Unit 5: Undertake Introductory Welding for Blacksmithing and Metalworking

Unit reference number: H/602/0495

QCF Level 3: BTEC National

Credit value: 10

Guided learning hours: 60

Aim and purpose

This unit aims to introduce learners to the skills and knowledge for introductory welding for blacksmithing and metalworking, and how these can be applied in practice. It is designed for learners in centre-based settings looking to progress into the sector or on to further/higher education.

Unit introduction

Joining metal using a range of fusion welding processes is an important and often essential alternative to the traditional blacksmith's forge (fire) weld.

Oxy-fuel gas cutting is also an invaluable addition to the range of cutting methods available to the metalworker, particularly for fixed work or cutting/shaping heavier sections.

In this unit learners will develop the knowledge and skills needed to join and cut steel in relatively simple situations and configurations. Operator welfare, health and safety and environmental issues will be stressed throughout the delivery of this unit.

Learning outcomes 1, 2 and 3 address the three welding processes commonly found in a blacksmith's workshop: oxy-acetylene, manual metal arc and metal arc gas shielded. Learners will be introduced to the equipment needed for each welding process and the variations in setting up and use. Techniques will be demonstrated and practised in the welding workshop so that learners can produce simple, repeatable, quality welded joints in steel. Learners will gain knowledge and experience in a largely practical situation.

In learning outcome 4 the use of oxy-acetylene equipment is extended to thermal cutting and applied on a continuing basis in the preparation of material for welding. Metal invariably needs to be cut before it is assembled into fabricated forms.

Learning outcomes

On completion of this unit a learner should:

1 Be able to demonstrate the principles and practice of oxy-acetylene welding

2 Be able to demonstrate the principles and practice of manual metal arc welding

3 Be able to demonstrate the principles and practice of metal arc gas shielded welding

4 Be able to demonstrate the principles and practice of oxy-acetylene and plasma arc cutting.

Unit content

1 Be able to demonstrate the principles and practice of oxy-acetylene welding

Equipment: components; gas sources; nozzle types/sizes; function and settings of controls; oxy-acetylene flame as a welding heat source

Consumables: high pressure oxygen; dissolved acetylene; filler wire; fluxes; mild steel; factors affecting selection

Health and safety: health and safety issues; set up; ventilation and extraction; use and maintenance of oxy-acetylene welding equipment; personal protective equipment (PPE); risk assessment; relevant current legislation eg health and safety at work legislation

Welding: methods used to produce fillet and butt joints in the flat position; quality issues

2 Be able to demonstrate the principles and practice of manual metal arc welding

Equipment: types; function and settings of controls

Consumables: range and application of manual metal arc electrodes; materials eg mild steel; factors affecting selection

Health and safety: health and safety issues; risks associated with and standards for electricity, radiation, particle and fume emission; set up; use and maintenance of equipment; PPE; risk assessment; relevant current legislation

Welding: methods used to produce fillet and butt joints in the flat position; quality issues

3 Be able to demonstrate the principles and practice of metal arc gas shielded welding

Equipment: types; function and settings of controls

Consumables: welding wire; shielding gas; mild steel; factors affecting selection

Health and safety: health and safety issues; risks associated with and standards for electricity, radiation, particle and fume emission; set up; use and maintenance of equipment; PPE; risk assessment; relevant current legislation

Welding: methods used to produce fillet and butt welds in the flat position; quality issues

4 Be able to demonstrate the principles and practice of oxy-acetylene and plasma arc cutting

Equipment: components; function and setting of controls; oxy-acetylene flame as a cutting heat source; nozzle types/sizes; plasma arc as a cutting heat source; semi-automatic cutting

Consumables: types of fuel gas; mild steel

Health and safety: health and safety issues; set up; ventilation and extraction; use and maintenance of oxy-acetylene cutting equipment; radiation, particle and fume emission; PPE; risks associated with and standards for electricity, radiation and fume emission; risk assessment; relevant current legislation

Cutting: methods used to produce simple manual cuts; quality issues

Assessment and grading criteria

In order to pass this unit, the evidence that the learner presents for assessment needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria for a pass grade describe the level of achievement required to pass this unit.

