Phase
2

Trade of Motor Mechanic

Module 10

Unit 1

Bench Fitting

Produced by

SOLAS

An tSeirbhís Oideachais Leanúnaigh agus Scileanna
Further Education and Training Authority

In cooperation with:

Subject Matter Experts

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&

CDX Global

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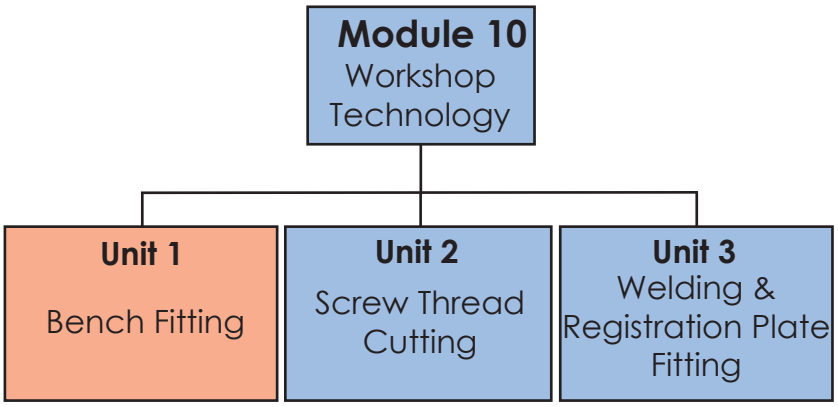
Introduction

There are three Units in Module 10. Units 1 focus on Bench fitting. Unit 2, screw thread cutting. Unit 3, welding and registration plate fitting.



Unit one covers the Bench fitting. You will receive information on Bench fitting procedures. The health and safety issues related to this unit will be also covered.

Unit Objective

By the end of this unit each apprentice will be able to:

- Define the term 'tolerance' in relation to linear and angular measurements
- Describe and use the SI units of linear and angular measurement
- Read/interpret basic technical metalwork 1st angle projection diagrams and instructions
- Describe the potential hazards and most appropriate safety procedures required when undertaking practical exercises with mild steel
- Produce the number of metalwork exercises shown in the activity diagrams:
    - Exercise No. 2.10.1a
    - Exercise No. 2.10.1b
    - Exercise No. 2.10.1c

1.0 Hazards and Safety Procedures with Mild Steel

Key Learning Points

- Danger of cuts, abrasions by burrs on metal, saw blades, loose/incorrectly fitted/fitting of file handles

1.1 Health and Safety

If the proper safety procedures are not adhered when working with mild steel this could lead to serious injury \health problems to personnel.

Instruction is given in the proper safety precautions applicable to working with mild steel which include the following:

- Danger of cuts
- Abrasions by burrs on metal
- Saw blades
- Loose/incorrectly fitted/fitting of file handles
- Use of Personal Protective Equipment (PPE) e.g. Eye protection, foot wear etc.

Refer to motor risk assessments, Environmental policy and Material Safety Data Sheets (MSDS)

2.0 SI Units of Linear and Angular Measurement

Key Learning Points

- SI units of liner and angular measurement

2.1 S.i. Units

Quantity	*Unit*	*Symbol*
Length	Meter	m
Angle	Degree	(e.g.) 90°

2.2 Derived Units

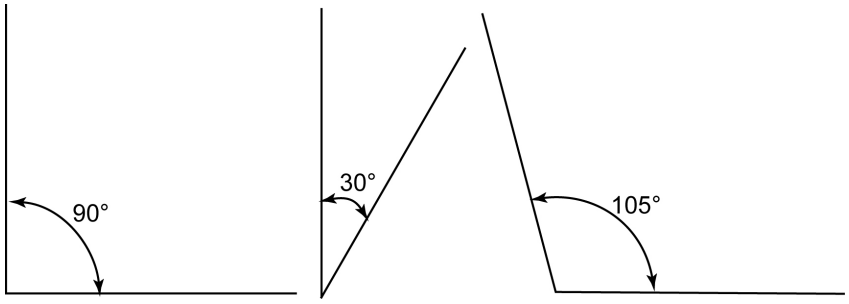
Derived units are those which can be expressed in terms of the primary units so as to provide more units to work with. There is a primary unit for length, but not for area or volume, however, it is possible to derive units for area and volume from the primary units. Any area is measured as the products of two lengths. It can be said that an area has the "dimensions" of (length) x (breadth) and so is measured in squared units.

