Higher National Unit specification

General information

Unit title: Physics 2 (SCQF level 7)

Unit code: H93E 34

Superclass: RC

Publication date: May 2015

Source: Scottish Qualifications Authority

Version: 01

Unit purpose

This Unit is designed to enable learners to understand key aspects of physics including the foundation theories regarding electromagnetic radiation, the behaviour of fluids and the mechanisms of heat transfer. 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 Explain and apply aspects related to electromagnetic radiation and spectra.
2 Describe and apply aspects related to fluids.
3 Describe and apply aspects related to heat transfer.
4 Perform a practical experiment related to physics.

Credit points and level

1 Higher National Unit credit at SCQF level 7: (8 SCQF credit points at SCQF level 7)

Recommended entry to the Unit

Entry is at the discretion of the centre, however it is recommended that learners should have completed the HN Unit H93D 33 *Physics 1* or equivalent, or have experience of Physics and Mathematics at Higher level.

Higher National Unit specification: General information (cont)

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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

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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

Explain and apply aspects related to electromagnetic radiation and spectra.

Knowledge and/or Skills

- Electromagnetic spectrum
- Energy levels of atoms and molecules: ground state, excited state, ionisation level
- Spectra: absorption, emission, atomic, molecular
- Planck's constant and relationship E = hf
- Spectrometer
- Photons

Outcome 2

Describe and apply aspects related to fluids.

Knowledge and/or Skills

- Density
- Pressure and its variation with depth of fluid
- The continuity equation
- Bernouilli's equation and applications
- Streamline, laminar and turbulent flow
- Viscosity

Outcome 3

Describe and apply aspects related to heat transfer.

Knowledge and/or Skills

- Transfer of heat energy: conduction, convection and radiation
- Kelvin temperature and absolute zero of temperature
- Heat capacity: specific heat capacity
- Change of phase: specific latent heat
- Kinetic model of an ideal gas
- Heat energy calculations

Higher National Unit specification: Statement of standards

Unit title: Physics 2 (SCQF level 7)

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 2 (SCQF level 7)

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 90 minutes. 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 the electromagnetic spectrum.
- Explain the ground state; explain one of the higher energy states of atoms and molecules: excited or ionisation levels.
- Solve problems related to absorption, emission, atomic and molecular spectra.
- Solve problems related to Planck's constant and E=hf.
- Explain the principles of a simple spectrometer.
- Explain photon energy and photon wavelength; solve problems related to photon energy and photon wavelength.

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:

- Solve problems related to density.
- Solve problems related to pressure and its variation with depth of fluid.
- Perform calculations involving the continuity equation.
- Solve problems related to Bernouilli's equation and applications.
- Describe streamline, laminar and turbulent flow.
- Describe viscosity; identify shear stress-strain profiles in Newtonian and non-Newtonian fluids.

Higher National Unit specification: Statement of standards (cont)

Unit title: Physics 2 (SCQF level 7)

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 transfer of heat energy for each of the following processes: conduction, convection, radiation.
- Describe the measurement of Kelvin temperature and absolute zero of temperature.
- Perform calculations involving heat capacity: specific heat capacity.
- Perform calculations involving change of phase: specific latent heat.
- Describe and apply the kinetic model of an ideal gas.
- Solve problems related to heat energy calculations.

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 the 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 2 (SCQF level 7)

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 but may be suitable for inclusion in other HN Science awards. It is designed to develop the more complex theoretical and practical aspects of physics introduced in the HN Unit H93D 33 *Physics 1*, and to provide underpinning knowledge of physics.

Outcome 1 — Explain and apply aspects related to electromagnetic radiation and spectra.

