Government of Western Australia
North Metropolitan TAFE

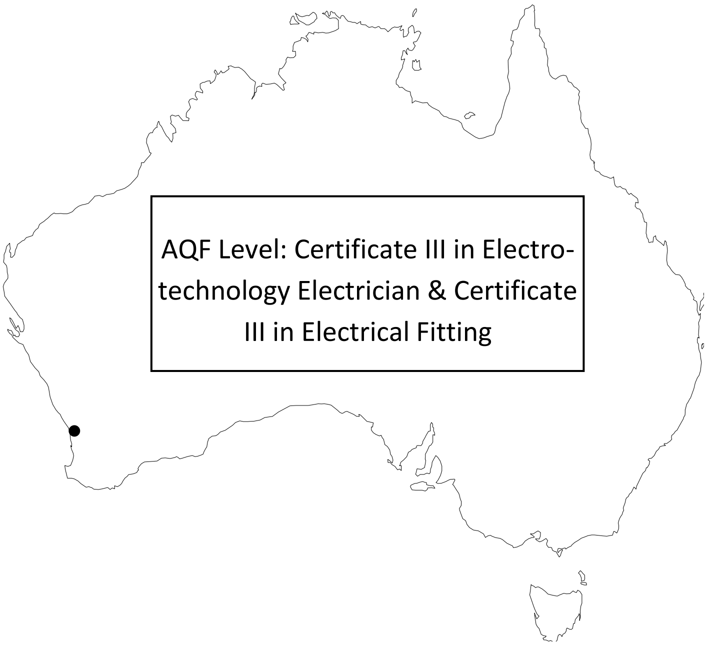
UEE11 Training Package Support Material
(Non-Endorsed Component)

Based on:
National Electro-technology Industry Standards

# Resource Book

## UEENEEE102A

**Fabricate, assemble and dismantle utilities industry components.**




North Metropolitan TAFE
V3 December 2018

Version 3 – 12/2018

**Acknowledgements**

This Unit Guide has been prepared by Balga Campus Lecturers.

It is intended for North Metropolitan TAFE students only.



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Version 3 - 2018

Edited & authored by Terry O'Grady, Lecturer (Balga) - integration of figures from Basic Skills Manuals - revise language used - improve coverage of the UOC RKAS – delete repeated content – delete activities generally not undertaken – focus on core skills.

# UEENEEE102A – Fabricate, assemble and dismantle utilities industry components

**C O N T E N T S**



**Training Achievement Record**

| Activity | Topic | Date | Lecturer | |
|---|---|---|---|---|
| **Section 1 – Engineering Drawings** | | | | |
| Sheet 1-1 | Engineering Drawings | | | |
| Activity 1-1 | Third Angle Projection | | | |
| Activity 1-2 | Free Hand Sketching of Objects | | | |
| Activity 1-3 | Materials Parts List | | | |
| | | | | |
| **Section 2 – Hand and Power Tools** | | | | |
| Sheet 2-1 | Safe Use of Hand Tools | | | |
| Activity 2-1 | Identification of Hand Tools | | | |
| Activity 2-2 | Measuring and Marking Out | | | |
| Sheet 2-2 | Drills and Drilling | | | |
| Sheet 2-3 | Threads and Thread Cutting | | | |
| Sheet 2-4 | Metric Micrometers and Vernier Callipers | | | |
| Activity 2-3 | Manufacture a Drill Angle Gauge | | | |
| Activity 2-4 | Jobbing Tasks | | | |
| Activity 2-5 | Identifying Threaded Fasteners | | | |
| Activity 2-6 | Using a Metric Micrometer | | | |
| Activity 2-7 | Using a Vernier Calliper | | | |
| Sheet 3 - 1 | Safe use of Power Tools | | | |
| Activity 3 - 1 | Use of Portable Power Tools | | | |
| Sheet 4-1 | Sheet Metal Fabrication Techniques | | | |
| Activity 4 -1 | Manufacture Tool Box from Sheet Metal | | | |
| Sheet 5 - 1 | Component Dismantling and Assembly | | | |
| Activity 5 -1 | Dismantle and Assemble a Component | | | |
| Sheet 6-1 | Welding and Brazing | | | |

**References:**


- The Occupational Safety and Health Act 1984 (WA).
- The Occupational Safety and Health Regulations 1996 (WA).
- Electrical Wiring Practice – Pethebridge & Neeson
- Basic Training Manual 16-1, Safe Procedures Electrical Trades
- Basic Training Manual 16-3, Hand Tools
- Basic Training Manual 16-4, Mechanical Measuring
- Basic Training Manual 16-6, Drilling, Tapping and Thread Cutting
- Apprentice Safety Guidelines – Energy Safety

**Competency Standard Unit**

# UEENEEE102A – Fabricate, assemble and dismantle utilities industry components

**Prerequisite Unit**

Granting competency in this unit shall be made only after competency in the following unit has been confirmed:

UEENEEE101A – Apply occupational health and safety regulations, codes and practices in the workplace.

| ELEMENT | | PERFORMANCE CRITERIA | |
|---|---|---|---|
| 1 | Prepare for dismantling, assembling and fabrication work. | 1.1 | OHS procedures for a given work area are obtained and understood through established routines and procedures. |
| | | 1.2 | Established OHS risk control measures and procedures in preparation for the work are followed. |
| | | 1.3 | Safety hazard not previously identified are reported and advice on risk control measures is sought from the work supervisor. |
| | | 1.4 | The nature of the work is obtained from documentation and from work supervisor to establish the scope of work to be undertaken. |
| | | 1.5 | Advice is sought from the work supervisor to ensure the work is coordinated effectively with others. |
| | | 1.6 | Materials required for the work are obtained in accordance with established routines and procedures. |
| | | 1.7 | Tools, equipment and measuring devices needed to carry out the work are obtained and checked for correct operation and safety. |
| | | 1.8 | Cutting tools such as drills and chisels are sharpened to suit the material on which they are to be used. |
| 2 | Dismantle and assemble utilities industry apparatus. | 2.1 | Established OHS risk control measures and procedures for carrying out the work are followed. |
| | | 2.2 | Circuits/machines/plant are checked as being isolated where necessary in strict accordance OHS requirements and procedures. |
| | | 2.3 | Appropriate tools are selected and used correctly and safely in dismantling and assembling apparatus. |
| | | 2.4 | Manufacturer apparatus dismantling and assembling guides are used where applicable. |
| | | 2.5 | Components are marked or tagged during the dismantling to help ensure correct and efficient reassembly. |
| | | 2.6 | Dismantled components and parts are stored to protect them against loss or damage. |
| | | 2.7 | Apparatus is dismantled and assembled efficiently without waste of materials and energy and/or damage to apparatus and the surrounding environment or services. |
| | | 2.8 | Procedures for referring non-routine events to immediate supervisor for directions are followed. |
| | | 2.9 | Routine quality checks are carried out in accordance with work instructions. |
| | | 2.10 | OHS risk control work completion measures and procedures are followed. |
| | | 2.11 | Work site is cleaned and made safe in accordance with established procedures. |
| | | 2.12 | Work supervisor is notified of the completion of the work in accordance with established procedures. |



| ELEMENT | | PERFORMANCE CRITERIA | |
|---|---|---|---|
| 3 | Fabricate utilities industry components. | 3.1 | Established OHS risk control measures and procedures for carrying out the work are followed. |
| | | 3.2 | Circuits/machines/plant are checked as being isolated where necessary in strict accordance OHS requirements and procedures. |
| | | 3.3 | Appropriate tools are selected and used correctly and safely in fabricating components. |
| | | 3.4 | Drawings and instruction for the fabrication of components are followed. |
| | | 3.5 | Component dimensions are determined directly or by calculation from information given in job drawings and instructions. |
| | | 3.6 | Components are fabricated efficiently without waste of materials and energy and/or damage to the surrounding environment or services. |
| | | 3.7 | Procedures for referring non-routine events to immediate supervisor for directions are followed. |
| | | 3.8 | Routine quality checks are carried out in accordance with work instructions. |
| | | 3.9 | OHS risk control work completion measures and procedures are followed. |
| | | 3.10 | Work site is cleaned and made safe in accordance with established procedures. |
| | | 3.11 | Work supervisor is notified of the completion of the work in accordance with established procedures. |

## UEENEEE102A – Fabricate, assemble and dismantle utilities industry components

**1. Performance requirements:**

1a. Related to the following elements:

1. Planning and preparing for fabrication assembling and dismantling work.
2. Assemble and dismantle electrotechnology apparatus.
3. Fabricate electrotechnology components.
4. Complete work and report.

1b. For each element demonstrate performance:

- across a representative body of performance criteria,
- on at least 2 occasions,
- autonomously and to requirements,
- within the timeframes typically expected of the discipline, work function and industrial environment.

**2. Representative range** includes the following:

All listed tasks related to performance across a representative range of contexts from the prescribed items below:

| **Group No** | **The minimum number of items on which skill is to be demonstrated** | **Item List** |
|---|---|---|
| A. | All of the following: | •Interpret mechanical drawings<br>• Dismantle and assemble an apparatus |
| B. | All of the following: | •Sharpening a drill bit for at least two different types of material<br>• Mark out metal in preparation for drilling tapping and bending<br>• Cut metal using hacksaw and shears<br>• Drill and tap ferrous metal<br>• Drill and tap non-ferrous metals<br>• Bend and shape sheet metal<br>• Shape metal using files<br>• Shape non metallic materials using tools<br>• Safely use power tools such as drills and grinders<br>• Fabricating a component that requires the selection and safe use of a variety of fabrication tools. |

**E102A Work Performance Tasks – (Q Tracker tasks):**

**Workplace Rules:**

| | |
|---|---|
| Rule 1 | Follow the instructions |
| Rule 2 | Tolerate ambiguity |
| Rule 3 | Meet your obligations |

Note: This information and current details of critical aspects for each competency standard unit (CSU) in this qualification can be found at the EE-Oz Training Standards website www.ee-oz.com.au**.**



**REQUIRED SKILLS AND KNOWLEDGE**

Evidence shall show that knowledge has been acquired of safe working practices and fabricating, dismantling, assembling of utilities industry components.

The knowledge and skills shall be contextualised to current industry standards, technologies and practices.

<table>
<tr><th></th><th>Hand and power tools and their application</th></tr>
<tr><td>KS01-EE102A</td><td>
Evidence shall show an understanding of hand and power tools and their application to an extent indicated by the following aspects:
T1 Mechanical drawing interpretation and sketching encompassing:
<ul>
<li>drawing standards and conventions used in drawings of mechanical components as specified in AS1100</li>
<li>basic abbreviations and symbols used in drawing of mechanical components</li>
<li>interpretation of mechanical drawings commonly used in the electrotechnology industry (orthogonal projection, third angle - detail and assembly drawings, pictorial views)</li>
<li>laying out a drawing of mechanical components using engineering drawing convention.</li>
<li>freehand drawings of mechanical components showing all information needed for its manufacture/fabrication</li>
</ul>
T2 Workshop planning and materials encompassing:
<ul>
<li>methods used to work safely in an industrial work environment.</li>
<li>typical non-electrical hazards in the workplace</li>
<li>control measures for dealing with hazards identified.</li>
<li>Conducting a risk assessment on a given work environment, documenting and assessing the risks identified</li>
<li>type of metallic and non-metallic materials used in the electrotechnology industry and application of the common materials</li>
<li>planning process</li>
</ul>
T3 Measuring and marking out encompassing:
<ul>
<li>reasons for measuring and marking out</li>
<li>tools used for marking out</li>
<li>measuring and marking out a project accurately following correct procedures.</li>
<li>sustainable energy work practices related to reducing waste when marking out.</li>
</ul>
T4 Holding and cutting encompassing:
<ul>
<li>common tools for holding (bench vices, multi-grips, vice grips, wrenches).</li>
<li>common tools for cutting metallic and non-metallic material (hacksaws, wood saws, chisels, pliers, files)</li>
<li>procedure for using a range of tools for cutting, shaping, and finishing metallic and non-metallic materials</li>
<li>safety procedures when using holding and cutting tools</li>
</ul>
T5 Drills and drilling encompassing:
<ul>
<li>types of drills used in the electrotechnology industry</li>
<li>sharpening twist drills</li>
<li>drilling metallic and non-metallic components</li>
<li>safe use of a bench drill</li>
</ul>
T6 Tapping and threading encompassing:
<ul>
<li>type and size of commonly used threads used in electrotechnology work</li>
<li>taps and tap wrenches</li>
<li>tapping metallic and non-metallic components</li>
<li>stock and die tools</li>
</ul>
</td></tr>
</table>

| | |
|---|---|
| | • threading metallic and non-metallic components<br><br>T7 General Hand Tools encompassing:<br><br>• hammers used in electrotechnology work<br>• screwdrivers used in electrotechnology work<br>• spanners and sockets used in electrotechnology work<br>• pliers used in electrotechnology work<br>• assembling components applicable to electrotechnology industry using a variety of hand tools.<br><br>T8 Joining techniques encompassing:<br><br>• types of machine screws and nuts<br>• forms of welding (Oxy-acetylene, electric arc welding).<br>• forms of brazing and hard soldering<br>• process of soft soldering<br>• joining components using machine screws<br>• joining components using welding, brazing or soldering techniques<br><br>T9 Portable electric power tools encompassing:<br><br>• portable electric power tools (grinders, drills, jigsaws, saws)<br>• applications of portable electric power tools used in the electrotechnology work.<br>• using portable power tools.<br>• fabricating components using power tools (drills, grinders)<br><br>T10 Sheet metal work encompassing:<br><br>• types of sheet metal materials used in the electrotechnology work.<br>• names and applications of the types of fabrication materials.<br>• tools used with sheet metals in electrotechnology work (hacksaw, tinsnips, guillotines, punches, notching tools, folding machines)<br>• techniques used in fabricating sheet metal (cutting, bending, drilling/punching, joining, cutting mitres).<br>• marking out, cutting, bending, drilling and/or cutting and/or punching holes, joining and cutting mitred joints using sheet metal.<br>• sustainable energy work practices to reducing waste when fabricating using sheet metal.<br>• fabricating components using sheet metal and fabrication tools.<br><br>T11 Low tolerance measurement encompassing:<br><br>• tolerance<br>• techniques in using Vernier callipers<br>• techniques in using micrometers.<br>• using Vernier callipers to measure engineering components<br>• using micrometers to measuring engineering components<br><br>T12 Dismantling and assembly techniques encompassing:<br><br>• tools used in dismantling and assembling electrotechnology equipment (spanners, screwdrivers, bearing pullers, etc).<br>• procedures for ensuring the safe treatment of dismantled components.<br>• dismantling electrical, electronic, instrumentation or refrigeration/air conditioning piece of equipment using correct procedures.<br>• assembling electrical, electronic, instrumentation or refrigeration/air conditioning piece of equipment using correct procedures<br>. |

# UEENEEE102A – Fabricate, assemble and dismantle utilities industry components

## Learning and Assessment Plan

Name of Lecturer: ____________________________________________

Contact Details: ____________________________________________

Delivery Mode/s: ◻ Face to Face ◻ On-Line ◻ Blended Delivery ◻ Other

Using:

| Session | Nominal Duration | Program of Work (Topics to be covered) | Primary Reference |
|---|---|---|---|
| 1 | 0.5 hour | Introduction to UEENEEE102A<br>Recognition of Prior Learning of CSU | Resource Book |
| | 4 hours | Mechanical Drawings | Resource Book – Section 1 |
| | 3 hours | Safe Use of Tools | Resource Book – Section 2 |
| 2 | 1 hours | Measuring and Marking Out | Resource Book – Section 2 |
| | 1 hours | Drills, Drilling, Threads and Thread Cutting | Resource Book – Section 2 |
| | 2 hour | Use of Micro-meters and Vernier Callipers | Resource Book – Section 2 |
| | 3.5 hours | Manufacture of Drill Angle Gauge | Resource Book – Section 2 |
| 3 | 4 hours | Sheet Metal Fabrication Techniques | Resource Book – Section 2 |
| | 3.5 hours | Fabricate Sheet Metal toolbox – Practical assessment. | Resource Book – Section 2 |
| 4 | 1 hour | Revision of Unit | |
| | 2 hours | Assessment of Unit<br>Written (theory) Assessment | Resource Book,<br>CSU - RSAK |
| | 4.5 hours | Dismantle and Assemble an Electro-technology Component | Resource Book – Section 2<br>CSU - Performance Criteria |

| **I acknowledge that I have received and read this Learning and Assessment Plan**<br>Student Name:______________________ Signature: ____________________ Date: _________ | | |
|---|---|---|
| Lecturer Name | Lecturer Signature | Date |



## Assessment Strategy

**Conditions of Assessment:**

Normally learning and assessment will take place in an integrated classroom/ laboratory environment.

It is essential to work through the worksheets and activities in this workbook and follow the guidance of your lecturer. The worksheets and practical activities will provide the essential knowledge and skills outlined in this Unit and assist you in achieving competency.

**Assessment Methods:**

Resource Book - The satisfactory completion of all worksheets and practical activities is required.

Written Theory Assessment – based on the **REQUIRED SKILLS AND KNOWLEDGE**. You must achieve a mark of 75% or more in this assessment.

Observed Practical Assessment – based on the Elements and Performance Criteria of this Competency Unit UEENEEEE102A. You must achieve a mark of 100% in this assessment.

**On-Job-Training:**

It is expected that the off-job component of this competency unit will be complemented by appropriate on-job development involving exposure to re-occurring workplace events and supervised experiences. (See Work Performance Tasks). Apprentices are required to log your on-the-job training in your on line ‘Q-Tracker’ account.

**Sufficiency of Evidence:**

In all instances competency is to be attributed on evidence sufficient to show that a person has the necessary skills required for the scope of work. These include:

- Task skills - performing individual tasks
- Task management skills - managing a number of different tasks
- Contingency management skills - responding to irregularities and breakdowns in routines
- Job/role environment skills - dealing with the responsibilities and expectations of the work environment including working with others.

Evidence must demonstrate that an individual can perform competently across the specified range of activities and has the essential knowledge, understanding and associated skills underpinning the competency.

## LABORATORY and WORKSHOP SAFETY INSTRUCTIONS

Students working in laboratories, workshops and installation skills areas at this college do so on the condition that they agree to abide by the following safety instructions. Failure to observe the safety instructions may result in immediate suspension.

1. **Appropriate eye protection must be worn AT ALL TIMES** where eye protection signs are displayed. Other personal protective equipment (PPE) must be worn where directed. **All students must provide their own eye protection.** Only clear lenses are permitted to worn in workshop areas (unless otherwise stated).

2. Loose clothing must not be worn when working on fixed or portable machines. Hairnets must be worn where applicable. Clothing must cover the upper arms and body.

3. **Safety boots or safety shoes** must be worn at all times on this campus. Thongs or sandals are not permitted.

4. Tools and safety equipment are issued from the tool store on request. It is your responsibility to ask for the correct item (Size, Type and Tool). Check to see that you have been given the correct item before using it. If in doubt ask your LECTURER, not the store-person.

5. Report any broken, damaged or unserviceable equipment to your Lecturer. Do not use damaged tools or machines.

6. Clean down the machines immediately after use. All tools must be cleaned before returning them to the store.

7. Skylarking is not permitted at any time.

8. Always use protective vice jaws when cutting off material in a bench vice.

9. Accidents resulting in cuts, abrasions or other personal injury must be reported to your Lecturer immediately - no matter how minor they may seem. A first-aid kit is available in the tool store.

10. Never leave a machine unattended while it is running. Do not allow yourself to be distracted when operating a machine.

11. Observe all safety signs and notices and follow the instructions given.

12. Do not use a fixed or portable machine unless you have been instructed in its proper use.

13. Read all risk assessment documentation provided (JSAs) and conduct a relevant risk assessment process before performing any task.

Student's Signature _________________________ Date: _________________

| Government of Western Australia North Metropolitan TAFE | **Fabricate, assemble & dismantle utilities industry components** | Summary 1 - 1 | E102A SGB 10/2012 |
|---|---|---|---|

## Engineering Drawings

1. Engineering drawings are intended to communicate precise information on a specialised subject. They use the language of technical drawings which is a combination of symbols, conventions and a uniform approach to preparing and reading drawings. The focus for the drawing segment of this module is on the basic principles of mechanical, electrical and architectural drawings as applied to the electrotechnology industry.

2. The main Australian Standards relevant to this module are:

   a. AS 1100 Technical drawing
   b. AS 1101 Graphical symbols for general engineering.
   c. AS/NZS 1102 Graphical symbols for electrotechnical documentation.

3. Australian drawing standards are closely aligned to international technical drawing standards and they change from time to time. Although it is not mandatory, Australian Standards should be followed in all drawings and sketches as a matter of sound engineering practise.

4. Several 'Plates' are provided at the end of this Section. These are intended to illustrate various aspects of engineering drawing practise as they can be applied to the electrotechnology industry.

### Conventions

5. The main conventions used in engineering drawings are described in the handbook SAA/SNZ HB1:1994, and relate to features such as:

   a. Layout of drawings and sheet sizes
   b. Lines and lettering
   c. Methods of projection
   d. Sectioning
   e. Representations and symbols
   f. Dimensioning

### Drawing Sheet Sizes

6. The preferred series of drawing sheets is known as the 'ISO A' series and the sheet sizes are called A0, A1, A2, A3, A4 and A5. An A0 sheet has an area of approximately 1 square metre and is 841 mm by 1189 mm. Folding an A0 sheet in half on the longest side gives an A1 sheet. Folding A1 in half gives A2 and so on.

**Drawing Layouts**

7. All technical drawings should have a drawing frame, a title block and, if relevant, a material or parts list. Plate 1 shows a typical layout for a drawing sheet, with a drawing frame, title block, grid referencing system, schedule of changes and camera alignment marks. Variations are permissible to suit local requirements (such as the inclusion of a parts list) and most firms involved in producing technical drawings adopt a uniform approach to suit their requirements based on this general layout. Note that Plate 1 is reproduced as an A4 sheet, but most actual engineering drawings are A3 or larger.

**Line Types**

8. Line types and line thickness have specific meanings in technical drawings. The drawing on Plate 2 illustrates the most common line types and thicknesses, and their typical application. See SAA/SNZ HB1:1994 Technical drawing for students.

**Methods of Projection**

9. Three common methods of projection used for engineering drawings are:

   a. Orthogonal projection (third angle or first angle).
   b. Oblique projection.
   c. Axonometric projection (isometric).

10. Plate 3 shows the same object drawn in three basic views – Third Angle, Oblique and Isometric. The view used to represent an object is a matter of personal judgement based on the object being represented.

**Third Angle Projections**

11. A third angle projection represents the object viewed from up to six sides. The number of view depends on the object – it is often sufficient to only show three views – front, top and right side. A symbol is used on the drawing to show that it is a third angle projection. There is another similar method of projection known as a first angle projection but this method is uncommon in Australia.

    Orthogonal projection is like having a box with six sides, each side has the view printed on it from which the object is perceived. The box is then unfolded and placed flat, the layout of the views on the inside of the box represent First Angle Projection whereas if the flattened box was to be overturned so that the outer sides of the box could be visible, then that is how Third Angle Projection would look.

**Oblique Projections**

12. A typical oblique projection is a view in which one front edge is horizontal and the other faces recede at an angle (typically 45 degrees) as shown in the sample in Plate 3. It is commonly used to show the overall shape and dimensions of an object, with explanatory notes if required.

13. There are two common types of oblique projection; Cabinet and Cavalier, Cabinet has its receding lines or depth dimensions of the object reduced to half of their actual value to give a more natural perspective of the object. The example in Plate 3 is drawn in Cavalier and has the lines of sight receding at 45 degrees, and in this case, all dimensions are full scale.



**Isometric Drawings**

14. An isometric drawings is a view in which one vertical edge is drawn with the two other bottom axes receding at 30 degrees to the horizontal as shown in the sample in Plate 3. It is used for applications similar to those for an oblique projection. Special isometric graph paper is available to enable isometric drawings to be drawn more easily. Circles in isometric or oblique projections are ellipses. All three dimensions are drawn in the same scale.

**Sectioning**

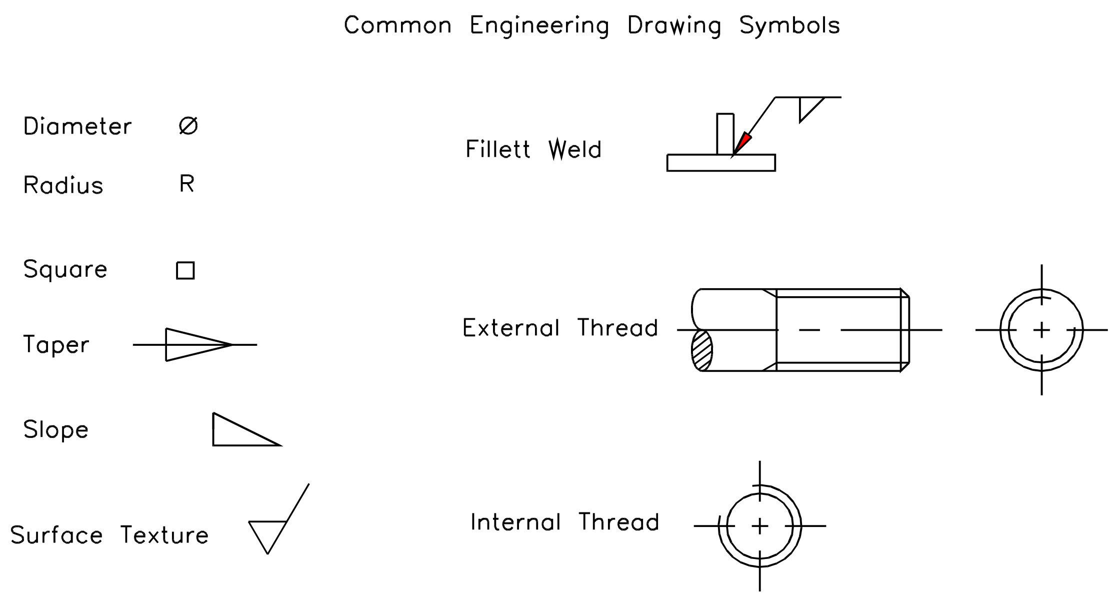
15. Sectioning is a technique used to view details of an object which are normally not visible. A cutting plane is usually shown on the object to indicate the location at which the object is to be viewed – it is usually referred to as 'a section through A-A' or similar. The shape of the object at the cutting plane is 'hatched' (thin lines drawn at an angle). Plate 4 shown an object with a sectional view.

**Dimensioning**

16. It is usually necessary to shown the dimensions of the object on an engineering drawing. Linear dimensions on an engineering drawing are usually expressed in millimetres, and angles are expressed in degrees. Dimensions should be expressed to the least number of significant figures, and they should be positioned outside the object. Numerals should be placed so that they can be read from the bottom or the right of the drawing, and decimals should always be drawn with a leading zero. Tolerances can be shown with the dimensions if necessary. Plate 5 illustrates the basic requirements for dimensioning.