Area = length x breadth and if the length of which of these is given in metres, then, area = m x m = m^2 so the derived unit for area is the square metre which is written m^2

Another derived unit is that of volume which is expressed in cubic metres written as m^3

Volume = length x breadth x height; m x m x m = m^3

The derived unit for volume of the cubic metre is written as m^3.



Degree

3.0 Technical Metalwork

Key Learning Points

- Reading/interpreting technical metalwork diagrams and instructions
- Use of metalwork marking out tools e.g. measuring instruments i.e. ruler, level gauge, square, scribe, centre punch etc.
- Measuring and marking out skills
- The Use of hacksaws, files and bending equipment, etc.

3.1 Basic Drawing Theory

What follows are some background notes and basic instructions on creating appropriate drawings, for different situations.

Graphical Methods

- Freehand sketches –these are usually straight line pencil drawings.
- Drawing using instruments and stencils.
- Airbrush techniques,
- Computer aided design – the use of graphics programs and CAD (Computer Aided Design).

Block Diagrams and Flow Diagrams

Block diagrams show schemes for completing tasks and flow diagrams might show the direction hydraulic fluid runs in a brake system, or the direction of coolant in a an engine.

Schematic Diagrams

These show the layout of the circuit using approved symbols.

Circuit Diagrams

This includes circuit diagrams using approved symbols, but also may show diagrams with full size components. A printed circuit board may be drawn full size or even larger than full size with the actual components in place. The design of computer parts or printed circuit boards require large scale drawings as the final components are very small and 1:1 scale drawings would be inadequate, or even impossible to draw. Circuit diagrams are drawn for pneumatic, hydraulic, electronic and electrical systems.

Detailed Drawings

Fully dimensioned drawings, sometimes to a very large scale, they may include tolerances and machining limits.

Assembly Drawings

This includes orthographic first and third angle, isometric and oblique line drawings. Perspective views of a complete assembly.

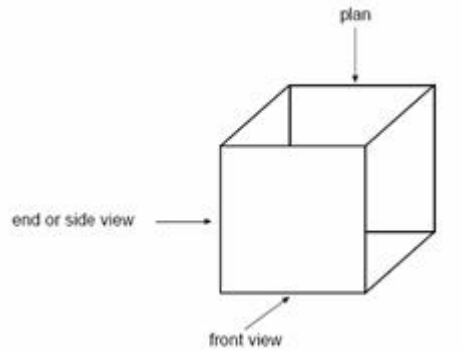
Orthographic Drawing

There are two types of orthographic drawing; these are called first angle projection and third angle projection. Both drawing types show three views of an object:

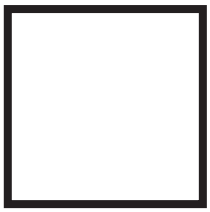
1. a plan
2. a side or end view
3. and a front view

The layout of the views is difference in first and third angle projections.

When we look at an object we see in three dimensions, we see light and shade, colours and shadows. Making an orthographic drawing of an object means taking the outlines of an object. The simplest objects to consider are a cube and a ball or sphere.

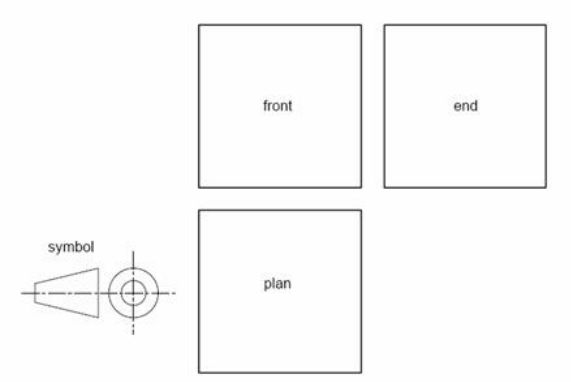


When drawn, because this is a cube and all the sides are the same, the front view, end view and plan will all look like this:

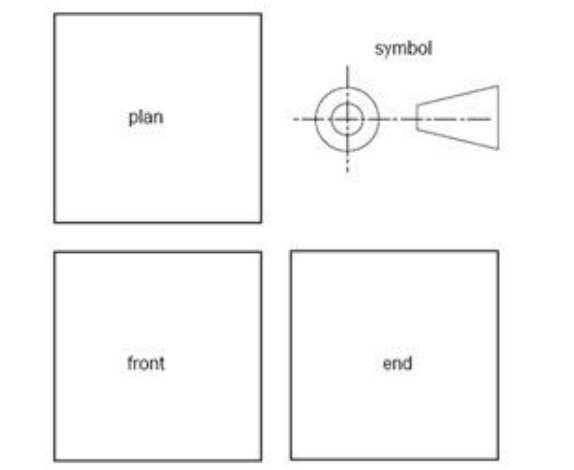


The front view, end view and plane of a ball or sphere will look like a circle. Check this for yourself!

