

SQA Advanced Unit specification: general information

Unit title: Engineering: Practical Skills

Unit code: HV3F 46

Superclass: XA

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Unit purpose

This Unit has been designed to provide candidates with an opportunity to develop knowledge and skills in any two of the following engineering areas: mechanical fitting, turning, milling, sheet metalwork or welding. Candidates will also have an opportunity to develop knowledge and skills in the areas of electrical installation or electronics. The main purpose of this Unit is to provide candidates with an appreciation of what is involved in using these skills in industry. This Unit is suitable for any candidate who wishes to develop practical skills in a range of engineering disciplines.

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

- 1 Demonstrate a range of engineering manufacturing skills.
- 2 Demonstrate a range of electrical or electronic engineering skills.

Recommended prior knowledge and skills

Entry to the Unit is at the discretion of the centre.

Credit points and level

2 SQA Credits at SCQF level 6: (16 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 National 1 to Doctorates.*

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Core Skills

Opportunities to develop aspects of Core Skills are highlighted in the Support Notes of this Unit specification.

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

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.

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

Demonstrate a range of engineering manufacturing skills.

Knowledge and/or Skills

- ◆ Interpret engineering information
- ◆ Select tools and equipment
- ◆ Select materials
- ◆ Apply marking out procedures
- ◆ Apply engineering skills
- ◆ Verify product measurements
- ◆ Safety
- ◆ Log book

Evidence Requirements

Candidates are required to develop Knowledge and Skills in any **two** of the following practical engineering skills areas:

- ◆ Mechanical fitting
- ◆ Turning
- ◆ Milling
- ◆ Sheet metalwork
- ◆ Welding

All Knowledge and/or Skills items should be assessed.

Candidate evidence should be generated by candidates manufacturing a product for each of the two practical engineering skills areas in which they have received training and which meet the Evidence Requirements shown below. Alternatively candidates may manufacture one product using the knowledge and skills they have developed in both practical engineering skills areas providing they satisfy the Evidence Requirements detailed. For mechanical fitting, turning and milling a product(s) manufactured by a candidate should be fit for purpose and have tolerances that are within ± 0.25 mm. For sheet metalwork and welding, a product(s) manufactured by a candidate should be fit for purpose and have tolerances that are within ± 1 mm. Candidates undertaking sheet metalwork should work on sheet less than 3 mm.

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

- ◆ interpret information from an engineering drawing(s) correctly to make the product.
- ◆ select appropriate tools and equipment to make the product.
- ◆ select appropriate materials to make the product.
- ◆ mark out materials appropriately to produce the product.
- ◆ apply the range of engineering skills necessary to make the product to the required tolerances.
- ◆ check the product to ensure it is fit for purpose and is within the required tolerances.
- ◆ conduct all engineering operations in a safe and healthy manner.
- ◆ maintain a record of practical activities in a log book.

Candidate evidence should be produced under supervised conditions.

A candidate's log book should contain a minimum of three entries for each product manufactured (or six entries if only one product is manufactured). Each entry should be a minimum of 150 words.

Outcome 2

Demonstrate a range of electrical or electronic engineering skills.

Knowledge and/or Skills

- ◆ Interpret circuit and wiring diagrams
- ◆ Select tools and equipment
- ◆ Select materials
- ◆ Apply marking out procedures
- ◆ Apply electrical or electronic skills
- ◆ Inspection and testing
- ◆ Safety
- ◆ Log book

Evidence Requirements

All Knowledge and/or Skills items should be assessed.

Assessment evidence should be generated by candidates producing an electrical installation circuit or an electronic circuit which meet the Evidence Requirements shown below. Candidate evidence should be produced under supervised conditions.

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

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- ◆ interpret information on circuit and wiring diagrams correctly to produce the given circuit.
- ◆ select the correct tools and equipment to produce the electrical or electronic circuit.
- ◆ select the correct materials to produce the electrical or electronic circuit.
- ◆ apply appropriate electrical installation skills and practical assembly skills to ensure the circuit will both function correctly and are within specification (it should be noted that all electrical installation work must comply with the latest version of BS 7671 Wiring Regulations).
- ◆ undertake appropriate inspection and testing of the assembled circuit to ensure both functionality and that it is within specification.
- ◆ conduct all electrical installation or electronic work in a safe and healthy manner.
- ◆ maintain a record of project activities in a log book.

