Higher National Unit specification

General information

Unit title: Physics Principles: Mechanics (SCQF level 7)

Unit code: H93H 34

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 the physics principles of mechanics. 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 principles 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 the concepts of vectors.
2 Apply the concepts of interaction of forces and motion.
3 Apply the concepts of work and energy.
4 Apply the concepts of momentum and impulse.

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 experience of Physics and Mathematics at Higher level.

Higher National Unit specification: General information (cont)

Unit title: Physics Principles: Mechanics (SCQF level 7)

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 5 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 Principles: Mechanics (SCQF level 7)

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 the concepts of vectors.

Knowledge and/or Skills

- Vector notation
- Component method
- Vector multiplication
- Kinematic equations
- Velocity
- Acceleration

Outcome 2

Apply the concepts of interaction of forces and motion.

Knowledge and/or Skills

- Newton’s First Law of Motion
- Newton’s Second Law of Motion
- Hooke’s Law
- Static and kinetic friction
- Uniform circular motion
- Simple harmonic motion
- Law of Universal Gravitation

Outcome 3

Apply the concepts of work and energy.

Knowledge and/or Skills

- Conservation of energy theorem
- Relationship between work and displacement
- Work-energy theorem
- Elastic potential energy
- Gravitational potential energy

Unit title: Physics Principles: Mechanics (SCQF level 7)

Outcome 4

Apply the concepts of momentum and impulse.

Knowledge and/or Skills

- Newton's Third Law of Motion
- Linear momentum
- Moment of inertia
- Torque and angular momentum
- Elastic and inelastic collisions
- Impulse

Higher National Unit specification: Statement of standards (cont)

Unit title: Physics Principles: Mechanics (SCQF level 7)

Evidence Requirements for this Unit

Written and/or oral recorded evidence for Outcomes 1–4 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 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.

Outcome 1

The assessment will sample of 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:

- ♦ Identify the key elements of vector notation. The identification must include magnitude and direction, and indicate that vectors can be separated into components.
- ♦ Apply addition and subtraction of vectors by component method to calculate displacement, velocity and acceleration.
- ♦ Apply the scalar and vector products to one arbitrary set containing two 3 dimensional vectors.
- ♦ Derive three kinematic equations of motion using calculus: displacement, velocity and acceleration.
- ♦ Apply the differential and average forms of kinematic equations to calculate instantaneous and average values of velocity.
- ♦ Apply the differential and average forms of kinematic equations to calculate instantaneous and average values of acceleration.

Outcome 2

The assessment will sample 5 of the 7 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:

- ♦ Apply Newton's First Law of Motion to describe the motion of a body of mass either at rest or at a constant velocity under balanced force conditions.
- ♦ Apply Newton's Second Law of Motion to calculate the force on an accelerating body having mass.
- ♦ Apply Hooke's Law to calculate the restorative force of an extended or compressed spring.
- ♦ Perform calculations to determine the coefficients of static and kinetic friction for systems of motion with frictional forces.
- ♦ Perform calculations to determine the centripetal and centrifugal force on a body of mass under uniform circular motion.

Unit title: Physics Principles: Mechanics (SCQF level 7)

- Perform calculations involving simple harmonic motion to determine the period of a vibrating body of mass.
- Apply the Law of Universal Gravitation to calculate the force of gravitation between two spherical masses.

Outcome 3

The assessment will sample 3 of the 5 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:

- Apply the conservation of energy theorem to equate different energy types and to calculate related values.
- Perform calculations to determine the work done on a body of mass subject to a 2 dimensional force over some horizontal displacement.
- Apply the work-energy theorem to calculate the work done by a body of mass undergoing a change in kinetic energy.
- Apply Hooke's Law to calculate the potential energy of an extended or compressed spring.
- Apply the Law of Universal Gravitation to calculate the potential energy of a body of mass at height in the presence of a gravitational field.

