Higher National Unit specification

General information

Unit title: Physics 1 (SCQF level 6)

Unit code: H93D 33

Superclass: RC

Publication date: May 2015

Source: Scottish Qualifications Authority

Version: 02

Unit purpose

This Unit is designed to enable learners to understand key aspects of physics including waves and optics, radioactivity and electricity. Learners will also develop practical skills in techniques relevant to physics. The Unit is suitable for learners studying at HNC level, and will provide the necessary underpinning knowledge and skills to enable progression to further study of physics at HND level or to seek employment in science based industries.

Outcomes

On successful completion of the Unit the learner will be able to:

1 Apply aspects related to waves and optics.
2 Apply and explain aspects related to radioactivity.
3 Apply aspects related to electricity.
4 Perform a practical experiment related to physics.

Credit points and level

1 Higher National Unit credit at SCQF level 6: (8 SCQF credit points at SCQF level 6)

Recommended entry to the Unit

Entry is at the discretion of the centre, however it is recommended that learners should have experience of Mathematics at National 5 level.

Higher National Unit specification: General information (cont)

Unit title: Physics 1 (SCQF level 6)

Core Skills

Achievement of this Unit gives automatic certification of the following Core Skills component:

Complete Core Skill	None
Core Skill component	Critical Thinking at SCQF level 6 Using Number at SCQF level 6

There are also opportunities to develop aspects of Core Skills which are highlighted in the Support Notes of this Unit specification.

Context for delivery

If this Unit is delivered as part of a Group Award, it is recommended that it should be taught and assessed within the subject area of the Group Award to which it contributes.

The Assessment Support Pack (ASP) for this Unit provides assessment and marking guidelines that exemplify the national standard for achievement. It is a valid, reliable and practicable assessment. Centres wishing to develop their own assessments should refer to the ASP to ensure a comparable standard. A list of existing ASPs is available to download from SQA's website **www.sqa.org.uk/sqa/46233.2769.html**.

Equality and inclusion

This Unit specification has been designed to ensure that there are no unnecessary barriers to learning or assessment. The individual needs of learners should be taken into account when planning learning experiences, selecting assessment methods or considering alternative evidence.

Further advice can be found on our website **www.sqa.org.uk/assessmentarrangements**.

Higher National Unit specification: Statement of standards

Unit title: Physics 1 (SCQF level 6)

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

Where evidence for Outcomes is assessed on a sample basis, the whole of the content listed in the Knowledge and/or Skills section must be taught and available for assessment. Learners should not know in advance the items on which they will be assessed and different items should be sampled on each assessment occasion.

Outcome 1

Apply aspects related to waves and optics.

Knowledge and/or Skills

- Wave motion: types and the relationship between wavelength, frequency, velocity, period
- Electromagnetic spectrum
- Reflection in mirrors: plane and curved
- Refraction: Snell's law
- Total internal reflection and optical fibres
- Ray diagrams and thin lenses: optical instruments including the eye, microscope, magnifying glass, telescope

Outcome 2

Apply and explain aspects related to radioactivity.

Knowledge and/or Skills

- Radioactive decay mechanisms: alpha, beta particles and gamma radiation
- Background radiation, radiation detection and monitoring, safety limits for members of the public and workers
- Half-life
- Half value thickness and safe handling procedures: shield, distance, time reduction
- Dosimetry: activity, absorbed dose, radiation weighting factor, equivalent dose
- Uses of isotopes in society and medicine

Higher National Unit specification: Statement of standards

Unit title: Physics 1 (SCQF level 6)

Outcome 3

Apply aspects related to electricity.

Knowledge and/or Skills

- Electromotive force and electric current
- Electrical resistance and Ohm's law
- Basic circuitry and symbols: I,V and R in simple series and parallel circuits
- Potential dividers
- Electrical energy, power and transformers
- Mains electricity and energy costs in the home

Outcome 4

Perform a practical experiment related to physics.

