



## National Unit Specification: general information

**UNIT** Mechanical Engineering Principles (SCQF level 5)

**CODE** F5K1 11

### SUMMARY

This Unit may form part of a National Qualification Group Award or may be offered on a free standing basis.

This mainly theory based Unit is designed to provide candidates with basic knowledge and understanding of mechanical engineering principles. During the delivery of this Unit candidates will learn about the basic quantities used in mechanical engineering systems and how to solve simple problems involving such systems. They will also develop the knowledge and understanding to solve mechanical engineering problems involving work, energy, conservation of energy and power. Candidates will also learn about terms used in simple mechanical machines and how to solve problems associated with such machines. They will also develop the knowledge and understanding to state terms and solve problems involving heat.

This Unit is suitable for candidates training to be maintenance or multi-disciplinary engineering craftspersons or technicians.

### OUTCOMES

- 1 State terms and solve problems involving mechanical systems.
- 2 State terms and solve problems involving work, energy, conservation of energy and power in mechanical systems.
- 3 State terms and solve problems involving simple mechanical machines.
- 4 State terms and solve problems involving heat.

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#### Administrative Information

**Superclass:** RC

**Publication date:** March 2009

**Source:** Scottish Qualifications Authority

**Version:** 01

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## **National Unit Specification: general information (cont)**

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### **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 Mathematics at General level
- ◆ Standard Grade Physics at General level
- ◆ Intermediate 1 Physics

### **CREDIT VALUE**

1 credit at SCQF level 5 (6 SCQF credit points at SCQF level 5).

*\*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**

There is no automatic certification of Core Skills in this Unit.

The Unit provides opportunities for candidates to develop aspects of the following Core Skills:

- ◆ Numeracy (SCQF level 5)
- ◆ Problem Solving (SCQF level 5)

These opportunities are highlighted in the Support Notes of this Unit Specification.

## **National Unit Specification: statement of standards**

### **UNIT      Mechanical Engineering Principles (SCQF level 5)**

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**

State terms and solve problems involving mechanical systems.

##### **Performance Criteria**

- (a) State correctly examples of scalar and vector quantities that commonly occur in mechanical engineering.
- (b) State correctly the difference between mass and weight.
- (c) Solve problems involving equations for velocity, acceleration, weight and force in mechanical systems.
- (d) State the meaning of the term torque.
- (e) Solve correctly a problem involving torque in a mechanical system.

#### **OUTCOME 2**

State terms and solve problems involving work, energy, conservation of energy and power in mechanical systems.

##### **Performance Criteria**

- (a) State correctly different forms of energy.
- (b) State correctly examples of energy transformations in engineering systems.
- (c) Solve a problem correctly using equations for work, energy and power.
- (d) Solve a problem correctly by applying the principle of the conservation of energy.

#### **OUTCOME 3**

State terms and solve problems involving simple mechanical machines.

##### **Performance Criteria**

- (a) State correctly the meaning of the term machine.
- (b) State correctly the meaning of terms commonly used in machine calculations.
- (c) Solve correctly a problem involving a lever.
- (d) Solve correctly a problem involving rope block pulleys.

## **National Unit Specification: statement of standards (cont)**

### **UNIT        Mechanical Engineering Principles (SCQF level 5)**

#### **OUTCOME 4**

State terms and solve problems involving heat.

#### **Performance Criteria**

- (a) State correctly units for heat and temperature.
- (b) Describe correctly the three phase change process that water goes through when heated or cooled.
- (c) State correctly the meaning of terms used in heat calculations.
- (d) Solve correctly a problem involving sensible heat and latent heat.

#### **EVIDENCE REQUIREMENTS FOR THIS UNIT**

Evidence is required to demonstrate that candidates have achieved all Outcomes and Performance Criteria.

Written and/or recorded oral evidence should be produced to demonstrate that a candidate has achieved all Outcomes and Performance Criteria.

Outcomes 1, 2, 3 and 4 may be assessed on an individual basis, as a combination of Outcomes, or as a single, holistic assessment covering all four Outcomes. The total time for assessment(s) of the four Outcomes must not exceed 2 hours. Assessment(s) must be conducted under supervised, closed-book conditions in which candidates may use reference materials provided by the centre but are not allowed to bring their own notes, handouts, textbooks or other materials into the assessment. Candidates must be provided with an appropriate formulae sheet for assessment(s) and should be allowed to use a non-programmable scientific calculator during assessment(s).

