National 5 Course Specification

National 5 Practical Metalworking

Course code:	C861 75
Course assessment code:	X861 75
SCQF:	level 5 (24 SCQF credit points)
Valid from:	session 2017–18

The course specification provides detailed information about the course and course assessment to ensure consistent and transparent assessment year on year. It describes the structure of the course and the course assessment in terms of the skills, knowledge and understanding that are assessed.

This document is for teachers and lecturers and contains all the mandatory information you need to deliver the course.

This edition: September 2017, version 2.0

Contents

Course overview

The course consists of 24 SCQF credit points which includes time for preparation for course assessment. The notional length of time for a candidate to complete the course is 160 hours.

The course assessment has two components.

Component	Marks	Scaled mark	Duration
Component 1: question paper	60	30	1 hour
Component 2: practical activity	70	70	See course assessment section.

Recommended entry	Progression
Entry to this course is at the discretion of the centre. Candidates should have achieved the fourth curriculum level or the National 4 Practical Metalworking course or equivalent qualifications and/or experience prior to starting this course.	♦ other qualifications in practical technologies or related areas ♦ further study, employment and/or training

Conditions of award

The grade awarded is based on the total marks achieved across all course assessment components.

Course rationale

National Courses reflect Curriculum for Excellence values, purposes and principles. They offer flexibility, provide more time for learning, more focus on skills and applying learning, and scope for personalisation and choice.

Every course provides opportunities for candidates to develop breadth, challenge and application. The focus and balance of assessment is tailored to each subject area.

The National 5 Practical Metalworking course provides a broad introduction to practical metalworking. It is largely workshop-based, combining elements of theory and practical metalworking techniques.

Candidates develop practical psychomotor skills (manual dexterity and control) in a universally popular practical craft. They are introduced to safe working practices and become proactive in matters of health and safety. They learn how to use a range of tools, equipment and materials safely and correctly.

Candidates develop skills in reading drawings and diagrams, measuring and marking out, cutting, shaping and finishing materials. They learn how to work effectively alongside others in a shared workshop environment. Course activities also provide opportunities to build self-confidence and to enhance skills in numeracy, thinking, planning, organising and communicating — these are all valuable skills for learning, for life and for work.

The course encourages candidates to become responsible and creative in their use of technologies and to develop attributes such as flexibility, enthusiasm, perseverance, reliability and confidence.

Purpose and aims

The National 5 Practical Metalworking course provides opportunities for candidates to gain a range of theoretical and practical metalworking skills relating to tools, equipment, processes and materials. They also develop skills in reading and interpreting working drawings and related documents as well as an understanding of health and safety.

The course is practical, exploratory and experiential in nature. It engages candidates with technologies, allowing them to consider the impact that practical technologies have on our environment and society.

Through this, they develop skills, knowledge and understanding of:

- metalworking techniques
- measuring and marking out metal sections and sheet materials
- safe working practices in workshop environments
- practical creativity and problem-solving skills
- sustainability issues in a practical metalworking context

Who is this course for?

This course is a broad-based qualification, suitable for learners with an interest in practical technologies. It is largely learner-centred, includes practical and experiential learning opportunities and is suitable for those wanting to progress onto further levels of study or a related career.

Course content

This course develops skills in three main areas. Each area provides opportunities for candidates to understand safe working practices, sustainability issues, and good practice in recycling within a workshop environment. Each area of study covers a different set of metalworking skills. All areas include skills and associated knowledge in measuring, marking out, cutting and joining techniques.

The areas of study are:

Bench skills

Candidates develop skills, knowledge and understanding in the use of metalworking hand tools, bench-fitting work, routine sheet-metal work, measuring and marking out, involving complex features. Candidates develop their ability to read and use drawings and diagrams depicting both familiar and unfamiliar metalwork tasks.

Machine processes

Candidates develop skills, knowledge and understanding in the use of metalworking machines, equipment, related processes, materials, measuring and marking out, involving complex features.

Fabrication and thermal joining

Candidates develop skills, knowledge and understanding in fabrication, forming and joining of metalwork components with some complex features. Candidates develop skills in thermal joining techniques and in measuring and marking out.