**Common Symbols**

17. Several common general engineering drawing symbols are shown below:





## Scales

18. Every drawing should be drawn in proportion, i.e. to a uniform scale and the scale should be stated on the drawing. Scales are shown as two numbers separated by a colon or as a statement such as Full Size (1:1). A reduction scale of 1:2 means that every 1 unit of length on the drawing represents 2 units on the object being represented (the object is half full size). An enlargement scale of 5:1 means that every 5 units on the drawing represents 1 unit on the object. Typical recommended reduction scales are:

1:2 1:5 1:10 1:20 1:50 1:100

Typical site plans of residential and commercial constructions are drawn at 1:200
Typical building constructions are 1:100 and individual details within dwellings are typically drawn at 1:50 or 1:20

## Freehand Sketching

19. Freehand sketching is drawing without the use of drawing instruments such as tee squares, set squares, compasses and drawing pens. They are used for purposes such as:

    a. Conveying information from a worksite to a factory, drawing office or other person.
    b. Planning the layout of a drawing.
    c. Drawing circuit diagrams for circuits or components in the workplace.
    d. Designing components to be manufactured.
    e. Showing details of alterations to a particular component or circuit.
    f. Recording details of connections or components before dismantling.

20. Freehand sketches should be made with a soft pencil so that alterations can be made with an eraser during the sketching process. Relevant drawing conventions and symbols should always be used when sketching so that the drawing can be understood by others. It is important to sketch a mechanical object in its proper proportions to avoid errors in interpretation.

21. When drawing a freehand sketch of an object it is customary to draw the basic overall outline in the form of a box, then fill in the details while maintaining the proper proportions. Special papers with square or isometric grids are available to aid sketching.

Plate 1 – Typical Drawing Sheet Layout

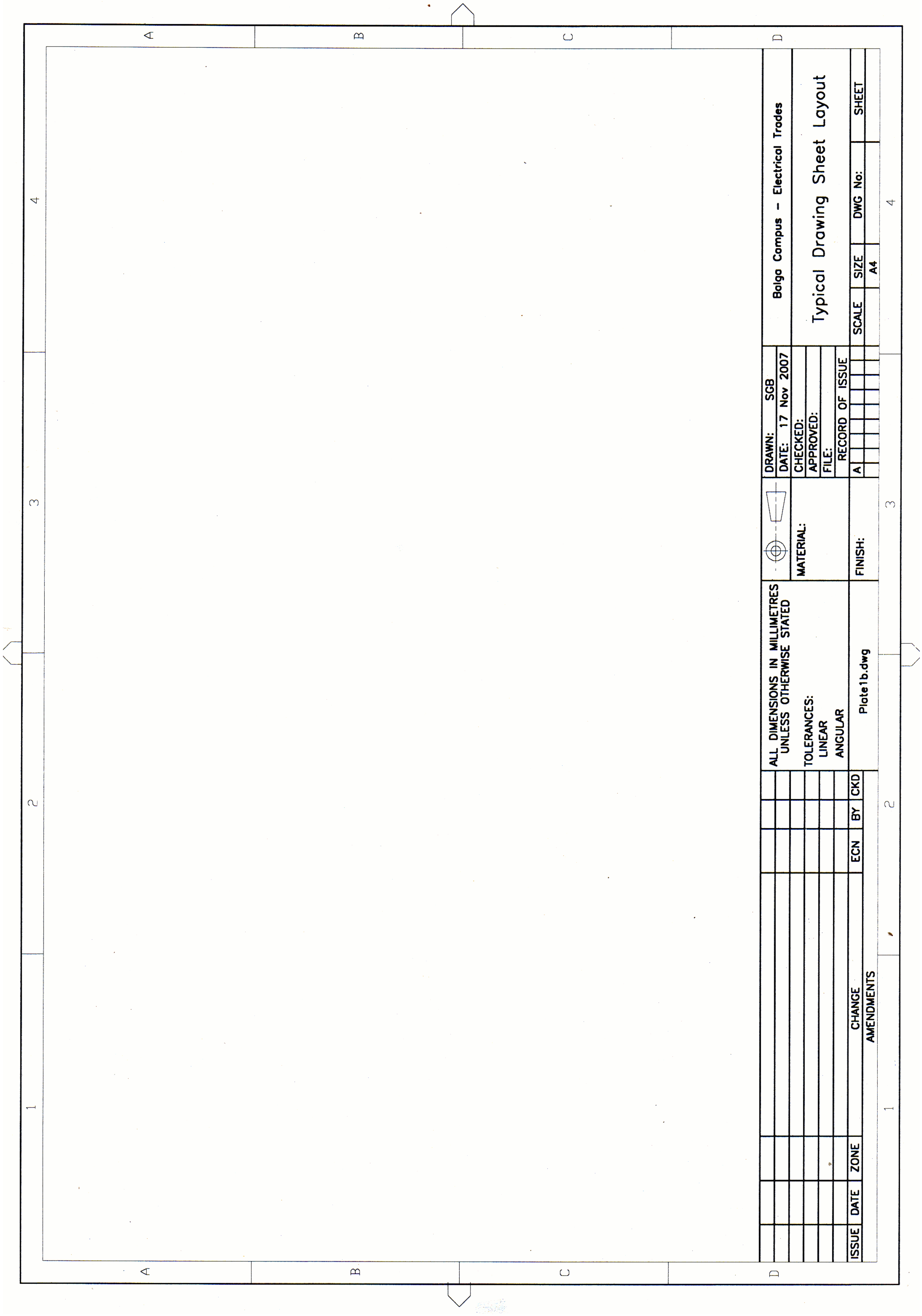
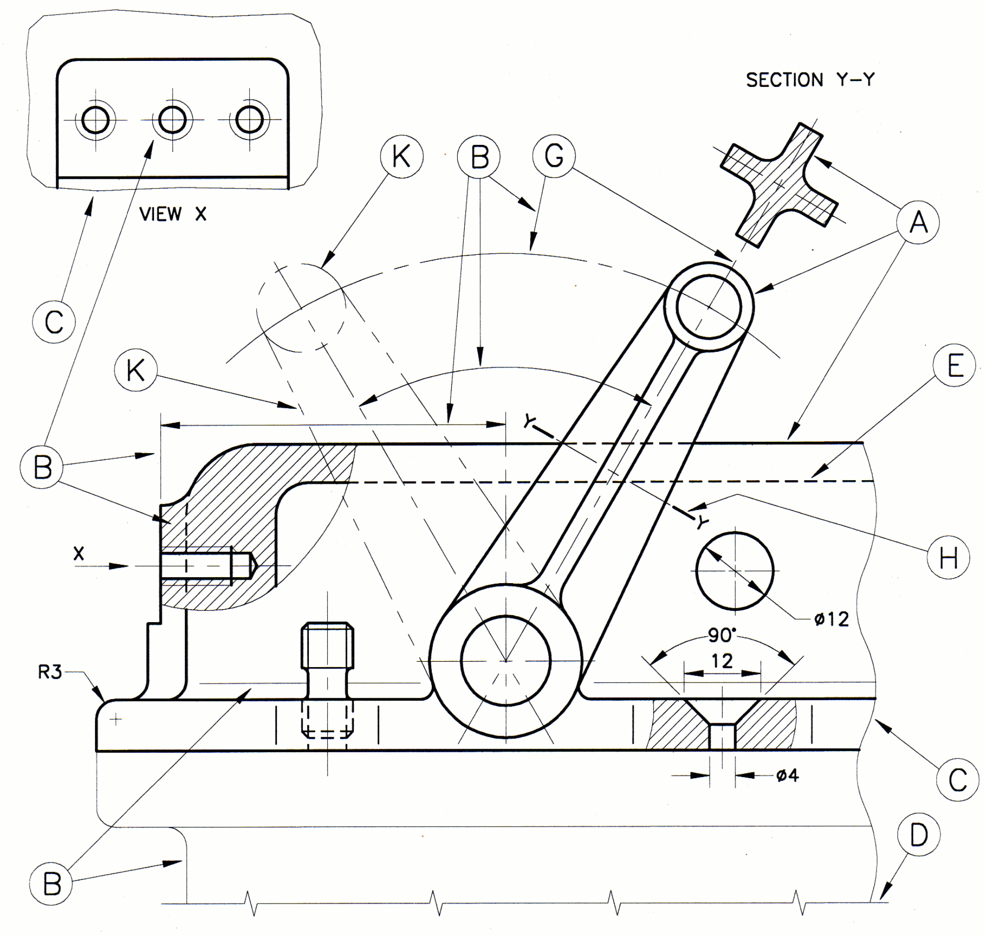




Plate 2 – Line Types




| TYPICAL MINIMUM LINE THICKNESSES FOR A2, A3 AND A4 | |
|---|---|
| TYPE A: | VISIBLE OUTLINES (CONTINUOUS) (0.35). |
| TYPE B: | FICTITIOUS OUTLINES, DIMENSIONS, HATCHING ETC. (0.18). |
| TYPE C: | TERMINATE PART VIEWS (THIN FREEHAND) (0.18). |
| TYPE D: | BREAK LINES (CONTINUOUS – WITH ZIG ZAG) (0.18) |
| TYPE E: | HIDDEN OUTLINES (THICK – DASHED) (0.25). |
| TYPE G: | CENTRE LINES, PITCH LINES (CHAIN) (0.35 & 0.18). |
| TYPE K: | ALT POSITION OF MOVING PARTS (CHAIN DOUBLE DASHED) (0.18). |

TYPE B LINES:
Fictitious outlines such as minor diameters of male threads.
Dimension lines, projection or extension lines.
Hatching.
Leaders.
Outlines of revolved sections.
Outlines of adjacent parts.
Imaginary intersection of surfaces.
Tooling outlines.
Fold or tangent bend lines.
Indication of repeated detail.
Short centre lines.

| Balga Campus | | Electrical Trades |
|---|---|---|
| DATE: 17 Nov 2007 | TYPICAL APPLICATIONS OF LINES (SAA/SNZ HB1:1994) | |
| SCALE: | | |
| DRN: SGB | | DRG No: |
| CHKD: | | FILE: Plate2b.dwg |

Plate 3 - Common Projections

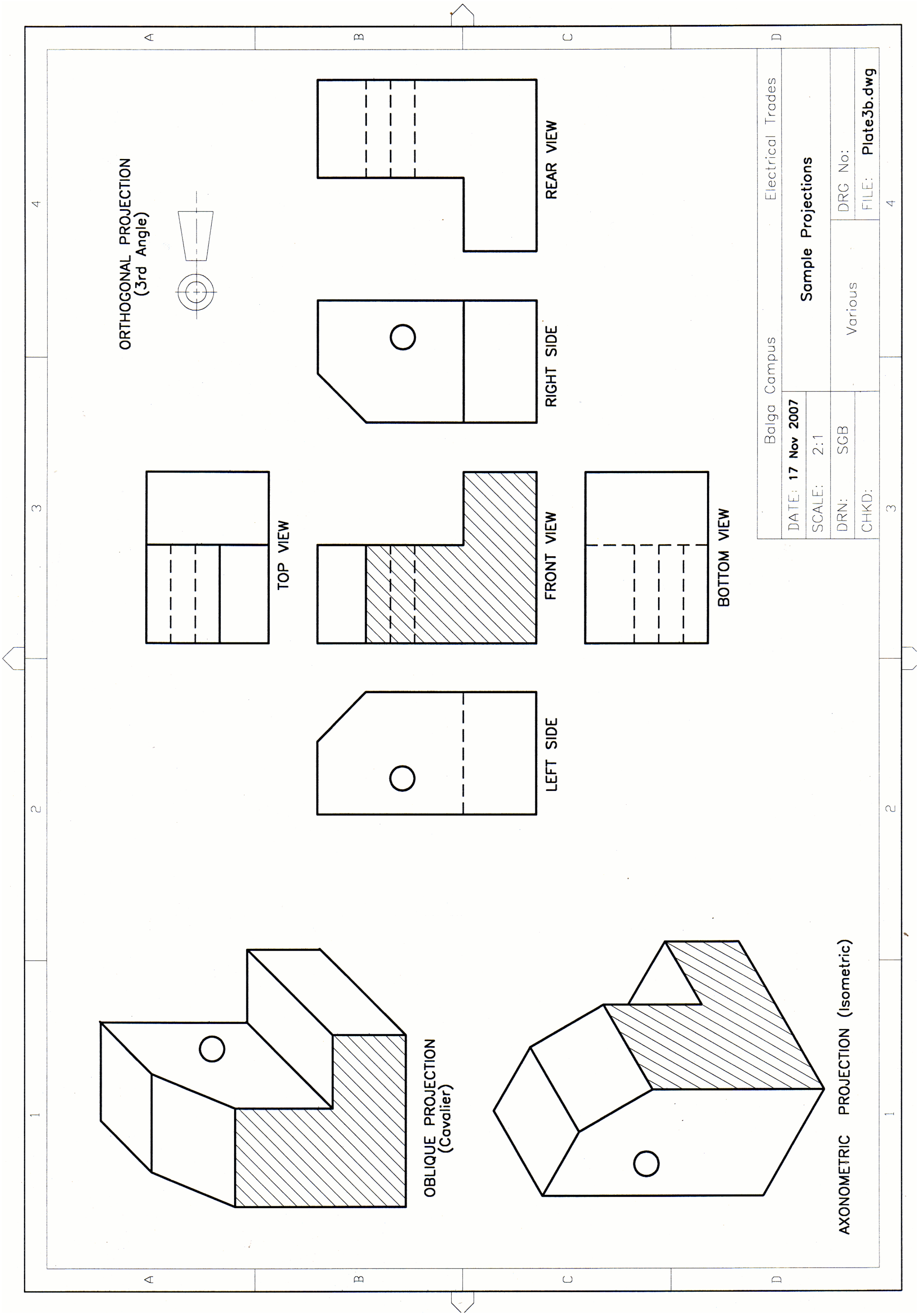




Plate 4 – Sectioning

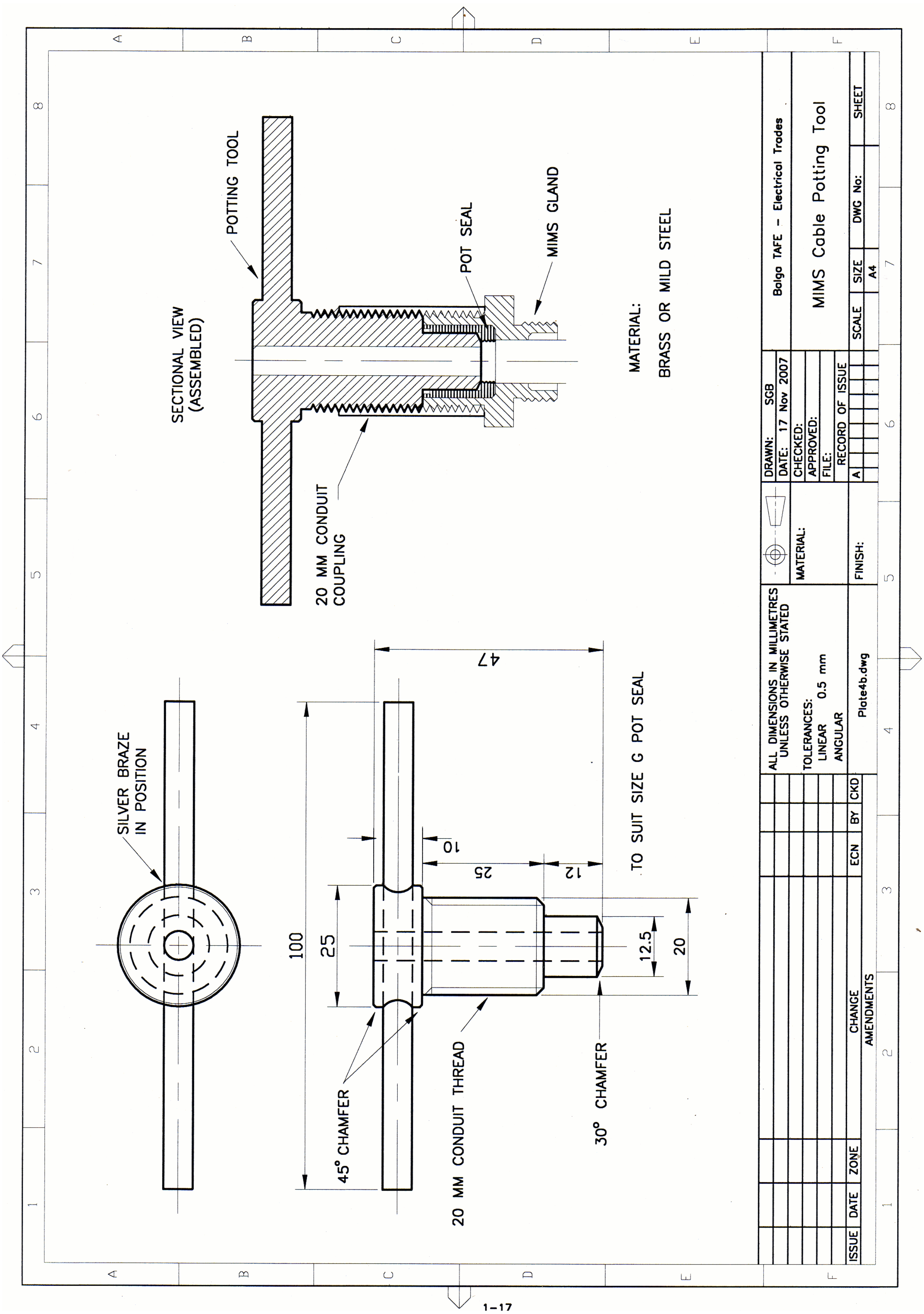
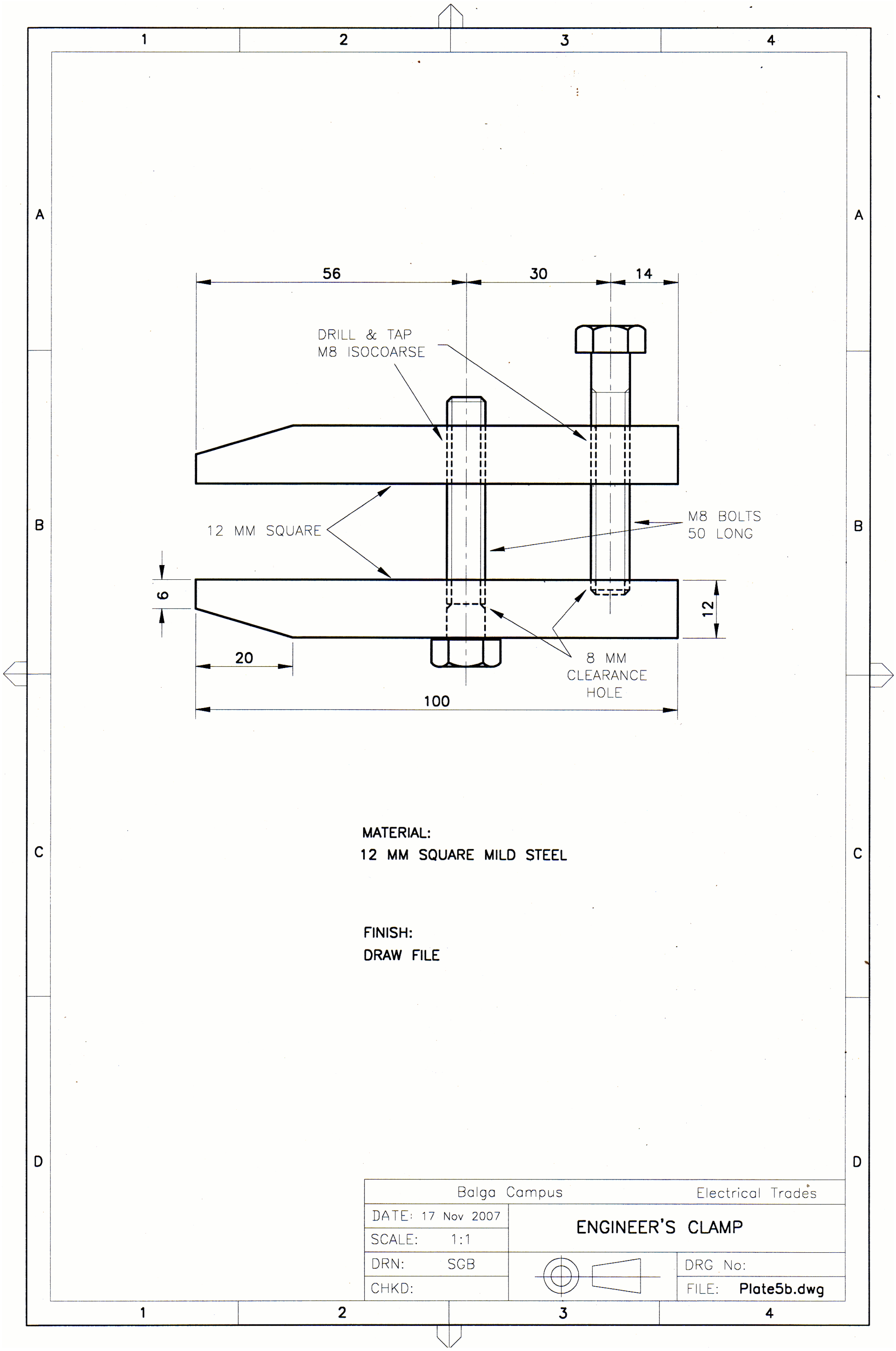


Plate 5 - Dimensioning





| Government of Western Australia North Metropolitan TAFE | **Fabricate, assemble & dismantle utilities industry components** | Work Sheet 1-1 | E102A SGB 10/2012 |
|---|---|---|---|

## Engineering Drawings

1. Name three common Australian Standard technical drawing sheet sizes.

2. Name four different types of lines used in mechanical drawings and give one common use of each one.

3. Name three basic methods of projection used in engineering drawings.

4. List four of the basic parts of the layout of a typical engineering drawing sheet (not including the object itself).

5. Draw the symbols which have the following meanings on an engineering drawing:

    a. Diameter

    b. Radius

    c. Surface texture

    d. Fillet weld

    e. External thread on a bolt

    f. Internal thread

6. Draw a neat free-hand pencil sketch of a side view of any M12 x 1.75 bolt as it would be shown on a typical mechanical engineering drawing. Layout the drawing on an A4 sheet of paper and include all drawing layout components.

| Government of Western Australia North Metropolitan TAFE | **Fabricate, assemble & dismantle utilities industry components** | Activity Sheet 1-1 | E102A SGB 02/2008 |
| --- | --- | --- | --- |

**Third Angle Projection**

## Objective

To draw a neat freehand pencil sketch showing an orthogonal (third angle) projection of an object from a given oblique projection.

## Equipment

Dimensioned oblique projection (attached)
Pencil, paper, eraser, 300 mm rule

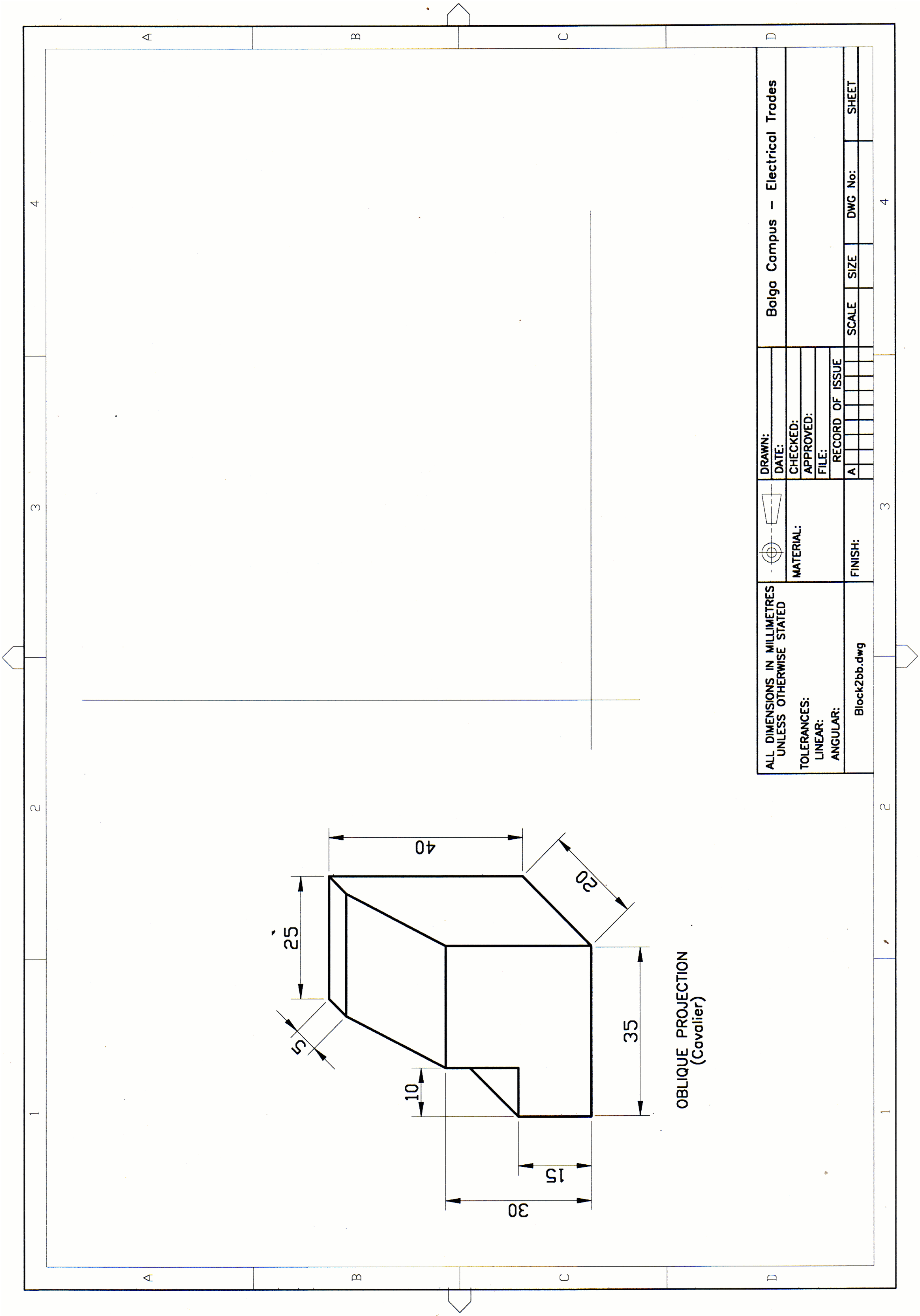
## Procedure

1. Examine the oblique projection provided on the attached sheet and sketch a third angle projection of the object (on the same page) using the general conventions of engineering drawing. Make valid assumptions for details not provided.
2. Include the actual full-size dimensions on your sketch.
3. Submit your completed sketch to your lecturer for comment and feedback.