Knowledge and/or Skills

- Physics experiment
- Working safely, within current health and safety regulations
- Consistent and accurate results
- Recording observations and results
- Evaluation skills
- Result analysis and conclusions

Higher National Unit specification: Statement of standards (cont)

Unit title: Physics 1 (SCQF level 6)

Evidence Requirements for this Unit

Written and/or oral recorded evidence for Outcomes 1−3 should be assessed using a holistic closed-book assessment under supervised conditions. The assessment will use a sampling approach to the Knowledge and/or Skills items as detailed below. It is recommended that the assessment be completed within one hour. Learners can only have access to the *SQA Databook for HN Physics* or any suitable replacement when sitting the assessment.

Written and/or oral recorded evidence for Outcome 4 should be assessed by production of a full laboratory report, or by completion of an appropriate pro forma. An assessor's observation checklist could be used to record performance evidence of the practical experiment.

Outcome 1

The assessment will sample 4 of the 6 Knowledge and/or Skills items. Learners will not have prior knowledge of which items are being assessed. Those items which are not sampled must be covered in the alternative (re-sit) assessment.

Where an item is sampled, a learner's response will be judged satisfactory where the evidence shows that the learner can:

- Solve problems related to waves in terms of wavelength, frequency, velocity and period.
- Solve problems related to the electromagnetic spectrum.
- Solve problems related to reflection in plane or curved mirrors.
- Solve problems related to refraction.
- Explain the action and use of optical fibres.
- Solve problems by constructing ray diagrams; explain the action of optical instruments in terms of the laws of reflection and refraction.

Outcome 2

The assessment will sample 4 of the 6 Knowledge and/or Skills items. Learners will not have prior knowledge of which items are being assessed. Those items which are not sampled must be covered in the alternative (re-sit) assessment.

Where an item is sampled, a learner's response will be judged satisfactory where the evidence shows that the learner can:

- State two mechanisms of radioactive decay.
- Explain methods of radiation detection and monitoring; solve problems related to safety limits for members of the public and/or workers.
- Solve problems related to half-life.
- Solve problems related to half value thickness; describe the methods of reduction of dose received.
- Solve problems related to dosimetry.
- Describe the uses of isotopes in society or medicine by providing a valid evaluation of the advantages and disadvantages of their use.

Higher National Unit specification: Statement of standards (cont)

Unit title: Physics 1 (SCQF level 6)

Outcome 3

The assessment will sample 4 of the 6 Knowledge and/or Skills items. Learners will not have prior knowledge of which items are being assessed. Those items which are not sampled must be covered in the alternative (re-sit) assessment.

Where an item is sampled, a learner's response will be judged satisfactory where the evidence shows that the learner can:

- Describe the measurement of the resistance of a component using an ammeter and a voltmeter.
- Perform calculations involving the relationships between power, current, voltage and resistance.
- Solve problems involving potential differences, currents and resistances in circuits containing resistors.
- Solve problems involving potential differences, currents and resistances in circuits containing potential dividers.
- Perform calculations involving voltage, current and number of turns in a coil in transformers.
- Differentiate between alternating current and direct current; perform calculations involving the relationships between power, energy and unit costs in the home.

Outcome 4

Learners will perform a minimum of one practical experiment, the content of which will be related to Outcomes 1−3. A learner's response will be judged satisfactory where the evidence shows that the learner can:

- Follow instructions to perform an experiment related to physics.
- Work in a safe manner regarding current health and safety regulations.
- Achieve consistent and accurate results.
- Record experimental observations and results clearly and accurately.
- Evaluate validity of results in terms of sources of and values of experimental errors.
- Analyse results correctly and state valid conclusions.

An assessor observation checklist will be used to record the learner's performance of the practical work in line with given instructions and health and safety requirements.

Learners may report results either by production of a full laboratory report, or by completion of an appropriate pro forma. Where a pro forma approach is deployed, the pro forma will not present information or assistance to the learners on how to correctly perform calculations, analyse experimental results or experimental errors. Learners will be expected to perform such activities independently on the basis of the experimental data.