Skills, knowledge and understanding

Skills, knowledge and understanding for the course

The following provides a broad overview of the subject skills, knowledge and understanding developed in the course:

- using a range of metalworking tools, equipment and materials safely and correctly for metalworking tasks with some complex features
- adjusting tools where necessary, following safe practices
- reading and interpreting drawings and diagrams in familiar and some unfamiliar contexts
- measuring and marking out metal sections and sheet materials in preparation for cutting and forming tasks with some complex features
- practical creativity in the context of familiar metalworking tasks with some complex features
- following, with autonomy, given stages of a practical problem-solving approach to metalworking tasks

- applying knowledge and understanding of safe working practices in a workshop environment
- knowledge and understanding of the properties and uses of a range of metalworking materials
- knowledge and understanding of sustainability issues in a practical metalworking context

Skills, knowledge and understanding for the course assessment

The following provides details of skills, knowledge and understanding sampled in the course assessment:

Practical activity		**Question paper**	
Skills	Candidates are required to demonstrate the ability to:	Knowledge and Understanding	Candidates are required to demonstrate a knowledge and understanding of:
Measuring and marking out	Use measuring and marking out tools from the list below: ♦ scriber and scribing block ♦ steel rule ♦ combination set ♦ engineer's square ♦ centre finder ♦ spring dividers ♦ calipers: oddleg, inside, outside ♦ micrometer: analogue or digital ♦ Vernier calipers: analogue or digital ♦ centre punch ♦ witness marks ♦ surface table ♦ angle block ♦ v-block	**Measuring and marking out**	A knowledge and understanding of the use of the tools and equipment listed below: ♦ scriber and scribing block ♦ steel rule ♦ combination set ♦ engineer's square ♦ centre finder ♦ spring dividers ♦ calipers: oddleg, inside, outside ♦ micrometer: analogue and digital ♦ Vernier calipers: analogue and digital ♦ centre punch ♦ witness marks ♦ surface table ♦ angle block ♦ v-block ♦ engineer's blue ♦ units of measurement

			♦ datum lines ♦ functional dimensions ♦ the need to make allowances for expansion, bending, stretching, forming, trimming, welding, brazing and soldering
Reading and interpreting drawings and documents	Read and extract relevant information from: ♦ working drawings, pictorial drawings, diagrams, cutting lists	**Reading and interpreting drawings and documents**	♦ working drawings, pictorial drawings, diagrams, cutting lists ♦ orthographic projection ♦ scale ♦ basic drawing conventions: line types — outlines, centre lines, fold lines, hidden detail and dimension lines ♦ reading and extracting information from working drawings: linear, radial, angular and diametric dimensions
Materials	Work safely with metalworking materials.	**Materials**	Properties of the metalworking materials listed below: ♦ ferrous metals: steel, high carbon steel, iron ♦ non-ferrous metals: aluminium, copper, nickel ♦ alloys: bronze, brass, stainless steel ♦ common sections: square bar, round bar, hexagonal bar, angle iron, tube ♦ sheet materials: tin plate, copper, brass, steel, aluminium
Bench work	Safely use tools listed below: ♦ engineer's vice ♦ hammers ♦ cold chisels	**Bench work**	The safe use of the following bench tools and their component parts. ♦ engineer's vice ♦ ball-pein hammer

	♦ files ♦ saws ♦ taps, tap wrench ♦ dies, die stock ♦ rivet set and snap		♦ cold chisels ♦ file types: flat, square, round, needle and 3 square ♦ file parts: tang, safe-edge, handle, ferrule ♦ file cut: smooth, 2nd cut and rough ♦ filing methods: cross filing and draw filing ♦ saws: hacksaw and junior hacksaw ♦ taps: taper, intermediate and plug, tap wrench, drill sizes for tapping ♦ dies: adjustment of split die, die stock ♦ rivet set and snap
Sheet metal tools and machines	Safely use the machines and tools listed below: ♦ bending/folding equipment ♦ notchers ♦ guillotine ♦ hide or rubber mallets ♦ tin snips ♦ pop riveter ♦ spot welder ♦ formers and jigs (as appropriate)	**Sheet metal tools and machines**	The safe use of tools, machines and equipment used in sheet metalwork listed below: ♦ folding bars ♦ folding machine ♦ notchers ♦ guillotine ♦ hide and rubber mallets ♦ tin snips (straight, curved, right and left hand) ♦ pop riveter ♦ spot welder

Machine processes	Carry out processes listed below: ♦ centre lathe: parallel turning, taper turning (using a compound slide), facing, chamfering, centre drilling and drilling generally, knurling, parting off, use of a 4-jaw chuck (if appropriate) ♦ pedestal/pillar drill for drilling and countersinking	**Machine Processes**	The actions carried out on the machines/processes listed below: ♦ pedestal/pillar drill: drilling and countersinking ♦ bench grinders ♦ centre lathe processes: facing off, parallel turning, taper turning, chamfering, drilling and use of compound slide ♦ milling machines: vertical, horizontal and CNC ♦ industrial cutting processes: laser and plasma cutters
Machine tools	Use machine tools listed below: ♦ lathe cutting tools ♦ knurling tool ♦ parting tool ♦ 3-jaw chuck, 4-jaw chuck, Jacob's chuck ♦ chuck keys ♦ revolving centres ♦ machine vices Use appropriate holding devices.	**Machine tools**	The safe use of the equipment and machinery parts listed below: ♦ parts of centre lathe: headstock, tailstock, tool post, compound slide, cross slide and saddle ♦ lathe cutting tools: left-hand knife tool, right-hand knife tool ♦ knurling tool ♦ parting tool ♦ 3-jaw chuck, 4-jaw chuck, Jacob's chuck ♦ chuck keys ♦ revolving centre ♦ machine vice