Assessment and grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	**To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:**	**To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:**
P1 use oxy-acetylene equipment to produce basic butt welded joints in mild steel to meet given specifications [RL, SM]		**D1** evaluate a selected welded component/artefact, recognising faults/defects and recommending improvements.
P2 use oxy-acetylene equipment to produce basic fillet welded joints in mild steel to meet given specifications [RL, SM]		
P3 use manual metal arc equipment to produce basic butt welded joints in mild steel to meet given specifications [RL, SM]		
P4 use manual metal arc equipment to produce basic fillet welded joints in mild steel to meet given specifications [RL, SM]		

Assessment and grading criteria					
To achieve a pass grade the evidence must show that the learner is able to:		**To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:**		**To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:**	
P5	use metal arc gas shielded equipment to produce basic butt welded joints in mild steel to meet given specifications [RL, SM]	**M1**	select and apply appropriate welding techniques to produce a component/artefact to given welding and/or fabrication specifications.		
P6	use metal arc gas shielded equipment to produce basic fillet welded joints in mild steel to meet given specifications [RL, SM]				
P7	use oxy-acetylene equipment to produce straight and curved cuts in mild steel to meet given specifications [RL, SM]	**M2**	select and apply appropriate thermal cutting techniques to produce a component/artefact to a given specification.		
P8	use plasma cutting equipment to produce straight and curved cuts in mild steel to meet given specifications. [RL, SM]				

PLTS: This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills applicable in the pass criteria. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

Key	IE – independent enquirers	RL – reflective learners	SM – self-managers
	CT – creative thinkers	TW – team workers	EP – effective participators

Essential guidance for tutors

Delivery

Delivery of this unit will involve practical assessments, written assessment, visits to suitable collections and will link to work experience placements.

Tutors delivering this unit have opportunities to use as wide a range of techniques as possible. Lectures, discussions, practical demonstrations, site visits, supervised welding practicals, case studies, internet and/or library-based research and the use of personal and/or industrial experience would all be suitable. Delivery should stimulate, motivate, educate and enthuse learners.

Work placements should be monitored regularly in order to ensure the quality of the learning experience. It would be beneficial if learners and supervisors were made aware of the requirements of this unit before any work-related activities are undertaken, so that naturally occurring evidence can be collected at the time. For example, learners may have the opportunity to demonstrate fusion welding and cutting, and they should ask for observation records and/or witness statements to be provided as evidence of this. Guidance on the use of observation records and witness statements is provided on the Pearson website.

Whichever delivery methods are used, it is essential that tutors stress the importance of safe working practice, before and during practical work, and the need to manage the resource using legal methods.

Health and safety issues relating to welding must be stressed and reinforced regularly, and risk assessments must be undertaken before any practical activities. Adequate PPE must be provided and used following the production of suitable risk assessments.

Visiting expert speakers could add to the relevance of the subject for learners. For example, an experienced welder could talk about their work, the situations they face and the methods they use.

Tutors should consider integrating the delivery, private study and assessment for this unit with other relevant units and assessment instruments learners are taking as part of their programme of study.

Learning outcome 1 covers the principles and practice of oxy-acetylene welding. Initial demonstrations should be followed by opportunities for learners to practise and develop their technique in oxy-acetylene welding. Supporting knowledge will be delivered and acquired mainly within the workshop but there should be directed and personal opportunities for research via information learning technology, supported by formal classroom activity.

Learning outcome 2 looks at the principles and practice of manual metal arc welding. Delivery will be similar to learning outcome 1. Welding should be in mild steel, in a range of thickness and configurations, in order for learner experience to be as broad as possible. Other metals should be considered where possible.

Learning outcome 3 covers the principles and practice of metal active gas welding. Delivery is likely to be similar to learning outcome 1. Similarities and distinctions between the welding processes should be emphasised when considering joining tasks.

Learning outcome 4 covers the principles and practice of oxy-acetylene and plasma cutting. Again, delivery is likely to be similar to learning outcome 1. Learners should develop the ability to select and carry out successful cutting techniques.

Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments.

The outline learning plan gives **an indication of the volume of learning it would take learners** to achieve the learning outcomes. It is **indicative and is one way of achieving the credit value.**

Learning time should address all learning (including assessment) relevant to the learning outcomes, regardless of where, when and how the learning has taken place.

Topic and suggested assignments/activities and/assessment
Introduction and overview of the unit.
Assignment 1: Producing Oxy-acetylene Welded Butts and Fillets in the Flat Position (P1, P2) Tutor introduces the assignment.
Demonstrate oxy-acetylene welding in relation to butt and fillet joints in the flat position.
Practical application of oxy-acetylene welding butt and fillet joints in the flat position.
Assignment 2: Producing Manual Metal Arc-welded Butts and Fillets in the Flat Position (P3, P4) Tutor introduces the assignment.
Demonstrate manual metal arc welding in relation to butt and fillet joints in the flat position.
Practical application of manual metal arc welding butt and fillet joints in the flat position.
Assignment 3: Producing Metal Arc Gas Shielded Welded Butts and Fillets in the Flat Position (P5, P6, M1, D1) Tutor introduces the assignment.
Demonstrate metal arc gas shielded welding in relation to butt and fillet joints in the flat position.
Practical application of metal arc gas shielded welding butt and fillet joints in the flat position.
Assignment 4: Thermal Cutting with Oxy-acetylene and Plasma Equipment (P7, P8, M2) Tutor introduces the assignment.
Demonstrate a range of cutting methods/techniques.
Practical application of oxy-acetylene and plasma cutting.
Unit review.