In first angle projection the layout is:

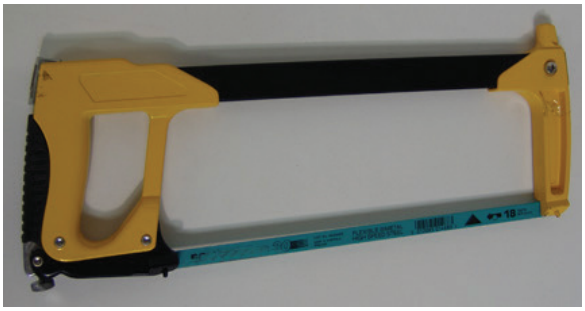


In third angle projection the layout is:



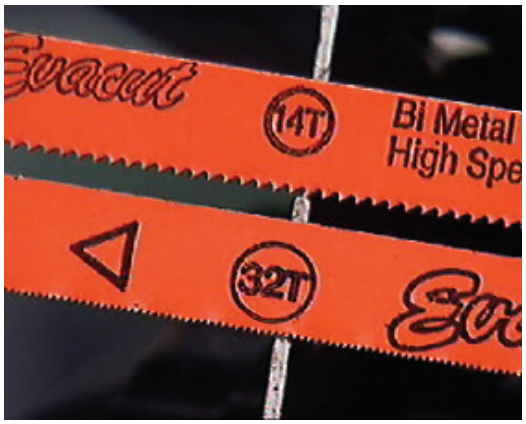
The first angle projection was most common in Britain. The third angle projection is more common in Europe and the USA; this has now been adopted in the UK.

3.2 Hacksaws



Hacksaws are a common workshop tool. The frames come in a range of shapes and sizes. For any given frame there's a range of available hacksaw blades to cope with different materials and situations.

The hacksaw frame can be adjusted to take different blade lengths and when the blade is placed in the frame and it is tightened to the correct tension by a tensioning device such as a wing nut.



The *hacksaw blade* must be of the right pitch which is determined by the number of teeth in an inch (TPI) of blade. A blade with many teeth per inch has a fine pitch; one with few teeth per inch has a coarse pitch.

The saw blade should be inserted into the frame so that it only cuts on the forward stroke. This is because the teeth gather the metal being removed and can only get rid of it when they come clear of the cut. If a blade cutting through a thick section of metal has too many teeth, in other words the pitch is too fine, they can clog up and stop cutting.

On the other hand, when cutting a piece of sheet metal, if the blade is too coarse the saw teeth could be stripped off of the blade at it try's to cut.

As a rough guide you can determine the correct blade (and number of teeth) by laying the blade across the section being cut. Normally, at least 3 teeth should touch the metal at that point. This will ensure that the blade can do its job.

After the job is done, the tension on the blade should be loosened, to prevent the frame from distorting over time.

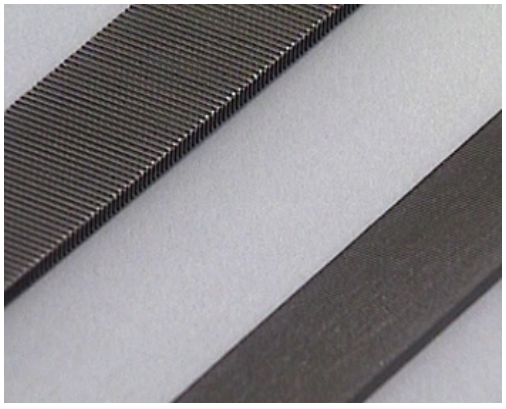
3.3 Files

Files are often sold without handles, but they shouldn't be used until a handle of the right size has been fitted. The handle should be checked before use. It can come loose and it may need a sharp rap to tighten it up.

Clean hands will help avoid slipping. Hands should always be kept away from the surface of the file and the metal that's being worked on. Filing can produce small slivers of metal which can be difficult to remove from a finger or hand and acids and moisture from the skin can cause corrosion.

