



National Unit Specification: general information

UNIT Land-based Engineering: Electrics: Introduction (SCQF level 6)

CODE F91A 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 basic knowledge and understanding of electrical components and circuits. During delivery of the Unit candidates will learn how electrical components and circuits work, interpret circuit diagrams and replace electrical components.

They will develop the knowledge and skills on how to maintain and test circuits and components (using appropriate test procedures and equipment). Candidates will develop the skills required to repair electrical systems found in vehicles which use either 12 or 24 volts. Candidates will also develop the knowledge and skills to perform fault finding techniques in electrical circuits and rectify simple faults. Candidates will develop practical skills and apply safe working practices whilst working with electrical systems.

This Unit is suitable for candidates training to be maintenance, mechanical or multi-disciplinary engineering craft persons or technicians but may also be delivered to candidates who are being introduced to vehicle electrical systems for the first time.

OUTCOMES

- 1 Describe the basic principles of electricity.
- 2 Identify electrical circuits and describe the principles of operation of circuit components.
- 3 Identify and rectify faults in electrical circuits.
- 4 Carry out electrical system maintenance, system testing and repair.

Administrative Information

Superclass: XJ

Publication date: July 2011

Source: Scottish Qualifications Authority

Version: 02

© Scottish Qualifications Authority 2011

This publication may be reproduced in whole or in part for educational purposes provided that no profit is derived from reproduction and that, if reproduced in part, the source is acknowledged.

Additional copies of this Unit Specification can be purchased from the Scottish Qualifications Authority. Please contact the Customer Contact Centre, telephone 0845 279 1000.

National Unit Specification: general information (cont)

UNIT Land-based Engineering: Electrics: Introduction (SCQF level 6)

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:

- ◆ Intermediate 2 Physics
- ◆ Intermediate 2 Technological Studies
- ◆ Intermediate 2 Maths

CREDIT VALUE

1 credit at 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 the candidate to develop aspects of the following Core Skills:

| | |
|---------------------|----------------|
| Problem Solving | (SCQF level 5) |
| Working with Others | (SCQF level 5) |
| Communication | (SCQF level 4) |
| Numeracy | (SCQF level 5) |
| ICT | (SCQF level 5) |

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

National Unit Specification: statement of standards

UNIT Land-based Engineering: Electrics: Introduction (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 basic principles of electricity.

Performance Criteria

- (a) Describe correctly the principles of alternating (ac) and direct (dc) current and typical applications of each.
- (b) State the effect of parallel and series connection of batteries.
- (c) State Ohms Law correctly and its application to electrical principles.
- (d) State correctly the principles and applications of electromagnetism.
- (e) Calculate cable sizes required for given circuits and length of cable.
- (f) Calculate fuse sizes required for specified circuits.

OUTCOME 2

Identify electrical circuits and describe the principles of operation of circuit components.

Performance Criteria

- (a) Identify components, cables, colour coding and circuits in an electrical circuit diagram.
- (b) State the types of thermal circuit protection devices and give examples of where these are used.
- (c) Describe the principles of operation, construction and function of electrical components.
- (d) Identify the different types of batteries and state their application.

OUTCOME 3

Identify and rectify faults in electrical circuits.

Performance Criteria

- (a) Correctly identify electrical faults in components and circuits.
- (b) Correctly test and repair electrical systems using appropriate methods and equipment.

OUTCOME 4

Carry out electrical system maintenance, system testing and repair.

Performance Criteria

- (a) Carry out electrical system maintenance.
- (b) Replace electrical components in accordance with original specification.
- (c) Correctly state the risks posed to electrical systems and components by other activities.

National Unit Specification: statement of standards (cont)

UNIT Land-based Engineering: Electrics: Introduction (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, product 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.

Outcome 1

Outcome 1 must be assessed by a single assessment designed to ensure that candidates can generate sufficient evidence to satisfy the Outcome and Performance Criteria. Candidate evidence must be in the form of written and/or recorded oral evidence. Assessment must be conducted under supervised, closed-book conditions in which candidates are not allowed to bring their own notes, handouts, textbooks or other materials into the assessment. Total assessment time for Outcome 1 must not exceed 1 hour.

With regard to Outcome 1 candidates must:

- ◆ state the effect on voltage when connecting batteries in either parallel or series
- ◆ describe the principles of alternating (ac) and direct (dc) current and typical applications of each
- ◆ state ohms law and its application to electrical principles
- ◆ state the principles and applications of electromagnetism
- ◆ calculate the current flow and identify the correct cable size required for given circuits and lengths of cable
- ◆ identify the correct fuse sizes required for specified circuits through calculation

Outcome 2

Outcome 2 must be assessed by a range of assessments designed to cover the Performance Criteria:

Candidates must undertake assessment on their own. Assessment must be conducted under supervised conditions. An observation checklist must be used to record evidence of whether candidates have satisfied all the Performance Criteria in the Outcome or not.

