National Unit specification: general information

Unit title: Our Dynamic Universe (SCQF level 6)

Unit code: FE42 12

COURSE Physics (Revised) Higher

Superclass: RC

Publication date: December 2010

Source: Scottish Qualifications Authority

Version: 01

Summary

This Unit develops knowledge and understanding and skills in physics related to mechanics and astrophysics. The Unit offers opportunities for collaborative and independent learning set within familiar and unfamiliar contexts. It provides opportunities to develop and apply concepts and principles in a wide variety of situations involving forces and motion, as experienced on Earth and from an astronomical perspective. Activities are undertaken which develop experimental, investigative and analytical skills. This Unit is suitable for those who are interested in pursuing a physics related career, as well as those whose interest is more general.

Outcomes

1 Demonstrate and apply knowledge and understanding of mechanics and astrophysics.
2. Demonstrate skills of scientific experimentation, investigation and analysis in mechanics and astrophysics.

Recommended entry

While entry is at the discretion of the centre, candidates would normally be expected to have attained one of the following, or equivalent:

♦ Standard Grade Physics with Knowledge and Understanding and Problem Solving at grade 1 or 2

or

♦ Intermediate 2 Physics

and

♦ Standard Grade Mathematics at 1 or 2 **or** Intermediate 2 Mathematics

General information (cont)

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Credit points and level

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

**SCQF credit points are used to allocate credit to qualifications in the Scottish Credit and Qualifications Framework (SCQF). Each qualification in the Framework is allocated a number of SCQF credit points at an SCQF level. There are 12 SCQF levels, ranging from Access 1 to Doctorates.*

Core Skills

Core Skills for this qualification remain subject to confirmation and details will be available at a later date.

Additional information about Core Skills is published in the Catalogue of *Core Skills in National Qualifications (SQA, 2001)*.

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.

Outcome 1

Demonstrate and apply knowledge and understanding of mechanics and astrophysics.

Performance Criteria

(a) Make accurate statements about mechanics and astrophysics facts, concepts and relationships.
(b) Use relationships to solve mechanics and astrophysics problems.
(c) Use knowledge of mechanics and astrophysics to explain observations and phenomena.

Outcome 2

Demonstrate skills of scientific experimentation, investigation and analysis in mechanics and astrophysics.

Performance Criteria

(a) Use a range of data-handling skills in a scientific context.
(b) Use a range of skills related to experimental design.
(c) Use a range of skills related to the evaluation of scientific evidence.

Evidence Requirements for this Unit

Evidence is required to demonstrate that candidates have met the requirements of the Outcomes.

For each of the Unit Outcomes, written and/or recorded oral evidence of the appropriate level of achievement is required. This evidence must be produced under closed-book, supervised conditions within a time limit of 45 minutes.

The Instrument of Assessment must sample the content in each of the following areas:

- Equations of Motion
- Forces, energy and power
- Collisions and explosions
- Gravitation
- Special relativity
- The expanding universe
- Big Bang Theory

National Unit specification: statement of standards (cont)

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An appropriate Instrument of Assessment would be a closed-book, supervised test with a time limit of 45 minutes. Items in the test should cover all of the Performance Criteria associated with both Outcomes 1 and 2 and could be set in familiar or unfamiliar contexts.

Further detail on the breadth and depth of content is provided in the content tables included in this specification.

For Outcome 2, PC(a), candidates are required to demonstrate that they can use a range of data-handling skills. These skills include selecting, processing and presenting information. Information can be presented in a number of formats including: line graphs, scatter graphs, bar and pie charts, tables, diagrams and text.

For Outcome 2, PC(b), candidates are required to demonstrate they can use a range of skills associated with experimental design. These skills include planning, designing and evaluating experimental procedures.

For Outcome 2, PC(c), candidates are required to demonstrate they can use a range of skills associated with the evaluation of scientific evidence. These skills include drawing valid conclusions and making predictions.

