National Unit Specification: general information

UNIT Statics (SCQF level 6)

CODE F5K8 12

SUMMARY

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

This Unit is designed to provide candidates with basic knowledge and understanding of Statics. During the delivery of the Unit candidates will learn to differentiate between scalar and vector quantities and identify the properties and effects of the application of force on a body, component and structure. They will also develop the knowledge and skills to solve problems involving forces in a plane as well as being able to analyse simple, idealised frameworks. Candidates will also learn to determine the effects of force on simple components.

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

OUTCOMES

1 Identify scalar and vector quantities and the properties and effects of force.
2 Solve problems involving forces in a plane.
3 Analyse idealised frameworks.
4 Determine the effects of force on a simple engineering component.

Administrative Information

Superclass: XH

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Source: Scottish Qualifications Authority

Version: 02

National Unit Specification: general information (cont)

UNIT Statics (SCQF level 6)

RECOMMENDED ENTRY

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

- Standard Grade Mathematics at credit level
- Standard Grade Physics at credit level
- Intermediate 2 Physics

CREDIT VALUE

1 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

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 Statics (SCQF level 6)

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

Identify scalar and vector quantities and the properties and effects of force.

Performance Criteria

(a) Identify correctly the difference between scalar and vector quantities.
(b) State correctly examples of scalar and vector quantities.
(c) State correctly the units for mass and force.
(d) Apply correctly the relationship between weight and mass.
(e) Identify correctly the effects of the application of force.

OUTCOME 2

Solve problems involving forces in a plane.

Performance Criteria

(a) Determine correctly graphically and analytically the rectangular components of a force.
(b) Determine correctly graphically and analytically the resultant and the equilibrant of concurrent forces.
(c) Determine correctly the resultant and equilibrant moment of a force system.

OUTCOME 3

Analyse idealised framework.

Performance Criteria

(a) State correctly the assumptions used when analysing an idealised framework.
(b) Determine correctly the reactions at the supports by applying the criteria for static equilibrium.
(c) Determine accurately by graphical means the forces and their nature in each member of a loaded framework.

National Unit Specification: statement of standards (cont)

UNIT Statics (SCQF level 6)

OUTCOME 4

Determine the effects of force on a simple engineering component.

Performance Criteria

(a) State correctly the definitions of the terms stress and strain.
(b) Apply correctly the relationships between force, stress, strain and Young's modulus.
(c) Interpret correctly stress/strain graphs for common engineering materials.
(d) Determine correctly stress, strain and change in length on a simple engineering component.
(e) Apply correctly the relationship between shear stress, force and cross sectional area on a simple engineering component.

EVIDENCE REQUIREMENTS FOR THIS UNIT

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

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

Outcomes 1, 2, 3, and 4 may be assessed on an individual basis, as a combination of Outcomes (eg Outcomes 1, 2 assessed together and Outcomes 3 and 4 together), 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 should be allowed to use a non-programmable scientific calculator during assessment.

With regard to Outcome 1

- candidates must identify three examples of scalars and three examples of vectors
- candidates should identify four examples of the effects of the application of force from the following list: acceleration, tension, compression, fatigue, shear, torsion, buckling or bending

With regard to Outcome 2

- the resultant and equilibrant of three concurrent forces should be determined graphically and analytically
- the resultant and equilibrant moment of three concurrent forces should be determined graphically or analytically

National Unit Specification: statement of standards (cont)

UNIT Statics (SCQF level 6)

With regard to Outcome 3

- the idealised framework should be subjected to two vertical forces and supports limited to one pin joint and one roller

With regard to Outcome 4

- Young's modulus for low carbon steel should be determined from a stress/strain diagram and the following regions/points should be identified on the stress/strain graphs for low carbon steel:
  - Elastic Region
  - Plastic Region
  - Yield Point
  - Ultimate Tensile Strength
  - Failure Point

- candidates must identify a further two materials from their stress/strain graphs (one material must be ductile and the other must be brittle)
- the problem in pc (d) should comprise of a component in single or double shear with multiple pins

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 Statics (SCQF level 6)

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 in Mechanical Engineering at SCQF level 6, but may also be offered on a free standing basis.