Assessment (Third Angle Projection):

| Satisfactory: | | | Not Satisfactory: | |
| --- | --- | --- | --- | --- |

Lecturer: ______________________________ Date: ______________


Balga Campus – Electrical Trades
ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE STATED
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| Government of Western Australia North Metropolitan TAFE | **Fabricate, assemble & dismantle utilities industry components** | Activity Sheet 1-2 | E102A SGB 10/2012 |
|---|---|---|---|

## Freehand Sketching of Objects

### Objective

To draw four neat freehand pencil sketches showing oblique or isometric views of common objects and present the results in an indexed folio.

### Equipment

Pencil, eraser, 300 mm rule.
A4 or A3 paper (square or isometric graph paper may be used).

### Procedure

1. Draw a neat freehand pencil sketch of the four objects supplied (at least one oblique and one isometric). Layout each of the four drawings using appropriate engineering drawing conventions (including dimensions, drawing frame, title block and parts/material list). Use the attached outline drawing sheets if you wish.

2. Submit your completed folio of sketches to your lecturer for comment and feedback.

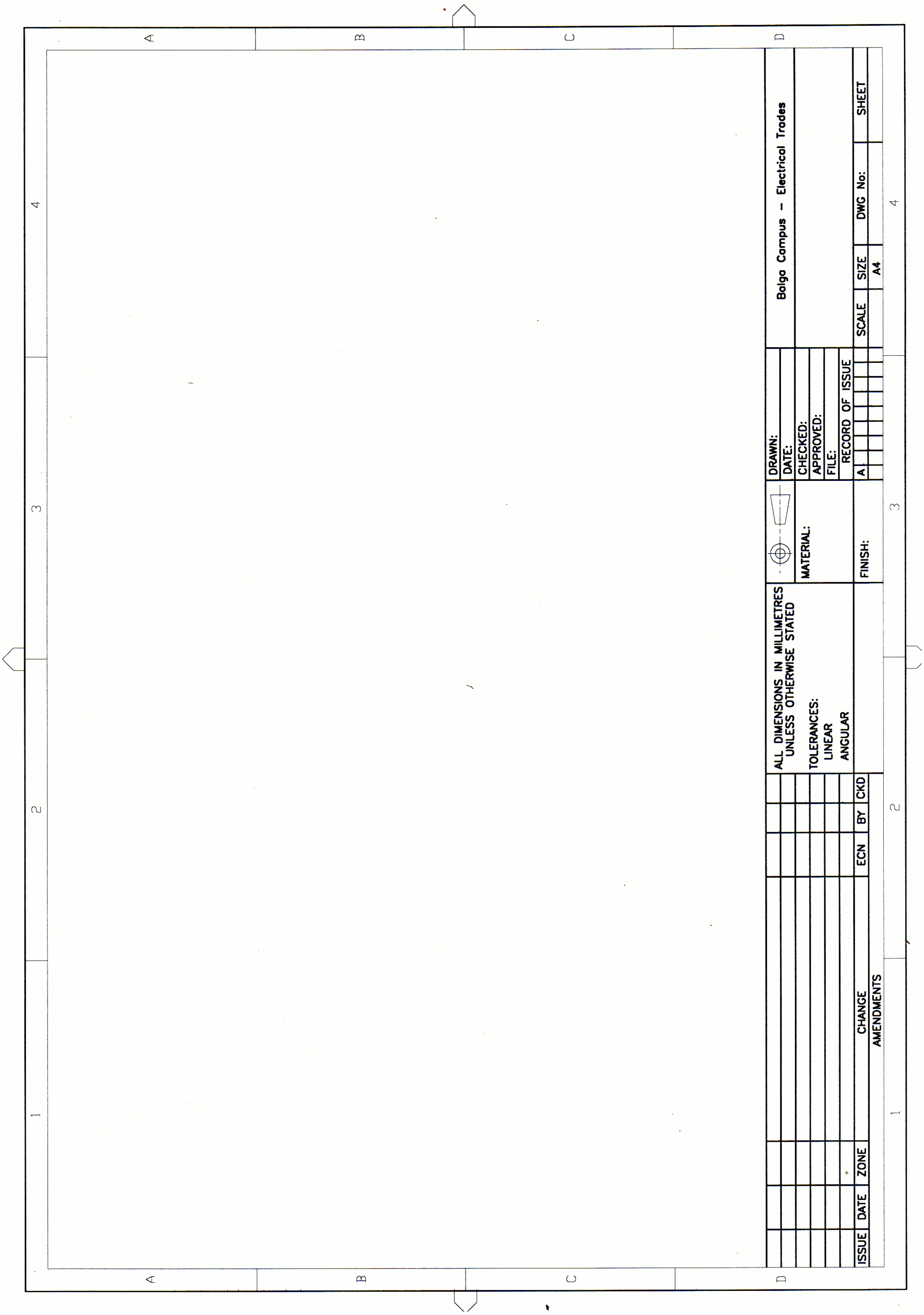
Assessment (Freehand Sketching):

| Satisfactory: | | Not Satisfactory: | |
|---|---|---|---|

Lecturer: ________________________________________ Date: _________________

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| Government of Western Australia North Metropolitan TAFE | **Fabricate, assemble & dismantle utilities industry components** | Activity Sheet 1-3 | E102A SGB 10/2012 |
|---|---|---|---|

## Materials Part List

### Objective

To prepare a materials parts list from a given general assembly drawing.

### Equipment

300 mm steel rule.
Manufacturers' catalogues and manuals as required.

### Procedure

1. Examine the general assembly drawing of the slotted motor bed attached. Note that the motor bed is slotted to allow for adjustment of the motor position during installation.

2. Make a list of the materials required to fabricate the slotted motor bed. Make valid assumptions for the detail not provided.

3. Submit your completed list to your lecturer for comment and feedback as part of your folio.

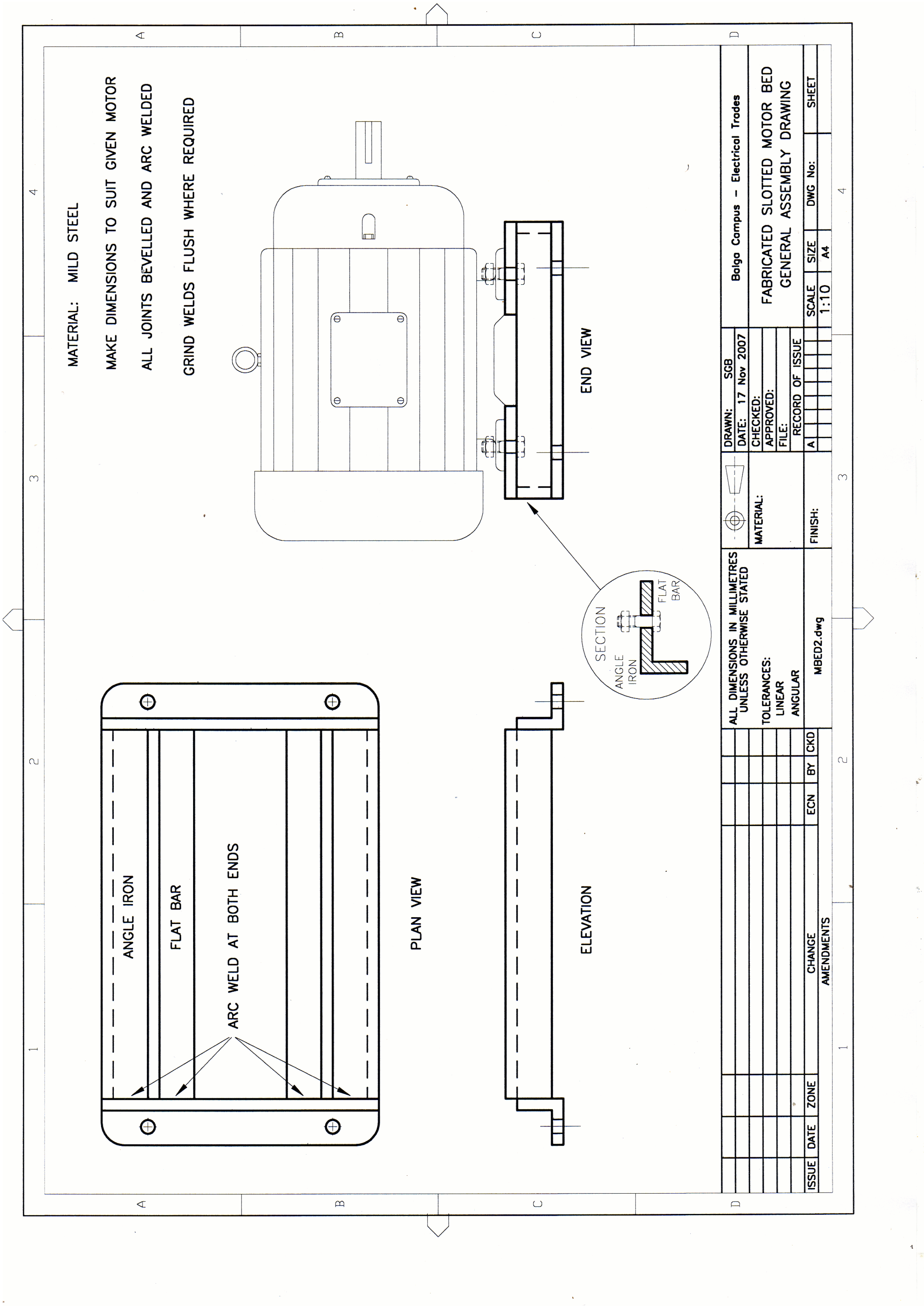
Assessment (Materials Parts List):

| Satisfactory: | | | Not Satisfactory: | |
|---|---|---|---|---|

Lecturer: ______________________________ Date: ______________




MATERIAL: MILD STEEL
MAKE DIMENSIONS TO SUIT GIVEN MOTOR
ALL JOINTS BEVELLED AND ARC WELDED
GRIND WELDS FLUSH WHERE REQUIRED
END VIEW
SECTION
ANGLE IRON
FLAT BAR
ANGLE IRON
FLAT BAR
ARC WELD AT BOTH ENDS
PLAN VIEW
ELEVATION
Balga Campus – Electrical Trades
FABRICATED SLOTTED MOTOR BED
GENERAL ASSEMBLY DRAWING
SCALE 1:10
SIZE A4
DWG No:
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# JOB SAFETY ANALYSIS WORKSHEET

**JSA No.:** ______________________

Date:

**Risk:** H = High
S= Significant
M = Medium
L = Low

| | A | B | C | D | E |
|---|---|---|---|---|---|
| 1 | H | H | H | S | S |
| 2 | H | H | S | S | M |
| 3 | H | H | S | M | L |
| 4 | H | S | M | L | L |
| 5 | S | S | M | L | L |

**Probability:**
A – common or repeating occurrence
B – known to occur or "It has happened"
C – could occur, "I've heard of it happening"
D – not likely to occur
E – practically impossible

**Consequences:**

People:
1 – fatality or permanent disability
2 – lost time injury or illness
3 – medical treatment
4 – first aid treatment
5 – incident report only

Environment:
1 – toxic release off site with detrimental effect
2 – off site release with no detrimental effect
3 – off site release contained with outside assistance
4 – on site release immediately contained
5 – no environmental impact

| STEP NO | JOB STEP<br>List the steps required to perform the task in the sequence they are carried out. | POTENTIAL HAZARD<br>Against each step list the potential risk/ hazards that could cause injury / damage when the task step is performed. | Probability | Consequence | Risk Rank<br>L<br>S<br>M<br>H | REQUIRED HAZARD CONTROL<br>For each hazard identified list the control measures required to eliminate or minimise the risk of injury. | RESPONSIBILITY<br>Nominate the person who will be required to action the control measures |
|---|---|---|---|---|---|---|---|
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## Job Safety Analysis Work Team Sign-on/ Review Register

Personnel are required to sign this register to indicate they have read, understand and will adhere to the requirements of the JSA

| This JSA covers: | | | | JSA No | |
|---|---|---|---|---|---|
| Name | Employee Signature | Date | Name | Employee Signature | Date |
| | | | | | |
| | | | | | |
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## UEENEEE102A – Fabrication, assemble and dismantle utilities industry components - Section 2 - Hand and Power Tools

| | | | |
|---|---|---|---|
| Government of Western Australia North Metropolitan TAFE | **Fabricate, assemble & dismantle utilities industry components** | Introduction 2 - 1 | E102A TOG 12/2018 |

### Safe Use of Hand Tools

**Task:**

To identify common engineering workshop hand tools and use them safely and correctly.

**Why:**

In order to work in an engineering workshop you need to know what tools are available for a particular task, what to call them, and how to use them safely and correctly.

**To Pass:**

1. You must correctly answer the questions on the work sheets provided.
2. You must demonstrate your ability to correctly identify and use the appropriate hand or power tool for a particular task.
3. You must demonstrate your ability to work safely in an engineering workshop environment.
4. You must satisfactorily complete the activities and practical projects in this section.

**Equipment:**

Hand tools and materials as required
Safety equipment as required
Screw pitch gauges (metric and imperial)
Sample threaded fasteners and a thread chart
Feeler gauges and sample templates
A 0-25 mm metric micrometer
A 150 mm or 200 mm metric Vernier Calliper
Risk assessment proformas

**References**

* Basic Skills Manual 16.1 - Electrical & Electronic Safe Procedures.
* Basic Skills Manual 16.2 - Materials and Benchwork.
* Basic Skills Manual 16.3 - Hand Tools Electrical Trades.
* Basic Skills Manual 16.4 - Mechanical Measuring.
* Basic Skills Manual 16.6 - Drilling, Tapping, Thread Cutting.

| Government of Western Australia North Metropolitan TAFE | **Fabricate, assemble & dismantle utilities industry components** | Study Guide 2 - 1 | E102A TOG 12/2018 |
|---|---|---|---|

**Safe Use of Hand Tools**

**Suggested Self-Study Guide**

Suggested Self-Study Guide

1. Study the following text and recommended references:

**Basic Training Manuals:**

**16-3 Hand Tools,**

**16-4 Mechanical Measuring and**

**16-6 Drilling, Tapping and Thread Cutting.**

2. Read the Summaries and practise answering the questions provided on the Work Sheets. Refer to other relevant texts if you feel it is necessary.

3. Answer the questions given on the Work Sheets. Use a separate answer sheet or sheets for each Work Sheet. Note that you are required to answer ALL questions correctly, although not necessarily at the same time.

4. Complete the activities in this manual.

5. Submit your answers to the Work Sheets and your completed Activity Sheets to your Lecturer for discussion and feedback.

| Government of Western Australia North Metropolitan TAFE | **Fabricate, assemble & dismantle utilities industry components** | Summary 2 - 1 | E102A TOG 12/2018 |
|---|---|---|---|

## Safe Use of Hand Tools

1. If you are working in a general electrical workshop environment you would be required to safely use a large number of hand tools. You need to be able to name each of the tools so that you can request them from a tool store, or in case you need to send a trades' assistant to get a particular item.

2. In many cases there are several variations of the same type of tool. You need to be aware of the usual possible variations so that you can specify the exact type you require for a particular task. Some tools are known by different names, so you need to be aware of the possible variations. A list of common tools is provided at the end of this section.

3. When requesting tools from a tool store it is not sufficient to ask for a 'hacksaw', a 'spanner' or a 'drilling machine'. It is your responsibility to make sure that you get the tool you want - the best way to ensure that do so is to describe the tool exactly. As a general guide, you always need to specify the following (at least):

   a. The size.
   b. The type.
   c. The general name of the tool.
   d. Any special characteristics or features.

4. For example:

   a. You should ask for a '300 mm hand hacksaw with a 24 point blade' rather than a 'hacksaw'.

   b. You should ask for a '250 gram ball pein hammer' rather than a 'hammer'.

   c. You should ask for a '0-25 mm outside micrometer' rather than a 'micrometer'.

   d. You should ask for a '10 mm parallel shank twist drill' rather than a '10 mm drill'.

4. Once you have selected the correct tool for a particular task, you need to be able to use it safely, without injuring yourself or any other person, without damaging the tool or its accessories, and without damaging the work piece. If you are unsure of how to use a particular tool you need to seek assistance from your supervisor.

5. During the course of this section you will be given the opportunity to learn the names, uses and safety precautions associated with a range of common tools. The list at the end of this section gives the general name of common tools and related items - in most cases additional information relating to size, type or quantity is required.



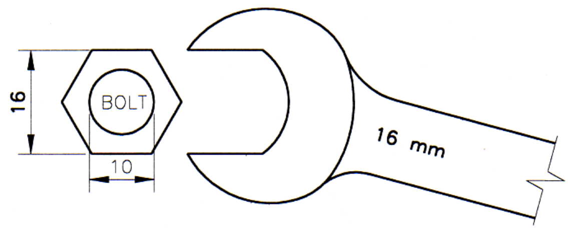
6. A list of the most commonly used engineering hand tools is given at the end of this section. The following points are provided as a guide to the correct and safe use of tools in various groups. You may wish to add other points as you become aware of them.

## Spanners

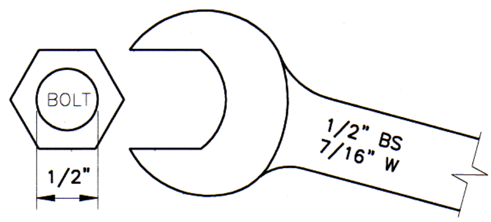
7. The length of the shank of a spanner is usually up to about 10 times the width of the jaw opening. This length enables the correct amount of tension to be applied to the nut or bolt by hand (after training and practice). Using a pipe to extend the length of a spanner or otherwise increasing the leverage can result in excessive torque being applied to the nut or bolt, in which case the result could be a stripped thread, a sheared bolt, or strained or broken spanner jaws.

8. **Spanner Sizes -** The method of specifying the size of the spanner required to fit a particular nut or bolt varies with the type of thread used. The most common methods are:

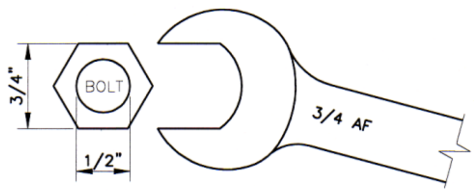
a. **Metric -** The spanner size is specified as the distance across the flats of the bolt or nut (in mm).



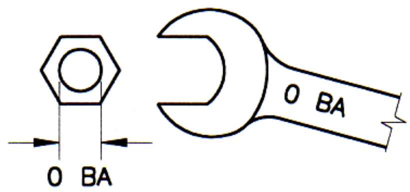

b. **BSW (British Standard Whitworth) and BSF** - The spanner size is specified as the major diameter of the bolt (in fractions of an inch - 1 inch = 25.4 mm).




c. **Unified Standard (UNF and UNC)** - The spanner size is specified as the distance across the flats of the bolt or nut (in fractions of an inch).



d. **BA (British Association) -** The spanner size is specified as the size of the thread - 0 BA, 1BA, 2BA and so on (the larger the number the smaller the thread).




9. Set spanners designed for one thread system should not be used on nuts or bolts designed for another system. A poorly fitting spanner is likely to result in damage to the nut or bolt.

10. When using open end or adjustable spanners the spanner should be pulled towards the shorter jaw to reduce the chance of the jaws springing open.

11. Set spanners should be used in place of adjustable spanners wherever possible because the movable jaw of an adjustable spanner is less rigid than the jaws in a set spanner.

12. All spanners should be turned by PULLING rather than pushing where possible because there is less chance of injuring your knuckles or losing your balance if the nut gives suddenly.

13. Tension wrenches (torque wrenches) with a click action should not be used to loosen a nut or bolt because the reverse torque can alter the calibration of the wrench.

14. Stillson wrenches and footprints are primarily intended for turning circular objects and pipes - they are not intended to be used on standard hexagon nuts or bolts. These wrenches are likely to leave jaw marks on the work.

**Screwdrivers**

15. Screwdrivers are classified according to the type of tip, the length of the shaft, the width or size of the tip and any other special purpose for which it may have been designed.

16. Standard screwdrivers with rounded or incorrectly shaped tips are dangerous because they can slip out of the screw slot and cause injury. Most quality screwdrivers cannot be re-sharpened successfully due to their precision nature. It is better and safer to replace screwdrivers that have worn tips rather than attempting to re-sharpen them.

17. A screwdriver should be treated as a cutting tool for safety purposes - always keep behind the 'cutting edge' (the tip). **Do not use a screwdriver as a lever or chisel.**

18. Penetrating oil can be used to allow rusted or tight screws to be unscrewed more easily, but for best results it needs to be applied about 24 hours before attempting to loosen the screw. Tight screws can sometimes be loosened by giving them a sharp tap, or by using an impact screwdriver.

19. The insulation provided on some screwdrivers is mainly to prevent the blade from short circuiting live components - it is not usually intended to protect the user from electric shock. Electricians should use screwdrivers with VDE or similar certification.

**Pliers**

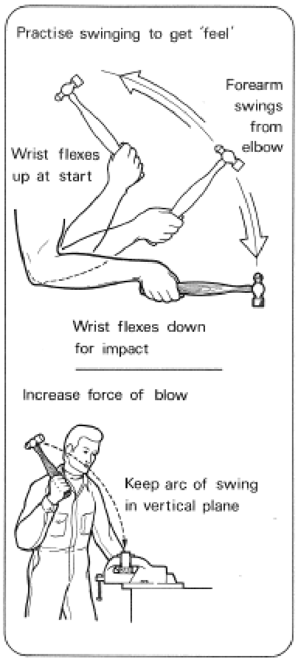
20. Pliers are classified according to their type and overall length. A common type used for electrical work is the 200 mm combination plier which has both a gripping and a cutting function.

21. Pliers are designed for gripping, bending, twisting or cutting - they should not be used to tighten or loosen nuts or bolts because they can damage nuts or the heads of bolts.

22. The insulation provided on some pliers should not be relied upon to provide protection from electric shock. Electricians should only use good quality pliers that also carry VDE or similar certification.

23. Good pliers should not be used to grip objects such as cable lugs while they are being heated because the heat could cause the pliers to lose their 'temper'. An old pair of pliers should be set aside for this purpose. Pliers that have become tight from rusting can be freed up using a penetrating oil on the pivot point.

**Hand Hammers**




24. Hand hammers are classified according to the type and/or the mass of the hammer-head. A common general purpose hand hammer for engineering applications is the 500 gram ball pein hammer. On construction sites a 500 gram claw hammer is common.

25. Before using any hammer, check to see that:

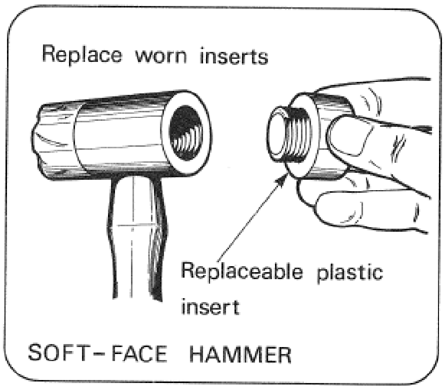
a. The head is firmly wedged on to the handle.
b. The head is not cracked.
c. The handle is in good condition and not split.
d. You are wearing the appropriate PPE such as eye protection.

26. Never strike one hammer head with another hammer - the head may split or shatter, sending small steel chips flying.

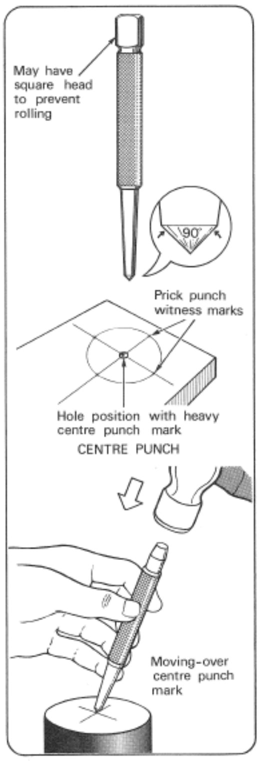
27. Always select a hammer which is the smallest possible to comfortably do the job. If a hammer seems to be too small for a particular job, get a larger hammer - using a small hammer with more force may break the handle.

28. A hand hammer should be gripped by the end of the handle - not by the neck of the handle. This gives a more precise control over the hammer, avoid crushing injuries to hands while delivering the required amount of force.

29. If a hammer must be used on a machined surface or to assemble/ disassemble machined parts, either protect the surface by using a soft metal drift or use a soft-faced hammer.



**Punches**




30. A centre punch (90 degree point) should always be used to locate the centre of a hole before it is drilled. A prick punch (60 degree point) is used to make witness marks on circles or to mark the position of lines.

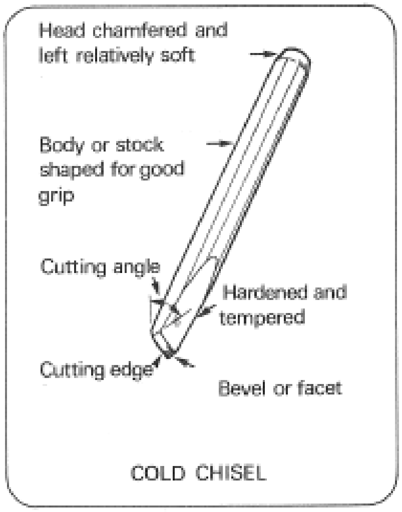
31. When using a wad punch to cut soft materials such as gaskets or thin shims, it should always be used on the END grain of a piece of timber.

32. If letter or number stamps are to be used, always practice on a piece of scrap metal of about the same thickness first - to check your judgement of the alignment. Always use a guide line.

33. Parallel pin punches are intended to be used to drive out comparatively loose pins. If the pins are very tight, start them off with a taper punch first, but do not allow the taper punch to jam in the hole.

**Cold Chisels**

34. Safety goggles should always be used when using a cold chisel or when working near a person who is using one. It may also be necessary to use a protective screen to protect other workers in the vicinity.




35. Do not use a cold chisel which has a cracked or mushroomed head -small pieces can fly off and cause injury.

36. A sharp flat cold chisel can be used to remove a rusted nut without damaging the stud or bolt, by carefully cutting the nut from the top or from the side. Heavily seized nuts can be split open on one side of the nut using a cold chisel. The nut is destroyed in this process.

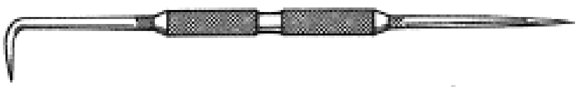
**Measuring and Marking Out**

37. When using a steel rule greater accuracy will be obtained if the rule is used on its edge rather than on its flat. Use a midpoint on the rule rather than the rule end to measure from.

38. Before marking out on metal, the metal needs to be cleaned and then a marking medium applied. The most common types of marking mediums are blue or black marker pens and dyes.