A candidate's log book should contain a minimum of six entries for the electrical or electronic construction project. Each entry should be a minimum of 150 words.

SQA Advanced Unit specification: support notes

Unit title: Engineering: Practical Skills

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 80 hours.

Guidance on the content and context for this Unit

This Unit has been written as part of the SQA Advanced Diploma in Engineering Systems. The Unit has been designed to allow candidates to develop knowledge and practical skills in any two of the following engineering areas: mechanical fitting, turning, milling, sheet metalwork or welding. Candidates will also have opportunities to develop knowledge and skills in electrical installation or electronics.

This Unit is **not** intended to produce skilled craftsperson in mechanical fitting, turning, milling, sheet metalwork, welding, electrical installation or electronics. Rather this Unit has been designed to allow candidates to develop an appreciation of what is involved in apply a range of multi-disciplinary skills in practical engineering situations.

It is recommended that the following areas are covered during the delivery of the Unit. The figure in bracket gives an indication of the notional time of delivery for each Outcome.

Outcome 1 — Demonstrate a range of engineering manufacturing skills (40 hours)

Common part

- ◆ Induction in engineering workshop health and safety procedures and practices
- ◆ Interpretation of information on engineering drawings by introducing appropriate conventions, standards, drawings etc
- ◆ Brief explanation of the properties of materials that could be used in making the product(s) that are going to be made by the candidates

Mechanical fitting

- ◆ Identification of the following tools: benches and vices, files, hammers, hacksaws, punches, spanners, screwdrivers, taps and dies, drills, compasses, dividers
- ◆ Explanation of marking and measuring out procedures
- ◆ Candidates practise marking and measuring out procedures
- ◆ Candidates practise use of hand tools
- ◆ Explanation of the use of a pillar drill including types of drills, drill geometry, workholding techniques, using drilling machine and common reasons for drill failure
- ◆ Candidates practise use of a pillar drill
- ◆ Explanation of how to use the following measuring instruments: vernier callipers, vernier height gauge, micrometer, protractor and gauges
- ◆ Candidates practise verification of measurements using vernier callipers, vernier height gauge, micrometer, protractor and gauges (eg depth, go-no-go etc.)

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OR

Turning

- ◆ Using an appropriate diagram identification of the various parts of a lathe
- ◆ Brief explanation of lathe tool geometry (eg clearance, rake etc)
- ◆ Explanation of different types of lathe tools available including the materials used in their construction
- ◆ Explanation of speeds and feeds
- ◆ Explanation of setting up procedures
- ◆ Explanation of different types of chucks (3 and 4 jaws)
- ◆ Candidates practise use of 3 jaw chuck
- ◆ Candidates practise turning between centres
- ◆ Turning operations:
 - facing off
 - facing to length
 - turning diameter to shoulder
 - turning between centres
 - centre drilling
 - drilling hole
 - reaming hole
 - knurling
 - parting off

OR

Milling

- ◆ Using appropriate diagrams identification of various parts of horizontal, vertical and universal milling machines
- ◆ Brief explanation of different types of cutters (eg face mill, slot drill, end mill, side and face cutters, slitting saws, angle cutters)
- ◆ Procedure for mounting cutters on horizontal or vertical or universal mill
- ◆ Explanation of cutting speeds and feeds
- ◆ Explanation of workholding techniques (eg setting vice parallel, clamping regular objects in the vice, setting of datum face, setting work to marking out)
- ◆ Candidates practise setting up and using milling machine(s)
- ◆ Milling operation:
 - milling a block
 - facing to length on horizontal and vertical mills
 - milling to a shoulder
 - milling a slot

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OR

Sheet metalwork

- ◆ Identification of the following tools: benches and vices, files, hammers/mallets, hacksaws, punches, spanners, screwdrivers, drills, compasses, dividers, hole cutters, stakes, folders and rollers
- ◆ Explanation of marking and measuring out procedures
- ◆ Candidates practise marking and measuring out procedures
- ◆ Candidates use tools to cut and shape/form materials
- ◆ Explanation of non-thermal joining methods (eg riveting, bolting, screwing, adhesive etc)
- ◆ Candidates practise use of non-thermal joining methods
- ◆ Dimensional checks on components (using rulers, callipers, dividers etc)

