}$ Selection of an appropriate fuse rating given the power rating of an electrical appliance. A 3 A fuse should be selected for most appliances rated up to 720 W, a 13 A fuse for appliances rated over 720 W.

Properties of matter
Specific heat capacity
Knowledge that different materials require different quantities of heat to raise the temperature of unit mass by one degree Celsius. Use of an appropriate relationship to solve problems involving mass, heat energy, temperature change and specific heat capacity. $E_h = cm\Delta T$ Knowledge that the temperature of a substance is a measure of the mean kinetic energy of its particles. Use of the principle of conservation of energy to determine heat transfer.
Specific latent heat
Knowledge that different materials require different quantities of heat to change the state of unit mass. Knowledge that the same material requires different quantities of heat to change the state of unit mass from solid to liquid (fusion) and to change the state of unit mass from liquid to gas (vaporisation). Use of an appropriate relationship to solve problems involving mass, heat energy and specific latent heat. $E_h = ml$
Gas laws and the kinetic model
Definition of pressure in terms of force and area. Use of an appropriate relationship to solve problems involving pressure, force and area. $p = \frac{F}{A}$ Description of how the kinetic model accounts for the pressure of a gas. Knowledge of the relationship between Kelvin and degrees Celsius and the absolute zero of temperature. $0\,\text{K} = -273\,^{\circ}\text{C}$ Explanation of the pressure–volume, pressure–temperature and volume–temperature laws qualitatively in terms of a kinetic model. Use of appropriate relationships to solve problems involving the volume, pressure and temperature of a fixed mass of gas. $p_1V_1 = p_2V_2$ $\frac{p_1}{T_1} = \frac{p_2}{T_2}$ $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ $\frac{pV}{T} = \text{constant}$ Description of experiments to verify the pressure–volume law (Boyle's law), the pressure–temperature law (Gay-Lussac's law) and the volume–temperature law (Charles' law).

Waves
Wave parameters and behaviours
Knowledge that waves transfer energy. Definition of transverse and longitudinal waves. Knowledge that sound is an example of a longitudinal wave and electromagnetic radiation and water waves are examples of transverse waves. Determination of the frequency, period, wavelength, amplitude and wave speed for longitudinal and transverse waves. Use of appropriate relationships to solve problems involving wave speed, frequency, period, wavelength, distance, number of waves and time. $v = \frac{d}{t}$ $f = \frac{N}{t}$ $v = f\lambda$ $T = \frac{1}{f}$ Knowledge that diffraction occurs when waves pass through a gap or around an object. Comparison of long wave and short wave diffraction. Draw diagrams using wavefronts to show diffraction when waves pass through a gap or around an object.
Electromagnetic spectrum
Knowledge of the relative frequency and wavelength of bands of the electromagnetic spectrum. Knowledge of typical sources, detectors and applications for each band in the electromagnetic spectrum. Knowledge that all radiations in the electromagnetic spectrum are transverse and travel at the speed of light.
Refraction of light
Knowledge that refraction occurs when waves pass from one medium to another. Description of refraction in terms of change of wave speed, change in wavelength and change of direction (where the angle of incidence is greater than 0°), for waves passing into both a more dense and a less dense medium. Identification of the normal, angle of incidence and angle of refraction in ray diagrams showing refraction.

Radiation
Nuclear radiation
Knowledge of the nature of alpha (α), beta (β) and gamma (γ) radiation. Knowledge of the term 'ionisation' and the effect of ionisation on neutral atoms. Knowledge of the relative ionising effect and penetration of alpha, beta and gamma radiation. Definition of activity in terms of the number of nuclear disintegrations and time. Use of an appropriate relationship to solve problems involving activity, number of nuclear disintegrations and time. $A = \frac{N}{t}$ Knowledge of sources of background radiation. Knowledge of the dangers of ionising radiation to living cells and of the need to measure exposure to radiation. Use of appropriate relationships to solve problems involving absorbed dose, equivalent dose, energy, mass and weighting factor. $D = \frac{E}{m}$ $H = Dw_r$ Use of an appropriate relationship to solve problems involving equivalent dose rate, equivalent dose and time. $\dot{H} = \frac{H}{t}$ Comparison of equivalent dose due to a variety of natural and artificial sources. Knowledge of equivalent dose rate and exposure safety limits for the public and for workers in the radiation industries in terms of annual effective equivalent dose. ♦ Average annual background radiation in UK: 2·2 mSv. ♦ Annual effective dose limit for member of the public: 1 mSv. ♦ Annual effective dose limit for radiation worker: 20 mSv. Awareness of applications of nuclear radiation: electricity generation, cancer treatment and other industrial and medical uses. Definition of half-life. Use of graphical or numerical data to determine the half-life of a radioactive material. Description of an experiment to measure the half-life of a radioactive material. Qualitative description of fission, chain reactions, and their role in the generation of energy. Qualitative description of fusion, plasma containment, and their role in the generation of energy.
Units, prefixes and scientific notation
Use of appropriate SI units and the prefixes nano (n), micro (μ), milli (m), kilo (k), mega (M), giga (G). Use of the appropriate number of significant figures in final answers. This means that the final answer can have no more significant figures than the value with the least number of significant figures used in the calculation. Appropriate use of scientific notation.

Skills, knowledge and understanding included in the course are appropriate to the SCQF level of the course. The SCQF level descriptors give further information on characteristics and expected performance at each SCQF level (www.scqf.org.uk).