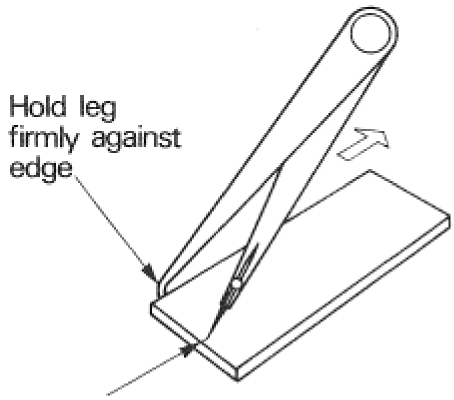
39. Pens or pencils are not a suitable marking tool for metal - a sharp scriber is best. Use a Jenny Calliper to scribe lines parallel to an edge or use a pair of Spring Dividers for scribing circles and arcs.

Permanent markers are not suitable if surfaces require painting as the mark can show through the paint.





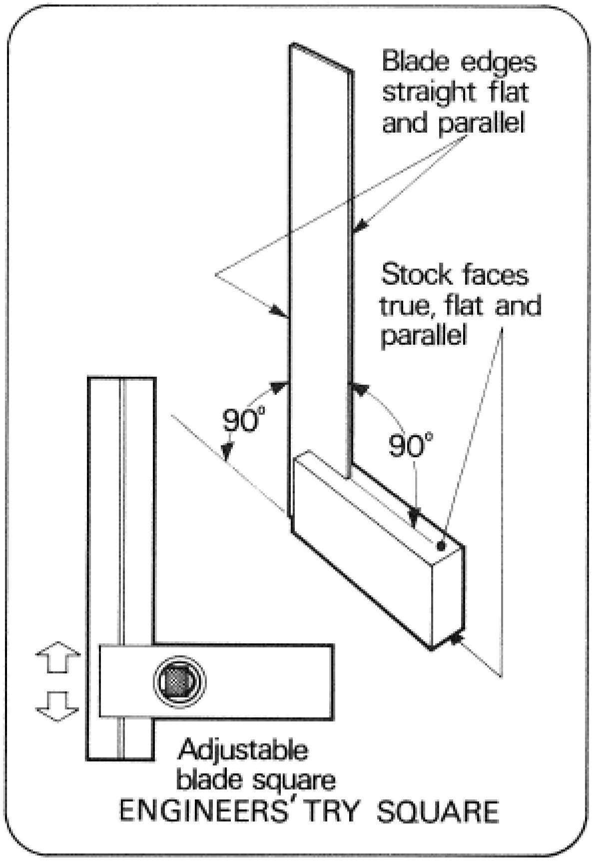
 

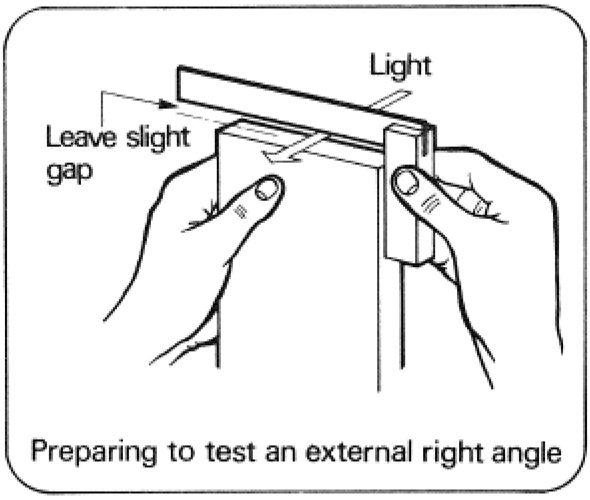



40. Pencils or scribers should never to be used to mark out the position of components or holes in insulating materials - because they can cause a conductive 'track'. The correct method of marking out on insulating materials is to place paper over the material, mark the position of the components, then drill through the paper.

Picture: Jenny Calliper

41. A tri square can be checked for 90 degrees by scribing a line at 90 degrees to a straight surface, then reversing the tri square and scribing another line. If the two lines are parallel the tri square is accurate.



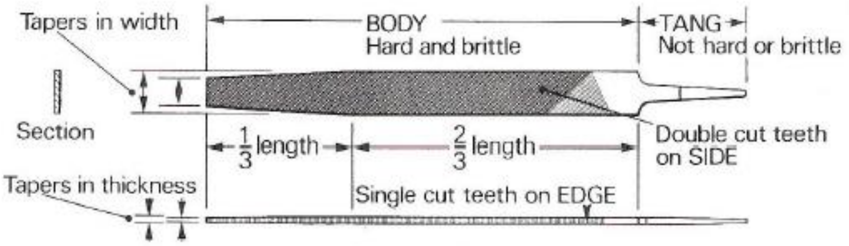


**Hand Files**

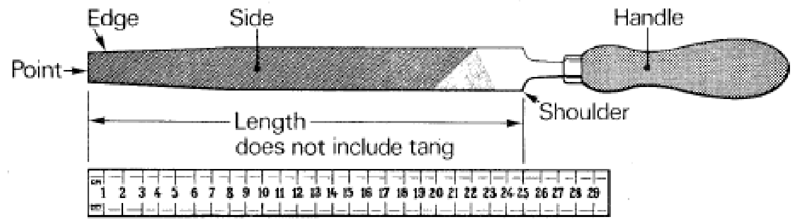
**Shape and parts of a file**

Flat files are the most commonly used files. Other files can be distinguished by comparing their outlines with these views of a flat file.



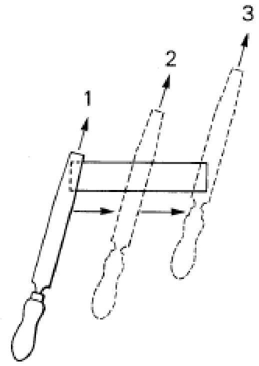
Outline views of a flat file

53. **Never use a file without a suitable handle.**



Parts of a 250 mm file

54. **Make the filing strokes correctly.**



Positions of file during cross filing

Long, steady filing strokes of moderate pressure made at about 35 to 45 strokes per minute are ideal for average filing. If the pressure is too light or the speed is too great, the file tends to slip over the work without cutting it. Slipping damages the file teeth. Always use sufficient pressure so that you feel' the file cutting.

For heavy filing, increase the pressure and decrease the speed of filing. If the work is very soft or its surface very narrow, use less pressure and a greater speed of filing.

To make the filing strokes correctly, start with your right arm close to your body. As your arms move forward, lean forward from the hips for the first two-thirds of the stroke. As you finish the stroke allow your body to return to the upright position. Maintain an even, unhurried tempo of regular rhythmic movement.

Accurate filing is hard and difficult work. Fatigue will be reduced by:

- Adopting a comfortably balanced upright stance
- Maintaining a suitable grip that is not too tight
- Filing with machine-like regularity and precision
- Using frequent breaks from filing to check your accuracy and to brush any chips from the file teeth.
- Do not cut or drag the file teeth across the piece on the backwards stroke, lift the file off lightly.



55. **Always select the size and type of file suitable for the job.**

For any job, there are five factors to be considered when selecting the files to be used. These are:

(a) The material to be filed
Many files are suitable for a wide range of materials and there are special files produced for specific materials such as stainless steel, aluminium and brass.

(b) The nature of the surface to be filed
For flat unrestricted external surfaces, there is a wide range of files of rectangular cross-section. The longest suitable file is usually chosen. For curved, restricted or internal surfaces, the nature of the surface, hole or slot determines the shape of the cross-section of the file and the size of this cross-section. In turn, this may restrict the length which may be related to the size of cross-section. When the surface to be filed is at right angles to a finished surface, a ‘safe edge’ with no teeth will be required on the file.

(c) The amount of material to be removed
The amount of material to be removed will determine the grade of cut required. It is usually necessary to use one grade of cut for roughing and a finer grade for finishing. Note than on hard metal more teeth cut more freely. Also using a coarse file on narrow surfaces risks breaking the teeth.

(d) The surface finish to be produced by filing
The surface finish to be produced will determine the type and grade of file to be used for finishing. Rough, Coarse or Bastard cut files are used only for parts to be formed to a general shape without requiring a good finish. Second cut files are used for general work to close sizes requiring good surfaces. Smooth or Dead Smooth files are used to produce the finest filed finish when the strokes are made in one direction and scratches are avoided.

(e) The amount of use the files have had.

56. **Always adopt the correct stance when filing.**

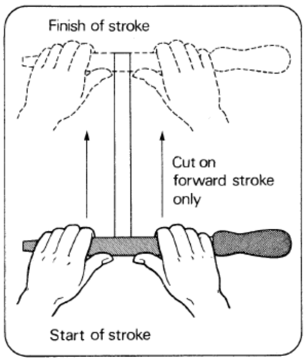
To start a filing stroke from the left, stand just to the left of the vice with the feet slightly apart.
Place the left foot closest to the bench and pointing nearly in the direction of filing as shown.
For balance place the right foot 250 to 300 millimetres behind the left.
Turn the right foot slightly outwards so that the body faces half right as shown.
Adopt the stance that is comfortable for you.
Take the weight of the body on the balls of the feet to allow the body to move slightly forwards and backwards.
Almost all the movement of the file is provided by the arms.

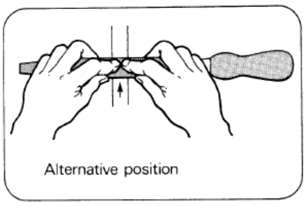
**For light filing and finishing**:

Grip the end of the handle between the root of the little finger and the ball of your thumb. Place your thumb on the top of the handle pointing in the direction of the length of the tile. Wrap your fingers around the handle as shown.
Apply forward push and downward pressure to the file with your right hand. In light filing, the arm muscles apply the downward pressure.
Use your left hand to guide and apply downward pressure to the file. The left hand is placed in one of a number of different positions.
For most light filing, hold the end of the file between the forefinger and thumb of your left hand. As shown, place your left thumb on top of the file body and curl your fingers over the point to grasp the under-side of the file body.
Alternatively, the left hand may form a bridge with the fingers towards the point and the thumb towards the middle of the file.

**For heavy filing**
Change both the height of the work and your grip to allow greater downward pressure to be exerted. Set the work lower than elbow height. Space your feet further apart. Allow your body to sway forward with the stroke. Allow your left knee to bend slightly to apply pressure to the file by using your body weight. This will reduce fatigue when you file for a long period.
The right wrist is inclined upwards but the grip on the handle is not changed appreciably. The fleshy part at the base of the thumb of your left hand is placed on the point of the file. The fingers are hooked under the point without gripping it. The wrist is bent to allow the left forearm to be held as shown.

**Draw Filing**
Draw filing is used when a smooth finish is required. The file is stroked at 90º to the work in forward backwards motion..

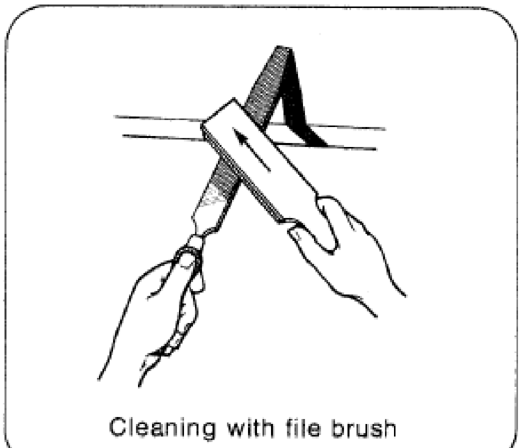



**Pinning of Files**

Pinning of files occurs when small particles of metal, larger than the normal chips, become embedded in the file teeth. These pins of metal project beyond the surface of the teeth. They cause deep scratches and reduce the efficiency of the file by impairing its free cutting action.
Pinning tends to occur when filing soft metals, on narrow surfaces or in corners where chips cannot clear. Also too much pressure on new and on smooth files causes pinning. Bad pinning occurs when new files are used on aluminium.
Single cut files are less likely to pin on soft metals than are double cut files. Thus coarse single cut files, called floats', are used for fast removal of soft metals.
Pinning may be reduced by rubbing chalk on files. However chalking also reduces the free cutting ability of a file. It is best to rely on frequent cleaning to remove pins and dirt.

**Cleaning of dirty or Pinned Files**


Cleaning with file brush

Files need to be cleaned frequently. A pinned file cannot produce a good finish. A dirty file acts like a dull file. Dust, grease and filings are likely to clog the teeth of a file.
To clean a file hold the handle in your left hand and brace the point on the bench.
Remove any pins by pushing the edge of a flattened piece of soft wire along the grooves of the teeth. A strip of aluminium or copper about 100 mm x 10 mm x 1 mm with one end flattened to a wedge is useful for this purpose,
It is not recommended that hard metal be used to dislodge pins as this could chip the teeth of the file,
Some files may be cleaned by a suitable wire brush or file card, File cards have short pieces of wire fixed in stiff canvas attached to a wooded handle. They are effective when the wire can penetrate the grooves between the teeth that is if the files are coarse enough.
Use the file brush or file card to clean the teeth of coarser files by brushing across the file following the groves made by the teeth.

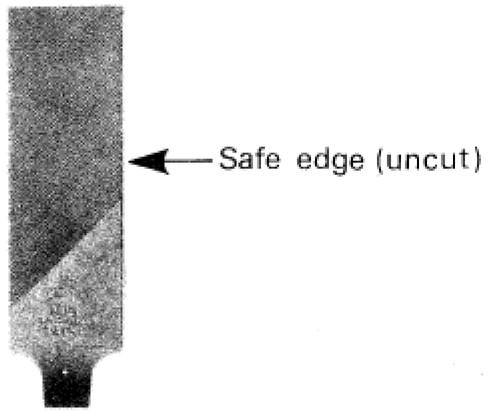


## 57. Types of Files

### Hand files

Hand files differ from flat files only in that they are parallel in width and are cut on one edge only. The uncut edge is called a ***safe* edge**. They are used for filing near shoulders, that is, to avoid damage to a finished surface at 90º to the surface to be filed.




### Warding Files

Warding files have a very thin rectangular section and they taper markedly in width.
They are used for very narrow slotting.

### Square Files

Square files are used for filing keyways and for enlarging square and rectangular holes. Reference is sometimes made to the length of side of the square file, e.g. 13mm square.

### Three Square Files

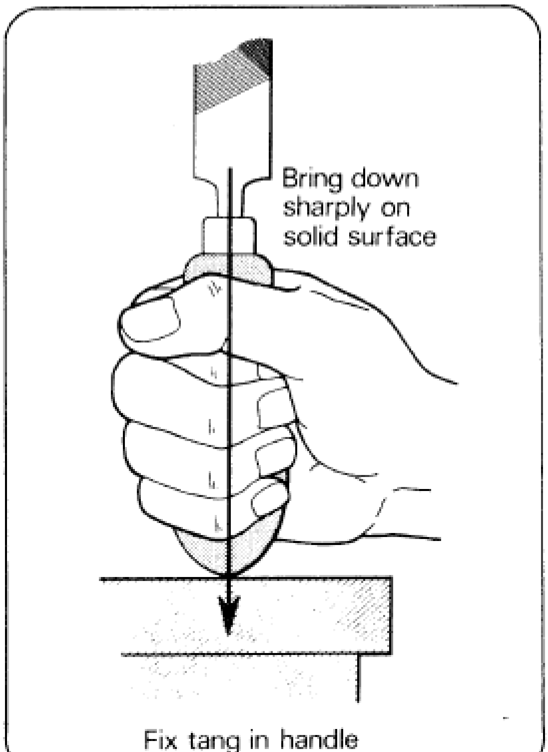
Three square files have a cross-section that is an equilateral triangle. They have limited use in clearing out square corners and filing acute internal angles greater than 60º.

### Half Round Files

Half round files are segmental in shape. They are double cut on the flat side. The teeth on the convex side may be either double or single cut, depending on the grade and length of file. The curved side must be used with a rolling motion to prevent grooving. It is desirable to choose a file so that the radius of the back is almost as large as the radius to be filed.
They are used for enlarging large round holes and for filing concave surfaces. The flat side may be used for filing in corners and grooves where the angle is less than 60º.

### Fixing a Handle to a File

The handle is predrilled to slightly smaller than the files tang. The tang of the file is wedged into the handle by tapping downwards on the handle.



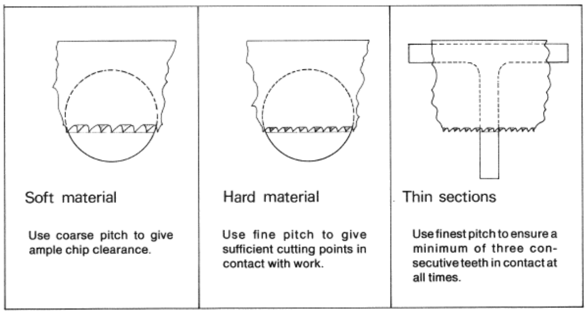
**58. Hacksaws**

A 300 mm (12”) Hand Hacksaw should have its blade fitted with the teeth pointing in the direction of the cut - usually away from the user. These blades often have an arrow painted on them to indicate the direction in which they cut. Blades need to be tensioned very tight with the adjusting screw before use.

A Junior Hacksaw however has its teeth pointing towards the user as it tensions the blade on the backstroke. The blade can be changed by compressing the frame and removing it.

Consult the manual when changing blades on Powered Hacksaws.

59. Most 300 mm hand hacksaws have provision for fitting the blade straight or at a 45° angle to allow for an awkward cutting situation.



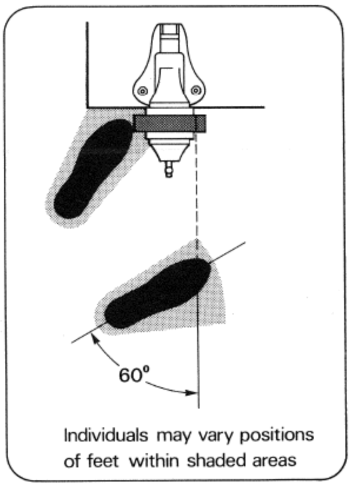

60. Hacksaw blades for 300 mm hand hacksaws are available in different types such as 'flexible', 'bimetal' and 'all hard'. Flexible and bimetal blades do not break easily but have a relatively short life. All hard blades have a longer working life but they are brittle and more expensive.

61. Hacksaw blades for 300 mm hand hacksaws are available in different pitches measured in TPI or teeth per inch. The most common are **18TPI, 24TPI and 32TPI**. The correct blade to choose for a particular task is usually the one that has the lowest pitch of which will allow at least three teeth to be in contact with the work at all times.

62. A hacksaw cut should be made on the waste side of a marked line and about 0.5 mm from it.

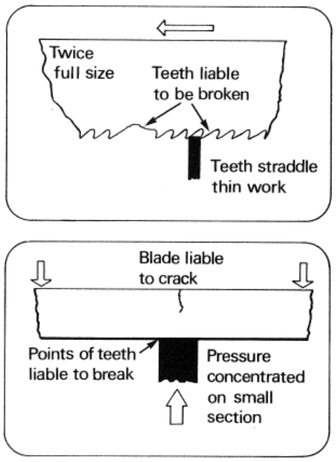
63. A new blade should not be fitted to a hacksaw part way through a cut, because the old cut will be narrower (due to wear on the blade) than the new blade and as such, the teeth on the new blade could jam and get damaged.

64. When using a hand hacksaw, ensure you have a good stance. Use a long stroke employing the full length of the blade at a rate of approximately 60 strokes per minute, use one hand on the handle with the thumb and forefinger of the other hand at the front of the hacksaw to guide the cut. Do not place fingers inside the frame of the hacksaw while sawing, if the blade were to break you may injure your hand.




65. The most common causes of blade breakage are:

a. Work-piece not supported.
b. Incorrect cutting speed.
c. Using a hacksaw with one hand instead of two.
d. Incorrect stance during sawing.
e. Incorrect blade tension.
f. Crooked cutting.
g. Blade jamming.
h. Too much pressure on the blade
i. Twisting the blade.



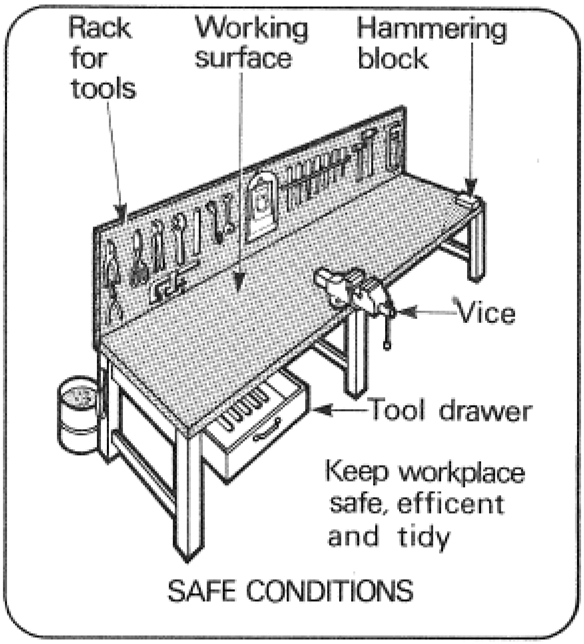
66. **Workbenches and Vices**

Workbenches and vices are used to:

- Mark out general work
- Shape materials with hand tools
- Assemble parts
- Repair light equipment

The working surface must be at a height to suit the task – lower for large heavy work and higher for light accurate work. Working surfaces must be solid enough to support the work. A hard wood top will withstand heavy work. A steel top is easily cleaned if working on dirty or greasy equipment.

Always clean away any swarf, dirty rags and debris from the bench tops and surrounding areas as its produced.

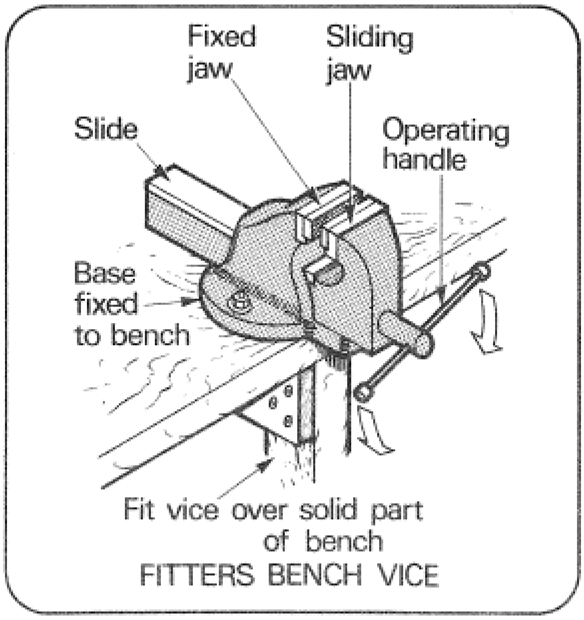


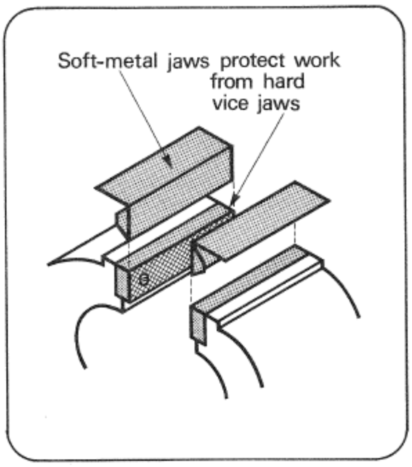

Vices of various types are used to hold work for hand processing. They must hold the work conveniently, securely and rigidly. The vice should be fitted over a supporting leg or at the end of the bench.

Soft jaws can be fitted to the jaws to prevent damage to softer material or finished precision parts.

Vices should be left clean after use with swarf brushed away and the jaws left slightly open.

**Bench vices should never be over-tightened, heated or subjected to severe impact as this may cause the vice to crack.**



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**Safe Use of Hand Tools**

1. Between what two points on a file is the LENGTH measured?

2. Why is it dangerous to use a hand file without a proper handle?

3. What is a SAFE EDGE on a file?

4. Is it necessary to lift a file off the work-piece on the backward stroke?

5. What is the softest part of a file?

6. What is the main use for the technique known as 'draw filing'?

7. What is the name of the special tool used to clean a file?

8. What is meant by the term 'pinning' a file?

9. What four factors must be considered when selecting a file for a particular task?

10. State four safety precautions which must be observed when working on or around workbenches.

11. A hacksaw blade should always have at least .....?..... teeth in contact with the work.

12. Why should a NEW hacksaw blade never be inserted in a cut made by a used blade?

13. What type of hand hacksaw blade should be used to saw through a high tensile (hard) steel bolt?

14. A saw cut should be made on the ________ side of a line and at least ____ mm away from it.

15. What are four common causes of hacksaw blade breakage?

16. What are the three most common tooth pitches on 300 mm hand hacksaw blades?

17. The blade in a hand hacksaw must be mounted in the frame with the teeth facing .....?..... the handle.

18. Name the four basic types of SET spanner.

19. What dimension is used to specify the SIZE of a metric spanner?

20. What dimension is used to specify the SIZE of a BSW or BSF spanner?

21. What dimension is used to specify the SIZE of a UNF or UNC spanner?

22. Why are open end and ring spanners made with a definite ratio between the width of the jaw opening and the length of the spanner?

23. What is one possible undesirable side effect of using a stillson wrench?

24. What type of tasks are stillson wrenches designed to perform?

25. What is the intended use of a tension (torque) wrench?

26. Why is it a bad practice to use some types of tension wrench to LOOSEN a nut or bolt?



 

27. Why should hand spanners be pulled rather than pushed?

28. An adjustable spanner should always be used with the movable jaw .....?..... the direction of pull on the handle. (ahead of/behind)

29. Why is it dangerous to use a standard screwdriver which has rounded corners at the tip?

30. Where should the left hand be positioned when using a screwdriver with the right hand?

31. What is the name of the most common series of screwdrivers for recessed head screws?

32. What is the name of the tool used to tighten or loosen a screw which has a hexagon socket head.

33. What two characteristics are used to classify hand pliers?

34. Name four common types of hand pliers.

35. How is the SIZE of an engineer's ball pein hammer specified?

36. What three pieces of information should always be given when asking a store-person for a particular hand tool?

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**Identification of Hand Tools**

## Objective

To identify common hand tools used for measuring, holding, turning, cutting, shaping, marking, finishing threading and bending metals and non-metallic materials.

## Equipment

A selection of hand tools used commonly in the electro-technology industry. Selection of photographs of various hand tools.

## Procedure

1. List the common name of each of the hand tools supplied and state the hazards associated with the use of each one.

| Name | Classification | Hazards |
|---|---|---|
| Screwdriver, flat blade | Turning | Possible slipping - rounded tip.<br>Puncture wound if in front of blade. |
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Assessment (Identification of Hand Tools):

| Satisfactory: | | Not Satisfactory: | |
|---|---|---|---|

Lecturer: ______________________________ Date: ________________



 

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## Measuring and Marking Out

### Objective

To measure dimensions from a technical drawing and mark out the shape on sheet metal.