Finishing	Carry out an appropriate preparation to a metal surface, which would allow a finish to be applied.	**Finishing**	The finishing processes listed below: ♦ planishing ♦ polishing ♦ bluing ♦ machine finishing (ground, milled) ♦ preparation and application of paint and powder-dip coating
Care and maintenance of tools and machinery, and safe working practices	Complete a log book detailing evidence of good and safe working practices covering the following: ♦ care and maintenance of tools and equipment ♦ reporting faults and fault reporting systems ♦ general condition before, during and after use ♦ position and condition of guards ♦ position and security of cutting tools on machine tools ♦ use of personal protective equipment	**Safe working practices**	Good practices and safe systems for general workshop and individual activities as appropriate. Personal protective equipment: apron, gloves, safety goggles, safety specs, visors, welding masks.

Fabrication and thermal joining	Use processes listed below: ♦ hot-forming techniques: twisting, drawing down and flattening ♦ hot-bending techniques: metal bar bending and metal strip bending ♦ thermal joining techniques: welding, soldering or brazing ♦ mechanical fixing techniques: riveting, screw-fixing	**Fabrication and thermal joining**	The processes and techniques listed below: ♦ thermal joining: welding (mig, spot and electric arc), soldering, brazing ♦ mechanical fixing: riveting (snaphead, countersink and pop), screw-fixing ♦ metalwork adhesives ♦ heat-treatment methods: annealing, hardening and tempering
Sustainability and recycling	Understand and follow workshop recycling practices and processes.	**Sustainability and recycling**	Best practice in selecting materials that are appropriate for a specific use. Understand and follow workshop recycling practices and processes.

Skills, knowledge and understanding included in the course are appropriate to the SCQF level of the course. The SCQF level descriptors give further information on characteristics and expected performance at each SCQF level (www.scqf.org.uk).

Skills for learning, skills for life and skills for work

This course helps candidates to develop broad, generic skills. These skills are based on SQA's Skills Framework: Skills for Learning, Skills for Life and Skills for Work and draw from the following main skills areas:

2 Numeracy

2.2 Money, time and measurement

4 Employability, enterprise and citizenship

4.3 Working with others

5 Thinking skills

5.3 Applying
5.5 Creating

These skills must be built into the course where there are appropriate opportunities and the level should be appropriate to the level of the course.

Further information on building in skills for learning, skills for life and skills for work is given in the course support notes.

Course assessment

Course assessment is based on the information provided in this document.

The course assessment meets the key purposes and aims of the course by addressing:

- breadth — drawing on knowledge and skills from across the course
- challenge — requiring greater depth or extension of knowledge and/or skills
- application — requiring application of knowledge and/or skills in practical or theoretical contexts as appropriate

This enables candidates to:

- apply skills, knowledge and understanding developed through the course to manufacture a finished product in metal to a given standard
- demonstrate practical creativity and problem-solving during the manufacturing process
- apply skills, knowledge and understanding to unfamiliar practical metalworking situations

Course assessment structure: question paper

Question paper 60 marks

The question paper gives candidates an opportunity to demonstrate skills, knowledge and understanding relating to:

Area	Range of marks
Measuring and marking out tools	4–6
Reading and interpreting drawings	4–6
Materials	4–6
Common bench tools	5–7
Sheet metalwork equipment and processes	4–6
Machine processes	6–8
Machine parts and tools	6–8
Finishing	3–4
Fabrication and thermal joining	4–6
Health and safety	6–8
Sustainability and recycling	3–5

The question paper has 60 marks out of a total of 130 marks. This is scaled by SQA to represent 30% of the overall marks for the course assessment.

A proportion of marks are available for more challenging questions, which generally require interpretation and/or integration of more complex practical metalworking situations. This could be in the complexity of the expected response, the descriptions and/or justifications of more detailed and/or complex processes, or problem-solving.

Questions will allow for a variety of response types including, short/limited responses and extended responses.

Setting, conducting and marking the question paper

This question paper is set and marked by SQA and conducted in centres under conditions specified for external examinations by SQA.

Candidates will complete this in 1 hour.

Specimen question papers for National 5 courses are published on SQA's website. These illustrate the standard, structure and requirements of the question papers candidates sit. The specimen papers also include marking instructions.

Course assessment structure: coursework

Practical activity 70 marks

The practical activity allows candidates to demonstrate the application of skills and knowledge developed during the course to produce a finished product, to a given standard and specification.