Depending on how hard or soft a material is a special file may be needed. It's no good trying to file something if the file is softer than what is being filed - softer metals like copper and aluminium can clog a conventional file.

What makes one file different from another is not just its shape but how much material it's designed to remove with each stroke. That depends on the teeth. The following are both flat files, the most common general purpose type, but their teeth are different.



The teeth on this coarse grade file (left) are longer, with a greater space between them. Filing this piece of mild steel removes a lot of material with each stroke. A coarse file leaves a rough finish.

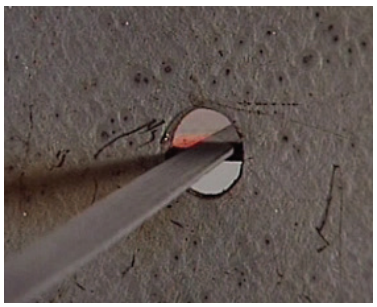
On the right is a flat file, but its shorter teeth remove much less material on each stroke and the finish is much smoother.

On a job, the coarse file is used first to remove material quickly and then a smoother file gently removes the last of it and leaves a clean finish to the work.

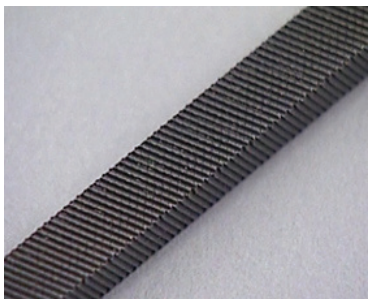
The full list of grades in flat files, from rough to smooth, is:

- rough
- coarse bastard
- second cut
- smooth
- dead smooth

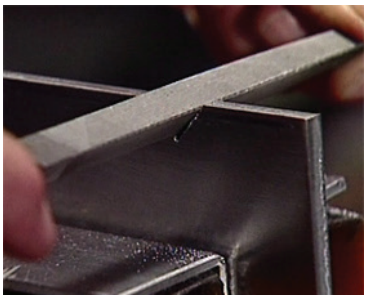
Some flat files are available with one smooth edge, called safe edge files. They allow filing up to an edge without damaging it. Flat files are fine on straightforward jobs but files need to be able to work in some awkward spots as well.



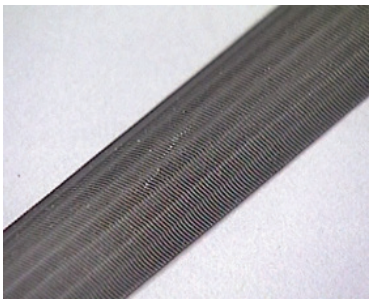
A *warding file* is thinner than normal, for working in narrow slots.



A *square file* has teeth on all 4 sides, so you can use it in a square or rectangular hole.



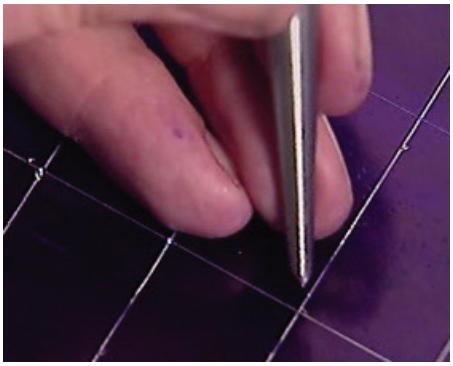
A square file can make the right shape for a squared metal key to fit in a slot. This is a *three square file*. It's triangular in section, so it can get into internal corners.



Curved files are either half-round, or round. This is a half round. Its shallow convex surface can file in a concave hollow, or in an acute internal corner. The fully round file, sometimes called a rat-tail file, can make holes bigger. Or it can file inside a concave surface with a tight radius.

Files should be cleaned after use. If they're clogged, they can be cleaned by a tool that's really part of the family called a filecard or filebrush. This is a thread file. It cleans clogged or distorted threads. It has 8 different surfaces that match different thread dimensions so the right face must be used.

