Unit 7: Undertake Forge Practice for Blacksmithing and Metalworking

Unit reference number: M/602/0497

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 a wide range of forging techniques for blacksmithing and metalworking, including setting, forged transitions producing fundamental joints by forge welding and riveting, and how they can be applied in practice. The unit is designed for learners in centre-based settings looking to progress into the sector or on to further or higher education.

Unit introduction

Forging techniques are essential elements of the blacksmithing and metalworking industries. This unit develops the knowledge, skills and understanding introduced in *Understanding and Using Forging Techniques for Blacksmithing and Metalworking*.

Within this unit learners will be introduced to a wider and developing range of forging techniques and equipment, including the skills of setting, forged transitions and producing fundamental joints by forge welding and riveting. As learners become more familiar with the underlying processes they will have the opportunity to expand their knowledge of specialised tooling and related maintenance requirements.

For learning outcome 1, learners will look at the principles and practice of forging processes. Some tasks should involve learners working together in a smith and striker situation. Learners will take on greater responsibility for themselves and their colleagues in the workshop environment with particular reference to the management of their own workspace and the use of associated processes and tooling.

Learning outcome 2 explores the condition and maintenance of forge tools. Starting material allowances, movement and wastage will be addressed for the forged, formed, cut and welded elements.

Learning outcome 3 covers the principles and practice of gas furnace control. Although the majority of the production would take place using a solid fuel forge hearth, learners will be introduced to the types, operation and maintenance requirements of the gas furnace.

In learning outcome 4, learners will consider health and safety procedures whilst working within the forge environment. The specific health and safety issues of working with, and in close proximity to, others will be emphasised in relation to blacksmithing processes and the general workshop environment.

Learning outcomes

On completion of this unit a learner should:

1 Be able to demonstrate principles and practice of forging processes

2 Be able to assess the condition of and maintain forge tooling

3 Be able to demonstrate principles and practice of gas furnace control

4 Understand health and safety management requirements in the forge environment.

Unit content

1 Be able to demonstrate principles and practice of forging processes

Forging: upsetting; sets; transitions; drawing down; spreading by hand; smith and striker; materials estimation

Forming: bending; twisting; dishing; by hand; materials estimation

Cutting: punching; drifting; splitting; chasing; by hand; materials estimation

Joining: rivet making; riveting eg fixed joint, moveable joint; fire welding eg butt/scarf weld, lap weld; materials estimation

Heat ranges: forging; fire welding; finishing

Health and safety: safe working practices in the forge eg personal protective equipment (PPE); relevant, current legislation eg health and safety at work legislation; risk assessment

2 Be able to assess the condition of and maintain forge tooling

Large forge tooling: reasons for maintaining large forge tooling eg health and safety, reducing costs, economics; forge tooling eg fly press, mandrels; use of tools; condition and maintenance of tools; acceptable repair procedures; tooling costs; maintenance costs

Anvil and power hammer tools: reasons for maintaining anvil and hammer tools eg health and safety, reducing costs, economics; types eg horns, top and bottom tools, spring tools, setting blocks; use of tools; condition and maintenance of tools; acceptable repair procedures; tooling costs; maintenance costs

Health and safety: safe working practices in the forge eg PPE; relevant, current legislation; risk assessment

3 Be able to demonstrate principles and practice of gas furnace control

Gas furnace: furnace types eg venturi, fan assisted; differences between furnace types; operating parameters; uses (production processes); costs; lining types eg reflective, refractive; maintenance of forge/furnace; control mechanisms; methods of use, running costs

Areas of furnace flame: oxidising; carburising/reducing; neutral; position of work piece within the furnace flame; effects of air blast; management of furnace flame

Health and safety: safe working practices in the forge eg PPE; relevant current legislation; risk assessment, with particular emphasis on ensuring adequate ventilation and managing risks from furnace linings,

4 Understand health and safety management requirements in the forge environment

Health and safety: reasons for maintaining a safe working environment; implications of accidents at work for the individual, the business and the national economy; safe working policies and practices; risk assessment (workshop and processes); hazards; tooling assessment; first-aid requirements; relevant current legislation; general duties of employees and employers; communications; working in teams; accident reporting procedures; PPE