The practical activity will be to manufacture a product and complete a log book. The log book will be provided as part of the assessment task.

Marks are awarded for:

Area
Log book
Bench work
Machining
Fabrication
Finishing
Overall assembly

The practical activity gives candidates an opportunity to demonstrate the following skills, knowledge and understanding:

- selecting and using a range of metalworking tools, equipment and materials
- reading, interpreting and following given working drawings, outline specification information and cutting lists
- marking out, cutting and shaping component parts
- fabricating and joining metalwork components
- manufacturing a finished product to given drawings and standards
- working and using tools and equipment in accordance with recognised procedures and safe working practices

The practical activity has 70 marks out of a total of 130 marks. This is scaled by SQA to represent 70% of the overall marks for the course assessment.

Practical activity overview

The standards and tolerances applicable to the product are as follows:

Operation	Tolerance
Individual components	
Marking out	±0.5mm
Fitting work	±0.5mm
Sheet metal work (cutting)	±1mm
Bending work — sheet metal	±2mm
Bending work — metal strip/ bar	±5mm
Forge processes (twisting, drawing down and flattening)	±3mm
Assembly, joining and fitting	
Functional sizes	±0.5mm linear
Thermal joining	Minimum length of 20mm consistent in width
Pedestal drill	
Drilling and countersinking	±0.5mm
Centre lathe	
Parallel turning, facing and chamfering	±0.5mm linear ±0.2mm diameter

The product will allow candidates to demonstrate skills and apply knowledge gained from the course.

Hand, power and machine tools will be used in the manufacture of the product, as specified in the practical activity.

The product surfaces will be well-prepared and finished as specified. However, no external finish is to be applied to the product.

While working on the practical activity, candidates must adhere to recognised safe working practices as well as those stipulated within their centre.

Functional dimensions

Functional dimensions are specified within the assessment task.

Setting, conducting and marking the practical activity

This practical activity is:

- set by SQA, on an annual basis
- conducted under some supervision and control (although a high degree of supervision is required for health and safety purposes)

Evidence is internally assessed by centre staff in line with SQA's marking instructions. All marking is quality assured by SQA.

High level instructions for centres, giving an overview of the product, materials and cutting list, are provided in advance.

Full instructions for candidates, giving specific joining and manufacturing details, are contained within the annually issued assessment task.

Assessment conditions

Time

This practical activity is carried out over a period of time, starting at an appropriate point in the course, once all content has been delivered.

Supervision, control and authentication

The practical activity must be carried out:

- without interruption by periods of learning and teaching
- in a workshop environment
- in time to meet the mark submission date set by SQA
- on an individual basis by the candidate (ie no group work is permitted)
- under supervision to ensure that work presented is the candidates' own
- under supervision to ensure a safe and controlled environment

Resources

The practical activity is undertaken in open-book conditions and, as such, candidates can have access to learning and teaching materials, the internet, notes, exemplar materials, resources on classroom walls or anything similar whilst it is being undertaken.

The practical activity will include instructions for deliverers and candidates and this will detail any equipment or materials that they will need.

Reasonable assistance

Candidates are expected to progress through each stage of the practical activity independently, having acquired the skills earlier in the course. Assessors will intervene throughout the undertaking of the practical activity to ensure the safe running of the workshop environment. However, where the assessor has to intervene, this must be recorded and reflected in the marks awarded in line with the marking instructions.

The practical activity is designed to discriminate between candidates. Once the practical activity has been completed, the product cannot be returned to the candidate for further work.

Evidence to be gathered

Full instructions for the evidence requirements are contained within each assessment task.

This will include:

- the completed product (and jigs created by the candidate)
- the completed log book
- record of any intervention relating to independence of work
- record of any intervention relating to safe working

All candidate evidence is internally assessed.

Volume

One completed log book and one completed product is required from each candidate.

Grading

A candidate's overall grade is determined by their performance across the course assessment. The course assessment is graded A–D on the basis of the total mark for all course assessment components.

Grade description for C

For the award of grade C, candidates will typically have demonstrated successful performance in relation to the skills, knowledge and understanding for the course.

Grade description for A

For the award of grade A, candidates will typically have demonstrated a consistently high level of performance in relation to the skills, knowledge and understanding for the course.

Equality and inclusion

This course is designed to be as fair and as accessible as possible with no unnecessary barriers to learning or assessment.

For guidance on assessment arrangements for disabled candidates and/or those with additional support needs, please follow the link to the assessment arrangements web page: www.sqa.org.uk/assessmentarrangements

Further information

The following reference documents provide useful information and background.