Skills for learning, skills for life and skills for work

This course helps candidates to develop broad, generic skills. These skills are based on SQA's Skills Framework: Skills for Learning, Skills for Life and Skills for Work and draw from the following main skills areas:

2 Numeracy

2.1 Number processes
2.2 Money, time and measurement
2.3 Information handling

5 Thinking skills

5.3 Applying
5.4 Analysing and evaluating

These skills must be built into the course where there are appropriate opportunities and the level should be appropriate to the level of the course.

Further information on building in skills for learning, skills for life and skills for work is given in the course support notes.

Course assessment

Course assessment is based on the information provided in this document.

The course assessment meets the key purposes and aims of the course by addressing:

- 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 enables candidates to:

- apply breadth and depth of skills, knowledge and understanding from across the course to answer questions in physics
- apply skills of scientific inquiry, using related knowledge, to carry out a meaningful and appropriately challenging investigation in physics and communicate findings

The course assessment has two components, a question paper and an assignment. The relationship between these two components is complementary, to ensure full coverage of the knowledge and skills of the course.

Course assessment structure: question paper

Question paper 135 marks

The purpose of the question paper is to assess breadth, challenge and application of skills, knowledge and understanding from across the course.

The question paper also assesses scientific inquiry skills and analytical thinking skills.

The question paper gives candidates an opportunity to demonstrate skills, knowledge and understanding by:

- making accurate statements
- providing descriptions and explanations
- applying knowledge of physics to new situations, interpreting information and solving problems
- planning or designing experiments to test given hypotheses or to illustrate particular effects, including safety measures
- selecting information
- presenting information appropriately in a variety of forms
- processing information (using calculations and units, where appropriate)
- making predictions based on evidence/information
- drawing valid conclusions and giving explanations supported by evidence/justification
- evaluating experimental procedures

The question paper has a total of 135 marks and contributes 80% of the overall marks for external assessment.

The question paper has two sections:

- Section 1 (objective test) has 25 marks.
- Section 2 contains restricted and extended response questions and has 110 marks. This is scaled to 75 marks.

The majority of marks are awarded for demonstrating and applying knowledge and understanding. The other marks are awarded for applying scientific inquiry and analytical thinking skills.

A data sheet containing relevant data and a relationships sheet are provided.

Setting, conducting and marking the question paper

The question paper is set and marked by SQA, and conducted in centres under conditions specified for external examinations by SQA. The question paper is 2 hours and 30 minutes in duration.

Specimen question papers for National 5 courses are published on SQA's website. These illustrate the standard, structure and requirements of the question papers candidates sit. The specimen papers also include marking instructions.

Course assessment structure: assignment

Assignment 20 marks

The purpose of the assignment is to assess the application of skills of scientific inquiry and related physics knowledge and understanding.

This component allows assessment of skills which cannot be assessed through the question paper, for example the handling and processing of data gathered as a result of experimental and research skills.

Assignment overview

The assignment gives candidates an opportunity to demonstrate the following skills, knowledge and understanding:

- applying knowledge of physics to new situations, interpreting information and solving problems
- planning, designing and safely carrying out experiments/practical investigations to test given hypotheses or to illustrate particular effects
- selecting information from a variety of sources
- presenting information appropriately in a variety of forms
- processing the information (using calculations and units, where appropriate)
- making predictions based on evidence/information
- drawing valid conclusions and giving explanations supported by evidence/justification
- suggesting improvements to experiments/practical investigations
- communicating findings/information

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
- familiar but integrates a number of concepts

Candidates will research and report on a topic that allows them to apply skills and knowledge in physics at a level appropriate to National 5.

The topic should be chosen with guidance from the teacher/lecturer and must involve experimental work.

The assignment has two stages:

- research
- report

The research stage must involve an experiment that allows measurements to be made. Candidates must also gather data from the internet, books or journals to compare against their experimental results. The candidate's research may also involve gathering extracts from internet/literature sources to support their descriptions and/or explanations of the underlying physics.

Candidates must produce a report on their research.

Setting, conducting and marking the assignment

Setting

The assignment is:

- set by centres within SQA guidelines
- set at a time appropriate to the candidates' needs
- set within teaching and learning and includes experimental work at a level appropriate to National 5

Conducting

The assignment is:

- an individually produced piece of work from each candidate
- started at an appropriate point in the course
- conducted under controlled conditions

Marking

The assignment has a total of 20 marks. The table below gives details of the mark allocation for each section of the report.

Section	Expected response	Max marks
Title	The report has an informative title.	1
Aim	A description of the purpose of the investigation.	1
Underlying physics relevant to the aim	An account of the physics relevant to the aim which shows understanding.	3
Data collection and handling	A brief description of the experiment.	1
	Sufficient raw data from the experiment.	1
	Raw data presented in a table with headings and units.	1
	Values correctly calculated from the raw data.	1
	Comparative data from an internet/literature source.	1
	A reference for the internet/literature source.	1
Graphical presentation	The correct type of graph used to present the experimental data.	1
	Suitable scales.	1
	Suitable labels and units on axes.	1
	All points plotted accurately, with line or curve of best fit if appropriate.	1
Analysis	Experimental data compared to data from internet/literature source.	1
Conclusion	A conclusion related to the aim and supported by all the data in the report.	1
Evaluation	A discussion of a factor affecting the reliability, accuracy or precision of the results.	2
Structure	A report which can be easily followed.	1
		20

The report is submitted to SQA for external marking.

All marking is quality assured by SQA.