Assessment

For P1, learners must use oxy-acetylene equipment to produce basic butt welded joints in mild steel to meet given specifications. Tutors should identify the joints and specifications or agree them through discussion with learners. The joints and specifications may be the same as those used to provide evidence for other grading criteria. Where possible, to ensure assessment is fair, the size and complexity of the tasks should be the same for all learners.

Learners are expected to provide evidence of at least two pieces of work produced using different skills and techniques. P1 could be assessed directly by the tutor during practical activities. If this format is used then suitable evidence from guided activities would be observation records completed by learners and the tutor, accompanied by appropriate work logs or other relevant learner notes. If assessed during a placement, witness statements should be provided by a suitable representative and verified by the tutor.

For P2, learners must use oxy-acetylene equipment to produce basic fillet welded joints in mild steel to meet given specifications. Tutors should identify the joints and specifications or agree them through discussion with learners. The joints and specifications may be the same as those used to provide evidence for other grading criteria. Where possible, to ensure assessment is fair, the size and complexity of the tasks should be the same for all learners.

Learners are expected to provide evidence of at least two pieces of work produced using different skills and techniques. P2 could be assessed directly by the tutor during practical activities. If this format is used then suitable evidence from guided activities would be observation records completed by learners and the tutor, accompanied by appropriate work logs or other relevant learner notes. If assessed during a placement, witness statements should be provided by a suitable representative and verified by the tutor.

For P3, learners must use manual metal arc equipment to produce basic butt welded joints in mild steel to meet given specifications. Tutors should identify the joints and specifications, or agree them through discussion with learners. The joints and specifications may be the same as those used to provide evidence for other grading criteria. Where possible, to ensure assessment is fair, the size and complexity of the tasks should be the same for all learners.

Learners are expected to provide evidence of at least two pieces of work produced using different skills and techniques. Evidence could be in the same form as for P1.

For P4, learners must use manual metal arc equipment to produce basic fillet welded joints in mild steel to meet given specifications. Tutors should identify the joints and specifications, or agree them through discussion with learners. The joints and specifications may be the same as those used to provide evidence for other grading criteria. Where possible, to ensure assessment is fair, the size and complexity of the tasks should be the same for all learners.

Learners are expected to provide evidence of at least two pieces of work produced using different skills and techniques. Evidence could be in the same form as for P1.

P5 requires learners to use metal active gas equipment to produce basic butt welded joints in mild steel to meet given specifications. Tutors should identify the joints and specifications, or agree them through discussion with learners. The joints and specifications may be the same as those used to provide evidence for other grading criteria. Where possible, to ensure assessment is fair, the size and complexity of the tasks should be the same for all learners.

Learners are expected to provide evidence of at least two pieces of work produced using different skills and techniques. Evidence could be in the same form as for P1.

P6 requires learners to use metal active gas equipment to produce basic fillet welded joints in mild steel to meet given specifications. Tutors should identify the joints and specifications, or agree them through discussion with learners. The joints and specifications may be the same as those used to provide evidence for other grading criteria. Where possible, to ensure assessment is fair, the size and complexity of the tasks should be the same for all learners.

Learners are expected to provide evidence of at least two pieces of work produced using different skills and techniques. Evidence could be in the same form as for P1.

For P7, learners must use oxy-acetylene equipment to produce simple cuts in mild steel to meet given specifications. Tutors should identify the cuts and specifications, or agree them through discussion with learners. The cuts and specifications may be the same as those used to provide evidence for other grading criteria. Where possible, to ensure assessment is fair, the size and complexity of the tasks should be the same for all learners.

Learners are expected to provide evidence of at least two pieces of work produced using different skills and techniques. Evidence could be in the same form as for P1.

For P8, learners must use plasma cutting equipment to produce simple cuts in mild steel to meet given specifications. Tutors should identify the cuts and specifications, or agree them through discussion with learners. The cuts and specifications may be the same as those used to provide evidence for other grading criteria. Where possible, to ensure assessment is fair, the size and complexity of the tasks should be the same for all learners.

Learners are expected to provide evidence of at least two pieces of work produced using different skills and techniques. Evidence could be in the same form as for P1.

For M1, learners must select and apply an appropriate welding process and incorporate fillet and butt welding techniques to produce a component/artefact to given welding and/or fabrication specifications. Tutors should identify the process, welds and specifications or agree them through discussion with learners. The welds and specifications may be the same as those used to provide evidence for other grading criteria. Where possible, to ensure assessment is fair, the size and complexity of the tasks should be the same for all learners.