- National 5 Practical Metalworking subject page
- Assessment arrangements web page
- Building the Curriculum 3–5
- Design Principles for National Courses
- Guide to Assessment
- SCQF Framework and SCQF level descriptors
- SCQF Handbook
- SQA Skills Framework: Skills for Learning, Skills for Life and Skills for Work
- Coursework Authenticity: A Guide for Teachers and Lecturers
- Educational Research Reports
- SQA Guidelines on e-assessment for Schools
- SQA e-assessment web page

Appendix: course support notes

Introduction

These support notes are not mandatory. They provide advice and guidance to teachers and lecturers on approaches to delivering the course. They should be read in conjunction with this course specification and the specimen question paper and/or coursework.

The course is delivered over 160 hours of class time (as indicated by its SCQF level and points). This includes 40 hours for induction, extending the range of learning and teaching approaches, support, consolidation, integration of learning, preparation for course assessment and the course assessment itself.

Note: this course is no longer auto-approved for delivery in centres. Centres that have not delivered in the three academic sessions prior to session 17–18 must seek approval to offer this qualification — full details of the approval process can be found at: http://www.sqa.org.uk/sqa/74661.6212.html.

Developing skills, knowledge and understanding

This section provides further advice and guidance about skills, knowledge and understanding that could be included in the course. Teachers and lecturers should refer to this course specification for the skills, knowledge and understanding for the course assessment. Course planners have considerable flexibility to select coherent contexts which will stimulate and challenge their candidates, offering both breadth and depth.

The 'Approaches to learning and teaching' section provides suggested activities that teachers and lecturers can build into their delivery to develop these skills, knowledge and understanding.

Approaches to learning and teaching

National 5 Practical Metalworking, like all National Courses, has been developed to reflect Curriculum for Excellence values, purposes and principles. The approach to learning and teaching developed by individual centres should reflect these principles.

Learning in this course should be primarily practical, hands-on and experiential in nature.

Learning and teaching activities should be designed to stimulate candidates' interest and to develop skills and knowledge to the required standard. Learning should be focused on practical activities, so that skills are developed simultaneously with knowledge and understanding.

Candidates may demonstrate a range of preferences for learning. Teachers and lecturers should use a variety of strategies to deliver the course in a way that builds candidates' competence and understanding. These could include demonstration, discussion, problem-solving, exploration and experimentation (particularly with materials).

In National 5 Practical Metalworking, whole-class demonstration and instruction is an important learning and teaching method. Practical demonstrations of metalworking techniques can be followed up by sessions with individual candidates or small groups and/or by close supervision and one-to-one assistance where required.

Where possible, visits to relevant local industrial/workshop environments should be undertaken. The use of online resources can also help to improve candidates' understanding.

Teachers and lecturers should employ co-operative and collaborative learning approaches to support and encourage candidates to achieve their full potential. Candidates engaged in this kind of learning capitalise on one another's knowledge and skills through sharing information, peer evaluation and monitoring group work.

Group work is not assessed by SQA. However, it is a fundamental aspect of working in practical technologies and should be encouraged and developed by teachers and lecturers.

Note: group work **cannot** be used for course assessment purposes.

Resources

Existing workshop equipment and classroom resources may be sufficient for delivering the course. Teachers and lecturers can also use digital resources to support knowledge consolidation.

Where possible, teachers and lecturers should source or produce models of completed work to enable candidates to visualise aspects of the course content. This may take the form of pre-built assemblies or work pieces that the candidates can use directly or in combination with the assemblies or items they create.

Visits to building sites, manufacturing metalwork businesses, metal fabricators and builders' merchants can be a valuable way for candidates to contextualise course content. Visits to local colleges to see the work being carried out by students and/or apprentices can also help candidates to identify future training/career pathways.

Online video clips and films of practical metalworking techniques, processes and practices are a valuable resource that can be used in class and for independent study.

Health and safety

In this course, health and safety is paramount.

Each centre has statutory obligations as well as local advice on health and safety practices. Centres have policies and approaches to learning and teaching which support best practice in the workshop environment.

Candidates must be aware of the importance of responsible working and the need to ensure the safety of self and others at all times. Teachers and lecturers should take the opportunity to emphasise these responsibilities throughout the course.

When candidates begin each new topic, teachers and lecturers should give them a thorough introduction to the work required and all aspects of safe working practices (this should include safe use of hand/machine/power tools, materials, thermal joining equipment, the forge and workshop conduct). Videos or interactive computer programs can be used to introduce metalworking processes and safety aspects. These can help candidates to relate the work of the course to the world of industry.

Teachers and lecturers can verify candidates' positive attitudes to safety, care and attention through observation of their working procedures, their responsible use of tools, conversations, simple question and answer sessions and other demonstrations of safe working practices.

Proper tool care and recognition of the dangers of tool defects must be a recurrent theme in the course. Teachers and lecturers should encourage candidates to use a log book for detailing their understanding of and adherence to safe working practices.