Assessment conditions

Controlled assessment is designed to:

- ensure that all candidates spend approximately the same amount of time on their assignments
- prevent third parties from providing inappropriate levels of guidance and input
- mitigate concerns about plagiarism and improve the reliability and validity of SQA awards
- allow centres a reasonable degree of freedom and control
- allow candidates to produce an original piece of work

Detailed conditions for assessment are given in the assignment assessment task.

Time

It is recommended that no more than 8 hours is spent on the **whole** assignment. A maximum of 1 hour and 30 minutes is allowed for the report stage.

Supervision, control and authentication

There are two levels of control:

Under a high degree of supervision and control	Under some supervision and control
♦ the use of resources is tightly prescribed ♦ all candidates are within direct sight of the supervisor throughout the session(s) ♦ display materials that might provide assistance are removed or covered ♦ there is no access to e-mail, the internet or mobile phones ♦ candidates complete their work independently ♦ interaction with other candidates does not occur ♦ no assistance of any description is provided	♦ candidates do not need to be directly supervised at all times ♦ the use of resources, including the internet, is not tightly prescribed ♦ the work an individual candidate submits for assessment is their own ♦ teachers and lecturers can provide reasonable assistance

The assignment has two stages.

Stage	Level of control
♦ research	conducted under some supervision and control
♦ report	conducted under a high degree of supervision and control

Resources

Please refer to the instructions for teachers within the assignment assessment task.

In the research stage:

- teachers/lecturers must agree the choice of topic with the candidate
- teachers/lecturers must provide advice on the suitability of the candidate's aim
- teachers/lecturers can supply instructions for the experimental procedure
- candidates must undertake research using only websites, journals and/or books, to find secondary data/information
- a wide list of URLs and/or a wide range of books and journals may be provided

Teachers/lecturers **must not**:

- provide an aim
- provide candidates with a set of experimental data for the candidate's experiment
- provide candidates with a set of experimental data to compare with the candidate's own data
- provide a blank or pre-populated table for experimental results

The only materials that **can** be used in the report stage are:

- the instructions for candidates, which must not have been altered
- the candidate's raw experimental data
- comparative data from the internet or literature
- a record of the source of the comparative data
- extract(s) from internet/literature source(s) to support the description of the underlying physics
- the experimental method, if appropriate

Candidates **must not** have access to a previously prepared:

- draft of a report
- draft of a description of the underlying physics
- specimen calculation or set of calculations for mean or derived values
- graph
- comparison of data
- conclusion
- evaluation of an experimental procedure

In addition, candidates **must not** have access to the assignment marking instructions during the report stage.

Reasonable assistance

Candidates must undertake the assessment independently. However, reasonable assistance may be provided prior to the formal assessment process taking place. The term ‘reasonable assistance’ is used to try to balance the need for support with the need to avoid giving too much assistance. If any candidates require more than what is deemed to be ‘reasonable assistance’, they may not be ready for assessment or it may be that they have been entered for the wrong level of qualification.

The assignment assessment task provides guidance on reasonable assistance.

Evidence to be gathered

The following candidate evidence is required for this assessment:

- a report

The report is submitted to SQA, within a given time frame, for marking.

The same report cannot be submitted for more than one subject.

Volume

There is no word count.

Grading

A candidate's overall grade is determined by their performance across the course assessment. The course assessment is graded A–D on the basis of the total mark for all course assessment components.

Grade description for C

For the award of grade C, candidates will typically have demonstrated successful performance in relation to the skills, knowledge and understanding for the course.

Grade description for A

For the award of grade A, candidates will typically have demonstrated a consistently high level of performance in relation to the skills, knowledge and understanding for the course.

Equality and inclusion

This course is designed to be as fair and as accessible as possible with no unnecessary barriers to learning or assessment.

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

Further information

The following reference documents provide useful information and background.

- National 5 Physics subject page
- Assessment arrangements web page
- Building the Curriculum 3–5
- Design Principles for National Courses
- Guide to Assessment
- SCQF Framework and SCQF level descriptors
- SCQF Handbook
- SQA Skills Framework: Skills for Learning, Skills for Life and Skills for Work
- Coursework Authenticity: A Guide for Teachers and Lecturers
- Educational Research Reports
- SQA Guidelines on e-assessment for Schools
- SQA e-assessment web page

Appendix: course support notes

Introduction

These support notes are not mandatory. They provide advice and guidance to teachers and lecturers on approaches to delivering the course. They should be read in conjunction with this course specification, the specimen question paper and the assignment assessment task.

Developing skills, knowledge and understanding

This section provides further advice and guidance about skills, knowledge and understanding that could be included in the course. Teachers and lecturers should refer to this course specification for the skills, knowledge and understanding for the course assessment. Course planners have considerable flexibility to select coherent contexts which will stimulate and challenge their candidates, offering both breadth and depth.

When developing physics courses there should be opportunities for candidates to take responsibility for their learning. Learning and teaching should build on candidates' prior knowledge, skills and experiences.

Flexibility and differentiation of tasks should be built into the course to allow candidates of differing abilities to demonstrate achievement.

An investigative approach is encouraged in physics, with candidates actively involved in developing their skills, knowledge and understanding. A holistic approach should be adopted to encourage the simultaneous development of candidates' conceptual understanding and skills.

Where appropriate, investigative work/experiments in physics should allow candidates the opportunity to select activities and/or carry out extended study. Investigative and experimental work is part of the scientific method of working and can fulfil a number of educational purposes.

