



## National Unit Specification: general information

**UNIT**        Engineering Materials (SCQF level 6)

**CODE**        F5KD 12

### SUMMARY

This 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 knowledge and understanding of engineering materials. During delivery of the Unit candidates will learn to state the names and applications of a range of engineering materials and describe the properties of engineering materials. They will also develop the knowledge and understanding to describe changes in the structure and properties of engineering materials due to cold working and annealing. Candidates will develop the knowledge and skills to carry out mechanical tests on engineering materials and develop conclusions based on the results obtained from these tests.

This Unit is suitable for candidates training to be fabrication and/or welding, manufacturing, mechanical or multi-disciplinary engineering technicians. It is also suitable for crafts persons who wish to develop more advanced knowledge and understanding in engineering materials.

### OUTCOMES

- 1 Describe the names, applications and properties of engineering materials.
- 2 Describe changes in the structure and properties of engineering materials due to cold working and annealing.
- 3 Carry out engineering material tests on a range of samples.

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#### Administrative Information

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

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### **RECOMMENDED ENTRY**

Whilst entry is at the discretion of the centre it would be beneficial if candidates had attained one of the following, or equivalent:

- ◆ the NQ Unit in *Engineering Materials* (SCQF level 5)
- ◆ appropriate industrial experience in the field of engineering

### **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 Skill:

Numeracy (SCQF level 6)

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

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

### **UNIT        Engineering Materials (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**

Describe the names, applications and properties of engineering materials.

##### **Performance Criteria**

- (a) State correctly the names of and uses of ferrous metals used in engineering.
- (b) State correctly the names of and uses of non ferrous metals used in engineering.
- (c) State correctly the names of and uses of non metallic materials used in engineering.
- (d) Describe correctly the properties of engineering materials using basic workshop tests.
- (e) Describe correctly how common engineering processes change material properties.

#### **OUTCOME 2**

Describe changes in the structure and properties of engineering materials due to cold working and annealing.

##### **Performance Criteria**

- (a) Describe correctly the effects of cold working on the structure and properties of an engineering material.
- (b) Describe correctly the effects of annealing on the grain size and grain growth of a work hardened engineering material.

#### **OUTCOME 3**

Carry out engineering materials tests on a range of samples.

##### **Performance Criteria**

- (a) Carry out engineering materials tests in a safe and correct manner.
- (b) Analyse correctly data gathered during the tests.
- (c) Evaluate correctly both numerical and graphical results and form clear and correct conclusions.
- (d) Complete fully and correctly a report on the tests.

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

### **UNIT        Engineering Materials (SCQF level 6)**

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

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

Written and/or recorded oral and performance evidence supplemented with an assessor observation checklist(s) should be produced to demonstrate that a candidate has achieved all Outcomes and Performance Criteria.

Outcomes 1, 2 and 3 may be assessed on an individual basis, as a combination of Outcomes or as a single, holistic assessment covering all three Outcomes. Assessment(s) for Outcomes 1 and 2 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. Total assessment time for Outcomes 1 and 2 must not exceed 2 hours. Assessment for Outcome 3 must be completed under supervised, open-book conditions.

#### **With regard to Outcome 1:**

- ◆ candidates must state the names of and an application of three ferrous metals from the following: low carbon steel, medium carbon steel, tool steel, cast iron or stainless steels.
- ◆ candidates must state the names of and an application of four non-ferrous metals from the following: copper, brass, aluminium, lead, tin, zinc or bronze.
- ◆ candidates must state the names of and an application of four non-metallic engineering materials from the following: rubber, thermosetting and thermoplastics, glass reinforced plastic or carbon fibre.
- ◆ candidates must identify and describe six common material properties using basic workshop tests from the following list: malleability, ductility, toughness, hardness, work hardening, resistivity, conductivity or wear resistance.
- ◆ candidates must describe how three common engineering processes change materials and/or mechanical properties. Engineering processes must be taken from the following: welding, cold working, hot working, machining, forging or any suitable alternative process.

#### **With regard to Outcome 2:**

- ◆ the Evidence Requirements are implicit within the stated Performance Criteria

#### **With regard to Outcome 3:**

- ◆ the test to be assessed must be selected from the following: tensile, compression, impact or hardness
- ◆ candidates must apply appropriate analysis to data obtained from the test (eg calculation of stress and strain values)
- ◆ tests must be carried out on a minimum of three different engineering material samples
- ◆ candidate evidence must be between 300–500 words plus diagrams and graphs
- ◆ an observation checklist must be used to record evidence that candidates have conducted practical activities in a safe and correct manner

## National Unit Specification: support notes

### UNIT      Engineering Materials (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 Awards in Fabrication and Welding, Manufacturing Engineering and Mechanical Engineering at SCQF level 6, but may also be offered on a free-standing basis.

This Unit is particularly suitable for those candidates who have successfully completed the Unit *Engineering Materials* at SCQF level 5.