### Equipment

300 mm steel rule.
150 mm spring dividers.
150 mm engineer's tri square.
150 mm scriber.
100 mm centre punch.
150 mm odd-leg callipers.
Combination set with protractor head.
Marking blue.
0.5 mm sheet mild steel or similar (about 110 x 70 mm)

### Procedure

1. Examine the technical drawing attached. Note that some of the dimensions are given but others are not.

2. Measure the dimensions not given (to scale) and mark them on the drawing.

3. Apply a thin film of marking blue to the work-piece and allow it to dry.

4. Mark out the shape of the work-piece on the sheet metal (start by constructing a horizontal and vertical datum line). All dimensions must be within 0.5 mm. Note: When scribing lines, always carry the line through for at least 2 mm at each end so that each corner is an intersection of two lines rather than junction of two end points. Not necessary to cut out once marked out.

5. Submit your work-piece to your Lecturer for comment and assessment.

6. Return all of the equipment to its proper place.

Assessment (Measuring and Marking Out):

| Satisfactory: | | Not Satisfactory: | |
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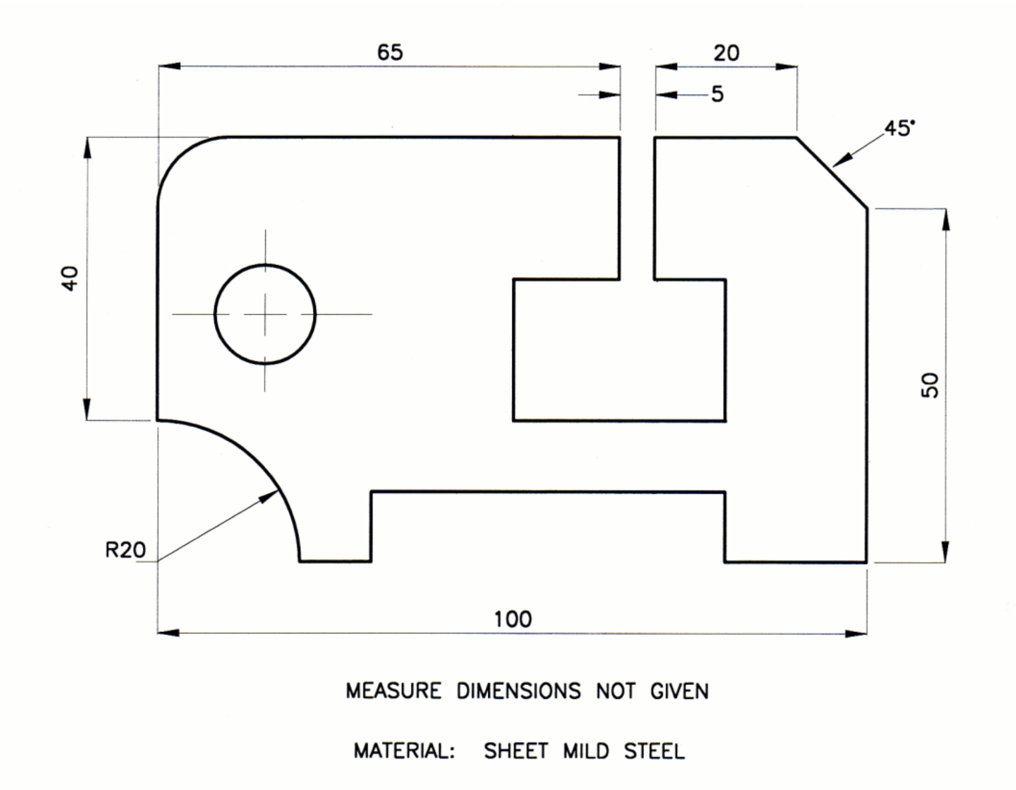
Lecturer: ________________________________________ Date: ______________



Marking Out Exercise



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## Drills and Drilling

### Drilling

1. Do not wear loose clothing around drilling machines.

2. Do not remove swarf with your fingers - it is hot, sharp and mobile.

3. Drill a pilot hole for holes over about 10 mm diameter (except in soft metals or materials), or where an accurate hold diameter is critical. The size of the pilot hole should be about the same diameter as the point of the drill.

4. Always check the required drilling speed on a machining speed chart. In general, large drills require a slow speed and small drills require a fast speed.

5. Make sure that the work-piece is adequately supported so that it cannot move.

### Twist Drills

6. A twist drill is an end cutting tool used to cut cylindrical holes when it is rotated and pressed against a material. The rotation of the drill must be CLOCKWISE with respect to the material being drilled.

7. Twist drills are available in a variety of shapes, but the two most common types are the straight shank type and the morse taper shank type - see Figure 1.

8. The main parts of a typical taper shank twist drill are:

   a. The tang.
   b. The shank.
   c. The cutting lips and point.
   d. The heel.
   e. The lands (including the margin).
   f. The flutes.
   g. The web between the flutes.
   h. The chisel point or dead centre.
   i. The body clearance.

9. A straight or parallel shank twist drill has the same cutting parts as a taper shank drill, but the shank is cylindrical so that it can be fitted to a drill chuck.

### Drill Size

10. The size of a metric twist drill is its diameter in millimetres, measured between the margins or across the body close to the end of the flutes.

11. Drill sizes in the imperial system are given in the following ways:

   a. As a fraction of an inch (fractional drills).

   b. As a number between 1 and 80 (number drills). A number 1 drill has a diameter of 0.288 inches (5.80 mm), and a number 80 drill has a diameter of 0.138 inches (0.35 mm).

   c. As a LETTER between A and Z (letter drills). A letter A drill has a diameter of 0.2323 inches (5.90mm and a letter Z drill has a diameter of 0.41134 inches (10.50 mm).

**Templates**

12. When several objects are to be made to the same shape, or when holes have to be drilled in the same place in several identical workpieces it is often useful to make one metal template and position it over each workpiece to drill the holes. A typical example could be if several switchboards need to be drilled to mount the same type of components.

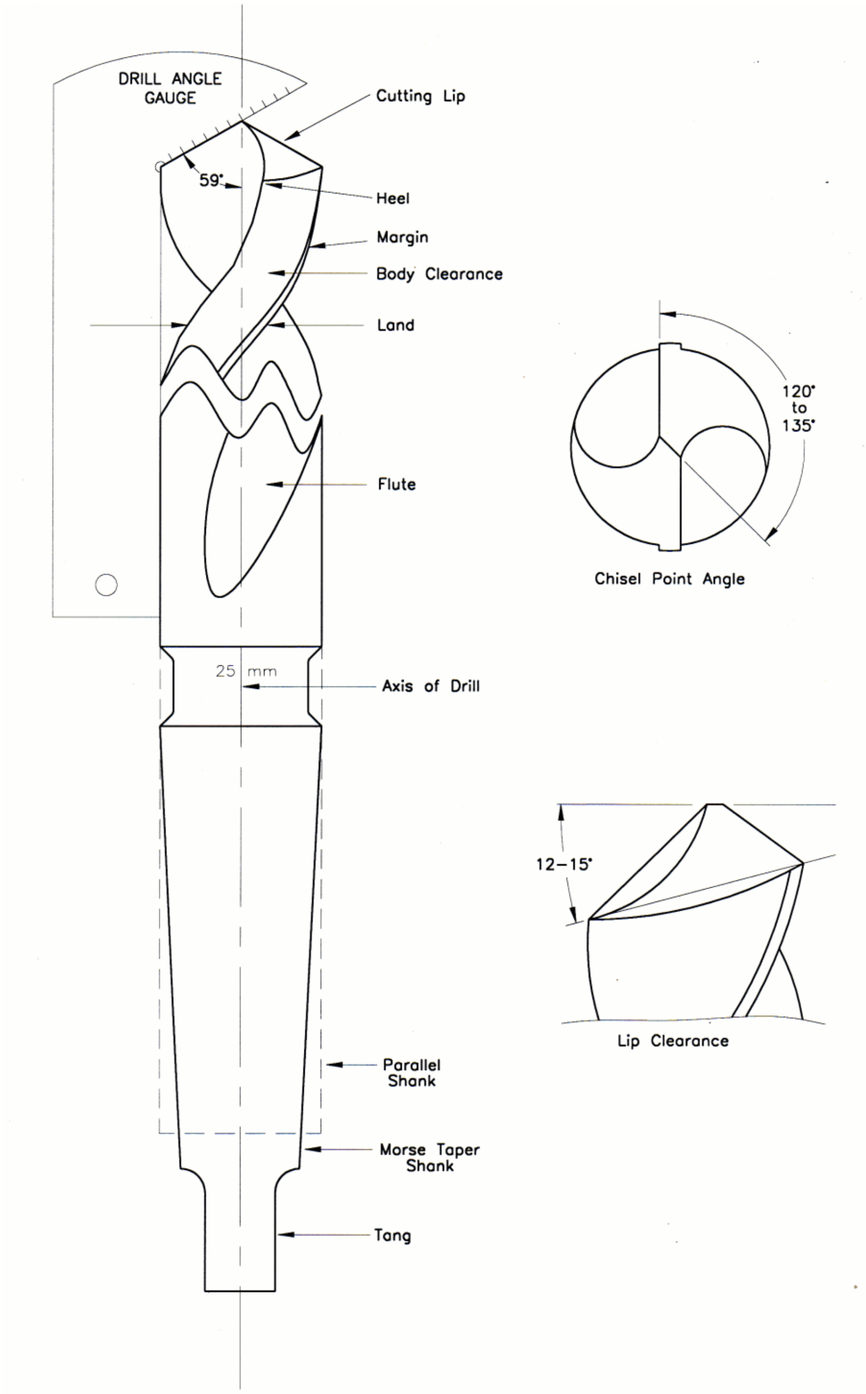



Figure 1 - Typical twist drill characteristics.



**Speed and Feed**

13. It is important to select the correct speed and feed for a particular drilling task. If the drilling speed is too high the drill could overheat, and if the feed is too heavy the drill could break. The chart at the end of this Section can be used as a guide when determining a satisfactory speed for drilling metals. In general, small drills require a faster speed and lighter feed than large drills.

**Lubrication**

14. Most metals require some form of cutting compound while they are being drilled to lubricate the rubbing parts and to cool the drill. Some of the commonly used cutting compounds are:

a. Soluble cutting oil - for mild steel, stainless steel, aluminium, copper, brass and bronze.

Cast iron should be drilled dry.

**Sharpening Twist Drills**

15. The four major considerations when sharpening twist drills are:

a. Keep the drill cool by frequently dipping it in water or soluble oil.

b. The lip clearance should be about 12-15 degrees for mild steel and soft materials such as bakelite, fibre or plastics. Hard and tough materials require a smaller amount of lip clearance (about 6-9 degrees).

c. The chisel point angle should be about 120-135 degrees.

d. The length and angle of each cutting lip must be the same, otherwise an oversize hole will be drilled. A typical angle of the cutting lips for general purpose drilling is 59 degrees to the axis of the drill. The angle should be reduced to about 30 degrees for drilling materials such as wood, rubber, bakelite, fibre or plastics. The length and angle of the cutting lips should be checked with a drill gauge as shown in Figure 1.

e. Non-ferrous metals such as copper and aluminium cut better when the cutting lips are at 45º to the axis of the drill bit.

**Safety Around Drilling Machines**

16. the following safety precautions should be observed around drilling machines:

a. Always hold the work firmly, with a machine vice or clamp if possible.

b. Do not wear loose clothing around drilling machines.

c. Always wear safety goggles when drilling or in the vicinity of drilling machines.

d. Do not remove swarf with your fingers - it is sharp, hot and mobile.

e. Keep hair away from a rotating drill or chuck

f. Do not press too hard on a drill while drilling.

g. Make sure the drill is held firmly in the drilling machine.

h. Never leave a drilling machine unattended while it is running.



**General Points on Drilling**

17. Always centre punch the centre of a hole to be drilled. Witness marks and a proof circle should be used if extreme accuracy is required.

18. When working with different types of steels, drilling a pilot hole is essential in most cases. A pilot hole is typically 3 – 3.5mm diameter. When drilling larger holes the hole should be enlarged in steps to ensure that the point of each successive drill bit can just fit the previously drilled hole i.e. the pilot hole should be at least the diameter of the width of the point of the next drill being used.

19. Pilot holes can be drilled in softer materials such as brass, aluminium, wood, Bakelite, composites and plastics, but care must be taken, because of the danger of the drill 'grabbing'.

20. When drilling any material it is good practice to clamp the material so that it will not move if the drill grabs.

21. When drilling, it is also good practice to place the material being drilled on top of a scrap piece of hardwood to reduce the “bust through” effect when the drill bit bursts through the other side of the material.

22. When drilling composite materials such as chipboard, plywood and laminates it pays to drill a pilot hole then drill the larger hole half way through from both sides to protect the surface finish from damage.

23. When drilling brass, copper or softer materials, the cutting lips should be 'backed off' to give a zero or negative rake to prevent the drill from grabbing. A pilot hole for softer materials is typically 6 – 6.5mm.

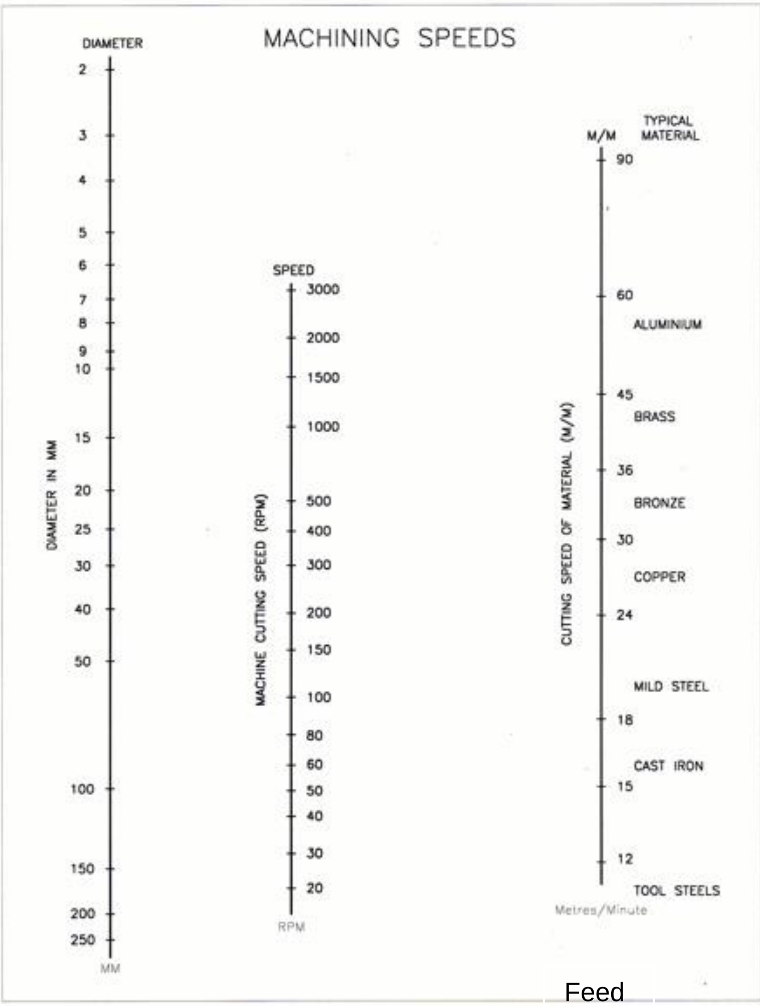
24. When drilling holes larger than about 5 mm in thin materials, mount the work-piece between thicker pieces of the same material and drill through all of them at the same time.

25. As a general rule the larger the hole to be drilled the slower the cutting speed.

26. When using hole saws and the like, plenty of lubricant should be used to keep the cutting teeth cool.

27. Always use a sharpened drill bit, never overheat the tip of the drill bit.

28. The chart right can be used to determine an approximate machining speed for general purpose drilling




**Machining Speed Chart**

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|---|---|---|---|

**Drills and Drilling**

1. What direction must a standard twist drill be rotated (when viewed from above the work-piece)?

2. What is the name given to the part of pedestal drilling machine that secures a parallel shank twist drill when drilling?

3. What item of safety equipment must always be worn when operating a pedestal drilling machine?

4. What two characteristics of SWARF make it highly dangerous if handled incorrectly?

5. What general category of twist drill requires a FAST speed and a LIGHT feed when drilling mild steel?

6. What are two possible reasons for drilling a pilot hole in mild steel?

7. Name the lubricant required when drilling (if any) the following materials:

   a. Mild steel
   b. Aluminium
   c. Brass
   d. Copper
   e. Cast Iron

8. State four different methods used to specify the diameter of a twist drill.

9. What is meant by the term 'drilling a blind hole'?



 

10. What is the most likely result if a twist drill is ground so that the cutting lips are of unequal lengths?

11. What procedure can be used to prevent a twist drill cutting an 'out of round' hole in thin sheet metal?

12. What is the recommended angle between the cutting lips and the AXIS of a twist drill when drilling mild steel?

13. What dangerous situation can arise if cloth is brought close to a revolving twist drill?

14. Why is it dangerous to drill a pilot hole in soft materials such as plastic or brass?

15. What is the purpose of using a Template when marking out or drilling holes?

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**Threads and Thread Cutting**

1. A gauge is a precision hand tool which is used to compare the shape of a workpiece or part of a workpiece with a known standard.

**Screw Pitch Gauges**

2. A screw pitch gauge is a gauge used to determine the pitch of vee threads on threaded fasteners or other components which have vee threads. They are packaged in sets of about 20-30 gauges and are used as shown in Figure 1. The individual gauges in the set close up to form a compact unit for convenient storage.

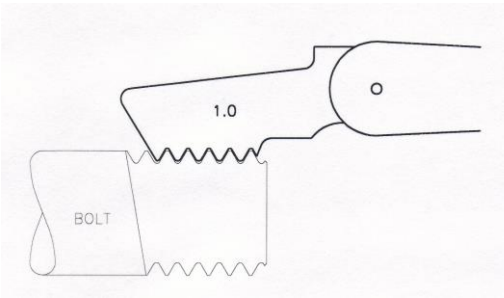



Figure 1 - Screw pitch gauge.

3. Metric screw pitch gauge sets have the range of pitches marked on one of the side plates, and each individual gauge has a particular pitch marked on it. The thread angle of all common metric vee threads is 60 degrees, so one set of screw pitch gauges can be used for all metric vee threads within the range covered by the set.

**Vee Threads**

4. The terms used to describe the parts of a vee thread are shown in Figure 2.

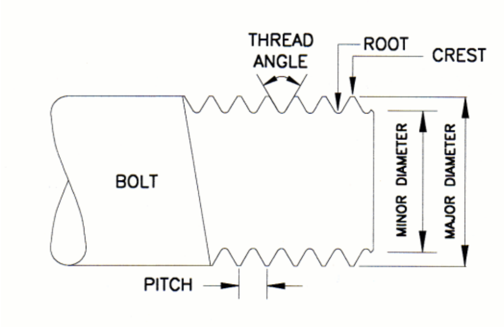



Figure 2 - Names of parts of a vee thread.

5. There are numerous imperial vee thread forms, most of which have a different thread angle and different shapes for the crest and root of the thread, so a different screw pitch gauge is required for each thread angle. The most common imperial thread forms found on threaded fasteners or electrical equipment are:

a. British Standard Whitworth (BSW) - 55 degree thread angle.
b. British Standard Fine (BSF) - 55 degree thread angle.
c. Brass - 55 degree thread angle.
d. Unified National Coarse (UNC) - 60 degree thread angle.
e. Unified National Fine (UNF) - 60 degree thread angle.
f. Metric Conduit - 60 degree thread angle.
g. British Association (BA) - 47.5 degree thread angle.

6. Imperial screw pitch gauges do not usually have the pitch marked on them - they have the number of threads per inch (tpi) (1 inch = 25.4 mm).

7. Although metric threads have been the standard in Australia for many years, there are still many machines in service which have imperial threads, so you need to be able to identify them when required.

8. In order to determine the thread used on a particular bolt or other fastener which has an external thread you need to:

a. Measure the major diameter of the thread with a rule or Vernier Calliper. (If you do not know whether the fastener is metric or imperial you will need to express this diameter as a fraction of an inch as well as in millimetres).

b. Use a screw pitch gauge to determine the pitch of the thread (or the threads per inch (TPI) if you suspect that it may not be a metric thread).

c. Consult a thread chart and find the thread which has the required diameter and pitch (or TPI).

9. A typical thread chart is included with the practical project on using a screw pitch gauge to identify threaded fasteners - at the end of this section.

## Internal Threads

### Hand Taps

11. To cut an internal thread, a “Thread Tap” is used. An appropriately sized hole must be drilled first. When using hand taps, a “Taper” tap must be used to start the thread, for thicker materials this is usually followed up with an “Intermediate” tap. If it is necessary to tap a thread into a “Blind” hole, a “Plug” tap (which is sometimes called a “Bottoming” tap) is used. A “Plug” tap can also be used to clean up a damaged thread inside a nut.

Note: A “Blind” hole is a hole with only one opening or in other words it does not continue all the way through the material and out the other side. They present a problem when tapping due to the swarf being trapped in the hole and potentially causing the Tap to break prematurely.

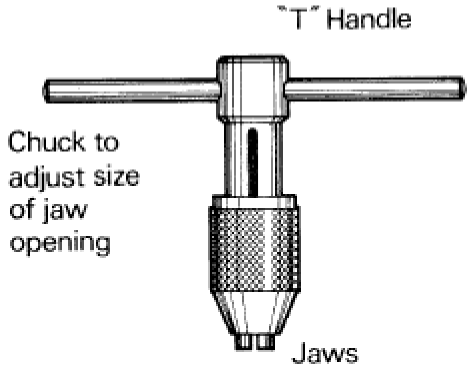
Hand taps are made in several types for special purposes, but the most common type for general purpose bench fitting work is the straight fluted type. Straight fluted taps are usually available in sets of three and are known as TAPER, INTERMEDIATE and PLUG (or BOTTOMING) taps. Details of size and thread pitch (or type) are usually marked on each tap (e.g. M10 x 1.5 meaning 10 mm major diameter and 1.5 mm pitch).

Taper Intermediate Plug



12. Thread Taps should be held in a suitable size and type of "Tap Wrench". If the Tap Wrench is too large then too much force may be applied to the tap causing it to break. Thread Taps are made from "Tool" steel, which is a very hard material, but this hardness also makes them somewhat brittle and they will break if exposed to too much twisting moment. Two common types of Tap Wrenches are the "Adjustable Bar" type and "T" bar type. The "T" bar type can get into more confined areas.

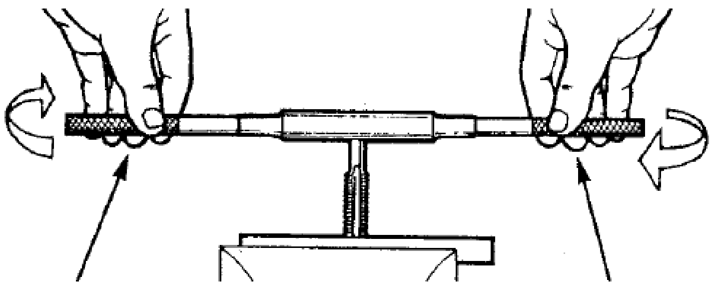



13. When tapping by hand the tap should be held in a suitable TAP WRENCH. The two main types of general purpose tap wrench are:

a. Tee Tap Wrench

b. Adjustable Bar Tap Wrench

14. Great care must be taken when tapping. Avoid putting too much pressure on the tap or uneven pressure on the handles of the tap wrench. If a tap breaks off while tapping it is usually very difficult to remove the broken portion from the hole. If a taps breaks it is not possible to drill it out because the tap is made from high quality heat treated cast steel (the same material as twist drills).



15. A suitable lubricant should be used when tapping or threading metals. Lubricating the cutting tool has many benefits, it reduces the effort required, it prevents the metal from "tearing", the tool stays sharper for longer and it also gives off a much better finish. A common multi-purpose lubricating compound is Trefolex®. Soluble oil can also be used in most cases with the exception Cast Iron which should be tapped or threaded dry.

16. Caution should be exercised when using different types of compounds and lubricants, always read the label and follow the safety advice given. Consult the appropriate MSDS for more detailed information about the product.

17. The cutting edges of the chamfered portion of a tap are given a clearance so that they will 'bite' into the metal being tapped. It is not usually successful to attempt to either sharpen or grind a hand tap on a grindstone.

**Tapping Drills**

18. The diameter of the drill required to tap a hole in a material must be correct for the type of thread being tapped - such drills are known as 'tapping drills'. The size of the tapping drill for a given thread should be obtained from tapping drill tables. The tapping drill required for a metric thread can be found by subtracting the pitch (in mm) from the major bolt diameter (in mm). This will produce about a 75% thread which is suitable for most general purpose applications.

19. Generally a "Tapping Drill Chart" will be consulted to find the correct sized drill bit for a particular thread when tapping. A chart showing the tapping drill sizes for common threads is given at the end of this Section.



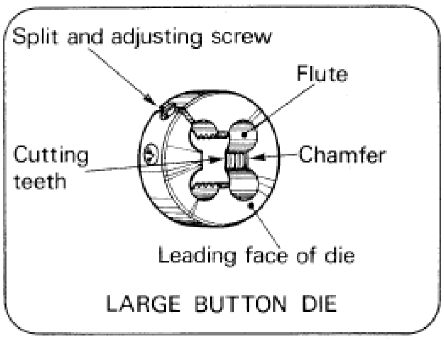
### External Threads

20. To cut a single start external thread, such as that on to either a round bar or pipe, a "Die" is used. The Die is held in a thing called a "Stock". This piece of equipment is often referred to as a "Stock and Die Set". The type of Die that is used with a Stock is referred to as a "Button" Die, as it resembles the shape of a button. The Button Die is secured in the Stock by two screws either side, a third screw serves to adjust the gap in the Die so the thread cutting depth may be adjusted.

21. Single start refers to there being only one thread set being cut i.e. just one track of thread.

### Button Die

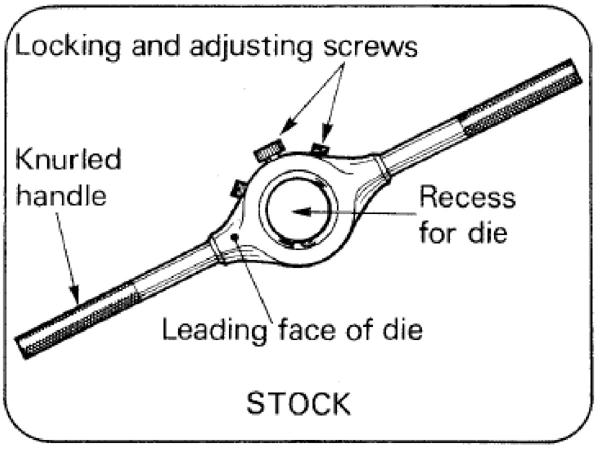
21. A button die is split on one side and it is used in a stock which has two locking screws - one on each side of the split. Small dies can be slightly adjusted with a conical pointed adjusting screw in the stock, while larger dies have a small tapered grub screw in the split to adjust its width.