Learning and teaching should offer opportunities for candidates to work collaboratively. Practical activities and investigative work can offer opportunities for group work, which should be encouraged.

Group work approaches can be used to simulate real-life situations, share tasks and promote team-working skills.

Laboratory work should include the use of technology and equipment to reflect current practices in physics. Appropriate risk assessment must be undertaken.

In addition to programmed learning time, candidates would be expected to contribute their own time.

Effective partnership working can enhance the learning experience. Where appropriate, locally relevant contexts should be studied, with visits if possible. Guest speakers from industry, further and higher education could be invited to share their knowledge of particular aspects of physics.

Information and Communications Technology (ICT) makes a significant contribution to the physics course. In addition to the use of computers as a learning tool, computer animations and simulations can be used to develop the understanding of physics principles and processes. Computer interfacing equipment can detect changes in variables, allowing experimental results to be recorded and processed. Results can also be displayed in real-time which helps to improve understanding.

Assessment should be integral to and improve learning and teaching. The approach should involve candidates and provide supportive feedback. Self- and peer- assessment techniques should be encouraged wherever appropriate. Assessment information can be used to set learning targets and next steps.

Approaches to learning and teaching

Teaching should involve a range of approaches to develop knowledge and understanding and skills for learning, life and work. The mandatory content **can be taught in any order** and may be integrated into a sequence of activities, centred on an idea, theme or application of physics or based on a variety of discrete contexts.

Examples of possible learning and teaching activities can be found in the table overleaf. The first column is identical to the ‘skills, knowledge and understanding for the course assessment’ section in this course specification. The second column offers suggestions for activities that could be used to enhance teaching and learning. All resources named were correct at the time of publication and may be subject to change. Learning should be experiential, active, challenging and enjoyable and include appropriate practical experiments/activities.

Dynamics Mandatory knowledge	Suggested activities
Vectors and scalars	
Definition of vector and scalar quantities. Identification of force, speed, velocity, distance, displacement, acceleration, mass, time and energy as vector or scalar quantities. Calculation of the resultant of two vector quantities in one dimension or at right angles. Determination of displacement and/or distance using scale diagram or calculation. Determination of velocity and/or speed using scale diagram or calculation. Use of appropriate relationships to solve problems involving velocity, speed, displacement, distance and time. $s = vt$ $s = \bar{v}t$ $d = \bar{v}t$ Description of experiments to measure average and instantaneous speed.	Set up an orienteering course in school grounds — calculate displacement and average velocity, distance and average speed. Use route mapper apps to find distance, speed and the magnitudes of displacement and velocity. Discuss and compare the difference between vector and scalar quantities. Calculate average speed/velocity using distance/displacement data and time data from a number of contexts, for example athletics, cars, flight, space and data from apps, light gates, etc. Analyse motion vectors using scale diagrams and/or trigonometry.

Dynamics **Mandatory knowledge**	**Suggested activities**
Velocity–time graphs	
Drawing or sketching of velocity–time or speed–time graphs from data. Interpretation of a velocity–time graph to describe the motion of an object. Determination of displacement from a velocity–time graph. $s = \text{area under } v\text{-}t \text{ graph.}$	Plot graphs from data sets (manually or using software). Capture and analyse data using appropriate software, eg trolleys running down slopes. Use video analysis or data logging software to produce speed–time and velocity–time graphs. Observe the v-t graph of bouncing ball using a motion sensor.
Acceleration	
Definition of acceleration in terms of initial velocity, final velocity and time. Use of an appropriate relationship to solve problems involving acceleration, initial velocity (or speed), final velocity (or speed) and time. $a = \frac{v-u}{t}$ Determination of acceleration from a velocity–time graph. $a = \text{gradient of the line on a } v\text{-}t \text{ graph.}$ Description of an experiment to measure acceleration.	Determine the acceleration of a vehicle using two light gates and timer and record times for instantaneous speeds and time between. Determine acceleration from a velocity–time graph by finding the gradient using data software. This could be done from a graph created from data logging or video analysis. Measure the acceleration of a vehicle using a light gate connected to a computer.

Dynamics Mandatory knowledge	Suggested activities
Newton's laws	
Application of Newton's laws and balanced forces to explain constant velocity (or speed), making reference to frictional forces. Application of Newton's laws and unbalanced forces to explain and/or determine acceleration for situations where more than one force is acting. Use of an appropriate relationship to solve problems involving unbalanced force, mass and acceleration for situations where one or more forces are acting in one dimension or at right angles. $F = ma$ Use of an appropriate relationship to solve problems involving weight, mass and gravitational field strength. $W = mg$ Explanation of motion resulting from a 'reaction' force in terms of Newton's third law. Explanation of free-fall and terminal velocity in terms of Newton's laws.	Investigate 'frictionless movement' using an air hockey puck, linear air-track or model hovercraft. Discuss practical examples of balanced forces, for example gliding, floating in water or tug of war. Investigate Newton's second law using a linear air track or other suitable means. Relate Newton's laws to car safety measures, for example seatbelts, air bags or crumple zones. Experiment with water rockets/compressed air rocket launchers. Investigate parachutes, for example by dropping flat and crushed sheets of paper. Demonstrate balanced forces and terminal velocity by dropping ball bearings into glycerine-filled measuring cylinders.