The standard to be applied and the breadth of coverage are illustrated in the National Assessment Bank items available for this Unit. If a centre wishes to design its own assessments for this Unit they should be of a comparable standard.

National Unit specification: support notes

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This part of the Unit specification is offered as guidance. The support notes 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

The recommended content together with suggestions for possible contexts and activities to support and enrich learning and teaching are detailed in the appendix to this Unit specification.

This Unit builds on candidates' knowledge of forces and movement. The content covered in the early topics of the Unit is set in familiar contexts. The equations of motion, motion-time graphs and resolving vectors are studied. After extending the work to include forces, energy, power and momentum, candidates continue their study by considering motion in space. Satellites and gravitation introduce the astrophysics section. The effects of motion at high speed are considered in an introduction to special relativity. Evidence for the expanding universe and the origin of the universe completes the topics covered in the Unit.

This Unit offers a wide variety of contexts and opportunities for practical work as highlighted in the ‘Contexts’ column of the content tables. Opportunities exist for candidates to learn as part of a group through practical work undertaken in partnership or in teams.

Guidance on learning and teaching approaches for this Unit

General advice on approaches to learning and teaching is contained in the Course specification.

Opportunities for developing Core Skills

This Unit provides opportunities to develop *Communication, Numeracy, Information and Communication Technology* and *Problem Solving* skills in addition to providing contexts and activities within which the skills associated with *Working with Others* can be developed.

Outcome 1, PC(b) and (c) develop a candidate’s ability to communicate effectively key concepts and to explain clearly physics concepts in written media.

Within this Unit candidates will need to extract and process information presented in both tabular and graphical formats developing the Core Skill of *Numeracy*. Candidates will gain experience in a range of calculations building competence in number.

The Content Table, included in this Unit Specification contains a column labelled ‘Contexts’ which include a large number of web based activities, computer simulations and modelling opportunities which all serve to develop higher levels of competence in the key *ICT* skills including; accessing information and providing/creating information. Also included are suggestions for practical investigations which provide candidates with the opportunity of working co-operatively with others.

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Problem Solving skills are central to the sciences and are assessed through Outcome 1, PCs (b) and (c) and also through Outcome 2, PCs (a), (b) and (c).

Guidance on approaches to assessment for this Unit

Outcomes 1 and 2

It is recommended that an holistic approach is taken for assessment of these Outcomes. Outcomes 1 and 2 can be assessed by an integrated end of Unit test with questions covering all the Performance Criteria. Within one question, assessment of knowledge and understanding and skills of experimentation, investigation and analysis can occur. Each question can address a number of Performance Criteria from either Outcome 1 or 2.

Appropriate assessment items are available from the National Assessment Bank.

Opportunities for the use of 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 e-checklists. Centres which wish to use e-assessment must ensure that the national standard is applied to all candidate evidence and that conditions of assessment as specified in the Evidence Requirements are met, regardless of the mode of gathering evidence. Further advice is available in *SQA Guidelines on Online Assessment for Further Education (AA1641, March 2003), SQA Guidelines on e-assessment for Schools (BD2625, June 2005)*.

Disabled candidates and/or those with additional support needs

The additional support needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments, or considering whether any reasonable adjustments may be required. Further advice can be found on our website **www.sqa.org.uk/assessmentarrangements**

National Unit specification: content tables

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The left hand column below details the content in which candidates should develop knowledge and understanding. The middle column contains notes, which give further details of the content.

The right-hand column gives suggested contexts in which knowledge and understanding and skills can be developed.