With regard to Outcome 1

- ◆ candidates must state two scalar and three vector quantities used in mechanical engineering
- ◆ candidates must solve two problems involving velocity, acceleration, weight and force in mechanical systems

With regard to Outcome 2

- ◆ candidates must state four forms of energy which could include the following: potential, kinetic, pressure, heat, electrical, chemical, magnetic, light, sound or nuclear
- ◆ candidates must state two examples of energy transformation processes

With regard to Outcome 3

- ◆ candidates must state the meaning of the terms Mechanical Advantage, Velocity Ratio and Efficiency
- ◆ the lever problem must be solved using simple moment theory
- ◆ the pulley problem must be limited to two double sheave pulleys

## National Unit Specification: statement of standards (cont)

### UNIT Mechanical Engineering Principles (SCQF level 5)

With regard to Outcome 4

- ◆ candidates must state both Celsius and Kelvin as temperature units
- ◆ candidates should describe the three phase change (solid — liquid — gas) in water in terms similar to the following:
  - sensible heat applied to ice to bring it to 0°C
  - conversion of ice to water through the application of latent heat of fusion, temperature remains constant
  - sensible heat applied to water to heat to 100°C
  - conversion of water to steam through the application of latent heat of vapourisation, temperature remains constant
  - continued heating of steam to produce dry steam
- ◆ candidates must state the meaning of the following terms: Specific Heat Capacity, Latent Heat of Fusion and Latent Heat of Vapourisation

The Assessment Support Pack for this Unit provides sample assessment material. Centres wishing to develop their own assessments should refer to the Assessment Support Pack to ensure a comparable standard.

## National Unit Specification: support notes

### UNIT Mechanical Engineering Principles (SCQF level 5)

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 forms part of the National Qualification Group Award (NQGA) in Mechanical Maintenance Engineering at SCQF level 5, but may also be offered on a free standing basis.

The aim of this Unit is to allow candidates to develop basic knowledge and understanding of mechanical engineering principles. On successful completion of the Unit candidates will have learnt about the basic quantities used in mechanical engineering systems and will be able solve simple problems involving such systems. They will also have the knowledge and understanding to solve mechanical engineering problems involving work, energy, conservation of energy and power. Candidates will also have learnt about terms used in simple mechanical machines and will be able to solve problems involving levers and rope block pulleys. They will also be capable of stating terms used in heat calculations and solve problems involving sensible and latent heat.

It is important to emphasise that this Unit has been designed to provide an introduction to the subject of mechanical engineering principles. As such it is suitable as a foundation Unit in the subject on which more advanced studies, at National Qualification and Higher National level, can be built. It is important that during the delivery of the Unit opportunities for candidates to develop a sound knowledge and understanding of the concepts and principles associated with mechanical engineering principles are maximised. Experience has shown that knowledge and understanding can best be developed by setting the concepts and principles within a practical mechanical engineering context and by encouraging candidates to solve realistic engineering problems.

In Outcome 1 candidates should be introduced to the concept of scalar and vector quantities. They should learn which mechanical quantities are scalars and which are vectors. Candidates should be taught the difference between mass and weight and also the relationship between the two (see below). They should also solve simple mechanical engineering problems using equations such as:

$$a = \frac{(v - u)}{t}$$

t

$$F = ma$$

$$W = mg$$

where u = initial velocity, v = final velocity, t = time a = acceleration, m = mass, F = force and W = weight.

Candidates should also be introduced to the concept of torque and taught to solve simple problems involving torque ( $T = Fr$  where T = torque and r = radius).

## National Unit Specification: support notes (cont)

### UNIT Mechanical Engineering Principles (SCQF level 5)

In Outcome 2 candidates should be introduced to the concepts of energy, work and power. Candidates should be taught to identify different forms of energy. They should also learn about different types of energy transformation processes as an introduction to engineering systems. Candidates should learn how to solve mechanical engineering problems involving work ( $W = Fd$ ), potential energy (ie  $PE = mgh$ ), kinetic energy ( $KE = 1/2mv^2$ ) and power ( $P = Fv$ ). Candidates should be taught the principle of the Conservation of Energy and be asked to solve mechanical engineering problems where this principle can be applied.