Dynamics **Mandatory knowledge**	**Suggested activities**
Energy	
Explanation of energy conservation and of energy conversion and transfer. Use of an appropriate relationship to solve problems involving work done, unbalanced force and distance/displacement. $E_w = Fd$, or $W = Fd$ Definition of gravitational potential energy. Use of an appropriate relationship to solve problems involving gravitational potential energy, mass, gravitational field strength and height. $E_p = mgh$ Definition of kinetic energy. Use of an appropriate relationship to solve problems involving kinetic energy, mass and speed. $E_k = \frac{1}{2}mv^2$ Use of appropriate relationships to solve problems involving conservation of energy. $E_w = Fd$, $W = Fd$ $E_p = mgh$ $E_k = \frac{1}{2}mv^2$	Investigate the conservation of energy for a model car or trolley released from the top of a slope. Discuss the difference between the values of potential energy and kinetic energy obtained.

Dynamics Mandatory knowledge	Suggested activities
Projectile motion	
Explanation of projectile motion in terms of constant vertical acceleration and constant horizontal velocity. Use of appropriate relationships to solve problems involving projectile motion from a horizontal launch, including the use of motion graphs. area under v_h-t graphs (horizontal range) area under v_v-t graphs (vertical height) $v_h = \frac{s}{t}$ (constant horizontal velocity) $v_v = u_v + at$ (constant vertical acceleration) Explanation of satellite orbits in terms of projectile motion, horizontal velocity and weight.	Observe the 'String of pearls' experiment (using a strobe light to see the separation of projectile motion). Observe the 'Monkey and hunter' experiment. Use tracking software to analyse a video recording of projectile motion. Investigate and calculate 'drop time' and 'time of flight'. Discuss Newton's 'thought' experiment. Investigate factors affecting the time of flight and horizontal range of a projectile.

Space Mandatory knowledge	Suggested activities
Space exploration	
Basic awareness of our current understanding of the universe. Use of the following terms correctly and in context: planet, dwarf planet, moon, Sun, asteroid, solar system, star, exoplanet, galaxy, universe. Awareness of the benefits of satellites: GPS, weather forecasting, communications, scientific discovery and space exploration (for example Hubble telescope, ISS). Knowledge that geostationary satellites have a period of 24 hours and orbit at an altitude of 36 000 km. Knowledge that the period of a satellite in a high altitude orbit is greater than the period of a satellite in a lower altitude orbit. Awareness of the challenges of space travel: ♦ travelling large distances with the possible solution of attaining high velocity by using ion drive (producing a small unbalanced force over an extended period of time) ♦ travelling large distances using a ‘catapult’ from a fast moving asteroid, moon or planet ♦ manoeuvring a spacecraft in a zero friction environment, possibly to dock with the ISS ♦ maintaining sufficient energy to operate life support systems in a spacecraft, with the possible solution of using solar cells with area that varies with distance from the Sun.	Discuss space exploration (emphasising that our knowledge of space is continually developing) using suitable simulations and/or DVDs. Observe lunar landing simulations. Use interactive software to model lunar landing. Create an animation of lunar landing and annotate it to show different stages of motion.

Space Mandatory knowledge	Suggested activities
Space exploration (continued)	
Awareness of the risks associated with manned space exploration: ♦ fuel load on take-off ♦ potential exposure to radiation ♦ pressure differential ♦ re-entry through an atmosphere Knowledge of Newton's second and third laws and their application to space travel, rocket launch and landing. Use of an appropriate relationship to solve problems involving weight, mass and gravitational field strength, in different locations in the universe. $W = mg$	View videos of re-entry, eg Joe Kittinger or Felix Baumgartner. Discuss the need for thermal protection systems to protect spacecraft on re-entry, including qualitative and quantitative specific heat capacity.
Cosmology	
Use of the term 'light year' and conversion between light years and metres. Basic description of the 'Big Bang' theory of the origin of the universe. Knowledge of the approximate estimated age of the universe. Awareness of the use of the whole electromagnetic spectrum in obtaining information about astronomical objects. Identification of continuous and line spectra. Use of spectral data for known elements, to identify the elements present in stars.	Research recent advances in astronomy and in our knowledge of the universe. Discuss how radio telescopes, the COBE satellite and the SETI institute have advanced our knowledge of the universe. Construct a simple spectroscope from a CD disk and examine common light sources. Use a spectroscope to look at a range of light sources, eg sodium lamp and other gas discharge lamps.

<table>
<tr><th>Electricity
Mandatory knowledge</th><th>Suggested activities</th></tr>
<tr><td colspan="2">Electrical charge carriers</td></tr>
<tr><td>Definition of electrical current as the electric charge transferred per unit time.

Use of an appropriate relationship to solve problems involving charge, current and time.

$Q = It$

Knowledge of the difference between alternating and direct current.

Identification of a source (as a.c. or d.c.) based on oscilloscope trace or image from data logging software.</td><td>Discuss and research the uses of electrostatics.

Investigate the interaction of charged objects, eg metallised polystyrene spheres attracted and repelled, Van de Graaff generator discharged through a microammeter.

Research the definition of current and its historical context.

Use an oscilloscope/data logging software to compare alternating and direct sources.</td></tr>
<tr><td colspan="2">Potential difference (voltage)</td></tr>
<tr><td>Knowledge that a charged particle experiences a force in an electric field.

Knowledge of the path a charged particle follows:
between two oppositely charged parallel plates; near a single point charge; between two oppositely charged points; between two like charged points.

Knowledge that the potential difference (voltage) of the supply is a measure of the energy given to the charge carriers in a circuit.</td><td>Observe demonstrations of electric fields using Teltron tubes, olive oil and seeds with an EHT supply, Van de Graaff generator, parallel plates and suspended pith ball.
Note: HT supplies must not be used with exposed live conductors.