Where a learner does not perform an assessed practical experiment to the required standard, they will be given the chance to either reattempt the same practical experiment, or to undertake a different practical experiment of similar complexity. Where a laboratory report or pro forma does not meet required standard, then the learner will be given a single opportunity to re-draft. If the required standard is still not attained, then an alternative practical experiment will be set.

Higher National Unit Support Notes

Unit title: Physics 1 (SCQF level 6)

Unit Support Notes are offered as guidance and are not mandatory.

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

Guidance on the content and context for this Unit

This Unit is intended as part of the framework for HNC/HND Applied Sciences, HND Applied Biological Sciences and HND Applied Chemical Sciences but may be suitable for inclusion in other HN Science awards. It is designed to introduce learners to the theoretical and practical aspects of physics.

Outcome 1 — Apply aspects related to waves and optics

- Wave motion: types and the relationship between wavelength, frequency, velocity, period. Differentiation between longitudinal and transverse waves.
- Electromagnetic spectrum (EMS). Members of the spectrum including how the frequency relates to the energy of the EMS wave.
- Reflection in mirrors: plane and curved. Construction of incident and reflect rays for plane, convex and concave mirrors.
- Refraction: Snell's law. Variation of angle of refraction with angle of incidence in transparent blocks for incident angles up to 90^{o}.
- Total internal reflection and optical fibres. Calculation of the critical angle. Construction of simple diagrams to exemplify incident angle, critical angle and refracted angle.
- The use of ray diagrams in converging lenses. Labelling of principal axis, focal length, object length and height. Determination of image length and height by scaled drawings. Thin lenses applications: optical instruments including the eye, microscope, magnifying glass, telescope. Correction of long and short-sightedness using appropriate lenses.

Higher National Unit Support Notes (cont)

Unit title: Physics 1 (SCQF level 6)

Outcome 2 — Apply and explain aspects related to radioactivity

- The three mechanisms of radioactive decay. Differentiation of alpha particles, beta particles and gamma radiation. Chemical equations to demonstrate the three types of radioactive decay.
- Methods of radiation detection and monitoring; for example Geiger-Muller tubes and X-Ray film badges. Solve problems related to safety limits for members of the public and/or workers.
- Half-life and its determination, using different isotopes as examples. Typical half-life plots of activity versus time. The positive use of half-lives in health and/or industrial applications. Carbon dating of organic materials.
- Half value thickness determination. Applications of shielding using different materials such as lead, aluminium or concrete.
- Dosimetry and radiation effects on living tissue. Relative biological effectiveness for different types of radiation. The use of shielding, distance and time to decrease radioactive contamination, for example Chernobyl.
- The uses of isotopes in health and industrial applications providing a valid evaluation of the advantages and disadvantages of their use. For example, the use of iodine (thyroid) and cobalt in gamma knife surgery (small inaccessible tumours) and industrial radiography.

Outcome 3 — Apply aspects related to electricity

- Electromotive force and electric current. Differentiation between static and current electricity. Explanation of electromotive force in terms of energy per unit charge; electric current in terms of rate of flow of charge.
- Electrical resistance and Ohm's law. Differentiation between electrical conductors and insulators in terms of free electrons and/or charged particles. Effects on resistance of material, length, cross-sectional area and temperature. Determination of resistance of a material by an ohmmeter/digital multimeter. Explanation of Ohm's law. Experiments to determine resistance using Ohm's law and experimental deviations.
- Basic circuitry and symbols: I,V and R in simple series and parallel circuits. The use of circuit symbols to construct simple circuits. Differentiation between components in series and in parallel. Measurements of potential difference and current in components in series or parallel using digital multimeters or appropriate meters.
- Potential Dividers. Calculation of resistance or potential difference in potential dividers. Applications of potential dividers using Light Dependent Resistors and Light Emitting Diodes in measurement circuits to control voltage.
- Electrical energy, power and transformers. Calculation of electrical power from voltage, current and/or resistance values. Relationship between electrical energy and power. The National Grid and electricity supply variation over 24 hours. The use of transformers in providing electricity. Calculation of number of turns, voltage or current using the appropriate equations.
- Mains electricity in the home. Energy costs and energy-saving lighting. Calculation of energy costs for different electrical equipment, for example electrical heaters, TVs, lighting.