- The electromagnetic spectrum in terms of wavelength, frequency and velocity. Calculations relating these quantities. Electromagnetic wave properties in different materials. Applications of electromagnetic radiation: wireless communication, laser surgery and medical applications such as X-Ray, Magnetic Resonance Imaging.
- Energy levels of atoms and molecules: ground state, excited state, ionisation level. The particle in a box model and its energy level diagrams.
- Spectra: absorption, emission, atomic, molecular. The interaction of electromagnetic radiation with materials causing electronic, molecular or atomic transitions. Continuous white light spectra versus gas discharge spectra. Applications in science areas, such as astrophysics (Fraunhofer spectrum of the sun) and chemical analysis.
- Planck's constant and relationship $E = hf$. Relating velocity and wavelength to energy in the electromagnetic spectrum. Relating energies to chemical spectra of materials.
- Basic principles of operation for a spectrometer: radiation sources and monochromators.
- The photoelectric effect, threshold frequency and the work function.

Higher National Unit Support Notes (cont)

Unit title: Physics 2 (SCQF level 7)

Outcome 2 — Describe and apply aspects related to fluids.

- Definition of and calculation of density. Densities of common materials.
- Pressure and its variation with depth of fluid. Pressure in a fluid. Variation of pressure with height or depth; the concept of buoyancy and its relation to density.
- The continuity equation. Incompressible fluids and conservation of mass. Volume flow rates and applications in chemical engineering.
- Bernouilli's equation and applications. Variation of an ideal fluid flow along fluid path. Variation of pressure and its relation to net work done. Relationship of work done to changes in kinetic and potential energy changes. Applications in chemical engineering; fluid flow in pipes.
- Streamline, laminar and turbulent flow of incompressible fluids. Velocity profile in a fluid. Flow patterns in laminar and turbulent flow. Diagnosis of turbulent flow in the aorta by a stethoscope.
- Definition of viscosity and demonstration using viscous fluids. Construct and differentiate between Newtonian and non-Newtonian fluids using shear stress-strain profiles. Relationship of viscosity to turbulent flow; applications in medicine; elevated blood pressure.

Outcome 3 — Describe and apply aspects related to heat transfer.

- Transfer of heat energy: conduction, convection and radiation. Definitions and examples of the three types of heat transfer. Thermal conductivity of materials. Experiments demonstrating heat transfer.
- The measurement of Kelvin temperature and absolute zero of temperature. The Zeroth Law of Thermodynamics. Temperature and thermal equilibrium. Temperature of mixing. Linear thermal expansion.
- Problem solving activities related to heat capacity of objects and specific heat capacity in materials. Applications to energy costs in the chemical industry. Simple experiments to determine specific heat capacity.
- Calculations involving change of phase: specific latent heat. Heats of fusion and vapourisation. Problem solving exercises involving specific latent heats of fusion and/or vapourisation. Applications to energy costs in the chemical industry.
- The Kinetic Molecular model of an ideal gas. Pressure and molecular kinetic energies; the Boltzmann constant.
- Problem solving activities related to heat energy calculations. Simple energy balances used in chemical engineering.

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.

Higher National Unit Support Notes (cont)

Unit title: Physics 2 (SCQF level 7)

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 the electromagnetic spectrum in terms of its wavelength frequency and energy, before moving onto the visible spectrum demonstrated with prisms and diffraction gratings. Flame tests of simple metal salts could be investigated to show different flame colours. Simulations of line absorption and emission spectra would clarify learners' understanding. This leads onto Planck's constant and E = hf. The introduction of moles of photons and single photon energy should be differentiated. Various spectrometers should be demonstrated. An assessed practical experiment using discharge tubes to determine diffraction grating spacing or emission wavelength could be carried out.

It is envisaged that delivery of Outcome 2 could commence with simple experiments to determine densities of common materials. This could lead onto the concepts of floating and sinking in water developing into explanations of pressure and its variation with depth in a fluid. Cartesian divers and submarines can be used to demonstrate this variation. Dependence on fluid density can be tested using different fluids. The continuity equation could be introduced next, developing into the Bernouilli equation. Streamline, laminar and turbulent flow could then be introduced with applications such as fluid flow in large pipes and the circulatory system. The concept of viscosity could be examined relating to fluid flow, and properties of viscous fluids.