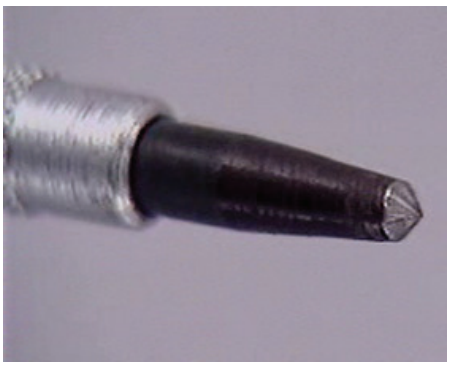
3.4 Punches



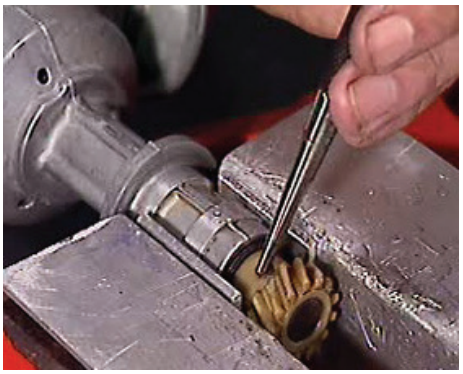
Punches are used when the head of the hammer is too large to strike the object being hit without causing damage to adjacent parts. A punch transmits the hammer's striking power from the soft upper end down to the tip that is hardened high carbon steel.

A punch transmits an accurate blow from the hammer at exactly one point, something that can't be guaranteed with a hammer on its own.

When some points need to be drawn on an object like a steel plate to help locate a hole to be drilled in it, a **prick punch** can be used to mark the points so they won't rub off, they can also be used to scribe intersecting lines between given points. Its point is very sharp so a gentle tap leaves a clear indentation. Its easier now to draw the lines based on permanent marks.

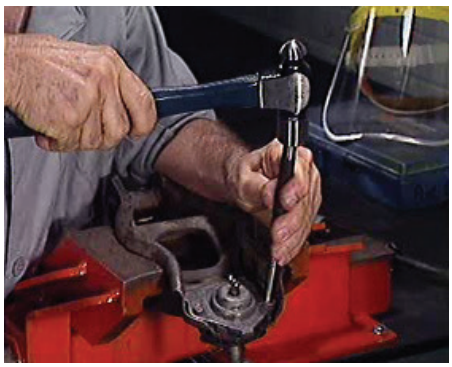


The *center punch* isn't as sharp as a prick punch and it's usually bigger. It makes a bigger indentation - called a center - that "centers" a drill bit at the point where the hole is required to be drilled.



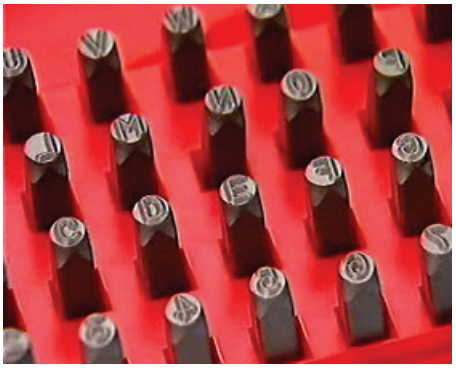
A lot of components are either held together or accurately located by pins. Pins can be pretty tight and a group of punches is specially designed to deal with them. This is a *starter drift punch* - starter because you should always use it first to get a pin moving.

It has a tapered shank and the tip is slightly hollow so it doesn't spread the end of a pin and make it an even tighter fit. Once the starter drift has got the pin moving a suitable pin punch will drive the pin right out, or in.



The *pin punch* is available in various diameters. It's used to drive out rivets or pins.

Special punches with hollow ends are called *wad punches or hollow punches*. They're the neatest tool to make a hole in soft sheet material like shim steel, plastic, leather, or most commonly in a gasket. When being used there should always be a soft surface under the work, ideally the end grain of a wooden block. If a hollow punch loses its sharpness or has nicks around its edge, it'll make a mess, not a hole.

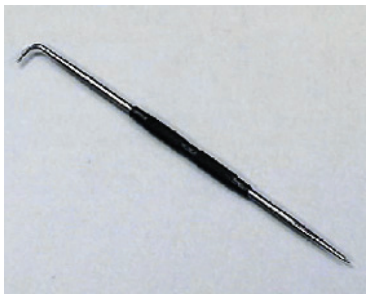


Numbers and letters like the engine numbers on a cylinder block are usually made with *number and letter punches* that come in boxed sets. As with all punches the rules for using them are the same. The punch must be square with the surface being worked on not on an angle and the hammer must hit the top squarely.