Discuss various models for electricity and their suitability for explaining potential difference (voltage).

Carry out practical investigations to measure potential differences across components in series circuits. Describe the energy transfers and show that although there is a transfer of energy in the circuit, energy is conserved.</td></tr>
</table>

Electricity **Mandatory knowledge**	**Suggested activities**
Ohm's law	
Calculation of the gradient of the line of best fit on a V-I graph to determine resistance. Use of appropriate relationships to solve problems involving potential difference (voltage), current and resistance. $V = IR$ $V_2 = \left(\frac{R_2}{R_1 + R_2}\right)V_s$ $\frac{V_1}{V_2} = \frac{R_1}{R_2}$ Knowledge of the qualitative relationship between the temperature and resistance of a conductor. Description of an experiment to verify Ohm's law.	Carry out a range of practical investigations to determine the relationship between potential difference, current and resistance using simple ohmic components. Investigate potential dividers using fixed and non-fixed resistors (eg LDRs, thermistors, variable resistors). Carry out investigations with non-ohmic conductors, for example, a ray-box lamp.
Practical electrical and electronic circuits	
Measurement of current, potential difference (voltage) and resistance, using appropriate meters in simple and complex circuits. Knowledge of the circuit symbol, function and application of standard electrical and electronic components: cell, battery, lamp, switch, resistor, voltmeter, ammeter, LED, motor, microphone, loudspeaker, photovoltaic cell, fuse, diode, capacitor, thermistor, LDR, relay, transistor.	Investigate the function of the named components in practical circuits, for example the function of a transistor as a switch.

Electricity **Mandatory knowledge**	**Suggested activities**
Practical electrical and electronic circuits (continued)	
For transistors, knowledge of the symbols for an npn transistor and an n-channel enhancement mode MOSFET. Explanation of their function as a switch in transistor switching circuits. Application of the rules for current and potential difference (voltage) in series and parallel circuits. $I_s = I_1 = I_2 = \ldots$ $V_s = V_1 + V_2 + \ldots$ $I_p = I_1 + I_2 + \ldots$ $V_p = V_1 = V_2 = \ldots$ Knowledge of the effect on the total resistance of a circuit of adding further resistance in series or in parallel. Use of appropriate relationships to solve problems involving the total resistance of resistors in series and in parallel circuits, and in circuits with a combination of series and parallel resistors. $R_T = R_1 + R_2 + \ldots$ $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$	Investigate the effect on the total resistance of a circuit of combining resistors in series and in parallel. Research and discuss the benefits of a ring circuit over a standard parallel circuit.

Electricity **Mandatory knowledge**	**Suggested activities**
Electrical Power	
Definition of electrical power in terms of electrical energy and time. Use of an appropriate relationship to solve problems involving energy, power and time. $P = \frac{E}{t}$ Knowledge of the effect of potential difference (voltage) and resistance on the current in and power developed across components in a circuit.	Measure and compare the power of various electrical devices. Use smart meters to measure voltage, current, energy and power for mains appliances.
Use of appropriate relationships to solve problems involving power, potential difference (voltage), current and resistance in electrical circuits. $P = IV$ $P = I^2R$ $P = \frac{V^2}{R}$	Investigate power loss using model power transmission lines. Carry out a survey into household/educational establishment energy consumption.
Selection of an appropriate fuse rating given the power rating of an electrical appliance. A 3 A fuse should be selected for most appliances rated up to 720 W, a 13 A fuse for appliances rated over 720 W.	Investigate the power rating and recommended fuses for household appliances.

Properties of matter Mandatory knowledge	Suggested activities
Specific heat capacity	
Knowledge that different materials require different quantities of heat to raise the temperature of unit mass by one degree Celsius. Use of an appropriate relationship to solve problems involving mass, heat energy, temperature change and specific heat capacity. $E_h = cm\Delta T$ Knowledge that the temperature of a substance is a measure of the mean kinetic energy of its particles. Use of the principle of conservation of energy to determine heat transfer.	Heat different masses of water in similar kettles predicting which will reach boiling point first and explain the reasons for this prediction. Carry out an investigation to compare the heat energy stored in different materials of the same mass when heated to the same temperature. Carry out experiments to determine the specific heat capacity of various metals. Research clothing used for specialist jobs, eg fire fighter, astronaut and polar explorer. Explain why some foods seem much warmer on the tongue than others when cooked, eg tomatoes in a cheese and tomato toastie. Design a heating system, for example heat pump, solar-heat traps, ground-storage systems, etc. Design a central-heating boiler to be as 'efficient' as possible and discuss how to reduce heat energy dissipation through the walls of the boiler.
Specific latent heat	
Knowledge that different materials require different quantities of heat to change the state of unit mass. Knowledge that the same material requires different quantities of heat to change the state of unit mass from solid to liquid (fusion) and to change the state of unit mass from liquid to gas (vaporisation). Use of an appropriate relationship to solve problems involving mass, heat energy and specific latent heat. $E_h = ml$	Plot cooling curves for substances in a temperature range which involves a change of state. Carry out practical investigations to compare the energy required to melt a mass of ice at 0 °C and to boil the same mass of water at 100 °C.

