SQA Advanced Unit specification

General information for centres

Unit title: Dynamics

Unit code: HT7E 47

Unit purpose: The Unit is designed to enable candidates to develop knowledge and understanding of principles and laws relating to motion.

On completion of the Unit the candidate should be able to:

1 Solve problems relating to linear and angular motion.
2 Solve problems relating to impulse, conservation of momentum, work, energy and power.

Credit points and level: 1 SQA Credit at SCQF level 7: (8 SCQF credit points at SCQF level 7*)

**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 National 1 to Doctorates.*

Recommended prior knowledge and skills: Candidates should have knowledge and understanding of mathematics and/or physics at Higher level or a National Certificate in Engineering as a minimum and it would be beneficial to have achieved the Unit Engineering Principles, although entry is at the discretion of the centre.

Core skills: There may be opportunities to gather evidence towards the following listed Core Skills components in this Unit, although there is no automatic certification of Core Skills or Core Skills components.

Using Number	SCQF level 6
Critical Thinking	SCQF level 6

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.

Assessment: The assessment for both Outcomes in this Unit should be combined together into one assessment paper. This paper should be taken by candidates at one single assessment event that should last 1.5 hours. Assessment should be conducted under controlled, supervised conditions.

SQA Advanced Unit specification: statement of standards

Unit title: Dynamics

Unit code: HT7E 47

The sections of the Unit stating the Outcomes, knowledge and/or skills, and evidence requirements are mandatory.

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. Candidates 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

Solve problems relating to linear and angular motion

Knowledge and/or skills

- dynamic quantities (initial velocity, final velocity, acceleration, time, displacement)
- unit conversion to SI units (eg kilometres per hour to metres per second)
- the four equations of linear motion
- the four equations of angular motion
- the bridging equations between angular and linear motion (eg $v = \omega r$)
- velocity–time graphs
- rope/wire tension caused by motion and acceleration
- projectile motion

Evidence requirements

Evidence for the knowledge and or skills in this Outcome will be provided on a sample basis. The evidence may be presented in response to specific questions. Each candidate will need to demonstrate that she/he can answer questions correctly based on a sample of the items shown above. In any assessment of this Outcome **seven from eight** knowledge and/or skills items should be sampled.

In order to ensure that the candidates will not be able to foresee what items they will be questioned on, a different sample of seven from eight knowledge and/or skills items is required each time the Outcome is assessed. Candidates must provide a satisfactory response to all seven items.

Where sampling takes place, a candidate's response can be judged satisfactory where the evidence provided is sufficient to meet the requirements for each item by showing that the candidate is able to:

- convert units for both linear and angular motion
- sketch velocity–time graphs
- label velocity–time graphs
- solve a problem using the area under a velocity–time graph
- calculate at least two different dynamic quantities (a, u, v, s and t) for linear motion
- calculate at least two different dynamic quantities (α, ω_1, ω_2, θ and t) for angular motion

- determine the tension in a wire/rope that is moving a mass vertically with acceleration and also with constant velocity
- determine the tension in a wire/rope that is moving a mass horizontally with acceleration and also with constant velocity
- determine the tension in a wire/rope that is moving a mass on a slope with acceleration and also with constant velocity
- calculate the range of a launched projectile
- calculate the maximum height of a launched projectile

The assessment of this Outcome must be combined with that for Outcome 2 to form a single assessment paper, details of which are given under Outcome 2.

Assessment guidelines

None.

Outcome 2

Solve problems relating to impulse, conservation of momentum, work, energy and power

Knowledge and/or skills

- linear impulse
- angular impulse
- conservation of linear momentum
- conservation of angular momentum
- work done during dynamic motion
- work done to overcome friction
- conservation of energy in combined linear and angular motion systems
- power
- moment of inertia

Evidence requirements

Evidence for the knowledge and or skills in this Outcome will be provided on a sample basis. The evidence may be presented in response to specific questions. Each candidate will need to demonstrate that she/he can answer questions correctly based on a sample of the items shown above. In any assessment of this Outcome **six from nine** knowledge and/or skills items should be sampled.

In order to ensure that candidates will not be able to foresee what items they will be questioned on, a different sample of six from nine knowledge and/or skills items is required each time the Outcome is assessed. Candidates must provide a satisfactory response to all six items.

Where sampling takes place, a candidate's response can be judged satisfactory where the evidence provided is sufficient to meet the requirements for each item by showing that the candidate is able to:

- convert units
- calculate quantities associated with linear impulse
- calculate quantities associated with angular impulse
- solve a linear momentum problem
- solve an angular momentum problem
- sketch a space diagram of a system

- sketch a free body diagram of a system
- calculate the energy used to overcome friction
- analyse a system relating to energy conversion and conservation
- determine the power required to cause/stop linear motion
- determine the power required to cause/stop angular motion
- calculate the moment of inertia using the radius of gyration
- determine the moment of inertia through energy balance

The assessment of this Outcome must be combined with that of Outcome 1 to form one assessment paper for the Unit. This single assessment paper should be taken at a single assessment event lasting no more than 1.5 hours and carried out under supervised, controlled conditions. Assessment should be conducted under closed book conditions and as such candidates should not be allowed to bring any textbooks, handouts, or notes to the assessment. Candidates will be permitted to use scientific, but not programmable, calculators during the assessment.

Assessment guidelines

The assessment paper should be composed of an appropriate balance of short answer, restricted response and structured questions.

Administrative Information

Unit code: HT7E 47

Unit title: Dynamics

Superclass category: XH

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History of changes:

Version	Description of change	Date

Source: SQA

SQA acknowledges the valuable contribution that Scotland's colleges have made to the development of SQA Advanced Qualifications.