Outcome 4

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:

- Apply Newton's Third Law of Motion to identify paired forces.
- Perform calculations to determine the linear momentum of a body of mass.
- Perform calculations to determine the moment of inertia for two of the following: a rod rotating about either its centre of mass or end point, a solid thin disc, a solid cylinder, a thick walled cylindrical tube.
- Perform calculations to determine the torque and angular momentum for one of the following systems: a rotating rigid body, a circulating particle.
- Perform calculations involving the initial and final conditions of a collision and the conservation of momentum, using the results to classify the collision as either elastic or inelastic.
- Perform calculations to determine the impulse on a body of mass.

Higher National Unit Support Notes

Unit title: Physics Principles: Mechanics (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 and Engineering awards. It is designed to develop the theoretical aspects of the physics principles of mechanics.

Outcome 1 — Apply the concepts of vectors

Clarification of defining vector and scalar quantities: vectors have magnitude and direction while scalars are defined by magnitude only. Correct notation to define the magnitude of a vector quantity and incorporating systems for defining direction. Cartesian coordinate system can be formalised and unit vectors introduced such that the learner may define vector quantities with greater rigour than that found at SCQF level 6.

Revision of the sine and cosine functions to decompose a vector into its components. Addition of x and y components to resolve systems of vectors in 2 and 3 dimensions and calculation of the resultant magnitude via Pythagoras' Theorem. Calculation of angle subtended by the resultant vector using the tangent function. Scale drawings can be used as a visual aid to demonstrate the addition of vector components.

Introduction to vector multiplication. Define the scalar (or dot) product as $\boldsymbol{A} \cdot \boldsymbol{B} = \boldsymbol{A_x B_x} + \boldsymbol{A_y B_y} + \boldsymbol{A_z B_z}$ and also $\boldsymbol{A} \cdot \boldsymbol{B} = |\boldsymbol{A}||\boldsymbol{B}|Cos(\theta)$ where $\boldsymbol{A}$ is a vector. Note that B may either be a vector or a scalar, however, the scalar product will always return a scalar. Define the magnitude of the vector (or cross) product as $|\boldsymbol{C}| = |\boldsymbol{A} \times \boldsymbol{B}| = |\boldsymbol{A}||\boldsymbol{B}|Sin(\theta)$. The direction will follow from the unit vectors of $\boldsymbol{A}, \boldsymbol{B}$ and is determined by either using the right hand rule or tables. Alternatively, the complete cross product vector may be computed by the determinant of the matrix of the components of $\boldsymbol{A}, \boldsymbol{B}$, namely

$$\boldsymbol{C} = \boldsymbol{A} \times \boldsymbol{B} = det \begin{vmatrix} \hat{\boldsymbol{\imath}} & \hat{\boldsymbol{\jmath}} & \widehat{\boldsymbol{k}} \\ \boldsymbol{A_x} & \boldsymbol{A_y} & \boldsymbol{A_z} \\ \boldsymbol{B_x} & \boldsymbol{B_y} & \boldsymbol{B_z} \end{vmatrix} = \left(\boldsymbol{A_y B_z} - \boldsymbol{A_z B_y}\right)\hat{\boldsymbol{\imath}} - (\boldsymbol{A_x B_z} - \boldsymbol{A_z B_x})\hat{\boldsymbol{\jmath}} + \left(\boldsymbol{A_x B_y} - \boldsymbol{A_y B_x}\right)\widehat{\boldsymbol{k}}$$

Unit title: Physics Principles: Mechanics (SCQF level 7)

Where this method gives the magnitude and direction of the cross product. Learners may use either method to compute the vector product. Learners should also be introduced to the notion of arbitrary vectors, for example, $\boldsymbol{A} = (\boldsymbol{x}, \boldsymbol{y}, \boldsymbol{z}) = (0{,}3{,}6)$ or vectors of the form $\boldsymbol{a} = (0{,}0, -9.81)$, $\boldsymbol{v} = (0{,}0{,}0)$, $\boldsymbol{r} = (0{,}0, h)$ to describe acceleration, velocity, position of, for example, the initial conditions of a body in freefall, released from rest at height h.