For M2, learners are expected to produce evidence of at least four pieces of work, two produced using oxy-acetylene equipment and two using plasma equipment, in each case to produce a straight and a curved cut. Cuts at merit grade should be within +/- 2 mm of the specification. Evidence of cuts could be in the same form as for P1.

For D1, learners must evaluate a selected welded component/artefact, recognising faults and/or defects against full BS4872 criteria, or its equivalent, and make recommendations for improvement. Tutors should identify the component/artefact to be evaluated or agree it through discussion with learners. The component/artefact may have been supplied, or have been produced, by the learner and used to provide evidence for other grading criteria. The component/artefact will possess a range of fillet and butt joints and, to ensure assessment is fair, the size and complexity of the task should be as similar as possible for all learners. Evidence could be through the production of evaluation sheets. Recommendations for improvement must be feasible and appropriate.

Programme of suggested assignments

The following table shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Pearson assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1, P2	Producing Oxy-acetylene Butt and Fillet Joints	Produce a range of components in mild steel incorporating oxy-acetylene butt and fillet joints to the specification provided.	Observation and assessment of practical work.
P3, P4	Producing MMA Butts and Fillet Joints	Produce components in mild steel incorporating manual metal arc butt and fillet joints to the specification provided.	Observation and assessment of practical work.
P5, P6, M1, D1	Producing MAGS Butts and Fillet Joints	Produce components in mild steel incorporating a range of metal arc gas shielded butt and fillet joints to the specification provided. You will evaluate the welded joints and make recommendations for improvement.	Observation and assessment of practical work.

Criteria covered	Assignment title	Scenario	Assessment method
P7, P8, M2	Thermal Cutting with Oxy-acetylene and Plasma Equipment	Produce a range of components in mild steel incorporating oxy-acetylene and plasma cutting to the specifications provided. You will also select and apply an appropriate thermal cutting process to meet a given specification.	Observation and assessment of practical work.

Links to other BTEC units

This unit forms part of the BTEC land-based sector suite. This unit has particular links with:

Level 2	Level 3
	Undertake Drawing Practice for Blacksmithing and Metalworking
	Undertake Oxy-acetylene Welding for Blacksmithing and Metalworking
	Undertake Manual Metal Arc Welding for Blacksmithing and Metalworking
	Undertake Metal Arc Gas Shielded Welding for Blacksmithing and Metalworking
	Undertake Fabrication Drawing for Blacksmithing and Metalworking
	Understanding and Using Fabrication Skills for Blacksmithing and Metalworking
	Understanding and Using Fabrication Techniques for Blacksmithing and Metalworking

Essential resources

Learners will need supervised access to workshops appropriate to their specialist pathways. These should have a comprehensive range of welding and cutting equipment and ancillary equipment such as guillotine, cropper, band saw and general and welding hand tools.

Weld test facilities are an essential requirement for establishing quality in any welding unit and should comprise an etching provision and bend/break testing equipment, each with suitable health and safety provision.

Health and safety considerations and effective learning require that sufficient facilities are provided to allow for one welding station per learner. Learners should be given health and safety information and support.

Learners should also have access to a sufficiently diverse range of stock sizes/sections to explore this unit fully.

This unit requires vocationally specific craft knowledge and appropriately qualified tutors to deliver it.

Employer engagement and vocational contexts

This unit focuses on introducing and developing the practical skills and underpinning knowledge associated with successful welding. Tutors are encouraged to make links with local blacksmiths and fabrication and engineering companies. A visit to a successful, broad-based welding and fabrication company is advised so that learners can appreciate the conversion process within an industrial context.

Delivery of personal, learning and thinking skills (PLTS)

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the pass assessment criteria of this unit.

Skill	When learners are ...
Reflective learners	selecting and applying welding and cutting techniques
Self-managers	selecting and applying welding and cutting techniques

Although PLTS opportunities are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are ...
Independent enquirers	researching appropriate thermal cutting processes for different situations
Creative thinkers	recommending improvements to a welded component/artefact
Team workers	evaluating a welded component/artefact with others, recognising faults/defects and recommending improvements
Effective participators	evaluating a welded component/artefact with others, recognising faults/defects and recommending improvements.

Functional Skills – Level 2

Skill	When learners are …
ICT – Find and select information	
Select and use a variety of sources of information independently for a complex task	researching appropriate thermal cutting processes for different situations
Access, search for, select and use ICT-based information and evaluate its fitness for purpose	researching appropriate thermal cutting processes for different situations
Mathematics	
Use appropriate checking procedures and evaluate their effectiveness at each stage	ensuring that measurements for joints are accurate
English	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	discussing appropriate thermal cutting processes for different situations
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	researching appropriate thermal cutting processes for different situations.