Properties of matter Mandatory knowledge	Suggested activities
Gas laws and the kinetic model	
Definition of pressure in terms of force and area. Use of an appropriate relationship to solve problems involving pressure, force and area. $p = \frac{F}{A}$	Investigation into the relationship between pressure and force using a gas syringe and masses.
Description of how the kinetic model accounts for the pressure of a gas. Knowledge of the relationship between Kelvin and degrees Celsius and the absolute zero of temperature. $0\ \text{K} = -273\ ^{\circ}\text{C}$	Research the kinetic theory of gases. Use a mechanical model to investigate kinetic theory (eg motor-driven polystyrene beads or small ball bearings). Observe Brownian motion in a smoke cell or an animation. Research the role of Lord Kelvin in the determination of the absolute scale of temperature.
Explanation of the pressure–volume, pressure–temperature and volume-temperature laws qualitatively in terms of a kinetic model. Use of appropriate relationships to solve problems involving the volume, pressure and temperature of a fixed mass of gas. $p_1V_1 = p_2V_2$ $\frac{p_1}{T_1} = \frac{p_2}{T_2}$ $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ $\frac{pV}{T} = \text{constant}$	Investigate the relationships between the pressure, volume and temperature of a fixed mass of gas. Research and discuss the limitations of the behaviour of real gases.
Description of experiments to verify the pressure–volume law (Boyle's law), the pressure–temperature law (Gay-Lussac's law) and the volume–temperature law (Charles' law).	Carry out experiments to verify Boyle's law, Gay-Lussac's law and Charles' law.

Waves **Mandatory knowledge**	**Suggested activities**
Wave parameters and behaviours	
Knowledge that waves transfer energy. Definition of transverse and longitudinal waves. Knowledge that sound is an example of a longitudinal wave and electromagnetic radiation and water waves are examples of transverse waves. Determination of the frequency, period, wavelength, amplitude and wave speed for longitudinal and transverse waves. Use of appropriate relationships to solve problems involving wave speed, frequency, period, wavelength, distance, number of waves and time. $v = \frac{d}{t}$ $f = \frac{N}{t}$ $v = f\lambda$ $T = \frac{1}{f}$	View video of effects of energy carried by large waves. View simulations of longitudinal and transverse waves. Investigate the wave equation using video analysis of waves on 'slinkies'. Identify, measure and calculate frequency, wavelength and speed for sound waves or water waves, eg using data loggers, or echo methods.
Knowledge that diffraction occurs when waves pass through a gap or around an object. Comparison of long wave and short wave diffraction. Draw diagrams using wave fronts to show diffraction when waves pass through a gap or around an object.	Investigate the diffraction of waves around objects and through gaps using ripple tanks or microwave kit. Consider radio and TV reception in hilly terrain.

Waves **Mandatory knowledge**	**Suggested activities**
Electromagnetic spectrum	
Knowledge of the relative frequency and wavelength of bands of the electromagnetic spectrum. Knowledge of typical sources, detectors and applications for each band in the electromagnetic spectrum. Knowledge that all radiations in the electromagnetic spectrum are transverse and travel at the speed of light.	Explore, discuss and compare applications of e-m spectrum beyond the visible, eg thermal imaging camera, IR webcam, fluorescence with UV, radio/mobile phone communication. Discuss and compare limitations for applications of e-m waves in relation to frequency and image resolution.
Refraction of light	
Knowledge that refraction occurs when waves pass from one medium to another. Description of refraction in terms of change of wave speed, change in wavelength and change of direction (where the angle of incidence is greater than 0°), for waves passing into both a more dense and a less dense medium. Identification of the normal, angle of incidence and angle of refraction in ray diagrams showing refraction.	Investigate the reason for the 'apparent depth' of water. Investigate the qualitative relationship between angle of incidence and the angle of refraction. Research practical applications of refraction in medicine and industry.

Radiation Mandatory knowledge	Suggested activities
Nuclear radiation	
Knowledge of the nature of alpha (α), beta (β) and gamma (γ) radiation. Knowledge of the term 'ionisation' and the effect of ionisation on neutral atoms. Knowledge of the relative ionising effect and penetration of alpha, beta and gamma radiation. Definition of activity in terms of the number of nuclear disintegrations and time. Use of an appropriate relationship to solve problems involving activity, number of nuclear disintegrations and time. $A = \frac{N}{t}$ Knowledge of sources of background radiation. Knowledge of the dangers of ionising radiation to living cells and of the need to measure exposure to radiation. Use of appropriate relationships to solve problems involving absorbed dose, equivalent dose, energy, mass and weighting factor. $D = \frac{E}{m}$ $H = Dw_r$	View demonstrations/simulations of the relative penetration of alpha, beta and gamma radiation. Research the extraction of naturally occurring radioactive materials. Measure background radiation in a number of locations. Discuss or debate the risks and benefits of radioactivity in society. Discuss or debate the biological effects of radiation. Compare the count rate from potassium chloride and sodium chloride. Research society's reliance on radioactivity for a range of medical and industrial applications, including energy sources.