Define velocity as the rate of change of displacement with regard to time and likewise for acceleration, defining as the rate of change of velocity with regard to time. Equations for average values, utilising non-zero changes in time before taking the limit of time to 0, yielding the respective instantaneous equations in terms of a derivative.

Calculate average values for velocity, expressed as a polynomial, and differentiate to give the instantaneous value at a given time. Equations might be of the following form: $v = ds/dt$ where s may be a displacement and substituted with x, y or z in the case of a specific direction. Equations for velocity may be integrated to yield displacement, namely $s = \int_{t_1}^{t_2} v\, dt = \frac{1}{2} v(t_2 - t_1)^2$ or $s = \int v\, dt = \frac{1}{2} vt^2 + C$

Calculate average values for acceleration, expressed as a polynomial, and differentiate to give the instantaneous value at a given time. Similarly, instantaneous acceleration may be denoted by $a = dv/dt = d^2s/dt^2$.

Outcome 2 — Apply the concepts of interaction of forces and motion

Define Newton's First Law of Motion. Examine various cases of objects at rest or at constant velocity under the action of balanced forces. Apply Newton's First Law of Motion to describe the objects' motion.

Define Newton's Second Law of Motion as force equalling the product of mass and acceleration. Use definitions for uniform and non-uniform acceleration, incorporating the differential form of acceleration in the case of the latter, ie $F = ma = m\, dv/dt$

Define the restorative force exerted by a spring or similar elastic material as being proportionate to the displacement from equilibrium. Introduce the spring constant as the constant of proportionality between the two quantities, defining Hooke's Law in the process.

Define static and kinetic friction. Revise normal force and define Amonton's first and second laws and Coloumb's law of friction. Define coefficient of static and kinetic friction. Examine cases of static bodies of mass on flat and inclined planes and bodies of circular motion on banked curves.

Unit title: Physics Principles: Mechanics (SCQF level 7)

Introduce uniform circular motion for a body of mass travelling in a circular path at a constant speed. Revision of equation for circumference of the unit circle and angle in terms of radians, defining angular velocity as the rate of change of angular displacement with regard to time in differential form ie $\omega = d\theta/dt$. Define angular acceleration as the derivative of angular velocity with regard to time and linear acceleration as the result of a constant velocity experiencing a changing direction. Substitute into Newton's Second Law of Motion to arrive at centripetal acceleration. The nature of centripetal and centrifugal force should also be clarified: centripetal force is a centre-seeking force and is a direct result of circular motion while centrifugal force (centre-fleeing force) arises as a consequence of inertia; the intrinsic property of mass which acts to resist changes in momentum. Even though it is clearly observable, centrifugal force is often referred to as a virtual force as a result of its definition. Other examples of similar cases can be used, such as the forward force experienced by a passenger when a vehicle suddenly decelerates.

General definition for oscillatory motion leading to definition for simple harmonic motion. Oscillatory motion of an ideal spring with an attached mass, accelerating in terms of the second time-derivative of the spring's extension, substituted into Newton's Second Law of Motion and incorporating terms derived from Hooke's Law. Introduce concept of differential equations and either give solution for angular velocity in terms of the spring constant and mass or justify solution to DE using phasor diagrams. Examine relationship of amplitude and period of SHO system. Examine the generalities of simple harmonic motion across other cases; the angular motion of a pendulum or the translational motion of a piston inside an internal combustion engine.

Define gravity as a mutually attractive force between two bodies of mass, proportionate to the product of the masses and inversely proportionate to the square of their separating displacement. Introduce the universal gravitational constant as the constant of proportionality between force, mass and displacement and define the Law of Universal Gravitation. Apply Newton's Second Law of Motion in terms of centripetal and gravitational forces to cases of orbiting satellites or systems of a similar nature.

Outcome 3 — Apply the concepts of work and energy

Reviewing equations for energy (for example, but not limited to: kinetic, potential, heat, electrical, etc), use with dimensional analysis or a similar method to determine the units of each equation thus demonstrating their algebraic equality. Define the Joule as a kilogram metre squared per second squared. Introduce the conservation of energy theorem as the physical equality of all energy types where consequentially, energy is neither created or destroyed thus necessitating a transformation of energy, detailed by the equality of their respective equations. The conservation of energy theorem and dimensional analysis will also allow the learner to perform computations using equations of energy which are not of a 'standard' form or which have not been formally defined yet, intending to offer a better appreciation of what conservation of energy entails.