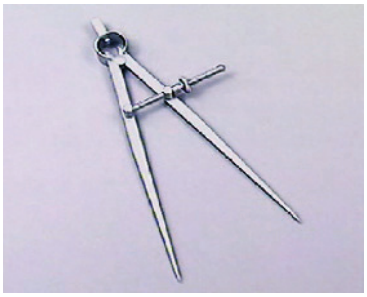
3.5 Marking Tools

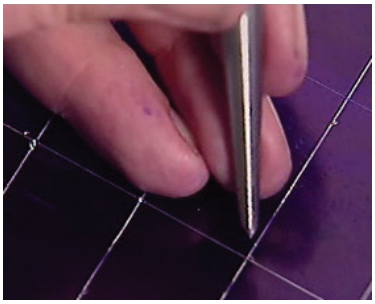
Making sharp, clean lines on metal requires a sharp, clean point.

A *scriber* is made from hardened and tempered tool steel. To mark a line with a scriber, draw it towards you and keep it angled in the direction it's going to travel so it doesn't dig into the surface being marked.



Dividers are used to mark up circles and arcs. They are held at an exact angle by an adjusting nut. Because of the sharp points on their legs, they also give an accurate way to transfer measurements from say, a steel rule, across to the work. Pin point the lines on the rule and make sure the circle has exactly the right radius. One way to make sure this leg of the dividers stays put on the surface is to make a small dent with the *prick punch*, before starting to draw.





On some hard or shiny surfaces, scribed marks can be hard to see, so *marking-dye* helps. A thin coat is applied to the area being marked. It dries very quickly. Then the path cut by the point of the scriber is easy to see.

Engineer's blue is similar to marking dye. It comes in tubes and it's a bit like blue butter. Sometimes in checking a fit, or testing for flatness, it's difficult to see the area being worked on. By smearing a small amount of engineer's blue on a surface plate it can be used to indicate if the surface to be tested is flat. The blue marks on the housing indicate the high areas which must be removed to obtain a flat surface. A flat surface would be blue over the whole surface.

4.0 Tolerance in Linear and Angular Measurements

Key Learning Points

- Definition of the term 'tolerance'

4.1 Introduction to Tolerances

Tolerance definition: The tolerance may be specified as a factor or percentage of the nominal value, a maximum deviation from a nominal value, i.e. a specified standard in the manufacture of a component or product or the upper and lower limits that are permissible.

5.0 Produce the Metalwork Exercises

Key Learning Points

- Final measurements of components within tolerances prescribed on the activity diagrams
- Exercise No. 2.10.1a
- Exercise No. 2.10.1b
- Exercise No. 2.10.1c

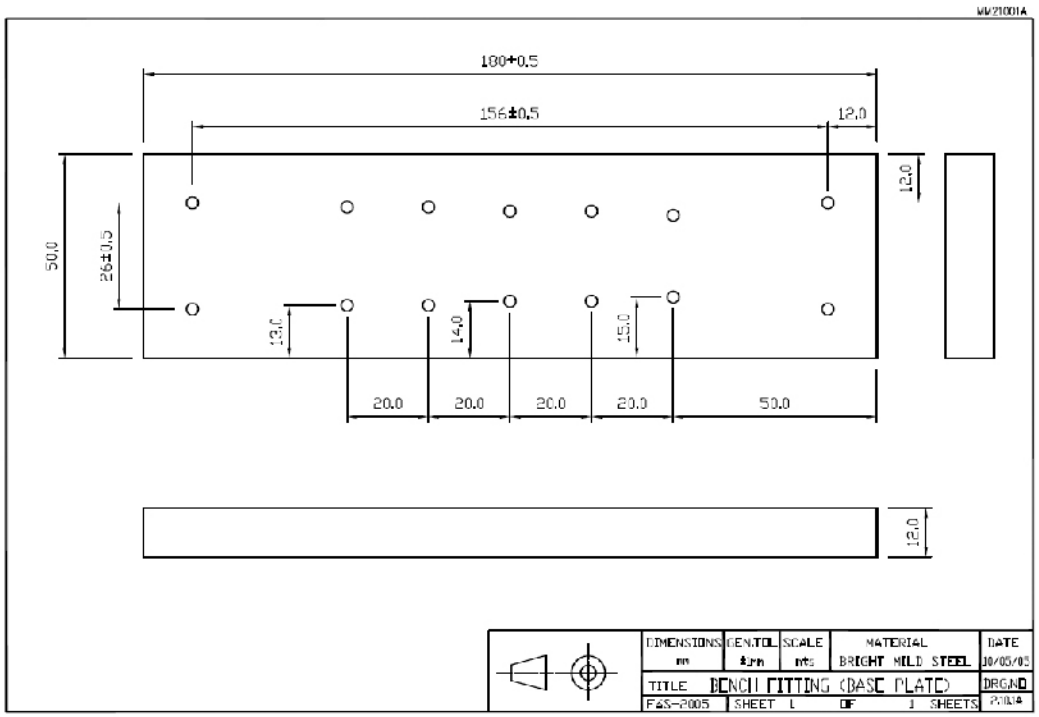
Practical Task

This is a practical task. Please refer to your instructor for additional information.