It is envisaged that delivery of Outcome 3 could commence with the three methods of heat transfer: conduction, convection and radiation with simple physics experiments demonstrating the three types; such as conduction bars, and Leslie cubes equipped with thermal emissivity probes. The Kelvin temperature and absolute zero could be introduced next along with the effects of thermal mixing of fluids and the Zeroth Law of Thermodynamics. Particle motion in solids, liquids and gases could be outlined using simulations showing particle movements. This could lead onto heat capacity and specific heat capacity. This topic could be enhanced using simple experiments and/or simulations such as determination of c in 1kg blocks of different metals. Specific latent heat could then be developed, again using simple experiments and/or simulations such as heating and cooling curves for water and stearic acid. The kinetic model of an ideal gas could be outlined using simulations and/or graphs to show the effects of pressure, volume and temperature. The Boltzmann constant could be used to bridge between the macroscopic and microscopic scales. Heat energy balances could then be introduced in terms of simple chemical engineering processes.

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 experiment.

Higher National Unit Support Notes (cont)

Unit title: Physics 2 (SCQF level 7)

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 90 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:

- Measurement of wavelength absorption or emission of an element, such as sodium, in the visible spectrum, using a gas discharge lamp and simple spectrometer equipped with a diffraction grating.
- Using LEDs of different colours to investigate the relationship between frequency and photon energy for light. Determination of Planck's constant.
- Measurement of viscosity using falling ball bearings. Effects of ball bearing diameter and/or temperature.
- Specific heat capacity experiments using different materials.

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 7.

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.

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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 the electromagnetic spectrum, the Bernouilli equation, and heat energy balances.

***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.

***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 including graph construction.

Sustainability

Sustainability can be embedded in the delivery of the Unit in a variety of ways. For example, by relating costs to usage of optimised fluid flow.

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 2 (SCQF level 7)

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 7, which you are likely to be studying as part of the first year of an HNC/HND Science programme. Before progressing to this Unit it would be beneficial to have completed the HN Unit H93D 33 *Physics 1* where you will have learned underpinning aspects of physics and developed your practical skills.

On completion of the Unit you should be able to:

1 Explain and apply aspects related to electromagnetic radiation and spectra.
2 Describe and apply aspects related to fluids.
3 Describe and apply aspects related to heat transfer.
4 Perform a practical experiment related to physics.

Outcome 1

In this Outcome you will investigate the electromagnetic spectrum in terms of its wavelength frequency and energy, before moving on to the visible spectrum demonstrated with prisms and diffraction gratings. Flame tests of simple metal salts could be investigated to show different flame colours.

You will investigate simulations of line absorption and emission spectra to clarify understanding, and you will use Planck's constant and E=hf to understand the concept of photons. You will also examine various spectrometers.

Outcome 2

In this Outcome you will use simple experiments to determine densities of common materials. You will investigate the concepts of floating and sinking in water using Cartesian divers, and you will use simple experiments to examine pressure and its variation with depth and density in different fluids.

You will investigate the continuity equation which develops into the Bernouilli equation, streamline, laminar and turbulent flow in fluids and you will examine applications such as fluid flow in large pipes and the circulatory system. You will also investigate the concept of fluid viscosity and relate viscosity to fluid flow, and properties of viscous fluids.

Outcome 3

In this Outcome you will investigate three methods of heat transfer: conduction, convection and radiation with simple physics experiments such as conduction bars, and Leslie cubes equipped with thermal emissivity probes.

You will investigate the Kelvin temperature scale and absolute zero, and you will perform calculations on thermal mixing of fluids and examine the Zeroth Law of Thermodynamics. You will examine the motion of particles in solids, liquids and gases using simulations and/or graphs, and you will investigate heat capacity and specific heat capacity.

You will also investigate specific latent heat, and you will gain knowledge of heat energy balances in simple chemical engineering processes. In addition, you will examine the kinetic model of an ideal gas at a macroscopic and microscopic level to investigate the effects of pressure, volume and temperature.

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.