Define mechanical work as a scalar equal to the product of force and displacement. Apply vector component theory to evaluate cases of a force in 2 dimensions and use the result to demonstrate the equivalence of computing work via the dot product.

Unit title: Physics Principles: Mechanics (SCQF level 7)

Define the work-energy theorem where work done is equal to the change in energy. Apply to cases of a body of mass in motion exhibiting a change in kinetic energy from an acceleration or deceleration. For example $W = \int F\, ds = \int F\, vdt = \frac{1}{2}m(v_2 - v_1)^2$ or $W = \Delta E$

From Hooke's Law, define the force which extends a spring by a given amount followed by the work done in doing so. Integrate Hooke's Law with regard to displacement over initial and final displacement to derive an expression for potential energy stored by a spring and relate to work-energy theorem. For example $U(x) = \int_{x_1}^{x_2} F\, dx = -\int_{x_1}^{x_2} kx\, dx = \frac{1}{2}kx^2$ such that the potential energy stored by the spring is equal to the work done in extending it.

Following a similar approach, integrate the Law of Universal Gravitation with regards to height to calculate the potential energy of a body of mass raised to some height (or generally, a displacement (r) between the bodies' centres of mass) in the presence of a gravitational field. For example $U(r) = \int_{r_1}^{r_2} \frac{GMm}{r^2} dr = -\frac{GMm}{r}$. This may be approximated for bodies close to the earth's surface ie $U = mgh$. Apply work-energy theorem to conclude that the potential energy is equal to the work done against gravity to displace the mass.

Outcome 4 — Apply the concepts of momentum and impulse

Define Newton's Third Law of Motion and apply to scenarios of paired forces. Identify pairs of forces and examine the consequences which the law entails, ie a body cannot exert a force upon itself. Derive Newton's Third Law of Motion as $\int F\, dt = P_2 - P_1$

Define momentum as the vector given by the product of mass and velocity. From the work-energy theorem, examine the consequence of a change in momentum in terms of velocity with a constant mass. Follow with the law of conservation of momentum and the generalised form of Newton's Second Law of Motion ie $F = dP/dt$.

Define inertia in greater detail and provide examples for the case of centrifugal force of the force felt during acceleration/deceleration, ie the propensity for a body of mass to resist changes in external forces. Examine conventionally simple solids (for example: ball, rod, disc, cylinder; all are rigid with uniform densities), identify the moments of inertia for a rotation about the centre of mass in the process while defining any assumptions made. For example, in the case of a rod, it is assumed to have mass m, length l and negligible thickness. Its moment of inertia about the centre of mass is given by $I_{centre} = \frac{ml^2}{12}$. Conventionally, the axis of rotation should intercept the centre of mass, unless otherwise stated. For example, a rod is assumed to rotate about the centre of its length but may also be specified as rotating about one of its end points. The cases of the cylindrical tube and torus should be highlighted since their centres of mass do not lie within the material of the body itself.

Consider forces which act to rotate a body about a fixed point while examining applications of such rotational forces. For example, a wrench tightening/loosening the nut on a bolt, a door opening/closing on its hinges, the difference felt between a lever with a long or short handle. Explain torque as the force which rotates a body about an axis, brought about by a linear force acting perpendicularly (or generally, the perpendicular component) to the line of action extending to the axis of rotation, defined as the vector product of the perpendicular linear force (F) and the displacement from F to the axis of rotation (r), such that $\tau = F \times r$.