Content	Notes	Contexts
1 Equations of Motion		
a) Equations of motion for objects with constant acceleration in a straight line.	Candidates should undertake experiments to verify the relationships shown in the equations.	Light gates, motion sensors and software/hardware to measure displacement, velocity and acceleration. Using software to analyse videos of motion.
b) Motion-time graphs for motion with constant acceleration.	Displacement-time graphs. Gradient is velocity. Velocity-time graphs. Area under graph is displacement. Gradient is acceleration. Acceleration-time graphs. Restricted to zero and constant acceleration. Graphs for bouncing objects and objects thrown vertically upwards.	Motion sensors (including wireless sensors) to enable graphical representation of motion.
c) Motion of objects with constant speed or constant acceleration.	Objects in freefall and the movement of objects on slopes should be investigated.	Investigate the variation of acceleration on a slope with the angle of the slope. Motion of athletes and equipment used in sports. Investigate the initial acceleration of an object projected vertically upwards (eg popper toy)

National Unit specification: content tables (cont)

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Content	Notes	Contexts
2 Forces, energy and power		
a) Balanced and unbalanced forces. The effects of friction. Terminal velocity.	Forces acting in one dimension only. Analysis of motion using Newton's First and Second Laws. Friction as a force acting in a direction to oppose motion. No reference to static and dynamic friction. Tension as a pulling force exerted by a string or cable on another object. Velocity-time graph of falling object when air resistance is taken into account, including changing the surface area of the falling object. Analysis of the motion of a rocket may involve a constant force on a changing mass as fuel is used up.	Forces in rocket motion, jet engine, pile driving, and sport. Space flight. Analysis of skydiving and parachuting, falling raindrops, scuba diving, lifts and haulage systems.
b) Resolving a force into two perpendicular components.	Forces acting at an angle to the direction of movement. The weight of an object on a slope can be resolved into a component acting down the slope and a component acting normal to the slope. Systems of balanced and unbalanced forces with forces acting in two dimensions.	Vehicles on a slope and ski tows, structures in equilibrium, eg supported masts.
c) Work done, potential energy, kinetic energy and power.	Work done as transfer of energy. Conservation of energy.	Investigating energy lost in bouncing balls. Rollercoasters, objects in freefall. Energy and moving vehicles.

National Unit specification: content tables (cont)

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Content	Notes	Contexts
3 Collisions and explosions		
a) Elastic and inelastic collisions.	Conservation of momentum in one dimension and in which the objects may move in opposite directions. Kinetic energy in elastic and inelastic collisions.	Investigations of conservation of momentum and energy.
b) Explosions and Newton's Third Law.	Conservation of momentum in explosions in one dimension only.	Propulsion systems – jet engines and rockets
c) Impulse.	Force-time graphs during contact of colliding objects. Impulse can be found from the area under a force-time graph.	Investigating collisions using force sensors and dataloggers. Hammers and pile drivers. Car safety, crumple zones and air bags.
4 Gravitation		
a) Projectiles and Satellites.	Resolving the motion of a projectile with an initial velocity into horizontal and vertical components and their use in calculations. Comparison of projectiles with objects in free fall. Newton's thought experiment and an explanation of why satellites remain in orbit.	Using software to analyse videos of projectiles Low orbit and geostationary satellites. Satellite communication and surveying. Environmental monitoring of the conditions of the atmosphere.
b) Gravity and mass.	Gravitational Field Strength of planets, natural satellites and stellar objects. Calculating the force exerted on objects placed in a gravity field. Newton's Universal Law of Gravitation.	Methods for measuring the gravitational field strength on Earth. Using gravity assist to travel in space. Lunar and planetary orbits. Formation of the solar system by the aggregation of matter.

National Unit specification: content tables (cont)

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Content	Notes	Contexts
		Stellar formation and collapse. The status of our knowledge of the force of gravity may be explored. The other fundamental forces have been linked but there is as yet no unifying theory to link them to gravity.
5 Special relativity		
a) Introduction to special relativity.	Relativity introduced through Galilean Invariance, Newtonian Relativity and the concept of absolute space. Experimental and theoretical considerations (details not required) lead to the conclusion that the speed of light is the same for all observers. The constancy of the speed of light led Einstein to postulate that space and time for a moving object are changed relative to a stationary observer. Length contraction and time dilation.	Newtonian Relativity can be experienced in an intuitive way. Examples include walking in a moving train and moving sound sources. At high speeds, non-intuitive relativistic effects are observed. Length contraction and time dilation can be studied using suitable animations. Experimental verification includes muon detection at the surface of the Earth and accurate time measurements on airborne clocks. The time dilation equation can be derived from the geometrical consideration of a light beam moving relative to a stationary observer.