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	combine forging processes by hand to produce a simple component/ artefact to meet a given specification	**M1**	select and combine forging techniques and processes to produce a complex component or artefact that is fit for purpose with appropriate construction and anvil finish	**D1**	evaluate the processes of heating and forging used to produce the finished component/artefact and recommend improvements to meet craft standard, using craft samples where appropriate.
P2	combine forging processes by smith and striker to produce a simple component/artefact to meet a given specification [TW]				
P3	combine hot forging cutting processes by hand to produce a simple component/artefact to meet a given specification				
P4	combine hot forging cutting processes by smith and striker to produce a simple component/artefact to meet a given specification [TW]				
P5	combine forming processes to produce a simple component/artefact to meet a given specification				
P6	combine joining processes to produce a simple component/artefact to meet a given specification				
P7	assess the condition and identify appropriate maintenance procedures for specified forge tooling [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:**
P8	set up and use a selected gas furnace to meet given objectives	**M2**	discuss the economics and safety issues involved with selecting, sourcing, installing, operating and maintaining selected forge tooling including specified gas furnaces.	
P9	identify and explain health and safety work policies and practices within a selected forge environment. [IE]			

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, seminar presentations, site visits, supervised workshop practicals, research using the internet and/or library resources 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 so that naturally occurring evidence can be collected at the time. For example, learners must have the opportunity to produce forged elements and they should be encouraged to 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 sound environmental management and the need to manage the resource using legal methods.

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

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

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 forging processes. Learners could develop the skills needed by undertaking a number of practical exercises in the forge environment. Demonstration should be followed by opportunities for learners to practise and develop their techniques and finish quality. As learners become more competent in individual techniques they should be encouraged to produce complex artefacts for themselves requiring the use of several techniques. Supporting knowledge should be delivered in the workshop and classroom environment via set and learner project work. The process of smith and striker is potentially dangerous, and a comprehensive induction, demonstration and close surveillance by the tutor are essential.

In learning outcome 2, learners will assess the condition of and maintain forge tooling. This is likely to be delivered using formal lectures, discussion, site visits, supervised forge practicals and independent learner research. Tutors should require learners to assess and maintain tools that they use within the forge. A collection of tools in various conditions could be kept and used for delivery of this unit. Any maintenance work must be of a safe and acceptable standard before the tool is re-used.

Learning outcome 3 covers the principles and practice of gas furnace control. Learners must be encouraged to gain an understanding of the correct flame control using industrially relevant forge equipment. They will need to research the operation and properties of a range of furnace linings and furnace types and gain knowledge of safely managing these different working environments. This is likely to be delivered through formal lectures, discussion, site visits, supervised forge practicals and independent learner research.

In learning outcome 4 learners will consider the requirements for the management of health and safety in the forge environment. This is likely to be delivered through formal lectures, discussion, site visits and independent learner research. Tutors need to stress health and safety throughout the delivery of this unit, in particular before the start of any practical activities with particular emphasis on ensuring adequate ventilation and managing risks from furnace linings. Tutors could compare the policies and practices of different forges during delivery of the unit.

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 a Simple Component/Artefact (P1, P2, P3, P4, P5, P6, P8, M1, D1) Tutor introduces the assignment. Following the introduction of tutor-set components/artefacts including specifications, the learner produces component(s)/artefacts(s) using the required forging processes within the tolerances. Learners should be given the opportunity to select the process and equipment.
Tutor demonstrations of sold fuel hearth and gas furnace operation during forging processes by hand and using smith and striker as appropriate during the project.
Learner practice and production of components/artefacts.
Learner research and production of workshop records.
Learner assessment/feedback.
Assignment 2: Economics and Safety Issues for Forge Tooling (P7, P9, M2) Tutor introduces the assignment. Learners are asked to produce a presentation plus related risk assessments covering the economics and safety issues involved with selecting, sourcing, installing, operating and maintaining selected forge tooling (four items) including a specified gas furnace. Learners could include forge tooling that they have worked with during Assignment 1.
Learners provide evidence (either orally, written or as a presentation) for at least four items of tooling, two of which should be classed as large forge tools and two as anvil and power hammer tools. Evidence could be in the form of written or verbal feedback using workshop maintenance systems.
Learner research and assignment preparation/writing.
Learner assessment/feedback.