22. The cutting teeth on the leading face (the unmarked face) are usually tapered so that the die can be started easily.

### Stocks

23. When starting a thread the Button Die is placed in the Stock so that the size and type markings on the Die faces uppermost. This is so the tapered cutting teeth are facing downward to be presented to the work first and aid in the "starting" of the thread. If a length of round bar or pipe is to be threaded a chamfer should be ground or filed into the end being threaded to aid the starting of the thread.



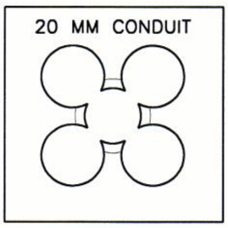

Once the thread has been cut to its required length, the Button Die is then inverted in the stock and run down the thread so that the cutting teeth at the topside of the die now face downwards. These teeth will cut the last few threads to their full depth.

24. Some stocks for button dies have adjustable guides to ensure accurate alignment when cutting the external thread.

### Warragul Die

25. Warragul dies are non-adjustable square dies used to cut threads on pipes such as screwed steel conduit. When cutting an external thread on to pipes, and in particular, metal conduits used for electrical applications, a "Warragul" Die Set is used. A Warragul Die fits into a special single handle stock that has a ratchet action, of which, is reversible. The stock also incorporates a Metal Guide insert which is made to suit the different sized conduits. Electrical conduit comes in metric sizes only, ranging from 16mm up to 63mm outside diameter.

26. The metric thread which is cut is unique to electrical conduit in that the **"Pitch"** of the thread is set at **1.5mm** for all sizes and as with all metric threads the **"Angle"** of the thread is set at **$60^0$**. Also like the Button Die the marked side of the Warragul Die faces away from the work when starting the thread.




A Warragul Die has a square appearance unlike the Button Die which has a circular appearance.

**Die Nut**

27. A die nut is a non-adjustable hexagonal die used for cleaning damaged threads. They are designed to be turned with a normal spanner. Die nuts should not be used to cut new threads because they can split.

**Use of Dies**

28. Chamfer the material slightly before starting to cut an external thread.

Always make sure the thread is started squarely.

Use an appropriate cutting compound when cutting a thread. Always read the label before use. The cutting compounds for internal or external thread cutting are generally the same as those used for drilling, i.e.

| | |
|---|---|
| Mild Steel | Soluble Oil or Trefolex |
| Copper | Soluble Oil |
| Brass | Soluble Oil |
| Aluminium | Soluble Oil |
| Bronze | Soluble Oil |
| Cast iron | Dry |

29. It can be helpful if threads are started using a tri-square, so as to align the tool square to the work piece, this is important so that the thread runs parallel to the hole or shaft.

30. A “Die Nut” can be used to clean up dirty or damaged external threads, they are not intended to start or cut a new thread.

**Stripped Threads**

31. If an internal thread in a machine is stripped so that the fastener will no longer hold it can be repaired by:

a. Drilling the hole out and re-tapping it for the next larger size of thread, and using a larger fastener.

b. Drilling and tapping the hole to a larger thread size and screwing a new piece of metal (of the same type) into it. The original side of thread can then be drilled and tapped in the insert. A commercially produced liquid (LOCTITE) is available to help retain the insert in position permanently.

c. Drilling the hole out, tapping it with a special tap, and fitting a commercially produced thread insert (HELICOIL) of the original size.

**Broken Bolts or Studs**

32. If a bolt or stud breaks off close to the surface of a machine, it can sometimes be removed by tapping it around gently with a centre punch or small cold chisel and hammer.

33. If the broken bolt cannot be removed with a centre punch, drill a hole down through the centre of the broken bolt and use a screw extractor (Easyout) of the appropriate size in a suitable tap wrench. The hole should be drilled so that it is slightly smaller than the minor diameter of the broken bolt. A screw extractor has a left hand thread mechanism and it will grip in the hole and remove the broken portion of the bolt when turned anticlockwise.

## Selected Thread Data - Metric and Imperial
## Tapping Drills and Threads per Inch

| | | Tapping Drills and Threads per Inch | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BSW (55°) | | BSF 55°) | | UNC (60°) | | UNF 60°) | | BA (47.5°) | |
| Selected Threads | Tapping Drill | Drill | TPI | Drill | TPI | Drill | TPI | Drill | TPI | Drill | Pitch |
| **M2 x 0.4 (60°)** | **1.6** | | | | | | | | | | |
| 8 BA (2.2 mm) | | | | | | | | | | 1.8 | 0.43 |
| 7 BA (2.5 mm) | | | | | | | | | | 2.0 | 0.48 |
| 6 BA (2.8 mm) | | | | | | | | | | 2.3 | 0.53 |
| **M3 x 0.5** | **2.5** | | | | | | | | | | |
| 5 BA (3.2 mm) | | | | | | | | | | 2.6 | 0.59 |
| 1/8" (3.18 mm) | | 2.5 | 40 | | | 2.6 | 40 | 2.6 | 40 | | |
| 4 BA (3.6 mm) | | | | | | | | | | 3.0 | 0.66 |
| 5/32" (3.97 mm) | | 3.2 | 32 | | | 3.3 | 32 | 3.3 | 32 | | |
| **M4 x 0.7** | **3.3** | | | | | | | | | | |
| 3 BA (4.1 mm) | | | | | | | | | | 3.4 | 0.73 |
| 2 BA (4.7 mm) | | | | | | | | | | 4.0 | 0.81 |
| 3/16" (4.76 mm) | | 3.7 | 24 | 4.0 | 32 | 3.8 | 24 | 4.1 | 32 | | |
| **M4.5 x 0.75** | **3.8** | | | | | | | | | | |
| **M5 x 0.8** | **4.3** | | | | | | | | | | |
| 1 BA (5.3 mm) | | | | | | | | | | 4.5 | 0.9 |
| **M6 x 1.0** | **5.1** | | | | | | | | | | |
| 0 BA (6.0 mm) | | | | | | | | | | 5.1 | 1.0 |
| 1/4" (6.35 mm) | | 5.1 | 20 | 5.3 | 26 | 5.2 | 20 | 5.5 | 28 | | |
| **M7 x 1.0** | **6.1** | | | | | | | | | | |
| 5/16" (7.94 mm) | | 6.5 | 18 | 6.8 | 22 | 6.6 | 18 | 6.9 | 24 | | |
| **M8 x 1.25** | **6.9** | | | | | | | | | | |
| **M8 x 1.00 (Fine)** | **7.1** | | | | | | | | | | |
| **M9 x 1.25** | **7.9** | | | | | | | | | | |
| 3/8" (9.53 mm) | | 7.9 | 16 | 8.3 | 20 | 8.1 | 16 | 8.5 | 24 | | |
| **M10 x 1.5** | **8.6** | | | | | | | | | | |
| **M10 x 1.25 (Fine)** | **8.9** | | | | | | | | | | |
| 7/16" (11.11 mm) | | 9.5 | 14 | 9.5 | 18 | 9.5 | 14 | 10 | 20 | | |
| **M12 x 1.75** | **10.4** | | | | | | | | | | |
| **M12 x 1.5 (Fine)** | **10.5** | | | | | | | | | | |
| 1/2" (12.7 mm) | | 10.5 | 12 | 11 | 16 | 11 | 13 | 11.5 | 20 | | |
| 1/2" Brass (26) | 11.8 | | | | | | | | | | |
| **M14 x 2.00** | **12.2** | | | | | | | | | | |
| **M14 x 1.5 (Fine)** | **12.5** | | | | | | | | | | |
| 9/16" (14.29 mm) | | 12 | 12 | 12.5 | 16 | 12.2 | 12 | 12.8 | 18 | | |
| 5/8" (15.68 mm) | | 13.5 | 11 | 14 | 14 | 13.8 | 11 | 14.5 | 18 | | |
| 5/8" Brass (26) | 14.75 | | | | | | | | | | |
| 16 mm Conduit | 14.75 | | | | | | | | | | |
| **M16 x 2.00** | **14.25** | | | | | | | | | | |
| **M16 x 1.5 (Fine)** | **14.5** | | | | | | | | | | |
| **M18 x 1.5 (Fine)** | **16.5** | | | | | | | | | | |
| 3/4" (19.05 mm) | | 16.5 | 10 | 16.5 | 12 | 16.5 | 10 | 17.5 | 16 | | |
| 3/4" Brass (26) | 18.0 | | | | | | | | | | |
| **M20 x 2.5** | **17.8** | | | | | | | | | | |
| **M20 x 1.5 (Fine)** | **18.5** | | | | | | | | | | |
| 20 mm Conduit | 18.5 | | | | | | | | | | |
| 25 mm Conduit | 23.5 | | | | | | | | | | |

Notes: Metric threads are Isocoarse unless otherwise noted.
All Brass threads are 26 threads per inch.

1" = 25.4 mm
1 mm = 0.039 37"

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|---|---|---|---|

**Threads and Thread Cutting**

1. What is a screw pitch gauge used for?

2. In what units is thread pitch measured for metric threads?

3. What is the name of the tool which can be used to remove a broken stud or bolt?

4. What is a template used for?

5. List five common vee thread forms.

6. If a given standard bolt had a diameter of 10 mm when measured at the un-threaded part, and a pitch of 1.5 mm, what would be the 'major diameter' of the bolt?

7. What three main dimensions or characteristics of the thread on a bolt must be known in order to be able to correctly identify the thread?

8. What is the thread angle for a metric vee thread?

9. Convert 2 inches to millimetres.

10. What is the PITCH of an M10 x 1.5 metric thread?

11. What are the two most common categories of metric thread?

12. What dimension is normally used to specify the size of the head of a hexagon headed metric bolt?

13. What dimension is normally used to specify the size of the head of hexagon headed UNF bolt?

14. What dimension is normally used to specify the size of the head of a modern hexagon headed BSW or BSF bolt?

15. What is a typical code marking used to identify a high tensile steel bolt?

16. What is the purpose of a spring or star washer when used with a threaded fastener?

17. If a spring washer is to be used with a typical nut and bolt, should the washer be fitted under the nut or under the head of the bolt?

18. What are the three types of parallel flute hand taps which made up a typical set?

19. What type of die should be used only to clean or recondition an existing thread?

20. Can worn out taps or dies usually be sharpened by hand?

21. What type of tap should be used to START a new thread?

22. What type of hand tap should be used to FINISH the thread in a blind hole?

23. What type of thread die has no provision for thread depth adjustment?

24. What undesirable situation can arise if a hand tap is not 'backed off' at least once every half turn or less?

25. Is it usually possible to remove a broken tap from a hole if it breaks as a result of careless tapping?



 

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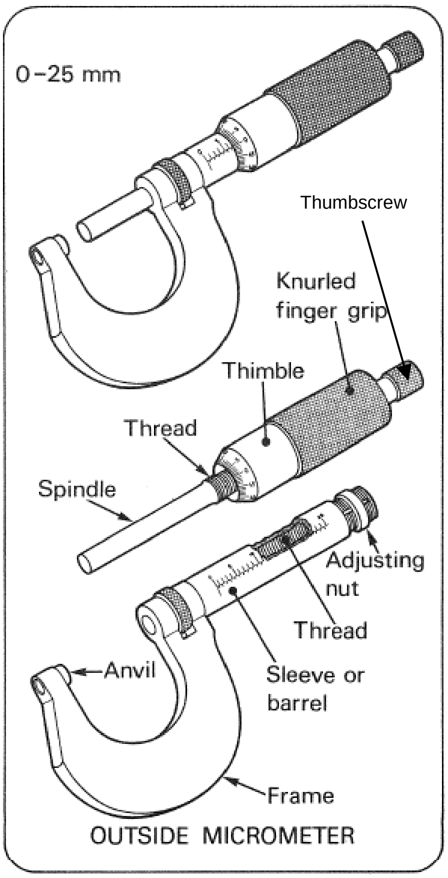
**Metric Micrometers and Vernier Callipers**

**The Micrometer**

1. The micrometer calliper is a precision measuring instrument which can give reliable readings correct to 0.01 mm. They are available for measuring outside dimensions (outside micrometers), inside dimensions (inside micrometers), depths (depth micrometers) and other types for special purposes.




2. Micrometers are available in both metric and imperial sizes. The size of a micrometer is taken as the range of measurements it has been designed to handle - such as 0-25 mm, 25-50 mm, 75-100 mm, 0-1" (inch) and so on.

3. The discussion in this module is specifically related to the 0-25 mm metric micrometer, although the principle of reading a metric micrometer scale can be applied to any other type.

4. A micrometer has an extremely accurate internal thread mechanism which has a pitch of exactly 0.5 mm. One complete revolution of the thimble causes the gap between the spindle face and the anvil to move 0.5 mm.

5. The thimble has a precisely graduated scale which has 50 divisions, so each division on the thimble represents a movement between the measuring faces of 1/50th of 0.5 mm which is 0.01 mm (1/100 of a mm).

**Reading a Metric Micrometer**

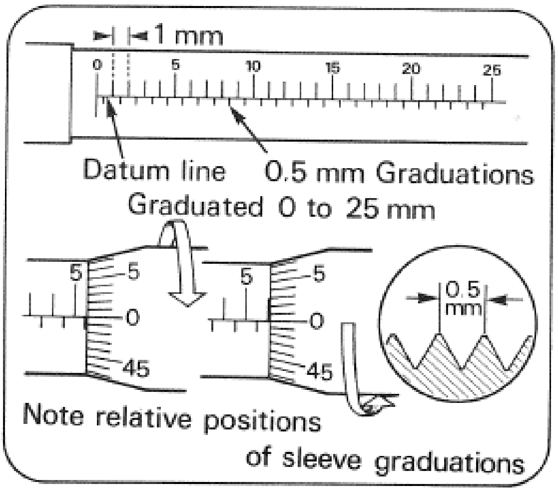
6. All metric micrometer scales are read in the same way, although there are minor variations in the way the scales are marked. The sequence for a typical reading is as follows:

a. Always use the thumbscrew to tighten jaws around the object to be measured.

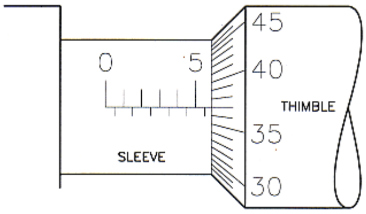
b. Note the number of divisions exposed on the sleeve scale, bearing mind that the divisions below the datum line are 0.5 mm.

c. Note the number of divisions indicated on the thimble scale at the datum line - each division is 1/50th of a mm or 0.01 mm.

d. Add the two readings together.



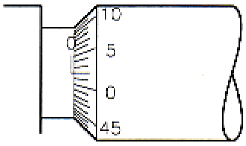
7. Typical reading:

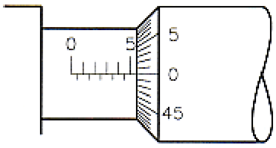


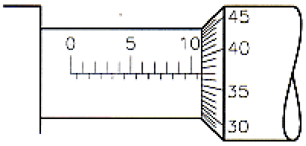

Top sleeve scale = 5.00 mm
Bottom sleeve scale = 0.50 mm
Thimble scale = 0.37 mm
Total 5.87 mm (final reading)

or: Sleeve reading = 5.50 mm
Thimble reading = 0.37 mm
Total 5.87 mm (final reading)

8. **Exercises:** Determine the readings on the micrometer scales shown below:

1



2



3
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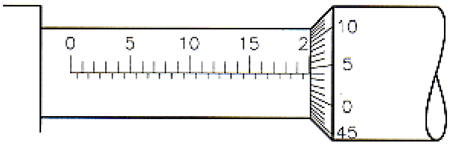



9. Most micrometers are supplied with a small 'C' spanner to enable small adjustments to be made to the position of the datum line on the sleeve scale. A small hole is provided in the sleeve to suit the spanner. Back off the distance between the anvil faces before attempting to adjust the position of the sleeve scale.

**Care of Micrometers**

10. Micrometers must be treated with care or they will lose their accuracy, therefore:

a. Use a clean cloth or thick clean paper to clean the measuring faces prior to use. Do not wipe the measuring faces with your fingers as this may cause them to corrode.

b. Do not store a micrometer with the measuring faces touching as this may distort the frame.

c. Do not use a micrometer on a dirty surface as this will not provide an accurate reading.

d. Do not use a micrometer on a work piece in a lathe while the machine is running, it may catch and cause an injury.

e. Do not pre-set the micrometer and try to force it over the work piece, again this may distort the frame.

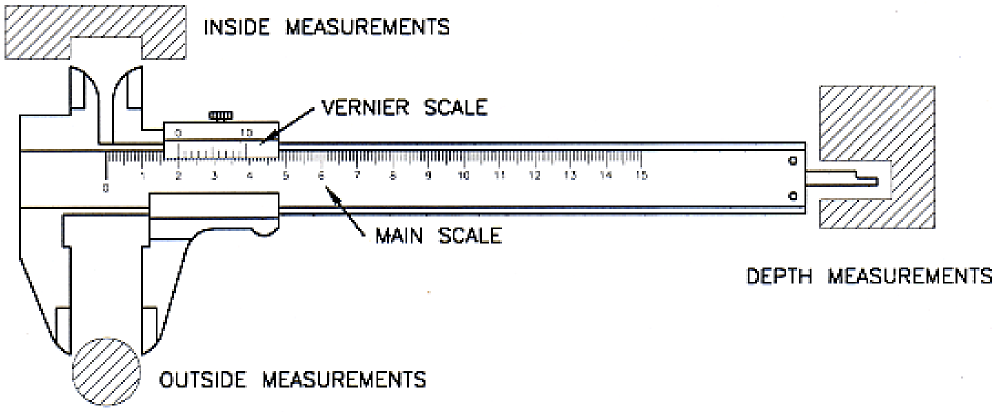
f. Do not over tighten a micrometer, always use the thumbscrew when taking measurements.

g. Check the micrometer for zero each before use.

h. Keep the micrometer clean, very lightly oiled and in its original box.

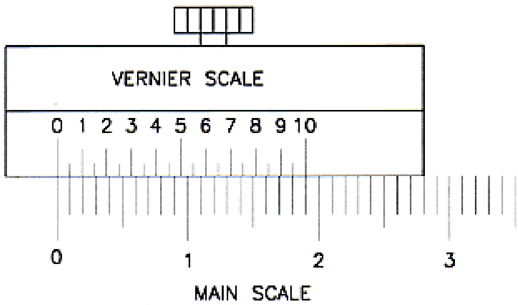
**Vernier Callipers**

11. A Vernier Calliper is a precision instrument for making accurate linear measurements. The type illustrated below can be used to make **outside** measurements, **inside** measurements and **depth** measurements. Several other measuring or marking out devices incorporate a Vernier scale to provide greater accuracy.




A Typical Vernier Calliper.

12. Vernier Callipers have two scales - a main scale and a Vernier scale. The Vernier scale slides parallel to the main scale and enables readings to be made to a fraction of a division on the main scale. The number of divisions on the Vernier scale varies with different models of Callipers. Common Vernier Callipers are graduated from 0-10, 0-25 or 0-50, depending on the accuracy for which the tool has been designed. A typical reading is shown below:




A typical Vernier Calliper reading.

13. The reading on the scale is taken as follows:

a. Read the main scale to the left of the zero on the Vernier scale (in mm).

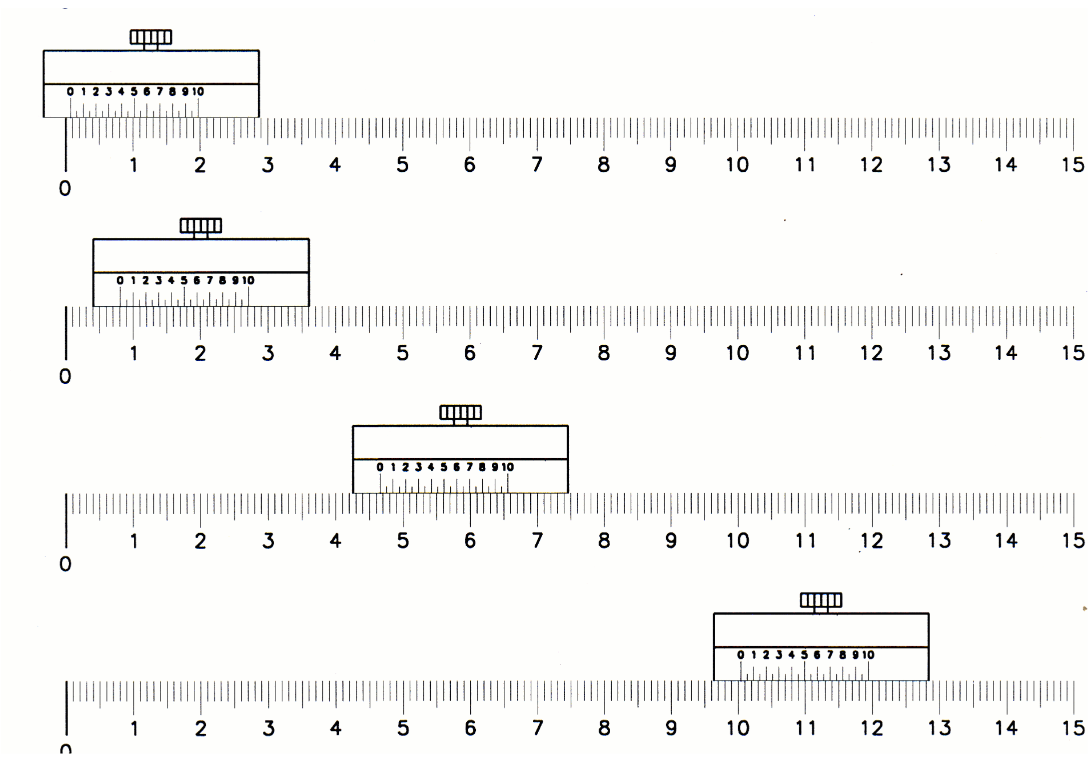
b. Determine which graduation on the Vernier scale lines up with a graduation on the main scale (taking 10 on the Vernier scale as equivalent to 1 mm).

c. Add the two readings together

d. Check the reading by estimating the position of the 0 on the Vernier scale in relation to the division before and after it on the main scale. In this case it is just over half way between 14 mm and 15 mm so the reading is correct.

14. **Exercises:** Determine the readings on scales shown below:

Note: Vernier Scale has accuracy down to 0.05mm (20 x ½ divisions of 0.05mm = 1.0mm)



Vernier Calliper reading exercises.

**Other Vernier Scales**

22. Some Vernier Callipers have Vernier scales divided into either 25 or 50 equal parts. These types allow measurements to be taken with an accuracy of 0.02 mm

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|---|---|---|---|

**Metric Micrometers and Vernier Callipers**

1. What is the distance between the graduations on the sleeve scale of a 0-25 mm outside micrometer?

2. How many divisions are there on the THIMBLE scale of a 0-25 mm outside micrometer?

3. How far does the spindle move away from the anvil for one anticlockwise revolution of the thimble of a metric outside micrometer?

4. Why is it undesirable to store a 0-25 mm outside micrometer with the measuring faces touching each other?

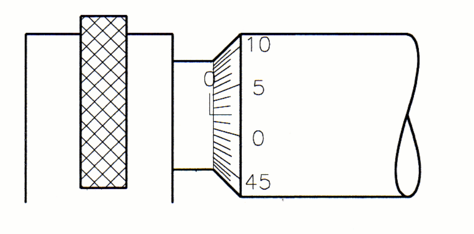
5. If the thimble on a 0-25 mm outside micrometer is rotated anticlockwise for one marked division, how far apart will the measuring faces move?

7. What check should be carried out on an 0-25 mm outside micrometer each time it is used?

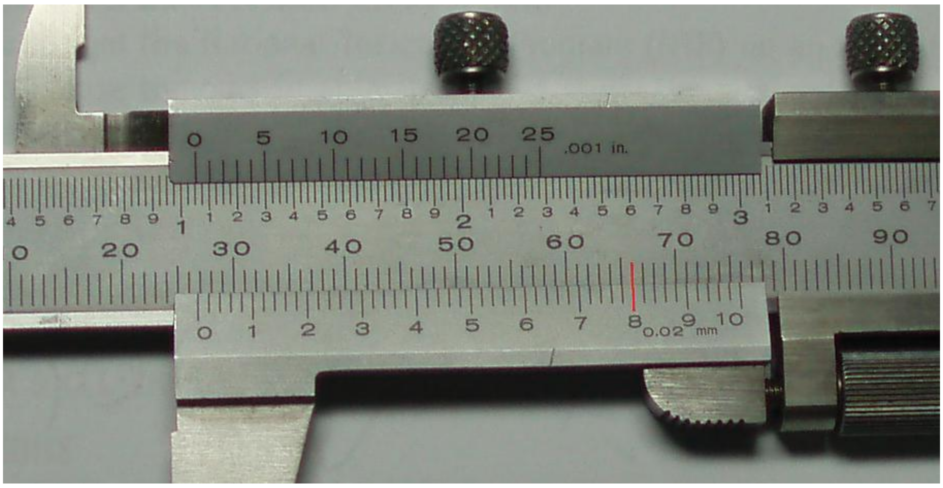
8. What type of spanner is required to adjust the zero position of the datum line on the sleeve scale of a micrometer?

9. What three types of measurement can be made with a typical 200 mm general purpose Vernier Calliper?

10. What is the reading on the metric micrometer scale shown below:



11. What is the reading on the metric Vernier Calliper scale shown below:




12. Give the reading for the micrometer below.

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| --- | --- | --- | --- |

## Manufacture a Drill Angle Gauge

### Objective

To manufacture a brass drill angle gauge to the given dimensions using hand tools.

### Equipment

155 mm of 25x3 mm brass bar.
300 mm steel rule.
300 mm hand hacksaw with a 24 point blade.
Junior hacksaw.
150 mm spring dividers.
150 mm engineer's tri square.
150 mm scriber.
100 mm centre punch.
150 mm odd-leg calipers.
Combination set with protractor head.
Marking blue.
Drills and taps for metric Isocoarse threads - M3, M4, M5 and M6.
Tee tap wrench.
Tapping drill tables.
2 mm twist drill.
Thread cutting compound (Trefolex or similar).
Hand files as required.
Portable electric drill.
Fine emery cloth.
1.5 mm letter and number stamps.
250 gram ball pein hammer or similar.
Workbench with vices.
Wooden filing block.
Working drawing of a Drill Angle Gauge (attached).
15 mm taper shank twist drill or similar.
Safety equipment as required.

### Procedure

1. File one edge and one end of the brass bar so that they are flat and square - finish by draw filing.

2. Apply a thin film of marking blue to the workpiece and allow it to dry.

3. Mark out the drill angle gauge, using the filed edges as datum lines. Note: When scribing lines, always carry the line through for at least 2 mm at each end so that each corner is an intersection of two lines rather than junction of two end points.

4. Check all of your measurements for accuracy.

5. Have your marking out checked by your Lecturer.

6. Determine the sizes of the tapping drills required for the metric Isocoarse threads (from a Tapping Drill Table) and obtain the drills.