Higher National Unit Support Notes (cont)

Unit title: Physics 1 (SCQF level 6)

Outcome 4 — Perform a practical experiment related to physics

Guidance on suitable practical experiments for assessment purposes is given elsewhere in this document. However, it is envisaged that learners will also participate in a range of other practical experiments which will both develop their laboratory skills and support the theory covered in Outcomes 1−3.

In carrying out such activities, learners should follow Good Laboratory Practice (GLP) and carry out or be familiar with the risk and Control of Substances Hazardous to Health (COSHH) assessments on all procedures undertaken. Opportunities should be taken to develop awareness of the sources of experimental error and of the accuracy of measurements, with quantification of errors where possible.

Guidance on approaches to delivery of this Unit

There is no particular order in which Outcomes 1−3 would be best delivered. It is envisaged that laboratory work and demonstrations will feature across the delivery of each of the Outcomes, and that the assessed practical experiment for Outcome 4 will be undertaken in a similar timeframe to the underpinning theory.

It is envisaged that delivery of Outcome 1 could commence with wave motion to include types and the relationship between wavelength, frequency, velocity, and period. This could be demonstrated via practical experiments and video clips. Electromagnetic spectrum could be outlined in terms of its wavelength frequency and energy, before moving onto the visible spectrum demonstrated with prisms and diffraction gratings. Reflection could be explained using simple physics equipments including plane and curved mirrors. Perspex or glass blocks could be used with a single collimated beam to demonstrate refraction and total internal reflection. The use of electronic transmitters and receivers equipped with optical fibres could be used to demonstrate data transmission through air/optical fibre and either mirrors or glass/Perspex blocks from iPods/MP3 players to classroom speakers. Snell's law could be investigated as an assessed practical using a collimated light beam through a glass/Perspex block. The use of ray diagrams could be delivered as an individual or paired working activity to predict magnification and image type. Thin lenses — optical instruments including the eye, microscope, magnifying glass and telescope — should be examined or demonstrated via practical experiments.

It is envisaged that delivery of Outcome 2 could begin with the three radioactive decay mechanisms: alpha, beta particles and gamma radiation. This topic could be exemplified via video clips/animations. Background radiation and its detection and monitoring could be demonstrated by use of a Geiger-Muller tube. The half-life can be demonstrated using radiation cubes or dice, and the half value thickness could then be related to safe handling procedures: shielding, distance, time reduction. Nuclear reactions and energy formation could be calculated using appropriate equations, and this could lead to dosimetry: experiment, absorbed dose, radiation weighting factor, equivalent dose as well as safety limits for members of the public and workers. The uses of isotopes in society could focus on medicine, for example the use of radioactive tracers, internal radiotherapy and gamma knife surgery. Access to video clips and animation would greatly enhance this Outcome.

It is envisaged that delivery of Outcome 3 could commence with demonstrations of static electricity, conductors and insulators — plasma lamps and van der Graaff generators. Electromotive force and electric current could then be examined, and investigated using simple circuits with digital multimeters. Circuit symbols could be introduced prior to or gradually throughout the Outcome. Animations such as the FENC Electricity Exploration tool would help to reinforce knowledge and understanding. Electrical resistance and Ohm's law could further progress learners' understanding with emphasis on the differences between series and parallel circuits. Potential dividers could then be used as an application of series circuits, illustrated by transistor switching of lighting, heating or cooling circuits. Electrical energy, power and transformers could be used to differentiate between AC and DC, and delivery of the Outcome could end with an examination of mains electricity and the calculation of energy costs in the home.