Areas of study for candidates

Subject knowledge

Knowledge and understanding should not be taught in isolation from the practical aspects of the course. For example, when candidates are learning which tools and materials are associated with different joining techniques, teachers and lecturers should encourage them to relate this knowledge to the practical work they are undertaking.

Candidates should be shown a completed example of each practical exercise to be undertaken so they can see the standard of work they are expected to produce. Orthographic and pictorial views can also help candidates to visualise items.

Candidates should be able to set up before a workshop session, select appropriate metalworking tools and materials and tidy up after completion.

Candidates should learn the terminology associated with different tools and their uses before and during practical activities. Teachers and lecturers should help to reinforce candidates' understanding of the names of various metalworking machine and power tools as well as their uses — turning, drilling, cutting, grinding, fixing.

Teachers and lecturers can use similar approaches to help candidates develop knowledge and understanding of the range of fixings and adhesives commonly associated with metalworking as well as the fitting and fixing of component parts.

It would be good practice for teachers and lecturers to introduce each of the machine tools separately and to plan practical sessions for their use. Alternatively, teachers and lecturers could introduce 'families' of similar tools and items of equipment.

Reading and interpreting drawings

Teachers and lecturers should provide candidates with the opportunity to practise reading and interpreting orthographic and pictorial drawings. It is expected that drawings will use a

variety of line types and conventions, eg screw threads. Where British Standard conventions are used as part of a drawing, teachers and lecturers should explain these to candidates.

Dimensioning should be mostly linear although it will be necessary to also include diameters and radii appropriate to the item being made. To assist candidates visualise an item more easily, teachers and lecturers could provide orthographic and pictorial views together.

Teachers and lecturers can help candidates to develop drawing-reading skills by giving them clear drawings to compare with scale physical models of the items drawn. When candidates are familiar with the format and content of cutting lists, they can try preparing their own using templates.

Recycling and sustainability

Whenever possible, teachers and lecturers should introduce sustainability concepts such as the sourcing and cost of materials, waste and cutting allowances, recycling and reuse. These concepts can be explored through workshop learning and teaching activities, site visits and online resources. Teachers and lecturers should help candidates to understand what they can do as individuals and as a class to support sustainability.

Using measuring and marking-out tools

Candidates should be introduced to the concept of marking out using datums. On metal, the datums should first be established by filing two adjacent edges straight and at 90°. Candidates should use basic marking-out equipment — steel rule, engineer's square, oddleg calipers, scriber, centre punch, and dividers — to achieve the required accuracy.

Teachers and lecturers should demonstrate the need for special marking-out techniques for certain precision work and irregular components. Marking-out of larger products and repetitive marking-out should also be covered.

Using a range of tools to manufacture metalwork products

Candidates should manufacture metalwork products using sheet metal and fitting tools.

Depending on candidates' prior experience, some initial practice work should normally be carried out. This could take the form of a cardboard mock-up or the manufacture of a simple introductory item. This will help candidates appreciate the finer points and problems involved in working with sheet-metal. It will also help candidates to develop the necessary experience to manufacture an item.

Teachers and lecturers should emphasise accuracy and quality when candidates are manufacturing a fitting item. If candidates produce a component that is not of an acceptable standard they should be given the chance to replace it.

The type of item produced might require candidates to use equipment and processes from other areas of the course. These should be sufficiently complex to provide an appropriate degree of challenge.

Although drilling is generally a machine process, teachers and lecturers are likely to cover it at this time. Accuracy should be determined by rule, in conjunction with Vernier calipers if

necessary. Devices such as micrometers could also be used. Teachers and lecturers should cover assembly/joining methods as well as finishing with no major flaws. Candidates can be provided with additional support here if necessary.

Demonstrating knowledge of common machine tools and equipment

Teachers and lecturers should make candidates aware of different metal-cutting situations and should also match these to particular machines. Where these machines are not available in the centre, they should be covered by an industrial visit, by visiting another centre or by an online resource.

Performing routine user checks on tools and machinery prior to their use

Candidates should be responsible for ensuring that the machinery to be used is set up appropriately, with all safety equipment in place prior to use. This should then be checked by teachers and lecturers. Similarly, the inspection of hand tools and reporting of defects should become routine practice for candidates throughout the delivery of the course.

Measurement using the micrometer and Vernier caliper

In order to ensure candidates achieve the greatest possible accuracy in manufacturing components, teachers and lecturers should encourage them to use micrometers and Vernier calipers.

Operating common machine tools in accordance with safe working practice

Candidates should use as many machines and items of equipment as possible. Items that are produced to working drawings should require the widest possible range of operations to give candidates experience of what can be undertaken in metalworking.