7. Secure the workpiece in a suitable vice and drill all holes with a small portable electric drill.

8. Tap the metric Isocoarse threads.

9. Cut and file the workpiece to shape and finish all edges by draw filing.

10. Have your workpiece checked by your Lecturer.

11. Mount your workpiece in a filing block and draw file both faces. Finish all surfaces with fine emery cloth.

12. Have your workpiece checked by your Lecturer.

13. Make a small cut with a junior hacksaw at each of the 2 mm markings on the 53 degree angle edge.

14. Mark the M3 to M6 threads with letter and number stamps (practice on a piece of scrap metal before you attempt to mark your workpiece). Stamp your initials on your workpiece.

15. Submit your finished drill angle gauge (with a 15 mm taper shank twist drill) to your Lecturer for comment and assessment.

16. Return all of the equipment to its proper place.

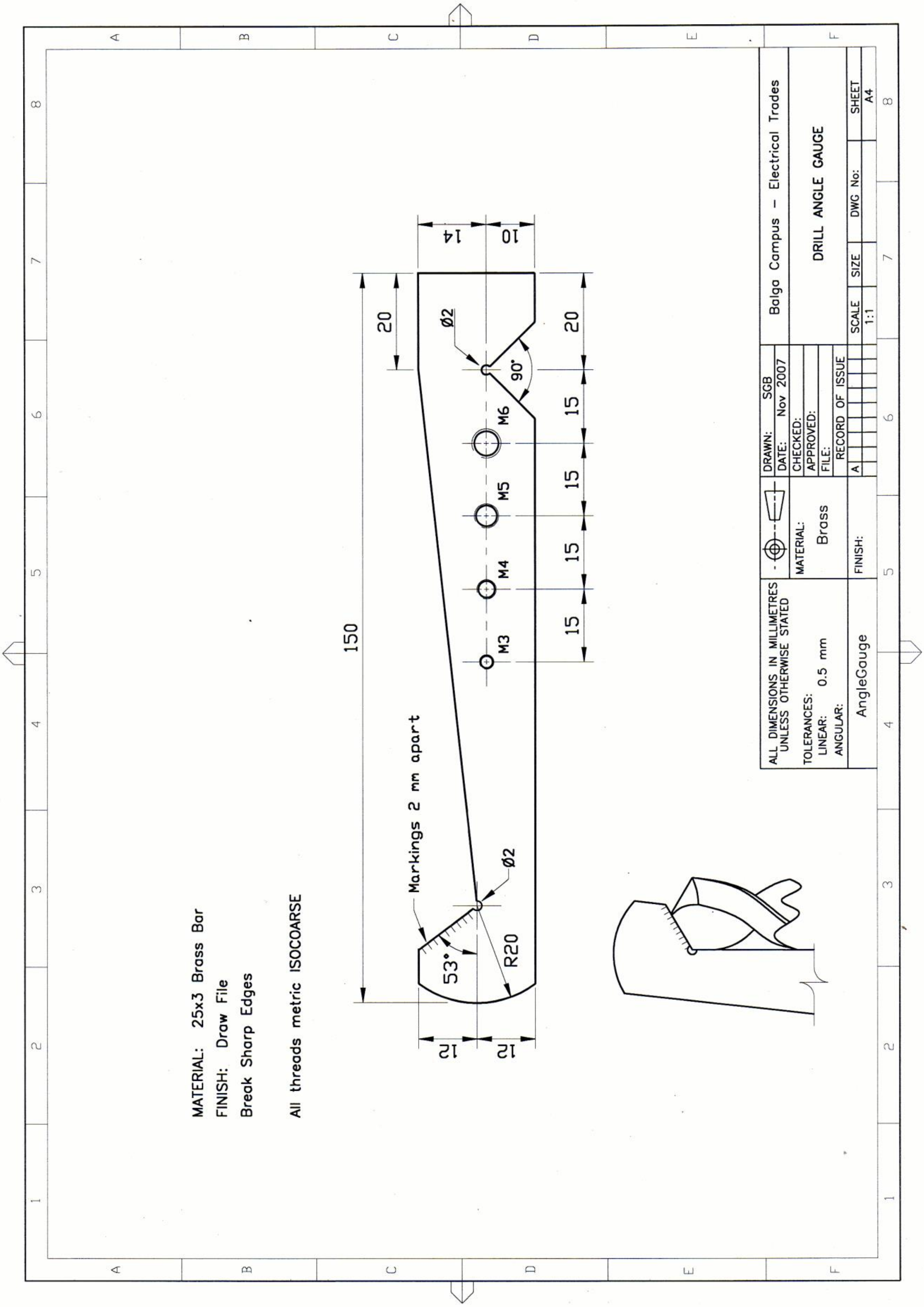
Assessment Task 1 (Drill Angle Gauge):

| Satisfactory: | | | Not Satisfactory: | |
|---|---|---|---|---|

Lecturer: ______________________________ Date: ______________




MATERIAL: 25x3 Brass Bar
FINISH: Draw File
Break Sharp Edges
All threads metric ISOCOARSE
Markings 2 mm apart
53°
R20
Ø2
150
20
90°
M3
M4
M5
M6
15
14
10
12
ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE STATED
TOLERANCES:
LINEAR: 0.5 mm
ANGULAR:
AngleGauge
MATERIAL:
Brass
FINISH:
DRAWN: SGB
DATE: Nov 2007
CHECKED:
APPROVED:
FILE:
RECORD OF ISSUE
Balga Campus - Electrical Trades
DRILL ANGLE GAUGE
SCALE 1:1
SIZE
DWG No:
SHEET A4

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|---|---|---|---|

**On the Job Tasks**

**Objective**

To perform a series of individual tasks on a jobbing basis. Look for these at your workplace and ask if you can be given a hand by your tradesperson or supervisor.

**Equipment**

Hand tools and materials as required.
Prepared samples of common metals.
Metalworking file display board.
Thread Tapping Charts (metric and imperial).
A 90 x 40 mm piece of 5 mm PVC sheet

**Procedure**

Select the correct tools as required and perform each of the following jobbing tasks. Have each of the tasks checked by your Lecturer as soon as you have completed it. Note that the tasks can be completed at various times during the course of this module.

1. Identify the following metals in the samples provided. [ ]

   a. Black mild steel
   b. Bright mild steel
   c. Cast iron
   d. Copper
   e. Brass
   f. Aluminium
   g. Stainless steel

2. Identify the following metalworking files and state 'size' of each. [ ]

   a. Hand file
   b. Flat file
   c. Warding file
   d. Millsaw
   e. Half round file
   f. Round file
   g. Triangular file
   h. Square file

3. Give a complete working description of each of the hand tools provided (Size - Type - Tool). [ ]

4. Cut an M10 thread for a length of 30 mm on a length of round mild steel bar. [ ]

5. Fit a new blade to a 300 mm hand hacksaw. [ ]

6. Select an appropriate hacksaw and make a square cut in a piece of 25 mm screwed steel conduit. [ ]

7. Distinguish between a single start right hand thread and a left hand thread. [ ]

8. Clean a damaged thread with a suitable die nut. [ ]

9. Make a running thread in 20 mm steel screwed conduit. [ ]

10. Remove a broken bolt which has sheared off flush with the surface of a piece of mild steel. [ ]

11. Drill and tap an M8 thread in the centre of a 25 x 6 mm . aluminium workpiece. [ ]

12. Drill and tap an M12 thread in a brass workpiece. [ ]

13. Fit and remove an M10 threaded stud. [ ]

14. Cut a 1/2" BSW thread for a length of 20 mm on a length of 1/2" round brass rod . [ ]

15. Remove a seized M8 nut with a flat cold chisel. [ ]

16. Sharpen two different twist drills using a pedestal grinder. [ ]

Note: Some of these tasks may be completed at your workplace if appropriate equipment and supervision are available.

Assignment:

| Satisfactory: | | | Not Satisfactory: | |
|---|---|---|---|---|

Lecturer: ______________________________ Date: ________________



 

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|---|---|---|---|

## Identifying Threaded Fasteners

### Objective

To identify the threaded metric and imperial fasteners supplied.

### Equipment

Sample threaded fasteners.
300 mm steel rule, or
Vernier Calliper, or
0-25 mm metric micrometer, or
150 mm spring outside calipers.
Screw pitch gauge sets - Metric, Whitworth, Unified, BA
Thread Charts - attached.

### Procedure

1. Identify each of the threaded fasteners provided and record the details of each in the Table below:

Results Table

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Major diameter (mm) and (inches) | | | | | | |
| Pitch (mm) or Threads per Inch | | | | | | |
| Thread form | | | | | | |
| Length | | | | | | |
| Material | | | | | | |
| Type of head | | | | | | |

1"=25.4 mm

2. Have your results checked by your Lecturer.

3. Return all of the equipment to its proper place.

Assignment:

| Satisfactory: | | Not Satisfactory: | |
|---|---|---|---|

Lecturer: ______________________________ Date: ______________

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|---|---|---|---|

**Using a Metric Micrometer**

## Objective

To measure the appropriate dimensions of an object using a 0-25 mm metric micrometer.

## Equipment

0-25 mm metric micrometer
Micrometer adjusting spanner
Sample stepped parallel drift
Sample object to measure

## Procedure

1. Check the zero setting of the micrometer and adjust the position of the sleeve scale if required.

2. Measure all diameters on the stepped parallel drift supplied and record your results.

   Diameter 1: _____________
   Diameter 2: _____________
   Diameter 3: _____________
   Diameter 4: _____________
   Diameter 5: _____________
   Diameter 6: _____________

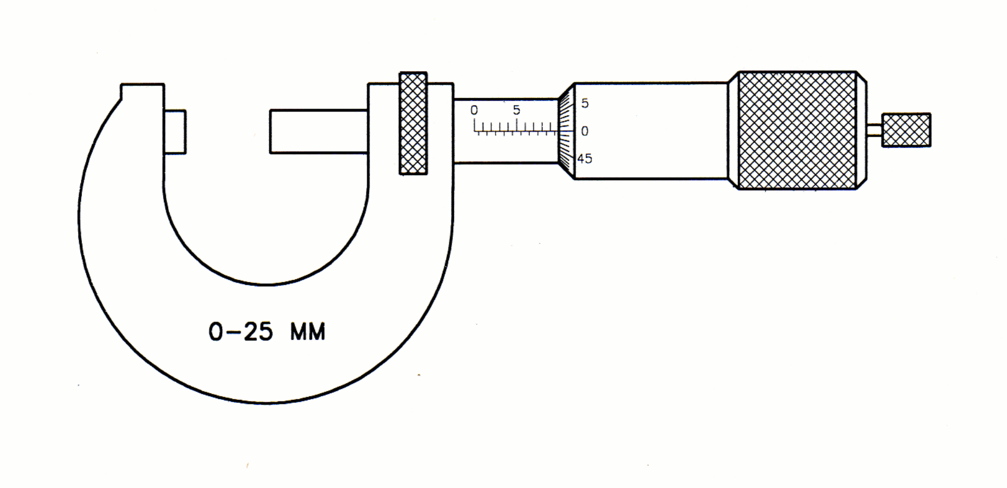
3. Measure all possible dimensions on the workpiece supplied and record your results. Draw a neat freehand pencil sketch of the object and show the measured dimensions.

4. Have your results checked by your Lecturer.

5. Return all of the equipment to its proper place.

**Questions**

1. Label the major parts of the micrometer shown below.




2. What degree of accuracy can be achieved with the micrometer shown above?

________________________________________________

3. How many divisions are on the thimble scale of a metric micrometer?

________________________________________________

4. How many millimetres are there between numbered divisions on the sleeve scale of a metric micrometer?

________________________________________________

5. What are four of the factors which need to be considered when caring for a micrometer?

________________________________________________
________________________________________________
________________________________________________
________________________________________________

Assignment (Using a Micrometer):

| Satisfactory: | | | Not Satisfactory: | |
|---|---|---|---|---|

Lecturer: ____________________________________ Date: ________________

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| --- | --- | --- | --- |

**Using a Vernier Calliper**

## Objective

To measure the appropriate dimensions of an object using a metric Vernier Calliper.

## Equipment

0-200 mm metric Vernier Calliper or similar
Sample stepped parallel drift.
Sample objects to measure (outside, inside and depth measurements)

## Procedure

1. Count the number of divisions on the Vernier scale of the Vernier Calliper and calculate the degree of accuracy of the tool.

_______________________________________________________

2. Measure all diameters on the stepped parallel drift supplied and record your results.

Diameter 1: ___________
Diameter 2: ___________
Diameter 3: ___________
Diameter 4: ___________
Diameter 5: ___________
Diameter 6: ___________

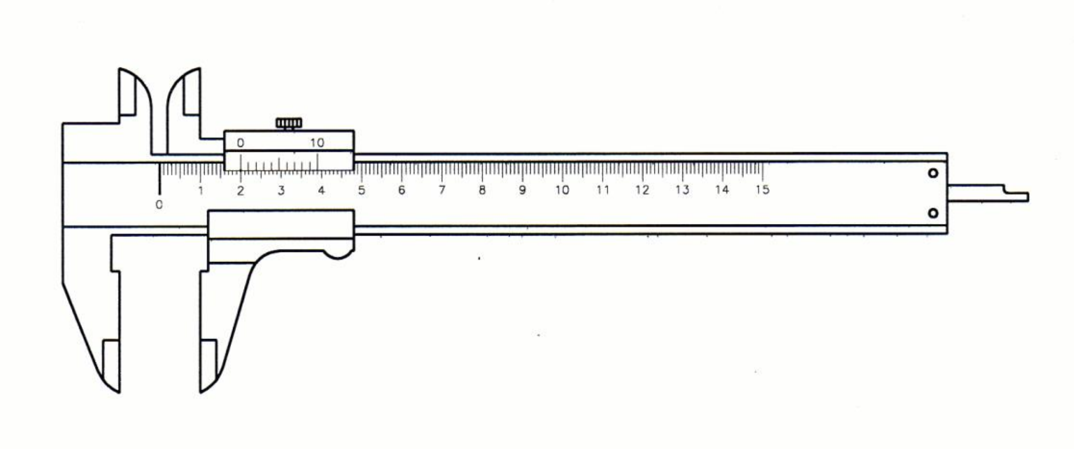
3. Measure all possible dimensions on the workpieces supplied and record your results. Draw a neat freehand pencil sketch of the objects and show the measured dimensions.

4. Have your results checked by your Lecturer.

5. Return all of the equipment to its proper place.

**Questions**

1. Label the parts of the Vernier Calliper shown below to indicate the part of the tool used to take outside measurements, inside measurements and depth measurements.




2. What degree of accuracy can be achieved with the Vernier Calliper shown above?

______________________________________________

3. How many divisions are on the Vernier scale of the Vernier Calliper used for this project?

______________________________________________

4. How many millimetres are there between numbered divisions on the main scale of the Vernier Calliper used for this project?

______________________________________________

5. What are two of the factors which need to be considered when caring for a Vernier Calliper?

______________________________________________

______________________________________________

Assignment (Using a Vernier Calliper):

| Satisfactory: | | | Not Satisfactory: | |
|---|---|---|---|---|

Lecturer: ______________________________ Date: ____________



## Safe Use of Power Tools

1. Portable power tools can be more dangerous than fixed machine tools because they are more mobile, so you need to take extra care when using them.

2. Typical portable power tools used in industry include various types of:

Angle grinders
Chipping hammers
Circular saws
Electric drills
Electric shears
Electric screwdrivers
Hammer drills
Jigsaws
Nibblers
Nut runners
Portable grinders
Orbital sanders
Percussion fixing tools
Wall chasing saws
Impact wrenches
Electric soldering irons

3. Portable power tools are available in two main types - those driven by electric motors and those driven by compressed air (pneumatic)

4. Most electric power tools expose the user to electrical hazards as well as mechanical hazards such as rotating or reciprocating cutting blades or other parts. On the other hand compressed air (pneumatic) tools have special hazards such as high noise emission and dangers associated with the unintentional or careless release of compressed air.

5. The following rules apply to the use of most portable power tools:

a. Always use appropriate safety equipment such as safety boots, safety glasses, hearing protection, helmets, hair restraints, lung protection where applicable.

b. Do not wear loose clothing when using power tools.

c. Do not skylark.

d. Handle heavy equipment and machinery using correct lifting techniques; lift with your legs, not your back; get a firm grip on the object; do not lift by a movable part; beware of sharp edges and corners; do not twist your spine when lifting; maintain a correct balance.

e. Keep rotating spindles, blades and wheels away from your body.

f. Do not put a rotating machine down until the blade or wheel has stopped.



g. Make sure that all guards are in place around moving components.

h. Use protective screens to protect others where applicable.

i. Make sure that the power tool is the correct one for the task.

j. Do not use tools which have an out-of-service tag fitted to them.

k. Do not use electrical power tools which have frayed or damaged cords.

l. Do not use electrical power tools in wet conditions.

m. Make sure that the work is rigidly clamped or can not move while you are working on it.

n. Do not use electrical power tools when the power cord is coiled on a drum or reel.

o. If you suspect that a power tool may be unsafe, report it to your supervisor immediately - if your supervisor is not available attach an out-of-service tag to it and do not use it.

p. Do not fit a wheel or saw which is larger than the size recommended for a particular power tool.

q. Make sure you have a firm grip and proper balance when you are using power tools - the torque of a jammed tool can cause serious injury.

r. Do not leave power tools lying around when they are not in use -coil the cord or hose up and store it away.

s. Do not attempt to remove or adjust the blade or wheel on a power tool without disconnecting the tool from the supply.

**Typical Power Tools**

6. There are many different types of power tools, several manufacturers, and different sizes and types of each tool. The detailed specifications and instructions for safe use for each tool can be obtained from manufacturers' handbooks, catalogues and brochures.

**Sustainable Energy**

7. Sustainable energy management is a process in which renewable natural resouces such as sunlight, wind, stored water, tides, geothermal heat, and biofuels are used to generate energy to supplement energy produced by burning fuels such as coal, oil, natural gas and wood. Burning fuels results in unwanted pollutants being released into the atmosphere.

8. The main principle of sustainable energy management is to make use of natural or renewable energy resources where possible, particularly in the high energy areas of lighting, heating and cooling of buildings. Another principle is to ensure that the energy produced is used in the most efficient way with minimum wastage. Heating of a building may be supplemented by wall or ceiling insulation, lighting may be supplemented by skylights, ventilation may be supplemented by opening windows, building orientation may reduce heating requirements and so on. Electricians need to be aware of these considerations so that they can apply energy efficient practices to workplace situations and provide informed advice to customers on such matters when required.



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|---|---|---|---|

**Safe Use of Power Tools**

1. List one essential piece of PPE that must be used whenever operating a power tool?

2. List four other items of PPE that may be required when using portable power tools.

3. When using a portable grinder, what basic checks should you carry out before using it?

4. When using any power tool, what basic electrical checks must be carried out before use?

5. What are two possible hazards if a portable drill jams in a workpiece?

6. Name six types of power tools frequently used within the Electro-technology industry.

7. Prior to replacing a blade or cutting tool on any power tool what essential precaution must be taken?

8. What simple sustainable energy principle should always be observed when working with power tools?

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|---|---|---|---|

**Sheet Metal Fabrication Techniques**

1. Metal is available in sheet form in thicknesses ranging from a fraction of a millimetre to several centimetres. For the purposes of this module 'sheetmetal' is regarded as ferrous (containing iron) or non-ferrous metals in sheet or roll form with a thickness of up to about 2 millimetres. Typical sheet sizes are 900 x 1800 mm, 900 x 2400 mm and 1200 x 2400 mm.

**Typical Tasks Involving Sheetmetal**

2. Tradespersons in the electrical/electronic industry are often required to perform tasks which involve the use of sheetmetal such as:

a. Installing cable tray, busways, troughing and ducting.

b. Manufacturing or modifying sheetmetal switchboard or control panel enclosures and associated fittings.

c. Manufacturing or modifying boxes or cabinets for equipment such as portable power supplies.

d. Saddling or fixing cables, conduits, ducting and so on.

e. Manufacturing or modifying escutcheon plates for switchboards.

f. Manufacturing or modifying panels for measuring instruments.

g. Manufacturing or modifying sheetmetal guards for electrical machinery.

h. Mounting components in enclosures using DIN rail or G rail pre-formed sheetmetal products.

i. Working with laminations in electromagnetic devices such as motors and transformers.

j. Manufacturing or modifying metallic chassis for mounting of the internal components in electronic equipment.

**Characteristics of Sheetmetal**

3. There are numerous types of sheetmetal products for various purposes. You need to be aware of the characteristics of the general characteristics of each type so that you can select an appropriate material for a given situation. The type of material selected for a particular task needs to have appropriate characteristics which could include:

a. Adequate mechanical strength for the job, without being excessive.

b. Appropriate resistance to corrosion.

c. The ability to be worked with the available tools and equipment.

d. Minimum cost consistent with other requirements.

e. Suitability in terms of appearance of the finished product.

f. Appropriate magnetic characteristics (magnetic or non-magnetic).

g. Appropriate electrical characteristics (such as conductivity between joined surfaces).

h. The ability to be able to be arc welded, soldered or brazed.

i. Functionality in terms of the necessity to see inside an enclosure without allowing contact with internal components.

j. Functionality in terms of the necessity to allow for ventilation without allowing personal contact with internal components, or the unintended ingress of dust, moisture or other contaminants.

k. Appropriate fire resistance.

l. Appropriate mass (or weight).

m. The ability to accept an appropriate type of functional or decorative surface finish such as electroplating or paint.

n. The ability to resist electrolytic corrosion between the material and fasteners or other associated equipment.

**Specifying Thickness of Sheetmetal**

4. The thickness of sheetmetal is usually expressed in millimetres or decimal fractions of a mm. However, before the introduction of the metric system the most common method of expressing thickness was using a numerical system of measurement for wires and sheetmetal known as the Imperial Standard Wire Gauge (SWG). Some local manufacturers still use the term 'gauge' when referring to thickness in mm, and overseas manufacturers in non-metric countries use 'gauge' although it is not always SWG - it can be, for example, the American Wire Gauge (AWG or B&S) which is not the same as SWG. The following table gives a sample to illustrate how equivalent sheet thicknesses are specified in three different systems.

| Sheet Thickness | | |
|---|---|---|
| Metric (mm) | SWG (Gauge) | Inches |
| 4.064 | 8 | 0.160 |
| 3.251 | 10 | 0.128 |
| 2.642 | 12 | 0.104 |
| 1.626 | 16 | 0.064 |
| 0.914 | 20 | 0.036 |
| 0.193 | 36 | 0.0076 |

25.4 mm = 1 inch

**Types of Sheetmetal**

5. Sheetmetal is used in a wide range of situations in the electrical/electronic industry. It is important to be able to determine the type of sheetmetal so that you can use the appropriate tools and techniques when installing or modifying equipment. In most cases it is possible to identify a particular type of sheetmetal by considering each of the following characteristics - you will be given the opportunity to learn to identify common materials in the practical component of this section:

a. The COLOUR of the metal.
b. The SHAPE of the component.
c. The SURFACE TEXTURE of the metal.
d. The MASS (or weight) of the component.

6. Typical uses for various common types of sheetmetal used in the electrical/electronic industry are given below. It would be useful if you added to the list from your own experience.

| | |
|---|---|
| Standard flat mild steel (MS) | Large switchboard enclosures<br>Control panel enclosures<br>Equipment supporting straps<br>Cable tray and troughing<br>Escutcheon plates<br>Gland plates for panel enclosures<br>Motor starter enclosures<br>Metallic enclosures for appliances |
| Perforated flat MS | Perforated cable tray<br>Guards on rotating machinery<br>Covers on ventilation openings |
| Embossed MS | Decorative enclosures |
| Wood grain MS (one side only) | Decorative enclosures<br>Escutcheon plates |
| Colorbond MS (painted both sides) | Luminaires<br>Roofing<br>Wall cladding |
| Zinc coated MS (galvanised) | Domestic switchboard enclosures<br>DIN rail<br>Unistrut mounting rail<br>Conduit saddles<br>Cable tray and troughing<br>Metallic wall boxes<br>In-plaster mounting plates<br>Escutcheon plates<br>Metallic enclosures for appliances<br>Busways<br>Sheetmetal angle iron<br>Roofing<br>Corrosion resistant enclosures |


 

| | |
|---|---|
| Stainless steel (standard) | Corrosion resistant enclosures |
| (mirrored) | Reflective surfaces |
| Aluminium (there are many grades) | Low-mass enclosures<br>Reflective surfaces<br>Chassis for electronic equipment<br>Escutcheon plates for switchboards<br>Roofing |
| Copper | MIMS cable saddles<br>Shims for mounting machinery<br>Buried earthing plates<br>Water tanks |
| Transformer/motor iron (Stalloy) | Transformer laminations<br>Motor laminations<br>AC electromagnetic relay cores<br>AC contactor relay cores |

**Fabrication Techniques**

7. This section relates to sheetmetal fabrication techniques as they apply to the installation of typical cable tray and the manufacture or modification of simple sheetmetal enclosures and other components likely to be found in the electrical/electronic industry.

**Safety**

8. The handling of sheetmetal requires special care because sharp edges and corners are usually common. You should use leather gloves when handling large sheets to avoid cutting yourself, and use lifting aids where necessary. If the sheet is awkward to handle you should seek assistance. When you are working with sheetmetal on a bench you should make sure that the edges of the metal do not project beyond the edge of the bench when unattended - the sharp edges are a safety hazard to others.

**Sheetmetal Tools and Equipment**

9. The type of hand tools and machines required for sheetmetal fabrication depends on the size of the job, the type of job and the location - i.e. on-site or in a workshop. Access to the following tools and equipment would enable you to perform most of the tasks you would be likely to encounter, but the machines would only be available if you are in a workshop with basic fabrication facilities.

a. A 300 mm steel rule.

b. A 3 or 5 metre measuring tape.

c. A junior hacksaw.

d. A 300 mm hand hacksaw with a fine (32 point) blade.

e. A fixed or portable work bench.

f. A try square - which includes a 45 degree head.



 

g. A scriber for accurate marking out - a pencil is not generally satisfactory.

h. A 1 metre straight edge or similar.

i. A pair of straight tinsnips.

j. A selection of metal cutting files to shape metal and 'break' sharp edges.

k. A 0-25 mm outside micrometer or Vernier Calliper for measuring sheet thickness.

l. Combination pliers for gripping parts.

m. Vice-grip pliers for gripping parts while they are drilled.

n. Clamps to clamp components in position while they are being aligned or drilled.

o. A centre punch for accurate positioning of holes.

p. A pair of spring dividers to mark circles.

q. A pair of odd-leg calipers to mark a line parallel to an edge.

r. A ball pein hammer to shape the sheetmetal - with a selection of small hardwood blocks so that direct contact between the hammer and the workpiece can be avoided.

s. A wooden mallet.

t. A pop riveting tool and a selection of pop rivets.

u. A set of sheetmetal hole saws for cutting round holes.

v. A set of sheetmetal punches (chassis punches) for cutting round holes in thin sheetmetal.

w. A fly cutter for cutting large round holes.

x. A hand nibbler for shaping square holes.

y. A string line and chalk to mark long straight lines.

z. A plumb bob to accurately position vertical components.

aa. A spirit level or line level to accurately position horizontal components.

bb. A portable drilling machine with a selection of drills.

cc. A bench drilling machine.

dd. A bench mounted hand shear to cut the sheetmetal.

ee. A foot operated guillotine to cut sheetmetal and give a straight edge.

ff. A hand operated sheetmetal folding machine (bending brake) with adjustable fingers.