Topic and suggested assignments/activities and/assessment
Assignment 3: Heating and Forging Processes (M1, D1) Tutor introduces the assignment. Learners are asked to produce an assignment or presentation outlining their reasons for their selections of heating and forging process during Assignment 1. Learners should refer to any forge tooling and components produced that they have worked with during Assignment 1. An evaluation should be included of what was learned during the making process and recommendations for improvement if the task was to be repeated. This should be referenced against research into professional craft expectations in the industry.
Learners provide evidence of the selection and evaluation of the forging and heating process (either orally, written or presentation) for producing a simple component/artefact.
Learner research and assignment preparation/writing.
Learner assessment/feedback.
Visiting lecturer, workshop/site visit or blacksmithing event.
Unit review.

Assessment

For P1, P2, P3, P4, P5 and P6, learners must combine forging processes to produce a simple component/artefact to meet a given specification. Tutors should identify the specification or agree it through discussion with learners. The specification should cover normal factors that can be found in industry, for example design criteria, measurements, materials, finish tolerances and any relevant standards. Where possible, to ensure assessment is fair, the size and complexity of the task should be the same for all learners.

P1, P2, P3, P4, P5 and P6 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 P7, learners must assess the condition of and identify appropriate maintenance procedures for selected forge tooling. Tutors should identify the tooling or agree it through discussion with learners. 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 for at least four items of tooling, two of which should be classed as large forge tools and two as anvil and power hammer tools. Evidence could be in the form of written or verbal feedback using workshop maintenance systems.

For P8, learners are required to set up and use a selected gas furnace to meet given objectives. Tutors should identify the gas furnace and the objectives or agree them through discussion with learners. Where possible, to ensure assessment is fair, the size and complexity of the task should be the same for all learners. Evidence could be in the same form as for P1, P2, P3, P4, P5 and P6.

For P9, learners must identify and explain health and safety work policies and practices within a selected forge environment. Tutors should identify the forge environment or agree it through discussion with learners. The forge environment may be the same as that used to provide evidence for other grading criteria. Where possible, to ensure assessment is fair, the size and complexity of the task should be the same for all learners. Evidence for P9 could take the form of a pictorial presentation with notes (possibly using appropriate software or an overhead projector) or a written assignment.

For M1, learners must select and combine forging techniques to produce a complex artefact to meet a given specification. Tutors should identify the specification or agree it through discussion with learners. The specification should cover normal factors that can be found in industry, for example design criteria, measurements, materials, finish tolerances and any relevant standards. Where possible, to ensure assessment is fair, the size and complexity of the task should be the same for all learners. Evidence could be in the same form as for P1, P2, P3, P4, P5 and P6.

For M2, learners must discuss the economics and safety issues involved with selecting, sourcing, installing, operating and maintaining selected forge tooling including specified gas furnaces. Learners could include forge tooling that they have worked with during the delivery of this unit as examples within their evidence. The inclusion of risk assessments for selected tooling could provide part of the evidence, which could be in the same form as for P9. Evidence for any risk assessment should be in a format that is recognised within the industry and by the Health and Safety Executive.

For D1, learners must evaluate the processes of heating and forging used to produce the finished component/artefact and recommend improvements to meet craft standard, using craft samples where appropriate. Tutors should identify the artefact and the specification or agree them through discussion with learners. The artefact and the specification 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 task should be the same for all learners. Recommendations for improvement must be appropriate and viable. These could be identified during the making process – where appropriate, improvements to quality should be demonstrated within the components/artefacts produced. Supporting evidence could be in the same form as for P7 or P9.

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, P3, P4, P5, P6, P8, M1, D1	Producing a Simple Component/Artefact	As a working blacksmith you will be required to produce components or finished artefacts that correspond to set specifications. These can often involve working in a team as smith and striker as well as by hand. Within this craft you will have to select and combine forging processes to produce simple components or artefacts that demonstrate these skills to a high standard.	Practical production of samples and components/artefacts. Observation records completed by learners and the tutor. Work logs or other relevant learner notes and drawings. Witness statements.