The aim of this Unit is to provide candidates with basic knowledge and understanding of Statics. On successful completion of the Unit candidates will be able to identify scalars and vectors and the properties and effects of the application of force on a body, component or structure. They will also have the knowledge and skills to solve problems involving forces in a plane as well as being able to solve simple, idealised framework problems. Candidates will also be able to determine the effects of force on simple components.

In Outcome 1 candidates should be introduced to the idea of scalar and vector quantities in general and the idea of force as a vector quantity with both magnitude and direction in particular. They should be encouraged to learn the units of mass and force (including multiple and sub-multiple forms: for example, kN, MN, g etc). Candidates should also be taught the relationship between weight and mass (ie weight = mass x acceleration due to gravity) and asked to perform calculations using this relationship. They should also be encouraged to appreciate the effects of the application of force on bodies, components and structures (eg acceleration, tension, compression, fatigue, shear, torsion, buckling and bending).

In Outcome 2 candidates should learn about simple vector analysis. Candidates should be taught to solve problems involving multiple forces by using scaled force diagrams and analytically using the resolution of components. Bow's notation may be introduced to help in describing force systems in space diagrams. Candidates should be introduced to the concepts of static equilibrium, non-static equilibrium, equilibrants, resultant and equilibrant moment and asked to solve problems using these concepts.

In Outcome 3 candidates should be introduced to the analysis of simple, idealised frameworks. Candidates should be shown different types of frameworks and methods of supporting them. Candidates should be taught the assumptions used in analysing idealised frameworks: for example,

- frameworks comprise of structures built up of straight bars, or members, connected to perfectly smooth pin joints and therefore the joints are not subject to friction
- external forces are applied only at pin joints
- any rollers used as part of the framework operate on smooth surfaces so that the reaction force is applied vertically.

National Unit Specification: support notes (cont)

UNIT Statics (SCQF level 6)

Candidates should be encouraged to solve a number of problems involving determining the forces in framework members and reactions at framework supports.

In Outcome 4 candidates should learn about the effects of force on simple engineering components as an introduction to the first stages of strength of materials. The concepts of stress and strain should be introduced, and their relationship established via Hooke's Law and the modulus of elasticity. Candidates should be shown the full stress/strain diagram for low carbon steel and taught the critical points and regions on this diagram. They should also be shown full stress/strain diagrams for a range of other materials. Candidates should also be taught to solve stress/strain problems involving simple engineering components and solve problems involving components in single or double shear with multiple pins.

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 and practical laboratory work. The Unit should be taught very much in an engineering context and as such relevant engineering examples should be used throughout Unit delivery. For example, discussions of materials properties will be greatly enhanced by examination of samples of materials and looking at typical applications.

Although the graphical skills required for this Unit are not of a particularly high level, candidates should be encouraged to work to a good standard in producing scaled drawings, consistent with the standard which would be expected in their studies of engineering communication.

While the majority of the Unit can be delivered in a classroom centres should allow candidates to undertake practical experiments so that they have opportunities to relate theory learnt in the classroom to practice. For example, where test equipment exists candidates should be allowed to produce stress/strain diagrams of different materials

The Internet contains a rich source of materials on Statics.

Wall charts, DVDs/videos illustrating different Static concepts and principles can also be very useful learning and teaching aids.

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

National Unit Specification: support notes (cont)

UNIT Statics (SCQF level 6)

OPPORTUNITIES FOR CORE SKILL DEVELOPMENT

The Using Number Core Skill component at SCQF level 5 may be developed in Outcomes 1, 2 and 4, while, for example, candidates are solving problems involving weight, mass and acceleration due to gravity, determining force and force components analytically and solving problems involving stress and strain on simple components.

Candidates may have opportunities to develop The Using Graphical Information Core Skill component at SCQF level 5 in Outcomes 2 and 3 while using space, scaled force diagrams and framework diagrams to solve force problems.

The Critical Thinking Core Skill component at SCQF level 5 may be developed in all four Outcomes while candidates solve problems in Statics.

GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT

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)*.

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 to solve Statics problems.

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.

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: support notes (cont)

UNIT Statics (SCQF level 6)

History of changes:

Version	Description of change	Date
02	Superclass changed from RC to XH. Change agreed on the basis that the Unit is delivered exclusively in a Mechanical Engineering context and is resource intensive.	31/05/2011