It is envisaged that Outcome 4 will be delivered alongside the theoretical based Outcomes 1−3. A range of practical experiments could be utilised to both support understanding of the underlying theory and to prepare learners for undertaking the assessed practical experiments.

Guidance on approaches to assessment of this Unit

Evidence can be generated using different types of assessment. The following are suggestions only. There may be other methods that would be more suitable to learners.

Outcomes 1−3 could be assessed by a single holistic closed-book assessment with an appropriate cut-off score that covers the sampling requirements as detailed in the Evidence Requirements. Assessment should be carried out in supervised conditions, and it is recommended that the assessment be completed within 60 minutes. Learners can only have access to the *SQA Databook for HN Physics* or any suitable replacement when sitting the assessment.

Where evidence of Outcomes 1−3 is assessed by sampling, the whole of the content listed in the Knowledge and/or Skills must be taught and available for assessment. Learners should not know in advance the items on which they will be assessed, and different items should be sampled on each assessment occasion. Any items not sampled in the first assessment, must be included in the alternative (re-sit) assessment.

In Outcome 4 learners are required to undertake one assessed practical experiment, the content of which will be related to Outcomes 1−3. Examples of suitable experiments are given below. However, this list is not prescriptive, and other practical experiments of similar complexity may be used by the centre.

Suitable practical experiments are:

- An investigation into the refraction of light through a transparent block.
- An investigation into background radiation and the radiation levels of commonly found materials.
- An investigation into the spectra produced from different light sources.
- An investigation into the variation in resistance or voltage output in a potential divider incorporating a Light Dependent Resistor or Thermistor or variable resistor.

The assessed practical experiment will usually be performed individually. However, there may be some experiments that are suitable to be undertaken in pairs or small groups. If this is the case then the assessor should ensure that all participants are actively involved and are able to adequately demonstrate the required skills.

An exemplar instrument of assessment with marking guidelines has been produced to indicate the national standard of achievement at SCQF level 6.

Centres are reminded that prior verification of centre-devised assessments would help to ensure that the national standard is being met. Where learners experience a range of assessment methods, this helps them to develop different skills that should be transferable to work or further and higher education.

Opportunities for e-assessment

E-assessment may be appropriate for some assessments in this Unit. By e-assessment we mean assessment which is supported by Information and Communication Technology (ICT), such as e-testing or the use of e-portfolios or social software. Centres which wish to use e-assessment must ensure that the national standard is applied to all learner evidence and that conditions of assessment as specified in the Evidence Requirements are met, regardless of the mode of gathering evidence. The most up-to-date guidance on the use of e-assessment to support SQA's qualifications is available at **www.sqa.org.uk/e-assessment**.

Opportunities for developing Core and other essential skills

The delivery and assessment of this Unit will provide learners with the opportunity to develop the Core Skills of *Numeracy* and *Problem Solving* at SCQF level 6, and *Information Communication Technology (ICT)* at SCQF level 4.

***Numeracy* — Using Number at SCQF level 6**

Learners will be required to decide on the steps and operations to solve complex problems, carrying out sustained and complex calculations, eg performing calculations related to quantitative electrolysis, or of electromotive force under non-standard conditions.

***Problem Solving* — Reviewing and Evaluating at SCQF level 6**

Following the assessed practical experiment learners will be required to review and evaluate the effectiveness of the exercise with a thorough interpretation of random and systematic sources of error. Learners will be required to reach sound conclusions on the basis of the data collected and the inherent errors.

Higher National Unit Support Notes (cont)

Unit title: Physics 1 (SCQF level 6)

Information and Communication Technology (ICT) **— Providing/Creating Information at SCQF level 4**

Learners will make effective and appropriate use of ICT packages to produce a laboratory report or pro forma in an appropriate format. Packages used will likely include word processing and spreadsheets.

