

SQA Advanced Unit Specification

General information for centres

Unit title: Mechanical Engineering Principles

Unit code: HV2V 47

Unit purpose: This Unit has been designed to enable candidates to develop knowledge and understanding of engineering principles and to apply these principles to the solution of problems involving engineering systems. The Unit will also provide candidates with a foundation of knowledge and understanding of engineering principles from which further studies in Dynamics, Engineering Principles and Statics and Strength of Materials can be developed.

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

- 1 Apply engineering principles to problems involving linear motion.
- 2 Apply engineering principles to problems involving work and power.
- 3 Apply engineering principles to problems involving the mechanical properties of engineering materials.

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: Entry to the Unit is at the discretion of the centre however it would be an advantage if candidates have a basic knowledge and understanding of engineering principles. Possession of a basic knowledge and understanding may be evidenced by possession of a Standard Grade credit pass in Technological Studies or the NQ units: Introductory Mechanics, Engineering Systems 1: Machines and Mechanisms, Dynamics or Strength of Materials.

Core Skills: There are opportunities to develop the Core Skills of Written Communication, Using Number and Critical Thinking at SCQF level 5 in this Unit, although there is no automatic certification of Core Skills or Core Skills components.

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 Outcomes 1 and 2 in this Unit should be combined into one assessment paper lasting one hour. Assessments should be conducted under controlled, supervised 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 should be permitted to use scientific calculators during the assessment.

Outcome 3 should be assessed in two parts. Firstly by an assignment in which candidates are asked to complete a material test laboratory experiment and write a report on the results obtained. The assignment should be completed in a maximum of one hour. Reports should be written up in the candidate's own time. Secondly by a single assessment paper covering factor of safety and should be taken at a single assessment event lasting 30 minutes and carried out under supervised, controlled conditions.

SQA Advanced Unit Specification: statement of standards

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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

Apply engineering principles to problems involving linear motion

Knowledge and/or skills

- ◆ Mechanical advantage
- ◆ Force ratio
- ◆ Displacement ratio
- ◆ Efficiency
- ◆ Velocity
- ◆ Accelerating force
- ◆ Velocity/time diagrams
- ◆ Newton's Laws of motion

Evidence Requirements

Evidence for the knowledge and/or skills items in Outcome 1 should be provided on a sample basis. The evidence may be presented in response to specific questions. The assessment of this outcome is by a closed book assessment. Each candidate will need to demonstrate that she/he can answer correctly questions based on a sample of the knowledge and skills items listed in the Outcome. In any assessment of this Outcome, **six** out of **eight** knowledge and/or skills items should be sampled. The sample must always include mechanical advantage and Newton's laws of motion.

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

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

- ◆ solve problems involving linear motion, including velocity/time graphs and acceleration
- ◆ apply equations, units and conventions to problems involving mechanical advantage including force, displacement ratios and efficiency
- ◆ apply equations, units and conventions to problems involving Newton's Laws of Motion

Assessment guidelines

The assessment of this Outcome must be combined with that for Outcomes 2. Details of the assessment are given in the Evidence Requirement section of Outcome 2.

Outcome 2

Apply engineering principles to problems involving work and power

Knowledge and/or skills

- ◆ Coefficient of friction
- ◆ Potential energy
- ◆ Kinetic energy
- ◆ Power
- ◆ Conservation of energy

Evidence Requirements

Evidence for the knowledge and/or skills items in Outcome 2 should be provided on a sample basis. The evidence may be presented in response to specific questions. The assessment for this outcome is by a closed book assessment. Each candidate will need to demonstrate that she/he can answer correctly questions based on a sample of the knowledge and skills items listed in the Outcome. In any assessment of this Outcome, **three out of five** knowledge and/or skills items should be sampled. The sample must always include calculations on friction and power.

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

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

- ◆ apply the principles of friction to mechanical engineering problems
- ◆ apply the principles of potential and/or kinetic energy to mechanical engineering problems
- ◆ apply the principles of power to mechanical engineering problems
- ◆ apply the principle of conservation of energy to mechanical engineering problems

The assessment of this Outcome should be combined with that for Outcome 1 to form a single assessment paper lasting 1 hour. Evidence should be generated through assessment undertaken in controlled, supervised 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 should be permitted to use scientific calculators during the assessment.

Assessment guidelines

Questions used to elicit candidate evidence should take the form of an appropriate balance of short answer, restricted response and structured questions.

Outcome 3

Apply engineering principles to problems involving the mechanical properties of engineering materials

Knowledge and/or skills

- ◆ Tensile, compressive and shear stress
- ◆ Strain
- ◆ Modulus of elasticity
- ◆ Factor of safety

Evidence Requirements

All knowledge and/or skills items should be assessed in this Outcome.