FURTHER INFORMATION: Call SQA's Customer Contact Centre on 44 (0) 141 500 5030 or 0345 279 1000. Alternatively, complete our Centre Feedback Form.

SQA Advanced Unit specification: support notes

Unit title: Dynamics

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

This Unit has been written in order to allow candidates to develop knowledge, understanding and skills in the following areas:

1 The use of basic dynamic concepts and theorems to solve problems in linear and angular motion.
2 The use of basic dynamic concepts and theorems to solve linear and angular impulse and momentum problems.

In designing this Unit the Unit writers have identified the range of topics they would expect to be covered by lecturers. The writers have also given recommendations as to how much time should be spent on each Outcome. This has been done to help lecturers to decide what depth of treatment should be given to the topics attached to each of the Outcomes. Whilst it is not mandatory for a centre to use this list of topics it is strongly recommended that it does so to ensure continuity of teaching and learning across the Dynamics Unit and because the assessment exemplar pack for this Unit is based on the knowledge and/or skills and list of topics in each of the Outcomes.

The list of topics is given below. Lecturers are advised to study this list of topics in conjunction with the knowledge/skills section of this document and the assessment exemplar pack so that they can get a clear indication of the standard of achievement expected of candidates in this Unit.

1 Solve problems relating to linear and angular motion (25 hours)

- Varying units. Converting from non-standard units for all dynamic properties into standard SI units
- convert units from and to both linear and angular motion
- velocity–time graphs for linear and angular motion
- descriptions and identification of all the scalars and vectors that can be used in dynamic problems and recognition of one from the other

2 Solve problems relating to impulse, conservation of momentum, work, energy and power (15 hours)

- elastic and non-elastic collision
- changes in direction including motion at different angles
- common properties derived from different theories such as the determination of the moment of inertia of a body by both $I = mk^2$ or by energy conservation
- the effect of impulse
- power requirements
- power, torque, force relationships

Areas of practical work for both Outcomes may include, but are not limited to, those covered within the Engineering Principles Unit.

Guidance on the delivery and assessment of this Unit

Practical demonstration and realistic problem solving should support the application of dynamic principles. Computer software should be made available where appropriate and candidates should be encouraged to take a logical problem solving approach throughout.

It should be noted that this Unit can be delivered on a free standing basis or combined with the Engineering Principles Unit for teaching and learning. This provides course planners with the flexibility to keep the two Units separate or combine them for teaching and learning purposes. Such flexibility may be important to a centre where, for example, both Units are included in a number of SQA Advanced Engineering courses.

The Unit has been written such that there is sufficient time built in for candidates to practise what they have learnt through appropriate formative assessment exercises. Additionally, the Unit has been designed to incorporate time for some experimental work and computer simulations (these will not be formally assessed in the Unit) so that candidates have an opportunity to confirm dynamic theories in practice. Whilst it is recognised that computer simulation can be a valuable tool in confirming mechanical theories, it is nevertheless felt important that candidates do some practical laboratory work so that they can gain experience in using test equipment and analysing the results of experiments.

As this Unit provides core dynamic principles which underpin much of the studies done in other areas of the SQA Advanced Certificate/Diploma in Mechanical Engineering, it is recommended that the Unit be delivered towards the start of these awards.

Where this Unit is incorporated into other Group Awards it is recommended that it be delivered in the context of the specific occupational area(s) that the award is designed to cover.

Details on approaches to assessment are given under Evidence Requirements and Assessment guidelines under Outcome 2 in the SQA Advanced Unit specification: statement of standards section. It is recommended that these sections can be read carefully before proceeding with the assessment of candidates.

Opportunities for developing Core Skills

There may be opportunities to gather evidence towards the following listed Core Skill components in this Unit, although there is no automatic certification of Core Skills or Core Skills components.

Using Number	SCQF level 6
Critical Thinking	SCQF level 6

Open learning

This Unit could be delivered by distance learning, which may incorporate some degree of on-line support. However, with regard to assessment, planning would be required by the centre concerned to ensure the sufficiency and authenticity of candidate evidence. Arrangements would be required to be put in place to ensure that the assessment, which is required to be at a single event, was conducted under controlled, supervised conditions.

For information on normal open learning arrangements, please refer to the SQA guide *Assessment and Quality Assurance of Open and Distance Learning* (SQA 2000).

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.

General information for candidates

Unit title: Dynamics

This Unit has been designed to allow you to develop knowledge, understanding and skills in basic dynamic concepts and theorems that underpin so much of more advanced studies in Mechanical Engineering. If you have studied these subjects before the early parts of this Unit it will provide you with an opportunity to revise the dynamic concepts and theorems you have learnt in previous courses.

The Unit will also provide you with an opportunity to study the ways in which velocity, displacement, time, acceleration, mass and force interlink in motion, impulse, and momentum and energy transfers.

It is good to gain sound theoretical knowledge and understanding but it is also important that you are able to set your theoretical knowledge within a practical Mechanical Engineering context. Thus, it is likely during the Unit that you will be provided with the opportunity to relate theory to practice by doing practical experiments and computer simulations on mechanical problems.

By the end of the Unit you will be expected to solve dynamic problems using the concepts and theorems you have learned. You will also be expected to sketch the graphs associated with velocity, time and acceleration.

The formal assessment for this Unit will consist of a single assessment paper lasting no more than 1.5 hours. The assessment will be conducted under closed book conditions in which you will not be allowed to take notes, textbooks etc. into the assessment. However, you will be allowed to use a scientific calculator. You will sit this assessment paper at the end of the Unit.

Candidates studying towards an SQA Advanced Certificate/Diploma in Mechanical Engineering will also have to answer questions on dynamics as part of the integrated assessment.