Unit title: Physics Principles: Mechanics (SCQF level 7)

Using linear momentum as a starting point, describe angular momentum (L) as its rotational counterpart, substituting the product of mass and velocity for the product of moment of inertia and angular velocity. Define as $L = I\omega$ for a rotating solid. For a particle rotating about a fixed point (ie the earth about the sun), the equation $L = r \times mv = r \times P$ should be used, which also gives a direct relationship back to linear momentum and is intuitively similar to the equation for torque. Lastly, the relationship between torque and angular momentum should be defined as $\tau = \frac{dL}{dt}$ which can be seen as the angular version of Newton's Second Law of Motion.

Define terminology and conditions for elastic and inelastic collisions. Apply to cases such as bouncing balls, carts travelling on an air track or the ballistic pendulum. Cases of inelastic collisions in 2 dimensions should also be covered to build upon knowledge from SCQF level 6.

Define impulse from the impulse-momentum theorem for a constant net force. Integration of Newton's Second Law of Motion then gives a generalised definition applying to forces which are not constant. Examine in a graphical setting by measuring the area beneath a force — time graph for cases of constant and varying net forces.

Guidance on approaches to delivery of this Unit

Outcomes 1−4 would best be delivered in order. It is envisioned that the Unit be delivered predominantly through lecturing such that the theory may be delivered while also setting an appropriate pace for the class. There is potential for practical and hands-on elements which may also take place on an ad-hoc basis through the usual lecture setting, ie quick demonstrations of apparatus.

It is envisaged that Outcome 1 will commence with a revision on vectors and the properties of motion. The new concepts of vector multiplication will be covered, offering the learner multiple ways to perform computation, however, the Unit does not intend on assessing the learner by the choice of equation used (ie $|\boldsymbol{A} \times \boldsymbol{B}| = |\boldsymbol{A}||\boldsymbol{B}|Sin(\theta)$ followed by determining the direction separately or using matrix determinants). Once the underpinning knowledge has been re-established, the concept of differentiation to evaluate a function at an instantaneous point will be applied to the properties of motion to give definitions for instantaneous velocity and acceleration. At this level only simple functions will be used to represent the velocity and acceleration of an object.

Outcome 2 will reintroduce Newton's First and Second Laws of Motion, utilising acceleration in its differential form for the case of the Second Law, both in terms of displacement (second order derivative) and velocity (first order derivative). The concepts of linear elasticity in solids over 1 dimension could be introduced through Hooke's Law, utilising the ideal spring as an example. Friction should be covered in greater detail than at SCQF level 6. Uniform circular motion will be delivered as an extension to the learner's existing knowledge of mechanics, requiring only a brief introduction to measurement in radians. The concepts of simple harmonic motion should be covered and learners should be able to recognise behavioural and mathematical similarities in various systems (eg a vibrating spring or pendulum) while receiving a brief exposure to the concept of differential equations and their solutions, which can be expanded upon in further study of physics at a higher level.

Unit title: Physics Principles: Mechanics (SCQF level 7)

The behaviour of SHO systems can be visualised with data from an accelerometer showing the time-variant acceleration of the oscillating body, thus illustrating terms such as amplitude, angular frequency and period. Similarly, the translational motion of a mass/spring system can be measured using a magnet attached to the oscillating mass and placed in the centre of a coil. The resultant induced voltage in the coil can be visualised on a PC connected oscilloscope. This could be done as a demonstration to the class or in groups as a non-assessed practical in a tutorial setting. This will also give an early exposure to methods in gathering experimental data by computational means.

Outcome 3 is intended to take various aspects regarding forces and present them in terms of energy, allowing for a new approach in rationalising familiar concepts. Calculating work as the integration of force over distance will allow learners to use previously defined equations. As before, the complexity of functions should be kept to a minimum but should require a varied usage of the various rules of differentiation and integration to demonstrate the relevance of calculus in physics. Learners may be made aware of computational mathematical software, including web based resources, to aid in checking work. Emphasis should also be made on delivering a structured solution with an explanatory narrative instead of listing the answer or steps taken without any context. This approach will also furnish the learner with good habits needed for further study.