Exercise No. 2.10.1a

Instructions

Mark out mild steel plate as per drawing. File to size



Tools and Materials

Benchfitting tools

1 of 181 x 50 x 12mm BMS

Standards General tolerance ± 1mm, Specific tolerance ± 0.5mm, finished smooth and square

Time 2 hours

Exercise No. 2.10.1b

Instructions

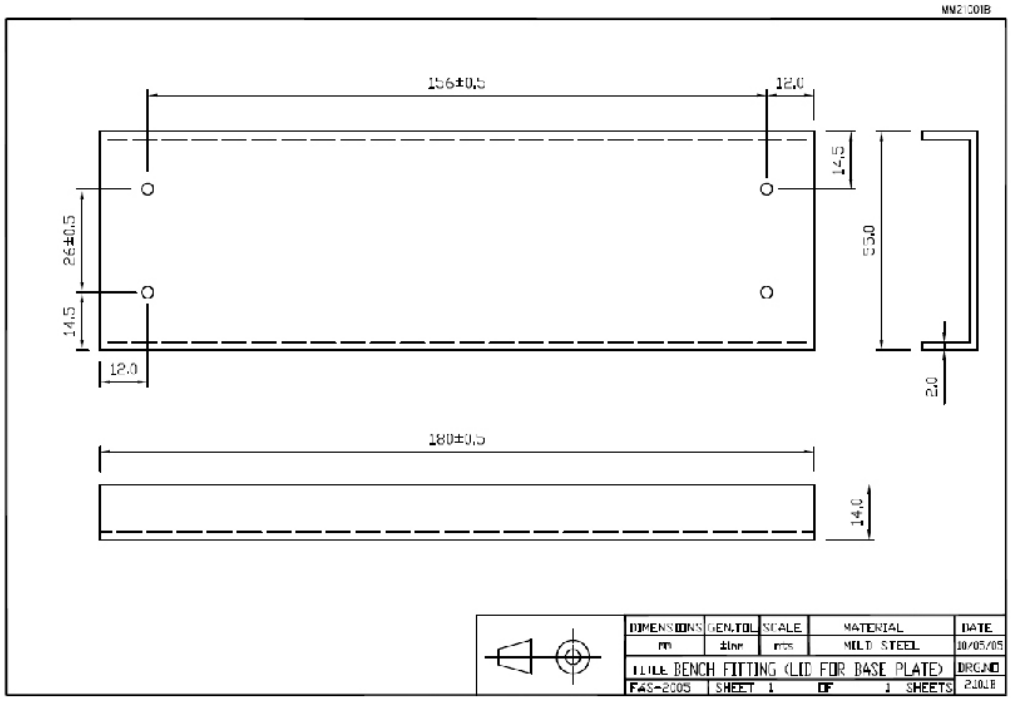
Mark out, cut, file and shape mild steel plate as per drawing

Tools and Materials

Benchfitting tools

1 of 200 x 100 x 2m mild steel sheet metal

Bending machine



Standards General tolerance ± 1mm, Specific tolerance ± 0.5mm, bends sharp and angles correct, minimum surface marks