OR

Welding

- ◆ Brief explanation of the following welding processes; MMA, MAG and TIG
- ◆ Brief explanation of the practical applications of the above three welding processes
- ◆ Demonstration of the set up and use of each welding process
- ◆ Candidates practise use of selected welding process
- ◆ Explanation of material preparation and joint set-up (ie for butt, lap, fillet or open corner)
- ◆ Explanation of weld defects
- ◆ Check joints for weld defect

Outcome 2 — Demonstrate a range of electrical or electronic engineering skills (40 hours)

Electrical installation

- ◆ Induction in electrical installation health and safety procedures and practices
- ◆ Interpretation of information on circuit and wiring diagrams by introducing appropriate conventions, standards, drawings etc
- ◆ Identification of cables (eg single, two and three core PVC cables, steel wire armour cable and mineral insulated cable)
- ◆ Identification of accessories (eg principally relevant to electrical wiring exercise(s) — switch boxes, joint boxes, ceiling roses, lamp holders, socket outlets, switched fuse outlets, distribution board, consumer Unit, clips, fuses, circuit breakers, RCD, etc)
- ◆ Identification of tools (eg pliers, wire strippers, side cutters, screwdrivers, hammers, knives, crimping tools, hacksaw, rule, hand drills, spirit level, plumb line etc)
- ◆ Candidates practise installation skills including correct and neat termination of wiring
- ◆ Explanation of simple inspection techniques
- ◆ Explanation of continuity and insulation resistance testing — introduction to test instruments and procedures used to conduct tests with these instruments
- ◆ Candidates practise inspection and testing procedures
- ◆ Interpretation of BS 7671 requirements appropriate to installation exercises

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OR

Electronics

- ◆ Induction in electronic workshop health and safety procedures and practices
- ◆ Interpretation of information on electronic circuit and wiring diagrams by introducing appropriate conventions, standards, drawings etc
- ◆ Explanation of pcb and copper strip board construction techniques
- ◆ Demonstration of board population and wiring skills
- ◆ Demonstration of soldering skills
- ◆ Candidate practise electronic construction skills
- ◆ Lecturer demonstrates use of electronic test equipment (eg digital multimeter, logic probe, power sources, signal generator and oscilloscope (for oscilloscopes basic testing techniques only)
- ◆ Candidate practise use of test equipment

Guidance on the delivery of this Unit

This Unit should be delivered in the following practical engineering workshops:

- ◆ Engineering workshop
- ◆ Fabrication/welding workshop
- ◆ Electrical installation
- ◆ Electronics

Lecturers should demonstrate practical skills to candidates and then, under appropriate supervision, allow candidates to practise these skills.

Charts, boards with tools/materials secured to them, can often prove useful in allowing candidates to learn the names of different tools and materials.

It is strongly recommended that centres delivering the welding option should have examples of acceptable and defective joints so that candidates can learn the differences between 'good' and 'bad' joints.

Prior to entering any workshop candidates should be inducted into health and safety issues relevant to the workshop. Health and safety should be emphasised and practised at all times while candidates are in workshops. Candidates should not be permitted to enter any workshop without wearing the appropriate (Personal Protective Equipment) PPE.

Centres may wish to consider allowing candidates to undertake their own risk assessment of a workshop(s) prior to entering it. Candidates could then compare their risk assessment with the workshop risk assessment done by the centre. Such an exercise may help to reinforce in candidates' minds health and safety issues while they are working in the workshop(s).

As candidates may be lifting heavy items during the delivery of this Unit it would be a good idea to instruct them in proper manual handling and lifting techniques.

Guidance on the assessment of this Unit

The assessment strategy for this Unit is as follows:

Assessment for Outcomes 1 should involve candidates in manufacturing the following to an acceptable standard:

Two products, one each from the two engineering skills areas in which the candidates have received training in. Alternatively candidates may manufacture one product which covers the Knowledge and/or Skills requirements associated with the two engineering skills areas in which they received training.

Assessment for Outcome 2 should involve candidates in manufacturing, inspecting and testing an electrical installation or an electronic circuit.

Candidates must maintain a log book to a satisfactory standard while undertaking the formal assessment tasks in the Unit.