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Content	**Notes**	**Contexts**
6 The expanding Universe		
a) The Doppler Effect and redshift of galaxies.	The Doppler Effect is observed in sound and light. For sound, the apparent change in frequency as a source moves towards or away from a stationary observer should be investigated. The Doppler Effect causes similar shifts in wavelengths of light. The light from objects moving away from us is shifted to longer wavelengths — redshift. The redshift of a galaxy is the change in wavelength divided by the emitted wavelength. For galaxies moving at non-relativistic speeds, redshift is the ratio of the velocity of the galaxy to the velocity of light. (Note that the Doppler Effect equations used for sound cannot be used with light from fast moving galaxies because relativistic effects need to be taken into account.)	Doppler Effect in terms of terrestrial sources eg passing ambulances. Investigating the apparent shift in frequency using a moving sound source and datalogger. Applications include measurement of speed (radar), echocardiogram and flow measurement.
b) Hubble's Law.	Hubble's Law shows the relationship between the recession velocity of a galaxy and its distance from us. Hubble's Law leads to an estimate of the age of the Universe.	Measuring distances to distant objects. Parallax measurements and data analysis of apparent brightness of standard candles. The Unit 'Particles and Waves' includes an investigation of the inverse square law for light. Centres may wish to include this activity in this topic.

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Content	Notes	Contexts
c) Evidence for the expanding Universe.	Measurements of the velocities of galaxies and their distance from us lead to the theory of the expanding Universe. Gravity is the force which slows down the expansion. The eventual fate of the Universe depends on its mass. The orbital speed of the Sun and other stars gives a way of determining the mass of our galaxy. The Sun's orbital speed is determined almost entirely by the gravitational pull of matter inside its orbit. Measurements of the mass of our galaxy and others lead to the conclusion that there is significant mass which cannot be detected — dark matter. Measurements of the expansion rate of the Universe lead to the conclusion that it is increasing, suggesting that there is something that overcomes the force of gravity — dark energy.	In practice, the units used by astronomers include light-years and parsecs rather than SI units. Data analysis of measurements of galactic velocity and distance. The revival of Einstein's cosmological constant in the context of the accelerating universe.

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Content	Notes	Contexts
7 Big Bang Theory		
a) The temperature of stellar objects.	Stellar objects emit radiation over a wide range of wavelengths. Although the distribution of energy is spread over a wide range of wavelengths, each object emitting radiation has a peak wavelength which depends on its temperature. The peak wavelength is shorter for hotter objects than for cooler objects. Also, hotter objects emit more radiation per unit surface area at all wavelengths than cooler objects. Thermal emission peaks allow the temperature of stellar objects to be measured.	Remote sensing of temperature. Investigating the temperature of hot objects using infrared sensors. Change in colour of steel at high temperatures. Furnaces and kilns.
b) Evidence for the Big Bang.	The Universe cools down as it expands. The peak wavelength of cosmic microwave background allows the present temperature of the Universe to be determined. This temperature corresponds to that predicted after the Big Bang, taking into account the subsequent expansion and cooling of the Universe.	History of Cosmic Microwave Background (CMB) discovery and measurement. COBE satellite. Other evidence for the Big Bang includes the observed abundance of the elements hydrogen and helium and the darkness of the sky (Olber's Paradox).

History of changes to Unit

Version	Description of change	Date

Additional copies of this Unit specification can be purchased from the Scottish Qualifications Authority. Please contact the Customer Contact Centre, telephone 0845 279 1000.