A candidate's response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements for each item by showing the candidate is able to:

- ◆ carry out a laboratory exercise on a tensile test and complete a report
- ◆ apply the principles of stress and strain to engineering problems
- ◆ apply the principles of factor of safety to an engineering problem

Outcome 3 should be assessed in two parts. Firstly by an assignment in which candidates are asked to complete a material test laboratory experiment involving stress and strain and write a report on the results obtained. The assignment should be completed in a maximum of one hour. Reports should be written up in the candidate's own time. Secondly by a single assessment paper covering factor of safety taken at a single assessment event lasting 30 minutes 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 should be permitted to use scientific calculators during the assessment.

Centres should make every reasonable effort to ensure the assignment solution is the candidate's own work. Where copying or plagiarism is suspected candidates may be interviewed to check their knowledge and understanding of the subject matter. A checklist should be used to record oral evidence of the candidate's knowledge and understanding.

Assessment guidelines

Questions used to elicit candidate evidence in the assessment paper should take the form of an appropriate balance of short answer, restricted response and structured questions.

Administrative Information

Unit code:	HV2V 47
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Superclass category:	RC
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SQA Advanced Unit Specification: support notes

Unit title: Mechanical Engineering Principles

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 developed to be one of the units in the SQA Advanced Certificate/SQA Advanced Diploma in Engineering Practice Frameworks. This Unit has been written in order to allow candidates to develop knowledge, understanding and skills in engineering science principles and how these can be applied to problems involving engineering systems. This Unit will also provide the candidate with a firm foundation for further advanced studies in Mechanical Engineering.

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 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 do so to ensure continuity of teaching and learning across the Engineering Science Principles 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 in conjunction with the assessment exemplar pack so that they can get a clear indication of the standard of achievement expected of candidates in this Unit. All timings include time for assessment.

1 Apply engineering principles to problems involving linear motion (14 hours)

- ◆ Speed
- ◆ Velocity
- ◆ Velocity/time graphs
- ◆ Relative velocity
- ◆ Resultant velocity
- ◆ Acceleration
- ◆ Newton's laws of motion
- ◆ Mechanical advantage
 - wheel and axle
 - screws and screw jack
 - pulleys
 - belt and chain drives
 - gears
- ◆ Efficiency

Areas for practical work may include, but not be limited to, the following:

- ◆ confirmation of velocity/time graphs
- ◆ confirmation of Newton's laws of motion
- ◆ confirmation of mechanical advantage and efficiency

2 Apply engineering principles to problems involving work and power. (14 hours)

- ◆ Coefficient of friction
 - situations where friction is undesirable
 - situations where friction is desirable
- ◆ Definition of the forms of energy (stored energy; transitory energy)
- ◆ Potential energy
- ◆ Kinetic energy
- ◆ Power
- ◆ Conservation of energy

3 Apply engineering principles to problems involving the mechanical properties of engineering materials. (12 hours)

- ◆ Tensile, compressive and shear stress
 - elongation
 - reduction in area
 - proof stress
- ◆ Strain
- ◆ Modulus of elasticity
- ◆ Factor of safety

It is strongly recommended that candidates undertake as many experiments as possible so that they gain experience in noting results, using test equipment, analysing the results of experiments, as well as confirming basic engineering principles.

Guidance on the delivery and assessment of this Unit

This Unit has been designed to incorporate sufficient time to allow lecturers to teach the core mechanical principles in the Unit. The Unit has also been written such that there is sufficient time built in for candidates to practice 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 where possible), which will not be assessed formally in the Unit, so that candidates have an opportunity to confirm basic engineering principles in practice.

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.

Candidates will have opportunities to develop the Core Skill component of Written Communication while writing up their laboratory report in Outcome 3. Candidates will have opportunities to develop the Core Skills of Using Numbers and Critical Thinking while undertaking formative assessment exercises involving mechanical problems and when analysing the results of experiments.

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

Opportunities for developing Core Skills

There are opportunities to develop the Core Skills of Written Communication, Using Number and Critical Thinking at SCQF level 5 in this Unit, although there is no automatic certification of Core Skills or Core Skills components.

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. Arrangement would be required to be put in place to ensure that the assessment papers for Outcomes 1 and 2 combined and Outcome 3 were 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: Mechanical Engineering Principles

This Unit has been designed to allow you to develop knowledge, understanding and skills in basic engineering principles and concepts that underpin so much of the more advanced studies in Mechanical Engineering such as Dynamics and Statics and Strength of Materials.

This Unit will also provide you with an opportunity to study the relationships that exist between linear motion, work, energy and power as well as evaluate properties of basic engineering materials.

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

By the end of the Unit you will be expected to be able to apply Newton's Laws of Motion to practical engineering problems as well as understand the relationship between work, energy and power. It is also important for engineers to understand the properties of engineering materials and how they change. This enables engineers to make value judgements on many aspects of practical engineering problems.

The formal assessment for this Unit will consist of a single assessment paper lasting one hour covering Outcomes 1 and 2 undertaken under supervised, controlled conditions. 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. The assessment for Outcome 3 is split into two parts, the first being a report on a practical experiment involving the tensile testing of materials. You will prepare the report in your own time. The second assessment will consist of a single assessment paper lasting 30 minutes covering factor of safety and again, 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.