Sustainability

Sustainability can be embedded in the delivery of the Unit in a variety of ways. For example, by encouraging minimum usage, correct disposal procedures and possibly recycling (eg of solvents) during practical experiments.

This Unit has the Critical Thinking components of Problem Solving and Using Number components of Numeracy embedded in it. This means that when candidates achieve the Unit, their Core Skills profile will also be updated to show they have achieved Critical Thinking at SCQF level 6 and Using Number at SCQF level 6.

History of changes to Unit

Version	Description of change	Date
02	Core Skills Components Critical Thinking and Using Number at SCQF level 6 embedded.	28/07/2015

General information for learners

Unit title: Physics 1 (SCQF level 6)

This section will help you decide whether this is the Unit for you by explaining what the Unit is about, what you should know or be able to do before you start, what you will need to do during the Unit and opportunities for further learning and employment.

This is a 1 credit Unit at SCQF level 6, which you are likely to be studying as part of the first year of an HNC/D Science programme. Before progressing to this Unit it would be beneficial to have experience of Mathematics at National 5 level. There will be a strong emphasis on the importance of experimental data in understanding physics principles, and on the applications of physical knowledge in practical situations.

On completion of the Unit you should be able to:

1 Apply aspects related to waves and optics.
2 Apply and explain aspects related to radioactivity.
3 Apply aspects related to electricity.
4 Perform a practical experiment related to physics.

Outcome 1

In this Outcome you will investigate two types of wave motion and the relationship between wavelength, frequency, velocity and period. You will examine the electromagnetic spectrum and relate wavelength and frequency to energy. Reflection in plane and curved mirrors will be investigated as well as refraction. You will learn about total internal reflection in optical fibres, and their applications in society, and you will use ray diagrams to determine image formation. Applications of thin lenses in optical instruments including the eye, microscope, magnifying glass and telescope will also be investigated.

Outcome 2

In this Outcome you will investigate radioactive decay mechanisms — alpha, beta particles and gamma radiation — and you will learn how to differentiate between these mechanisms. You will also learn about background radiation, radiation detection and monitoring.

You will investigate half-life and half value thickness using appropriate equations, and you will also investigate dosimetry through experiment, absorbed dose, radiation weighting factor and equivalent dose.

You will gain an understanding of safety limits for members of the public and workers, and you will examine safe handling procedures using the concepts of shielding, distance and time reduction. In addition, you will learn about the uses of isotopes in society and medicine.

Outcome 3

In this Outcome you will investigate electromotive force and electric current through simple circuits. Through practical experiments you will learn about electrical resistance and Ohm's law.

You will learn to recognise circuit symbols in simple circuits, you will examine basic circuitry through practical experiments and you will learn how I, V and R may be calculated in simple series and parallel circuits.

General information for learners (cont)

Unit title: Physics 1 (SCQF level 6)

How potential dividers are used in electronic circuits to switch on lighting, heating or cooling equipment will also be covered.

You will gain an understanding of the transmission of electricity through the National Grid by the use of transformers, and you will also investigate electrical energy and power related to electrical equipment in the home.

Outcome 4

In this Outcome you will undertake a practical experiment, based on the content of Outcomes 1−3.

During this practical work, you will also be expected to develop good laboratory practices as well as improve your skills of manipulation, observation and measurement. You will be encouraged to develop safe working practices and to strive constantly to improve the accuracy and reliability of your results. The reporting and analysis of experimental data is an important aspect of the practical sessions.

Assessment

For Outcomes 1−3 you will take a closed-book, end of Unit assessment.

Outcome 4 will be assessed after you have learned the necessary practical skills, and will take the form of one practical experiment, for which you will report your results either in a full laboratory report, or by completion of a pro forma report.

Core Skills

You will have opportunities to develop the Core Skills of *Numeracy* and *Problem Solving* at SCQF level 6, and *Information and Communication Technology (ICT)* at SCQF level 4.