The aim of this Unit is to provide candidates with knowledge and understanding of engineering materials. On successful completion of the Unit candidates will be able to state the names and applications of a range of engineering materials and describe the properties of engineering materials. They will also have the knowledge and understanding to describe changes in the structure and properties of engineering materials due to cold working and annealing. Candidates will have the knowledge and skills to carry out mechanical tests on engineering materials and develop conclusions based on the results obtained from these tests.

In Outcome 1 candidates should be introduced to a range of ferrous metals such as low carbon steel, tool steel, cast iron and basic stainless steels. The applications of these ferrous materials in car panels, cutting tools, vices and airframe fittings etc should be explained. Candidates should also be taught about a range of non ferrous metals such as copper, brass, aluminium, lead, tin, zinc and bronze and some of their common applications such as electrical wire, decorative work, aerospace uses, tank linings, plating and plain bearings. Candidates should also be introduced to non metallic materials used in engineering such as rubber, thermosetting and thermoplastics, glass reinforced plastic and carbon fibre and their uses such as sacrificial gears, shock absorption, marine, automotive and aerospace. With regard to all three categories of materials lecturers should explore with candidates the reasons behind the choice of particular materials for particular applications so that the principles behind material selection can be reinforced. The properties of engineering materials should also be explored. Simple workshop tests should be used to identify as many of these properties as possible. Properties such as malleability, ductility, toughness, hardness, work hardening, resistivity, conductivity and wear resistance should be identified. Methods of identifying these properties may include magnetic, spark, visual, weight and colour checks and the use of basic mechanical tests (eg hardness and bending tests). The candidate should be made aware of how some engineering processes such as welding, cold working, hot working, machining, forging can change the properties of materials and the steps that can be taken to prevent or limit changes to material and/or mechanical properties.

In Outcome 2 candidates should examine the effects of cold working on materials and the steps taken to ensure that materials are suitable for further work or in a condition to satisfy customer requirements. An introduction to the process of cold working of materials should give candidates some insight into how grain growth occurs and the effects of such growth on the properties of materials.

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

### **UNIT        Engineering Materials (SCQF level 6)**

Candidates should also be introduced to further work that can be carried out on materials using heat treatment processes. This should be done by considering the annealing process where candidates should learn about the effects this process has on grain size and grain growth. Candidates should also be taught that annealing can act as a precursor to further work being carried out on materials.

In Outcome 3 candidates should carry out different types of materials (eg tensile, compression, impact or hardness) tests on metallic samples. They should analyse the data gathered from the tests (eg calculation of stress and strain values), produce results in suitable numerical and/or graphical formats and evaluate the test results in terms of standard or expected results. Such an evaluation should allow clear and valid conclusions to be drawn.

### **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, investigations using paper based and electronic sources and practical exercises. The Unit is best delivered by a mixture of classroom and engineering workshop teaching in which practical activities involving the visual inspection and testing of materials are used to enhance learning.

The materials chosen for this Unit should be such that candidates can carry out simple tests on them that can be readily reported on.

The Internet contains rich sources of information on the properties and applications of engineering materials and on the structure and properties of engineering materials.

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

Candidates apply their knowledge and understanding of the properties and structures of common engineering materials to describe and test changes which arise in cold working and heat treatment. They have to interpret and record the results of mechanical testing on a range of metallic samples. They calculate stress and strain using data gathered during the tests, and evaluate results. *Numeracy* skills will be naturally enhanced, with practical interpretation and presentation of both numerical and graphic information. Formative activities should be contextualised to provide examples from engineering situations.

### **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)*.

## National Unit Specification: support notes (cont)

### UNIT      Engineering Materials (SCQF level 6)

Formative assessment exercises involving candidates in investigating and describing the applications and properties of a range of engineering materials, describing the effects of cold working and annealing on materials and conducting simple materials tests can play a particularly important role in building candidate knowledge, understanding and confidence of Unit content.

Outcome 1 Performance Criterion (a), Performance Criterion (b) and Performance Criterion (c) may be assessed by candidates being presented with a range of materials, mounted on a board, and asked to complete a checklist in which they identify materials and state one application of each material.

Outcome 1 Performance Criterion (d) and Performance Criterion (e) may be assessed by candidates performing simple checks and tests on a number of materials to identify six common properties of these materials. Centres may use a suitable form to allow candidates to record their descriptions of the properties of the materials. As part of this assessment candidates may also be asked to describe how common engineering processes change material and/or mechanical properties.

Outcome 2 may be assessed by an assessment paper comprising of restricted response questions.

Outcome 3 may be assessed by a practical laboratory assignment involving candidates in carrying out materials tests on a minimum of three samples of materials. Candidate evidence may be in the form of a written report. The exact structure of the report is left to centres to decide although a structure of the following form would be acceptable:

- ◆ purpose of assignment
- ◆ details of equipment used
- ◆ description of procedure
- ◆ results and calculations
- ◆ analysis of results
- ◆ conclusions

Laboratory reports may be completed in the candidate's own time. Centres should make every reasonable effort to ensure that the report 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.

### **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)