Outcome 4 should commence by defining Newton’s Third Law of Motion to examine the nature of paired forces. Momentum will be defined for both constant and varying velocities. Newton’s Second Law of Motion may also be expressed in its generalised form as the time derivative of momentum. Following from this, momentum in its angular form will be defined, taking advantage of vector products in an applied setting. For angular momentum and force, comparisons may be drawn to their linear counterparts to aid understanding but the new theories should also stand by themselves and not be seen as a mere extension to that previously covered. Spinning tops, gyroscopic stabilisers and flywheels for storing energy can be used as applied examples or in demonstrations. The law regarding conservation of momentum will be covered and leads to the classification of collisions; elastic or inelastic. There is good potential for simple demonstrations, for example, collisions of carts on air tracks. The impulse-momentum theorem will then follow from this by examining the effect that time intervals have on momentum, firstly for an average or constant net force and then a time-varying net force. Graphs can make for good examples, both in visualising and in quantifying the impulse from the area beneath the line or curve. Data, either representing a simulated impulse or a measured one, can be analysed and displayed using various software packages, including that for spreadsheets.

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 1−4 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.

Unit title: Physics Principles: Mechanics (SCQF level 7)

Where evidence of Outcomes 1−4 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.

An exemplar instrument of assessment with marking guidelines has been produced to indicate the notional 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.

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

This Unit has the *Critical Thinking* component of *Problem Solving* and the *Using Number* component of *Numeracy* embedded in it. This means that when learners achieve the Unit, their Core Skills profile will also be updated to show they have achieved *Critical Thinking* at SCQF level 5 and *Using Number* at SCQF level 6.

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 parameters of instantaneous motion and force by applying differentiation and integration of functions and equations.

Problem Solving — **Critical Thinking at SCQF level 5**

Learners will be required to identify relevant information for a mechanical system through evaluation of its description or diagram, eg free body diagrams.

History of changes to Unit

Version	Description of change	Date
02	Core Skills Components Critical Thinking at SCQF level 5 and Core Skills Component Using Number at SCQF level 6	28/07/2015

Additional copies of this Unit specification can be purchased from the Scottish Qualifications Authority. Please contact the Business Development and Customer Support team, telephone 0303 333 0330.

General information for learners

Unit title: Physics Principles: Mechanics (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 experience of Higher Physics and Higher Mathematics, where you will have learned underpinning aspects of mechanics.

On successful completion of the Unit you should be able to:

1 Apply the concepts of vectors.
2 Apply the concepts of interaction of forces and motion.
3 Apply the concepts of work and energy.
4 Apply the concepts of momentum and impulse.

Outcome 1

In this Outcome you will cover aspects of vector theory with regards to the principles of motion. You will then re-examine the familiar equations of average motion before using the calculus of limits and differentiation to define new equations for instantaneous motion, opening up new possibilities for the analysis of more realistic scenarios.

Outcome 2

In this Outcome you will take a more rigorous approach to the theories and laws regarding mechanical forces and their effects on moving and stationary objects. You will examine Newton's Second Law of Motion for uniform and non-uniform accelerations, static and kinetic friction, restorative forces in elastic materials, uniform circular motion and centripetal forces, simple harmonic motion and gravitation.

Outcome 3

In this Outcome you will learn how to perform mathematical integration on equations of force in order to evaluate a mechanical system in terms of its work done. You will revisit familiar concepts from Outcome 2 and examine the consequences stemming from the laws and theorems of work, energy and conservation of energy.

Outcome 4

In this Outcome you will formally define Newton's Third Law of Motion and examine its consequences on mechanical systems before moving on to defining momentum for constant and varying velocities, from which Newton's Second Law of Motion can be generalised. You will be introduced to angular momentum and torque and perform vector multiplication over 3 dimensions to compute related values. The classifications of collisions will be defined and the effect of time intervals on forces will be examined for constant forces and in its more generalised setting for a time varying force, via integration.

General information for learners (cont)

Unit title: Physics Principles: Mechanics (SCQF level 7)

Assessment

For Outcomes 1−4 you will take a closed-book, end of Unit assessment.

Core Skills

This Unit has the Core Skill component of *Using Number* at SCQF level 6 embedded in it, as well as the Core Skill component of *Critical Thinking* at SCQF level 5.