If a milling machine is not available for candidates, then at least one drilling-machine operation should include an activity where the machine vice is clamped to the table. This will ensure that candidates have practical experience of work holding of this type.

Turning operations should include: plain parallel turning, facing, taper turning using a compound slide, parting off, centre drilling and drilling, and knurling. Teachers and lecturers could extend this range to include boring and other relevant operations. Candidates should also be able to demonstrate use of a four-jaw chuck to hold square-shaped or irregularly shaped components. Candidates should be able to produce machined finishes without significant defects. Quality of work can be confirmed by comparing with models, by thumbnail check, and by visual examination.

Using hot-forging techniques to form shapes and components as an alternative to material removal

Forging is related to fabrication. Teachers and lecturers could introduce the technique with a video that shows the terminology, equipment and applications used in an industrial context. Teachers and lecturers should discuss with candidates the advantages of creating shapes by hot-forging rather than removing material. Practical applications should also be provided.

Teachers and lecturers should give candidates practical experience of using basic hot-forging shaping processes. Candidates should undertake exercises that cover hot-bending of the strip on the flat surface or on edge, drawing down, flattening and twisting. Wherever possible, these exercises should be incorporated into completed items.

Heat treatment of metals

The forging process leads naturally on to the observation of effects of heat on carbon steels. Candidates can best study this through the manufacture of a cold chisel or screwdriver. This exercise also has the advantage of covering skills from the 'Machine processes' content area.

Thermal joining techniques

Teachers and lecturers should also introduce candidates to the thermal joining techniques used in industry. This is best carried out through an industrial visit, although video material can be used as an alternative. Teachers and lecturers should cover the thermal joining of components by welding. This should include manual metal arc (MMA), metal inert gas (MIG), tungsten inert gas (TIG). Teachers and lecturers should also cover spot welding, by brazing and by soldering, to give candidates an insight into a permanent method common in steel fabrication. Candidates should have practical experience of as many techniques as possible.

Using mechanical fixings and adhesives

Candidates are expected to use a range of mechanical fixings and/or adhesive bonding to join metal sections and sheet materials.

Teachers and lecturers can best demonstrate the use of screws, fixing, riveting, bolting and proprietary fixings with examples that are related to the candidates' own experience (eg in holding the parts of a bicycle together). This method can also be used to introduce the concept of permanent and temporary fixing of components.

Where metalwork adhesives are used, teachers and lecturers will need to show candidates how to achieve neat secure joints. The use of these adhesives in the industrial context should also be discussed.

In order to gain the confidence and skills required for working on a larger product, candidates should cover all of these joining techniques by producing test pieces rather than complete items.

Using fabrication and thermal joining techniques to manufacture a product

Candidates could produce one or two items to incorporate most of the skills required for this area of course content. This will also provide an opportunity to revisit skills from other areas as required. Candidates should complete a log book as part of the manufacturing activity.

At this stage, teachers and lecturers must demonstrate and closely supervise all stages of manufacture. They should emphasise accuracy and quality over speed when manufacturing an item. If candidates produce a component that is not of an acceptable standard, they should be given the chance to replace it.

Adhering to safe working practices at all times

Thermal joining and forging have their own safety-specific practices and procedures, including personal protective equipment, ventilation, equipment checks and work holding. Teachers and lecturers must cover these fully with candidates and emphasise the need to adhere to them at all times.

Suggested tasks for candidates

Candidates should be able complete the following tasks to help them develop the skills, knowledge and understanding required to complete the course assessments.

Prepare for metalwork bench tasks by:

- selecting the appropriate metalworking tools, equipment and materials
- confirming that metalworking tools and equipment are in good condition and safe working order before, during and after use
- adjusting tools where necessary and following safe working practices
- using correct names and terminology when referring to common metalworking tools, equipment, materials and processes

Use a range of marking out tools and hand tools by:

- creating and using datum marks
- marking out components or work pieces in accordance with working drawings and with five functional and two linear sizes to within specified tolerances
- using a minimum of six fitting tools, three sheet-metal tools and three measuring tools
- cutting, shaping, forming and fitting metal components using sections and sheet materials
- using tools safely and correctly

Manufacture metalwork products from working drawings using bench fitting skills by:

- checking materials supplied against working drawings
- manufacturing metalwork products with three functional and two linear sizes within specified tolerances in fitting work, sheet-metal work and bending
- working in accordance with recognised procedures and safe working practices
- carrying out good practice in terms of sustainability and recycling

Prepare for metalwork machine process tasks by:

- selecting the appropriate metalworking tools, equipment and materials
- confirming that metalworking tools and equipment are in good condition and safe working order before, during and after use
- adjusting tools where necessary and following safe working practices
- using correct names and terminology when referring to common metalworking tools, equipment, materials and processes

Use a range of marking out tools, machine tools and equipment by:

- correctly creating and using datum marks
- marking out components or work pieces in accordance with working drawings with three functional and two linear sizes to within specified tolerances
- performing drilling and countersinking operations on a pedestal drill to within specified tolerance
- performing parallel turning, facing and chamfering operations on a centre lathe with neatness and consistency of finish
- using tools and equipment safely and correctly

Manufacture a metalwork product from working drawings using machine tools and processes by:

- checking materials supplied against working drawings
- manufacturing a metalwork product with three functional sizes within specified tolerances
- working in accordance with recognised procedures and safe working practices
- carrying out good practice in terms of sustainability and recycling

Prepare for metalwork fabrication and joining tasks by:

- selecting the appropriate metalworking tools, equipment, materials and fixings
- confirming that metalworking tools and equipment are in good condition and safe working order before, during and after use
- adjusting tools where necessary and following safe working practices
- using correct names and terminology when referring to common metalworking tools, equipment, materials and processes
- describing three or more industrial processes relating to fabrication and joining of metalwork

Apply fabrication and joining techniques to form, bend and join metal by:

- selecting appropriate metals in the form of sections and sheet materials to demonstrate fabrication and joining techniques
- using forming techniques of bending, twisting, drawing down and flattening and to specified tolerance
- carrying out welding, brazing or soldering operations, consistent in width and form and in several short runs, each to a minimum length of 50 mm
- carrying out spot welding operations, consistent in quality and to form neat and effective joints
- applying a range of mechanical fixings and/or adhesive bonding of metal sections and/or sheet materials so that connections are secure and without damage in torque and tightening, including pilot holes as required and to specified tolerance in marking out
- using tools and equipment safely and correctly

Manufacture a metalwork product from working drawings using fabrication and joining techniques by:

- checking materials against working drawings
- creating and using datum marks and marking out components
- manufacturing a metalwork product with three or more component parts such that connections are secure and without damage in torque and tightening and to specified tolerance in marking out

Preparing for course assessment

The course has in-built time which teachers and lecturers can use at their discretion to enable candidates to prepare for course assessment. This time may be used near the start of the course and at various other points for consolidation and support.

Teachers and lecturers are free to decide how they will prepare candidates to undertake the course assessment in a way that ensures they will be as successful as possible.

For the question paper, time will be required for:

- revision and consolidation of learning
- question paper techniques
- familiarisation with past, specimen and sample question papers
- practice question paper(s) — eg prelim examination

For the practical activity, time will be required for:

- revision and consolidation of learning
- familiarisation with practical activity

Developing skills for learning, skills for life and skills for work

Course planners should identify opportunities throughout the course for candidates to develop skills for learning, skills for life and skills for work.

Candidates should be aware of the skills they are developing and teachers and lecturers can provide advice on opportunities to practise and improve them.

SQA does not formally assess skills for learning, skills for life and skills for work.

There may also be opportunities to develop additional skills depending on approaches being used to deliver the course in each centre. This is for individual teachers and lecturers to manage.

Candidates are expected to develop broad, generic skills as an integral part of their learning experience. This course specification lists the skills for learning, skills for life and skills for work that candidates should develop through this course. These are based on Skills Framework: Skills for Learning, Skills for Life and Skills for Work and should be built into the course where there are appropriate opportunities. The level of these skills will be appropriate to the level of the course.

For this course it is expected that the following skills for learning, skills for life and skills for work will be developed through the activities and practices described in the second column.

2 Numeracy	
Skill	**How to develop**
2.2 Money, time and measurement	♦ measuring and marking out materials in accordance with working drawings ♦ interpreting and calculating dimensions and scale in drawings/diagrams/orthographic projections and applying them to work pieces ♦ reading sizes from a micrometer or Vernier caliper ♦ checking the accuracy of completed components and assemblies against drawings and cutting lists ♦ manufacturing items to strict measurements of tolerances and accuracy ♦ managing time to achieve set tasks and goals ♦ discussing costs in the context of sustainability and recycling
4 Employability, enterprise and citizenship	
Skill	**How to develop**
4.3 Working with others	♦ sharing tools, equipment and materials with others during workshop practice and working together to balance individual tasks and time ♦ participating in group work ♦ assisting other candidates to carry out tasks
5 Thinking skills	
Skill	**How to develop**
5.3 Applying	♦ learning new techniques and processes and applying them in practical tasks ♦ planning and organising tools, equipment and materials in preparation for a practical activity ♦ applying practical skills to solve a problem in a drawing or specification
5.5 Creating	♦ creating assemblies based on drawings and diagrams and applying individual interpretation where necessary

Administrative information

Published: September 2017 (version 2.0)

History of changes to course specification

Version	Description of change	Date
2.0	Course support notes added as appendix.	September 2017