Centres may allow candidates to produce the engineering product(s) and/or electrical installation and/or electronic circuit as part of an integrated project.

All assessment should take place under supervised conditions.

Assessment Guidelines

Outcome 1

Centres should develop appropriate checklists that cover the Evidence Requirements to record candidate assessment evidence.

Centres may allow candidates to produce the engineering product(s) as part of an integrated project.

Candidates may include the following information in their log book (the list is not intended to be exhaustive):

- ◆ How they intend to undertake the manufacture of the product
- ◆ Progress made in making the product
- ◆ Interpretation of measurement results
- ◆ Any health and safety issues
- ◆ What new knowledge they have gained from manufacturing the product
- ◆ Any transferable skills they may have acquired (eg how they have learnt working with others skills from sharing tools and equipment with other candidates in an engineering workshop, how they have improved their numeracy skills while using measuring equipment etc.)

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Presenting information in graphical format in the log book should be actively encouraged.

It is recommended that candidate evidence should include as a minimum the following:

Mechanical fitting

- ◆ Use a minimum of five different hand tools
- ◆ Carry out measuring and marking out procedures
- ◆ Use measuring and marking out equipment
- ◆ Cut and shape materials
- ◆ Carry out drilling operations
- ◆ Use taps and dies
- ◆ Perform appropriate fitting skills
- ◆ Verify measurements using appropriate measuring equipment

Turning

- ◆ Set up lathe
- ◆ Select speeds and feeds
- ◆ Use 3 jaw chuck
- ◆ Turn between centres
- ◆ Turning operations (*minimum of six operations*):
 - facing off
 - facing to length
 - turning diameter to a shoulder
 - turning a diameter between centres
 - centre drilling
 - drilling hole
 - reaming hole
 - knurling
 - parting off
- ◆ Verify measurements using appropriate measuring equipment

Milling

- ◆ Use a horizontal or vertical or universal milling machine
- ◆ Mount and use appropriate cutters (a minimum of two from: face mill, slot drill, end mill, slab mill, side and face cutters, slitting saws or angle cutters)
- ◆ Select appropriate speeds and feeds
- ◆ Use appropriate safe workholding techniques
- ◆ Milling operations (*minimum of three operations*):
 - milling a block
 - facing to length on horizontal or vertical mill
 - milling to a shoulder
 - milling a slot
- ◆ Verify measurements using appropriate measuring equipment

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Sheet metalwork

- ◆ Use a minimum of five different hand tools
- ◆ Carry out measuring and marking out procedures
- ◆ Use measuring and marking out equipment
- ◆ Cut and shape/form materials
- ◆ Use any two non-thermal joining techniques
- ◆ Perform appropriate fitting skills
- ◆ Verify measurements using appropriate measuring equipment

Welding

- ◆ Use Manual Metal Arc (MMA) or Metal Active Gas (MAG) or Tungsten Inert Gas Arc Welding (TIG) process
- ◆ Set up equipment for welding
- ◆ Prepare materials to be welded
- ◆ Perform any two of the following welds: butt, lap, fillet or open corner to an acceptable standard
- ◆ Visually identify weld defects

Outcome 2

Centres may allow candidates to produce the electrical installation or electronic circuit as part of an integrated project.

Centres should develop appropriate checklists that cover the Evidence Requirements to record candidate assessment evidence.

Candidates may include the following information in their log book (the list is not intended to be exhaustive):

- ◆ How they intend to manufacture the electrical installation or electronic circuit
- ◆ Progress made in manufacturing the electrical installation or electronic circuit
- ◆ Interpretation of inspection and test results
- ◆ Any health and safety issues
- ◆ What new knowledge they have gained from manufacturing the electrical installation or electronic circuit
- ◆ Any transferable skills they may have acquired (eg how they have learnt working with others skills from sharing tools and equipment with other candidates in electrical installation and electronic workshops; how they have improved their numeracy skills while using electrical and electronic test equipment)

Presenting information in graphical format in the log book should be actively encouraged.

There now follows information specific to the electrical installation exercise and the electronic project.

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Electrical installation

The electrical installation may involve either a domestic or an industrial electrical wiring system. Examples of each are shown below.