Radiation Mandatory knowledge	Suggested activities
Nuclear radiation (continued)	
Use of an appropriate relationship to solve problems involving equivalent dose rate, equivalent dose and time. $\dot{H} = \frac{H}{t}$ Comparison of equivalent dose due to a variety of natural and artificial sources. Knowledge of equivalent dose rate and exposure safety limits for the public and for workers in the radiation industries in terms of annual effective equivalent dose. ♦ Average annual background radiation in UK: 2·2 mSv. ♦ Annual effective dose limit for member of the public: 1 mSv. ♦ Annual effective dose limit for radiation worker: 20 mSv.	
Awareness of applications of nuclear radiation: electricity generation, cancer treatment and other industrial and medical uses. Definition of half-life.	Research the significance of half-life in medical and industrial applications.
Use of graphical or numerical data to determine the half-life of a radioactive material. Description of an experiment to measure the half-life of a radioactive material.	View a demonstration of an experiment to determine half-life. Carry out a virtual experiment of half-life measurement. Observe the decay of the daughter products of radon from a charged balloon.
Qualitative description of fission, chain reactions, and their role in the generation of energy. Qualitative description of fusion, plasma containment, and their role in the generation of energy.	Research current applications and developments of fission and fusion reactions to generate energy. Research the fission process in nuclear power stations. Research developments into creating the conditions for nuclear fusion.

Units, prefixes and scientific notation **Mandatory knowledge**	**Suggested activities**
Use of appropriate SI units and the prefixes nano (n), micro (μ), milli (m), kilo (k), mega (M), giga (G). Use of the appropriate number of significant figures in final answers. This means that the final answer can have no more significant figures than the value with least number of significant figures used in the calculation. Appropriate use of scientific notation.	

Preparing for course assessment

Each course has additional time which may be used at the discretion of teachers and lecturers to enable candidates to prepare for course assessment. This time may be used at various points throughout the course for consolidation and support. It may also be used towards the end of the course for further integration, revision and preparation.

The question paper assesses a selection of knowledge and skills acquired in the course. It also provides opportunities to apply skills in a range of contexts, some of which may be unfamiliar.

During delivery of the course, opportunities should be found:

- for identification of particular aspects of work requiring reinforcement and support
- to develop skills of scientific inquiry in preparation for the assignment
- to practise responding to multiple-choice, short-answer, extended-answer, and open-ended questions
- to improve exam technique

Developing skills for learning, skills for life and skills for work

Course planners should identify opportunities throughout the course for candidates to develop skills for learning, skills for life and skills for work.

Candidates should be aware of the skills they are developing and teachers and lecturers can provide advice on opportunities to practise and improve them.

SQA does not formally assess skills for learning, skills for life and skills for work.

There may also be opportunities to develop additional skills depending on approaches being used to deliver the course in each centre. This is for individual teachers and lecturers to manage.

Candidates are expected to develop broad, generic skills as an integral part of their learning experience. This course specification lists the skills for learning, skills for life and skills for work that candidates should develop through this course. These are based on SQA's Skills Framework: Skills for Learning, Skills for Life and Skills for Work and must be built into the course where there are appropriate opportunities. The level of these skills will be appropriate to the level of the course.

For this course, it is expected that the following skills for learning, skills for life and skills for work will be developed:

Numeracy

This is the ability to use numbers in order to solve problems by counting, doing calculations, measuring, and understanding graphs and charts. This is also the ability to understand the results. Candidates will have opportunities to extract, process and interpret information presented in various formats including tabular and graphical. Experimental work will provide opportunities to develop time and measurement skills.

2.1 Number processes
Number processes means solving problems arising in everyday life through carrying out calculations, when dealing with data and results from experiments and everyday class work, making informed decisions based on the results of these calculations and understanding these results.

2.2 Money, time and measurement
This means using and understanding time and measurement to solve problems and handle data in a variety of contexts, including experiments.

2.3 Information handling
Information handling means being able to interpret data in tables, charts and other graphical displays to draw sensible conclusions throughout the course. It involves interpreting the data and considering its reliability in making reasoned deductions and informed decisions. It also involves an awareness and understanding of the chance of events happening.

Thinking skills

This is the ability to develop the cognitive skills of remembering and identifying, understanding and applying. The course will allow candidates to develop skills of applying, analysing and evaluating. Candidates can analyse and evaluate experiments and data by reviewing the process, identifying issues and forming valid conclusions. They can demonstrate understanding and application of concepts and explain and interpret information and data.

5.3 Applying
Applying is the ability to use existing information to solve problems in different contexts, and to plan, organise and complete a task such as an investigation.

5.4 Analysing and evaluating
Analysis and evaluating is the ability to solve problems and make decisions that are based on available information. It may involve the review and evaluation of relevant information and/or prior knowledge to provide an explanation.

In addition, candidates will also have opportunities to develop literacy skills, working with others, creating and citizenship.

Literacy

Candidates will develop the skills to communicate key concepts effectively. They will have opportunities to communicate knowledge and understanding and to develop listening and reading skills when gathering and processing information.

Working with others

Throughout the course, learning activities provide many opportunities for candidates to work with others. Practical activities and investigations offer opportunities for group work, which is an important aspect of physics and should be encouraged.

Creating

Through learning in physics, candidates can demonstrate their creativity. In particular, candidates have the opportunity to be innovative when planning and designing experiments.

Citizenship

Candidates will develop citizenship skills when considering the application of physics on our lives. Citizenship includes having concern for the environment and for the safety of others. This course has an extensive range of suggested practical activities which provide opportunities for candidates to work safely with others. Awareness of health and safety issues and safe working practices are key considerations. Candidates will develop an awareness of their rights and responsibilities and learn to act responsibly.

Administrative information

Published: October 2018 (version 3.0)

History of changes to course specification

Version	Description of change	Date
2.0	Course support notes added as an appendix	September 2017
3.0	‘Course assessment structure: assignment’ section: minor amendments to pages 19–23 to clarify the research and report stages.	October 2018

Note: you are advised to check SQA’s website to ensure you are using the most up-to-date version of the course specification.