Criteria covered	Assignment title	Scenario	Assessment method
P7, P9, M2	Economics and Safety Issues for Forge Tooling	When setting up and operating your blacksmithing workshop, you will have to select, source, install and maintain your equipment. One of these is the gas furnace that is often used in production work, especially when using longer heats for forging and bending. You should be able to prepare a reasoned case discussing the issues involved with purchasing and operating this type of equipment.	Oral questioning. Written assignment or presentation. Risk assessment. Tooling examples. Visual records. Research.
M1, D1	Heating and Forging Processes	As a blacksmith working in a busy workshop you need to select a process and evaluate your work as you go along, including a review of the finished pieces. Part of this process is either putting in place improvements to your work process or arriving at recommendations for improving future production.	Oral questioning. Written assignment or presentation. Tooling examples. Visual records. Work logs or other relevant learner notes and drawings. Research.

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 Forging Techniques for Blacksmithing and Metalworking
	Undertake Blacksmithing Processes
	Understanding and Using Blacksmithing and Construction Skills
	Understanding and Using Blacksmithing Installation Skills

Essential resources

Learners will need supervised access to workshops and classrooms appropriate to their specialist pathways. They should contain a comprehensive range of blacksmithing and forge tools, including solid fuel forge hearths, gas furnaces, anvils, leg vices, fly presses, mandrels, power hammers supported by a range of tongs, hammers, swages, fullers, setting blocks and other ancillary equipment.

Health and safety considerations require that sufficient facilities be provided to allow for one forging station per learner. Health and safety information and support must be provided.

Learners must have access to a sufficiently diverse range of materials and stock sizes/sections to explore this unit fully.

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

Employer engagement and vocational contexts

This unit focuses on introducing and developing the practical skills and underpinning knowledge associated with smaller scale blacksmithing work. Tutors are encouraged to promote learner/employer links for potential work experience with blacksmithing, fabrication and engineering companies. Introducing learners to the wider world of blacksmithing via forging competitions, vocational visiting demonstrators and workshop visits should be integral to the unit.

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 …
Independent enquirers	identifying and explaining health and safety work policies and practices within a forge environment
Creative thinkers	making recommendations for improvements to a finished component/artefact to meet craft standard
Reflective learners	evaluating the processes of heating and forging used to produce a finished component/artefact
Team workers	combining forging processes by smith and striker to produce a component/ artefact combining hot forging cutting processes by smith and striker to produce a component/artefact
Self-managers	assessing the condition of and identifying appropriate maintenance procedures for forge tooling
Effective participators	discussing the economics and safety issues involved with selecting, sourcing, installation, operating and maintaining forge tooling.

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 the economics and safety issues involved with selecting, sourcing, installation, operating and maintaining forge tooling
Access, search for, select and use ICT-based information and evaluate its fitness for purpose	researching the economics and safety issues involved with selecting, sourcing, installation, operating and maintaining forge tooling
ICT – Develop, present and communicate information	
Enter, develop and format information independently to suit its meaning and purpose including: • text and tables • images • numbers • records	producing a reasoned case for the selection of an appropriate range of forge tooling, with details of installation and running costs
Bring together information to suit content and purpose	producing a reasoned case for the selection of an appropriate range of forge tooling, with details of installation and running costs
Present information in ways that are fit for purpose and audience	producing a reasoned case for the selection of an appropriate range of forge tooling, with details of installation and running costs
Evaluate the selection and use of ICT tools and facilities used to present information	producing a reasoned case for the selection of an appropriate range of forge tooling, with details of installation and running costs
Mathematics	
Identify the situation or problem and the mathematical methods needed to tackle it	discussing the economics involved with selecting, sourcing, installing, operating and maintaining forge tooling
Select and apply a range of skills to find solutions	discussing the economics involved with selecting, sourcing, installing, operating and maintaining forge tooling
Interpret and communicate solutions to practical problems in familiar and unfamiliar routine contexts and situations	discussing the economics involved with selecting, sourcing, installing, operating and maintaining forge tooling
Draw conclusions and provide mathematical justifications	discussing the economics involved with selecting, sourcing, installing, operating and maintaining forge tooling

Skill	When learners are …
English	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	discussing the economics and safety issues involved with selecting, sourcing, installing, operating and maintaining forge tooling
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	researching the economics and safety issues involved with selecting, sourcing, installing, operating and maintaining forge tooling
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	producing a reasoned case for the selection of an appropriate range of forge tooling, with details of installation and running costs.