Domestic

A domestic installation comprising of a two-way controlled lighting circuit and a socket ring circuit containing a minimum of three sockets and one fused spur. The installation should be wired on a board with both the lighting and ring socket circuits being wired in multi-core PVC. Tests on the completed installation should include continuity, polarity and insulation resistance testing.

It is recommended that centres develop a checklist to support assessment judgements. The checklist may include the following items:

- ◆ Accessories are positioned accurately
- ◆ Accessories are installed securely
- ◆ Wiring systems are installed correctly
- ◆ Electrical terminations are electrically and mechanically sound
- ◆ Wiring systems are satisfactorily inspected
- ◆ Wiring systems are correctly tested and results are appropriately recorded

Industrial

An industrial installation that requires the candidate to wire up a 3-phase motor connected to a Direct on Line starter with remote stop/start station. The candidate should be required to manufacture a length of metal trunking, as a joining piece between a distribution board and the motor starter and cable tray, to include a 90° flat bend between the starter and the motor. Wiring should be done using PVC single core cable and either steel wire armour cable or mineral insulated cable as appropriate.

The terminations at the motor starter and motor terminals should be crimped terminations. Tests on the completed installation should include continuity, polarity and insulation resistance testing.

It is recommended that centres develop a checklist to support the assessment judgements. The checklist may include the following points:

- ◆ Accessories are positioned accurately
- ◆ Accessories are installed securely
- ◆ Wiring systems are manufactured correctly
- ◆ Wiring systems are installed correctly
- ◆ Electrical terminations are electrically and mechanically sound
- ◆ Wiring systems are satisfactorily inspected
- ◆ Wiring systems are correctly tested and results are appropriately recorded

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Electronic circuit

Examples of circuits candidates may construct are as follows: two stage transistor amplifier, a summer amplifier using an operational amplifier, a timer circuit, a combinational logic circuit involving a minimum of four integrated circuits.

It is recommended that centres develop a checklist to support assessment judgements. The checklist may include the following items:

- ◆ Interpret information on circuit and wiring diagrams correctly when constructing the electronic circuit
- ◆ Select a pcb or copper strip board to construct the electronic circuit
- ◆ Select passive and active components correctly
- ◆ Populate the board with components and devices correctly and wire the circuit according to the circuit and wiring diagrams
- ◆ Solder all components, devices and wires accurately and neatly avoiding any dry joints
- ◆ Crimp any terminals to stranded conductors as required
- ◆ Test the completed circuit to ensure correct functionality
- ◆ Construct the electronic circuit in a safe and healthy manner

Online and Distance Learning

As this Unit has a strong practical content it cannot be delivered by open and distance learning.

Opportunities for developing Core Skills

Candidates will have opportunities to develop the graphical information Core Skills component while interpreting information from different types of engineering drawings and when drawing sketches, diagrams etc. in their log books.

Critical Thinking and Review and Evaluation skills should be developed while candidates are completing their log books.

The *Working with Others* Core Skill may be developed while candidates are sharing space, tools and equipment in different workshops. This Core Skill may also be developed if, as part of the delivery and assessment of the Unit, candidates work together to produce parts for a project.

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.

History of changes to Unit

Version	Description of change	Date

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SQA acknowledges the valuable contribution that Scotland's colleges have made to the development of SQA Advanced Qualifications.

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General information for candidates

Unit title: Engineering: Practical Skills

This Unit has been designed to allow you to develop knowledge and skills in any two of the following engineering areas: mechanical fitting, turning, milling, sheet metalwork or welding. You will also develop knowledge and skills in the areas of: electrical installation or electronics.

It is important to emphasise that in doing this Unit you will not become a skilled craftsperson in any of the engineering areas identified in the previous paragraph. However, on completion of the Unit you will have gained an appreciation of what is involved in using these skills in industry.

Delivery of Unit content is likely to be principally by your lecturers demonstrating the various practical skills to you and then you being allowed to practise these skills. Your lecturers will emphasise the importance of health and safety throughout the Unit.

Formal assessment will comprise of you demonstrating that you have achieved the engineering skills to the appropriate standard for:

Outcome 1 — Producing an engineering product(s)

Outcome 2 — Completing an electrical installation or an electronic circuit

You will also be required to maintain a logbook to a satisfactory standard while doing the formal assessments in the Unit.