With regard to Outcome 2 candidates must be able to:

- ◆ identify the different types of batteries and state their application
- ◆ state how battery size, pole type, orientation and battery capacity is identified
- ◆ identify components, cables, colour coding and circuits in an electrical circuit diagram
- ◆ state the types of thermal circuit protection devices and give examples of where these are used
- ◆ describe the principles of operation, construction and function of electrical components for example:
 - i starter motors and circuits including safety start switches
 - ii alternators and the charging circuit
 - iii lighting circuits including brake lights, indicator circuits, ancillary lighting systems
 - iv instrumentation and sender units including temperature, oil pressure, fuel contents, tachometer or rev counter, hour meter
 - v switches, relays

- vi ancillary circuits and components eg windscreen wiper, horn, cab heater/ventilation fans, electric clutches, actuators

National Unit Specification: statement of standards (cont)

UNIT Land-based Engineering: Electrics: Introduction (SCQF level 6)

Outcome 3

Outcome 3 must be assessed by a series of practical tasks designed to generate evidence of candidates' abilities to test, diagnose and rectify faults in electrical circuits and components.

Candidates must undertake the assessment on their own and it must be conducted under supervised conditions.

An observation checklist must be used to record evidence of whether candidates have satisfied all the Performance Criteria.

With regard to Outcome 3 candidates must be able to:

- ◆ test, diagnose and repair electrical systems using appropriate methods and equipment
- ◆ repair broken cables or wiring looms to a manufacturer's standard
- ◆ identify electrical faults in components and circuits. Candidates must diagnose, rectify and report on one fault on each of the following:
 - i open circuits
 - ii earth
 - iii switches
 - iv relays
 - v battery
 - vi terminals and connections
 - vii components

Outcome 4

Candidates must undertake the assessment on their own and it must be conducted under supervised conditions.

An observation checklist must be used to record evidence of whether candidates have satisfied all the Performance Criteria.

With regard to Outcome 4 candidates must be able to:

- 1 Carry out electrical system maintenance.
- 2 Replace the following electrical components:
 - i battery
 - ii starter motor
 - iii alternator
 - iv bulbs
 - v relays
 - vi circuit protection devices
 - vii senders
 - viii electrical plugs and sockets (12 or 24 volt)
 - ix connections using appropriate crimped or soldered connectors

National Unit Specification: general information (cont)

UNIT Land-based engineering: Electrics: Introduction (SCQF level 6)

3 Identify the potential risks to electrical systems or components due to the following:

- ◆ electrical welding
- ◆ battery disconnection
- ◆ battery short circuit
- ◆ short circuit in wiring or components
- ◆ overcharging
- ◆ reverse polarity

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 Land-based engineering: Electrics: Introduction (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 Land-based Engineering at SCQF level 6, but may also be offered on a free standing basis.

This Unit is designed to provide candidates with basic knowledge and understanding of electrical principles, components and circuits. During delivery of the Unit candidates will learn how electrical components and circuits work, interpret circuit diagrams and replace electrical components of the vehicle.

Candidates will develop the knowledge and skills on how to maintain and test circuits and components (using appropriate test procedures and equipment). They will develop the skills required to repair electrical systems found in vehicles which use either 12 or 24 volts. Candidates will also develop the knowledge and skills to perform fault finding techniques in electrical circuits and rectify simple faults. Candidates will develop practical skills and apply safe working practices whilst working with electrical systems.

In Outcome 1 candidates will develop a knowledge of the basic principles of electricity and how it is used in land-based vehicles.

In Outcome 2 candidates will be able to identify the main electrical components and circuits and demonstrate an understanding of how they work.

In Outcome 3 candidates should learn to diagnose faults in components and circuits, with an emphasis being placed on identifying the cause of the fault before rectifying and reporting.

In Outcome 4 candidates will be able to maintain electrical components, replace components and repair circuits without compromising the safety or function of the circuits and components.

National Unit Specification: support notes (cont)

UNIT Land-based engineering: Electrics: Introduction (SCQF level 6)

GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT

HEALTH, SAFETY AND THE ENVIRONMENT

As Outcomes 2, 3 and 4 require the candidate to practically service and repair equipment either on-site or in a workshop situation, it is strongly recommended that the candidates are inducted into current legislation, regulations and safe working procedures and practices, before starting practical work.