Time 1 hour

Exercise No. 2.10.1c

Instructions

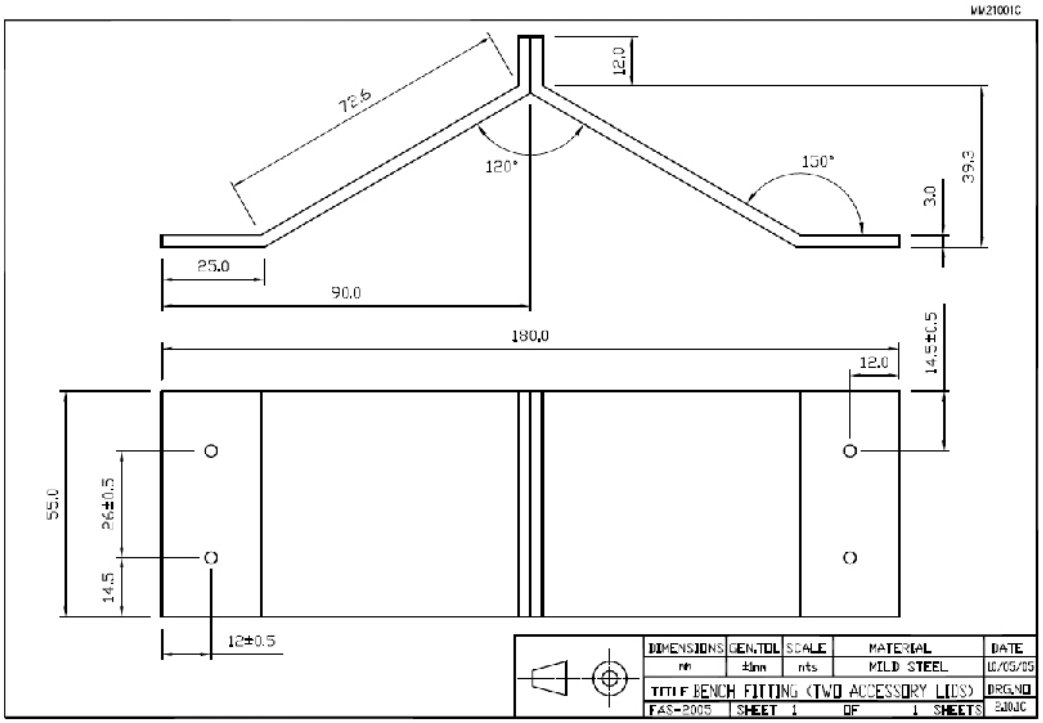
Mark out, cut, file and shape mild steel metal as per drawing

Tools and Materials

Benchfitting tools

2 of 120 x 60 x 2mm mild steel sheet metal

Bending machine



Standards General tolerance ± 1mm, Specific tolerance ± 0.5mm, bends sharp and angles correct, minimum surface marks

Time 2 hours

Self Assessment

See Unit 3

Suggested Exercises

1. Produce the metalwork components shown in the unit exercise/procedure diagram Nos. 2.10.1a, 2.10.1b and 2.10.1c within the specified tolerances

Training Resources

- Technical information in book/electronic form on: metalwork techniques and procedures of diagram reading and drawing interpretation; measuring, cutting, filing, bending and finishing of mild steel to required tolerances; the associated hazards and recommended safety procedures
- Basic metalwork benches, vices, tool kits, work benches, appropriate metal
- First aid kit

Suggested Further Reading

- Advanced Automotive Diagnosis. Tom Denton. ISBN 0340741236
- Automobile Electrical and Electronic Systems (3rd Edition). Tom Denton. ISBN 0750662190
- Automotive Mechanics (10th Edition). William H. Crouse and Donald L. Anglin. ISBN 0028009436
- Bosch Automotive Electrics Automotive Electronics: Systems and Components (4th Edition). Robert Bosch. ISBN 0837610508
- Bosch Automotive Handbook (6th Edition). Robert Bosch. ISBN 1860584748
- Bosch Automotive Technology Technical Instruction booklet series (numerous titles)
- Hillier's Fundamentals of Motor Vehicle Technology: Book One (5th Edition). V.A.W. Hillier and Peter Coombes. ISBN 0748780823
- Hillier's Fundamentals of Motor Vehicle Technology: Book Two (5th Edition). V.A.W. Hillier and Peter Coombes. ISBN 0748780998
- Modern Automotive Technology. James E. Duffy. ISBN 1566376106
- Motor Vehicle Craft Studies - Principles. F.K. Sully. ISBN 040800133X
- National Car Test (NCT) Manual (Department of Transport, Vehicle Testers Manual - DoT VTM). Department of Transport
- Transmission, Chassis and Related Systems (Vehicle Maintenance and Repair Series: Level 3) (3rd Edition) John Whipp and Roy Brooks. ISBN 186152806X
- Vehicle and Engine Technology (2nd Edition). Heinz Heisler. ISBN 0340691867
- http://www.cdxglobal.com/
- http://auto.howstuffworks.com/
- http://www.autoshop101.com/
- http://www.cdxetextbook.com/
- Automotive Encyclopedia and Text Book Resource (CD version of e-textbook), Available from your instructor.

Notes

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An tSeirbhís Oideachais Leanúnaigh agus Scileanna
Further Education and Training Authority

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