In Outcome 3 candidates should be introduced to simple machines. They should be taught the meaning of the term machine. They should also be taught about terms commonly used in machine theory such as:

$$\text{Mechanical Advantage} = \frac{\text{Load}}{\text{Effort}}$$

$$\text{Velocity Ratio} = \frac{\text{distance moved by effort}}{\text{distance moved by load}}$$

$$\text{Efficiency} = \frac{\text{energy transferred from the machine to the load}}{\text{energy transferred from the effort to the machine}}$$

Candidates should be encouraged to solve practical problems involving levers and rope block pulleys.

In Outcome 4 candidates should be introduced to heat. Candidates may be taught that heat can be viewed in terms of the kinetic energy of vibration of the molecules of an object. The greater the vibration the hotter the object. Temperature may be viewed as a measure of the mean kinetic energy per molecule. Candidates should be taught about the Celsius and Absolute temperature scales and how to convert between the two. They may also be taught about the Fahrenheit temperature scale and how to convert between this and the Celsius scale and vice versa. Candidates should be taught about the three phase change process that water goes through as heat is applied or removed from it. In the context of this conversion process the difference between wet and dry steam should be particularly emphasised. Candidates should be taught technical terms, and their units, used in heat calculations such as:

- ◆ specific heat capacity
- ◆ latent heat of fusion
- ◆ latent heat of vapourisation

Candidates should be encouraged to solve practical problems involving the calculation of both sensible and latent heat using the equations:

$$Q = mC\Delta T$$

$$Q = mL$$

Where  $Q$  = heat gained or lost,  $C$  = specific heat capacity  $T$  = temperature and  $L$  = Latent heat of fusion or vapourisation.

## **National Unit Specification: support notes (cont)**

### **UNIT            Mechanical Engineering Principles (SCQF level 5)**

#### **GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT**

It is recommended that the Unit is delivered in the same sequence the Outcomes are presented in the National Unit Specification: statement of standards section of the Unit. The Unit may be delivered by a combination of lectures, tutorial work, computer simulation and laboratory work. While the majority of the Unit can be delivered in a classroom centres should allow candidates to undertake practical mechanical laboratory experiments so that they have opportunities to relate theory learnt in the classroom to practice. Computer simulation illustrating different engineering principles may also provide a good source of learning.

The Internet contains a rich source of materials on basic mechanical engineering principles, machines and heat.

Wall charts illustrating different mechanical, machine and heat concepts and principles can also be a very useful learning and teaching aid.

The Unit should be fully supported with relevant learning materials (eg handouts in paper and electronic form, textbooks, on-line materials etc).

#### **OPPORTUNITIES FOR CORE SKILL DEVELOPMENT**

Candidates will learn during formative work to interpret, calculate and translate numerical and graphical data in mechanical engineering contexts. Numeracy skills may be further developed in all four Outcomes while candidates are manipulating and evaluating equations to solve problems involving mechanical engineering principles, machines and heat.

Elements of the Core Skill of *Problem Solving*, that is, Critical Thinking and Planning and Organising, will be developed in all Outcomes as candidates solve a number of problems where mechanical engineering principles have to be applied. They have to analyse a range of requirements and determine needs in systems and work out solutions which assure energy, conservation of energy and power. Discussion of issues during formative work would provide opportunities, with assessor support, to review and evaluate approaches taken.

#### **GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT**

Centres are encouraged to use formative assessment extensively as it plays a particularly important role in allowing candidates to develop a sound knowledge and understanding of basic mechanical engineering, machine and heat concepts and principles to solve problems in these three subject areas.

Regardless of whether assessment is carried out on an individual basis, as a combination of Outcomes or on a single, holistic basis any assessment paper(s) used may comprise a suitable balance of short answer, restricted response and structured questions.



## **National Unit Specification: support notes (cont)**

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#### **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](http://www.sqa.org.uk/assessmentarrangements)