A safe system of work should be established in line with the Health, Safety and the Environment Unit guidelines whilst taking cognisance of the candidate's previous experience and abilities prior to the commencement of the practical activities. The storage and handling of materials and methods of disposal of waste materials produced during the servicing of land-based equipment should comply with current legislation and good practice. Health, safety and environmental issues associated with this Unit ***should be taught together with the subject topics and not separately*** in the Land-based Engineering: Health, Safety and the Environment Unit.

It is recommended that the Unit is delivered in the same sequence as the Outcomes are presented in the National Unit Specification: statement of standards section of the Unit. The Unit may be delivered largely by a combination of lectures, computer simulation and practical work.

It is recommended that Outcome 4 is delivered using circuit boards/lighting boards so that the candidate can assemble circuits. The function, integrity and quality of the candidate's work with electrical wiring, termination and ability to use circuit diagrams can be assessed.

Fault-finding on land-based vehicles is to be encouraged to enable the candidate to develop confidence and skills although some work must be carried out on real equipment so that they can experience some of the problems associated with cable routing and component access. This does need to be limited due to the potential damage that can be caused.

Good wall charts and videos/DVDs on electrical circuits and components may also provide useful sources of learning (eg animations to illustrate the ways in which components operate).

OPPORTUNITIES FOR CORE SKILL DEVELOPMENT

Problem solving

The Critical Thinking Core Skills component at SCQF level 5 may be developed in Outcomes 2, 3 and 4 while candidates are involved in identifying components, making circuits, circuit testing and fault finding in land-based vehicle electrical systems.

The Planning and Organising Core Skill component at SCQF level 5 may be developed in Outcome 2 and 4 while candidates are involved with practical tasks, as they could be tasked with organising how the required resources will be allocated.

The Reviewing and Evaluating Core Skill component at SCQF level 5 may be developed in Outcome 3 and 4 while candidates carry out circuit testing and rectifying faults.

National Unit Specification: support notes (cont)

UNIT Land-based engineering: Electrics: Introduction (SCQF level 6)

Working with Others

The *Working with Others* Core Skill at SCQF level 5 may be developed in Outcomes 2, 3 and 4 while candidates complete making and testing electrical circuits on circuit boards and land-based equipment.

The *Reviewing the Co-operative Contribution* Core Skill component at SCQF level 5 may be developed in Outcomes 3 and 4 while candidates engage in practical work as they have to interact with their lecturers, support staff and other candidates, for example; while sharing engineering workshop areas, tools and equipment or in developing a plan and completion of the intended testing, diagnosing and replacement of components on electrical systems.

Communication

The *Communication* Core Skill at SCQF level 4 may be developed in Outcome 1 through assessments and Outcomes 2, 3 and 4 through written and oral instructions together with group work while candidates are engaged in practical work. Candidates will also be expected to present written reports and diagrams to support the practical work they have carried out.

Numeracy

The *Numeracy* Core Skill at SCQF level 5 may be developed in Outcomes 1, 2, 3 and 4 while candidates carry out assessments, make circuits and test electrical circuits on circuit boards and land-based equipment.

The *Using Graphical Information* Core Skill component at SCQF level 5 may be developed through Outcomes 1, 3 and 4 during assessments and while carrying out system maintenance, testing, repair and fault finding.

ICT

The *ICT* Core Skill at SCQF level 5 may be developed in Outcomes 2, 3 and 4 while candidates carry out assessments, make circuits and test electrical circuits on circuit boards and use electrical simulation to help their understanding of electrical circuits and components.

GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT

Assessment of health, safety and environmental issues within this Unit could be cross matched and assessed in the associated Land-based Engineering: Health, Safety and the Environment Unit.

A single, holistic assessment paper of short answer, multiple choice or restricted response may assess Unit knowledge in Outcome 1. Alternately assessment of individual parts of the Outcome may be carried out at appropriate points during Unit delivery. Candidate evidence must be in the form of performance and written and/or recorded oral evidence.

Formative assessment exercises involving candidates in workshop inspections and repair skills acquisition will play an important role in building candidate knowledge, understanding, skills and confidence of Unit content. Candidates would be expected to complete an appropriate written job card/inspection report associated with Outcomes 2, 3 and 4. An observation check list must be used to record the evidence of candidates having satisfied all the Performance Criteria in Outcomes 2, 3 and 4.

National Unit Specification: support notes (cont)

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 communications 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

History of changes:

| Version | Description of change | Date |
|---------|--|------------|
| 02 | Changes to Outcome 1 Performance Criteria (b)-part of Performance Criteria moved to Outcome 2 as new Performance Criteria(d) | 26/07/2011 |
| | | |
| | | |
| | | |
| | | |