 

**Marking Out**

10. One of the most critical operations when working with sheetmetal is marking out - if the job is not marked out accurately it is unlikely that you will achieve a satisfactory outcome.

11. If you need to mark out a three dimensional object (such as a box) on a two dimensional plane (such as a piece of flat sheetmetal) you need to mark out the shape as a 'development'. A development or developed view is a view which shows all surfaces opened out flat or unfolded. Figure 1 shows an oblique view of a small sheetmetal box and the corresponding development at a scale of 2:1. The dotted lines on the development represent the lines along which the material is to be folded - in this case all folds are inwards.

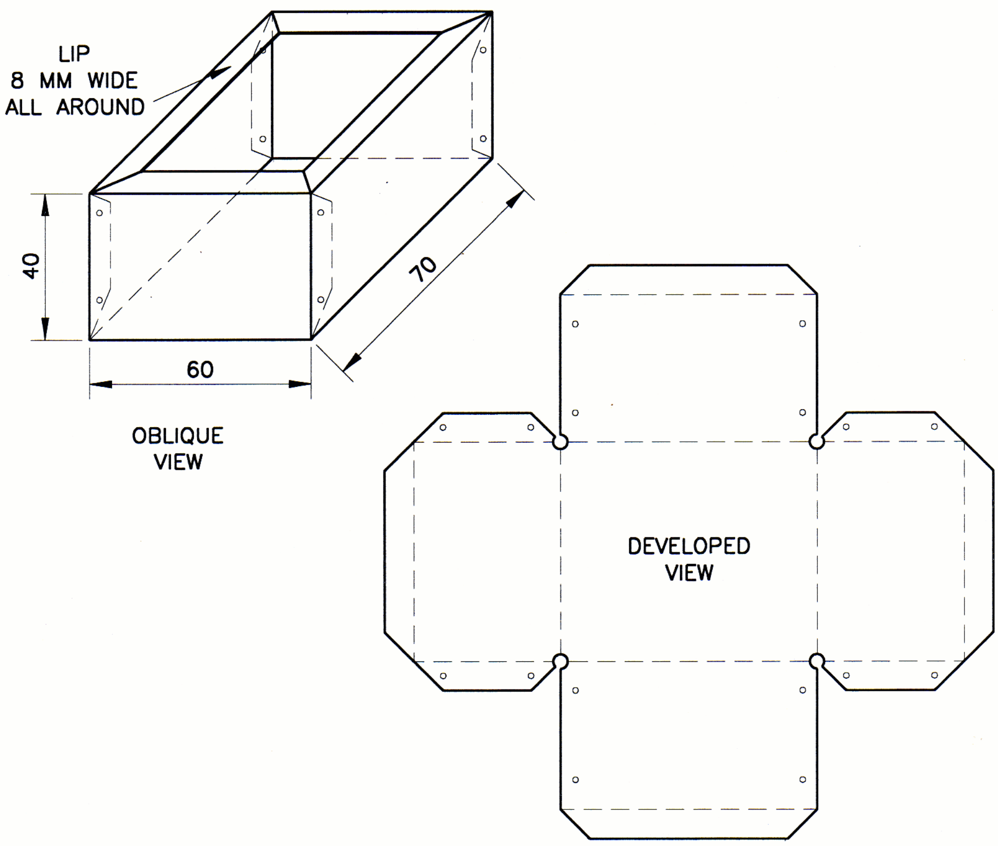


Figure 1 - Oblique view and the corresponding development.

12. Figure 2 shows how the development was constructed. A critical feature of this type of development is the need to begin by constructing a horizontal datum line and a vertical datum line - all subsequent measurements should be taken from either of these two lines.

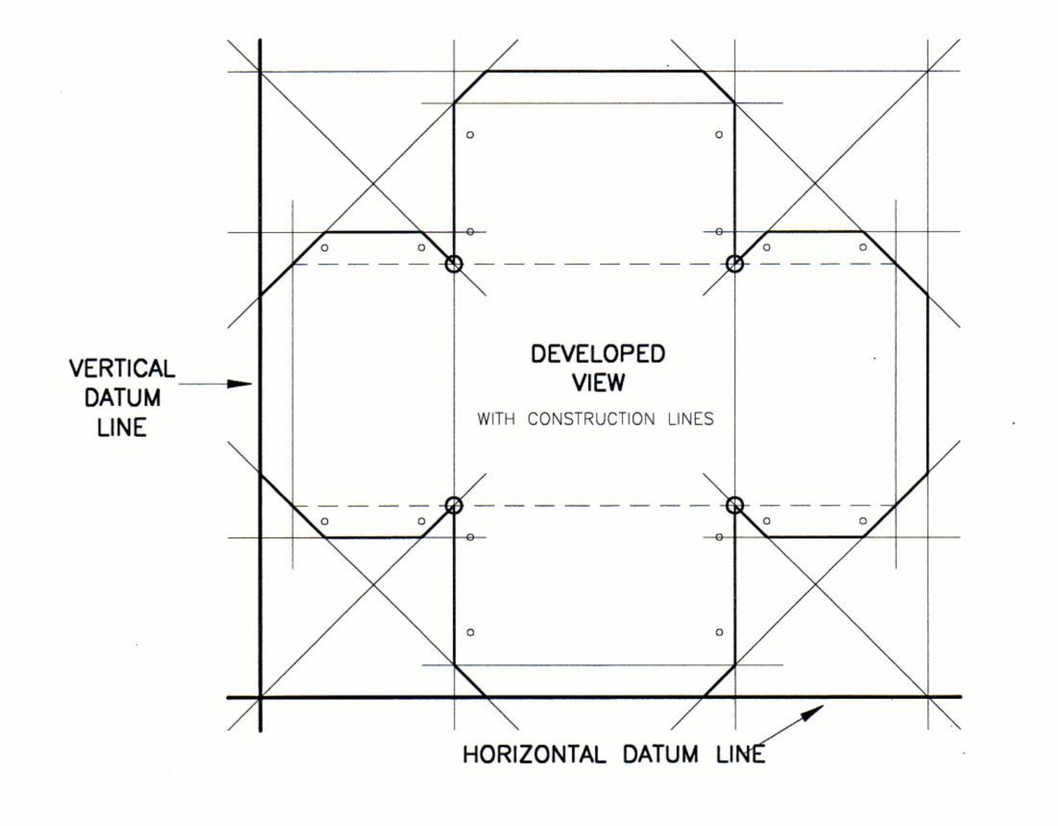


Figure 2 - Construction of a development of a box.

13. If the sheetmetal has a straight edge, that edge can be used as a datum line. If the metal has two straight edges which appear to be at right angles (90 degrees) to each other the edges can be used as the datum lines, but you must check to see that the angle between them is in fact a right angle.

14. It is a common practise to drill a small hole at the junction of intersecting fold lines - this makes it easier to cut and fold the sides.

15. **Exercise** Draw a development of the box shown in Figure 1 on a sheet of A4 paper. Use Figure 2 as a guide, but draw your development full size. When you have drawn the development, cut it out and fold the paper to the required shape to check that your marking out has been accurate.

**Working with Cable Tray**

16. There are several different types of cable tray, ducting or troughing. Most types have special fittings for use where the tray changes direction or terminates, but if such fittings are not available you would need to fabricate them yourself. The remainder of this section gives an outline of how the basic shapes are constructed using plain cable tray - you will be fabricating them in the practical section of this module. The most common shapes are:

a. A butt joint.
b. A down turn.
c. An internal mitre.
d. An external mitre.

**A Butt Joint**

17. A butt joint is where the cable tray is to be joined in a straight line. Some types of cable tray have a small difference in width between one end and the other so that they can be joined with a lap butt joint. If this is not the case a butt joint and sleeve can be used. The length of the overlap or the joining sleeve are not critical, but about a 50 mm overlap is customary for a lap joint and about a 100 mm sleeve is customary for a butt joint. The general arrangement of both joints is shown in Figure 3.

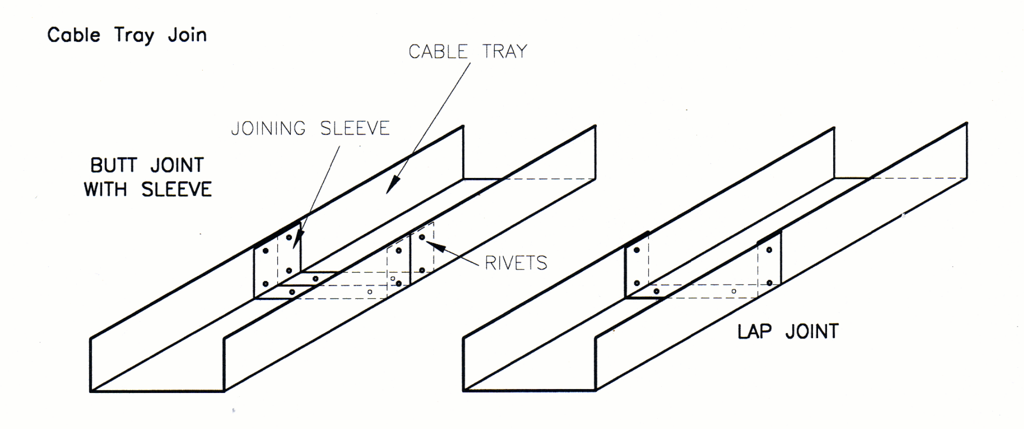


Figure 3 - Typical butt and lap joints in cable tray.

**A Down Turn**

18. A typical down turn is where a horizontal cable tray is to change direction downwards. A typical down turn is shown in Figure 4. The dimensions of the gussets are not critical, but they need to be at least as deep as the cable tray, with an overlap of about 50 mm on each side of the cut in the tray. The angle of the down turn is critical so it should be carefully checked before you fix the gussets in place.

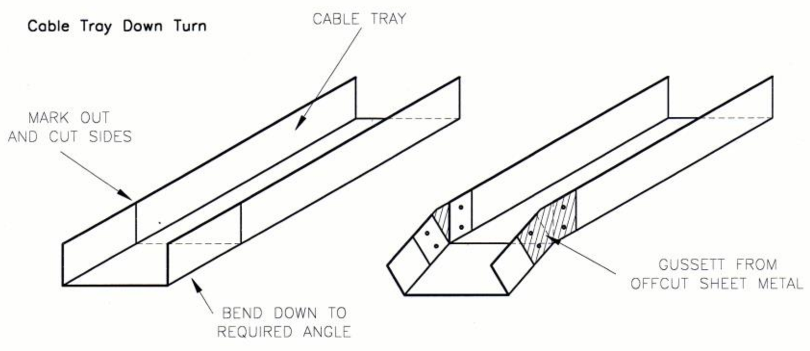


Figure 4 - A typical down turn in cable tray.

**A Stop End**

19. A stop end is a term used to describe where a cable tray terminates outside an enclosure. A typical stop end is shown in Figure 5. Notice that a top stiffening lip is used in addition to the riveted lips.

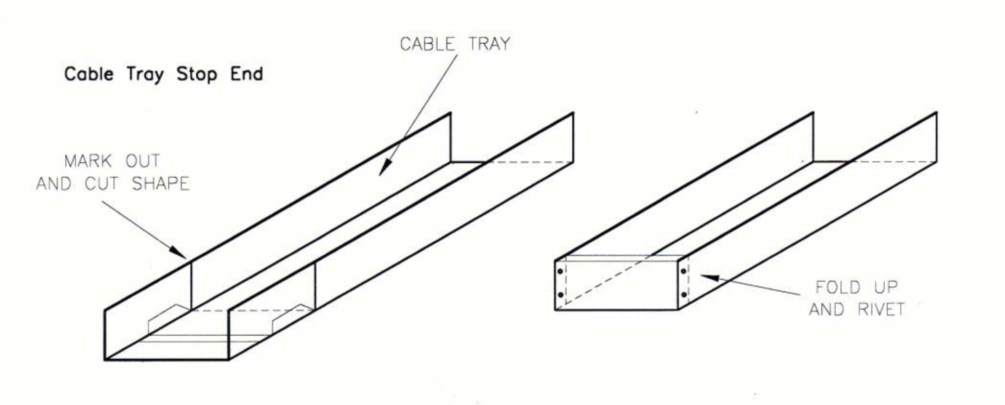


Figure 5 - A typical stop end in cable tray.

**A Mitre**

20. A typical mitre is where a horizontal cable tray is to change direction horizontally at right angles. There are two basic types - a typical internal mitre and an external mitre are shown in Figure 6.

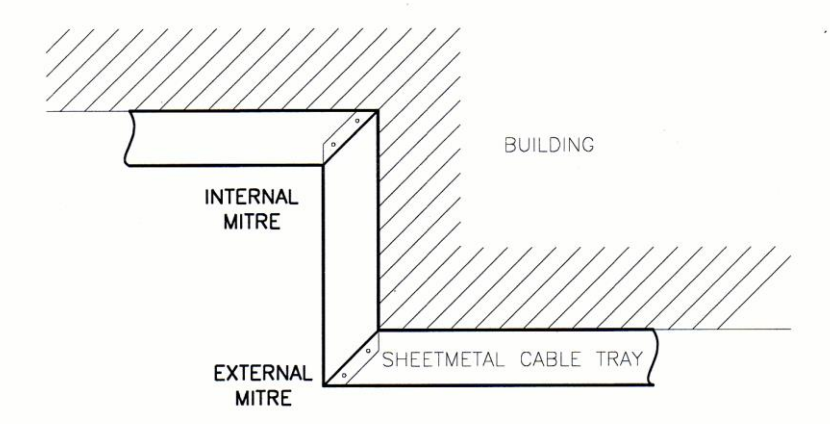


Figure 6 - An internal and an external mitre in cable tray.

21. The basic technique can be the same for both types, but you need to take special care when marking out an external mitres because you will probably be marking it out upside-down. The construction of a typical mitre is shown in Figure 7.

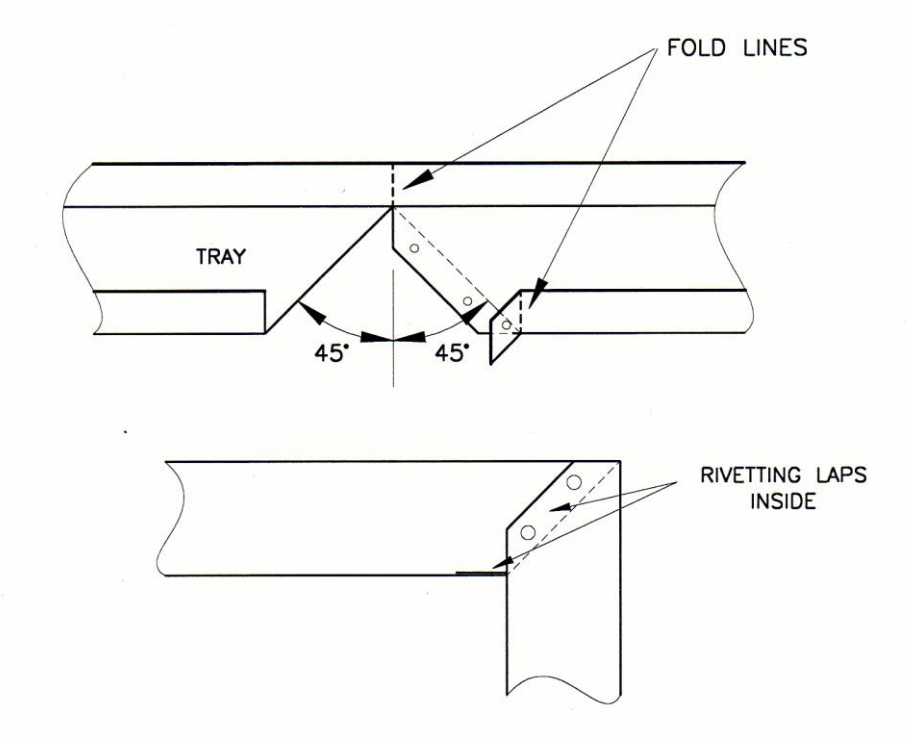


Figure 7 - Typical construction of a mitre in cable tray.

**Installation of Cable Tray**

22. When you are installing cable tray you should always use a spirit level or a line level to check to see that the tray is horizontal and vertical as appropriate. A plumb bob can also be used to check a tray for vertical. If you need to mark a long straight line you could use a chalked string line.

**Cutting and Bending Sheetmetal and Cable Tray**

23. Thin sheetmetal can be cut with tinsnips, but thicker material usually needs to be cut with a junior hacksaw or a 300 mm hand hacksaw with a 32 point blade. Cutting sheetmetal with a guillotine always produces a cleaner edge than tinsnips so a guillotine should be used where possible.

24. A bending machine with adjustable fingers is the preferred method of bending sheetmetal. If a bending machine is not available the bends should be made between blocks of hardwood. If you have to use a hammer when forming a bend you should always place a hardwood block between the hammer and the work to avoid marking the workpiece (or you should use a wooden mallet).



 

**Cutting Holes in Sheetmetal and Cable Tray**

25. Drilling holes in thin material with a standard twist drill over about 6 mm in diameter is a very hazardous operation unless proper precautions are taken to avoid the drill 'grabbing' in the hole. If the point of a standard twist drill breaks through the work before the outer corners of the cutting edges have begun to cut the drill is almost certain to grab. This problem can be avoided by:

a. Sandwiching the sheetmetal between two pieces of thick metal and clamping them in place before commencing to drill.

b. Grinding the twist drill so that it has shallower point angle (about 140 degrees).

c. Using a special 'dowelling' drill or a twist drill ground to approximately the same shape.

26. For larger round holes in sheetmetal you should use a tool other than a twist drill, such as:

a. A metal punch (or chassis punch).

b. A hole saw (a circular hacksaw blade in a special arbor.

c. A fly-cutter in a pedestal drill.

27. In all cases you need to be aware of the potential hazards associated with making holes in sheetmetal, and you need to make sure that the workpiece is rigidly clamped so that it can not move.

28. If you need a square or rectangular hole in thin material you can cut an initial hole with, say, a hole saw, then cut it to the required shape with a hand or power operated 'nibbler'.



 

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**Sheet Metal Fabrication Techniques**

1. How is the thickness of sheetmetal specified in metric units?

2. Name four different types of sheetmetal used in the electrical/electronic industry and give one common use for each.

3. What are four major characteristics which usually enable a particular type of sheetmetal to be identified.

4. Give one example of a method of referring to the thickness of a particular piece of sheetmetal which does not involve the use of the preferred metric system.

5. In what type of situations would you expect the sheetmetal known as 'Stalloy' to be found.

6. What is the main advantage of using zinc plated mild steel sheet compared to a non-plated mild steel?

7. What light corrosion resistant metal is commonly used as the chassis for mounting electronic components inside

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**Manufacture Tool Box from Sheet Metal**

Objective: Manufacture a Tool Box from Sheet Metal

Resources: 1 piece of Zinc plated Sheet metal - 600 x 300mm
Hand tools for sheet metal work
Foot Guillotine
Hand Guillotine
Manual and Electric Bending machines
Portable power tools such as a drill
Electrical conduit threading equipment
Drill bits, hole-saws and chassis punches

Procedure:
Refer to the attached development view of a sheet metal Tool Tray.

1. Measure the thickness of the standard zinc coated MS sheet provided using a micrometer.
   MS sheet diameter measured with Micrometer : ________mm

From the standard sheet size provided determine the best method of cutting out the overall *tool tray* template using sustainable work practices to minimize wastage.
Have this checked by your Lecturer before cutting. Using **Guillotine Safe Operating Procedure** cut out overall shape on Guillotine.

2. Clearly mark out developed view of *tool tray* using scriber, odd leg callipers, steel rule and combination square. Cut-out and fold marks should be identified.

3. Use a *centre punch* for all holes to be drilled. Drill holes using *drill press* and correct size metal twist drill and 20mm whole saw for handle mounting hole.

4. Fold safe edges with hand bender and hammer flat using appropriate size *ball pein* hammer. Bend up sides using *hand* and *Magna benders*.

5. Clamp tabs with *vice grips* and drill correct size holes for pop rivets with electric pistol drill. Fit pop rivets with pop rivet gun.

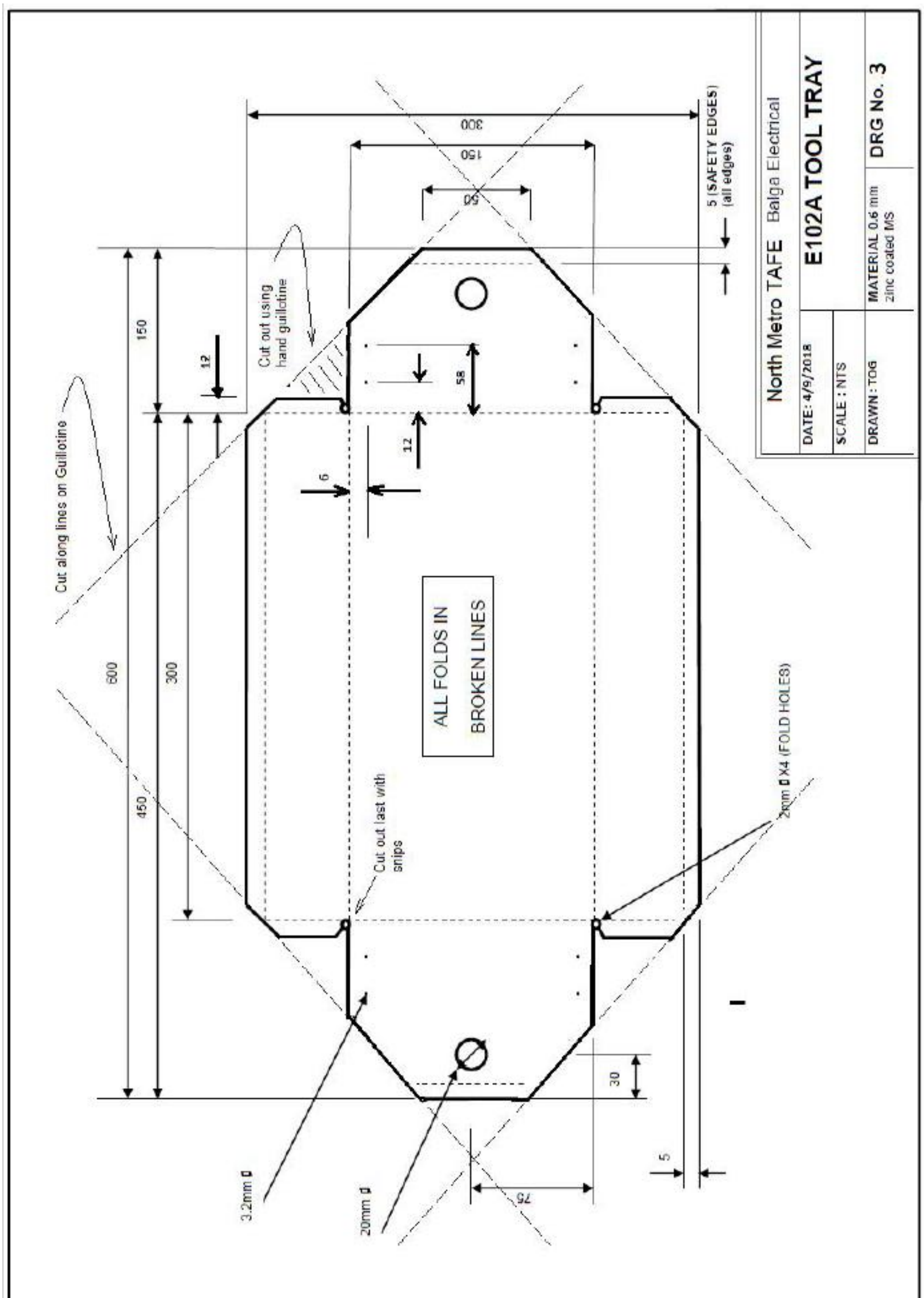
6. Using 20mm steel conduit cut handle to correct length with hacksaw with 24 pitch blade. Using appropriate cutting compound (Trefolex or similar) thread both ends using *Warragul stock and die*. Fit handle using PVC lock rings and female bushes.

7. Present project to Lecturer for assessment.

Assessment Task 2 (Manufacture Tool Box):

| Satisfactory: | | | Not Satisfactory: | |
|---|---|---|---|---|

Lecturer: ________________________________________ Date: ________________


North Metro TAFE Balga Electrical
E102A TOOL TRAY
DATE: 4/9/2018
SCALE : NTS
DRAWN : TOG
MATERIAL 0.6 mm
zinc coated MS
DRG No. 3
ALL FOLDS IN
BROKEN LINES
Cut along lines on Guillotine
Cut out using
hand guillotine
Cut out last with
snips
5 (SAFETY EDGES)
(all edges)
2mm Ø X4 (FOLD HOLES)
3.2mm Ø
20mm Ø
300
150
50
600
450
300
150
12
58
12
6
30
5
75



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**Component Dismantling and Assembly**

1. A major part of the activities of an electrical tradesperson is the dismantling and re-assembly of components for various reasons. Typical reasons include:

a. Routine inspection.
a. Routine service - for preventative maintenance purposes.
b. Temporary emergency repairs.
c. Breakdown.
d. Major inspection and overhaul.

2. The degree to which the component is dismantled depends on the purpose of the action. If it is a routine service, parts of the component may be left intact; if it is a major overhaul all parts will usually have to be dismantled; if it is a breakdown you would focus only on those components which need attention to return the machine to normal service.

3. In most cases it is relatively easy to dismantle the component - it is much more difficult to re-assemble it correctly. Careful and systematic attention to detail during the dismantling process is the key to correct re-assembly.

4. For the purposes of this module we will assume that the component is small enough to be handled on a workbench, and that it is to be dismantled for a major inspection and overhaul. We will assume that the component has been removed from its normal location and transported to the workshop for the inspection and overhaul.

**Dismantling**

5. A typical general procedure for dismantling a component could be as follows:

a. Make sure you have the right component.

b. Examine the component and record the details contained on the nameplate. If the component has no nameplate, make a note of the type of component and any identifying information which may be available. Enter the information on a service record card is one is available (check with your supervisor to see if a previous service record card is available). Draw a neat sketch of the connections if applicable.

c. Plan the job. Examine the component and see how it has been assembled (as far as possible), and what tools will be required initially. Prepare a Job Safety Analysis (JSA).

d. Mark the components so that they can be re-assembled in their correct position if it is possible that they could be replaced in another position (particularly cable lugs). The method of marking parts depends on the nature of the job, but typical methods of marking include using a felt pen, identifying parts with masking tape, marking parts with a prick punch, marking parts with letter stamps, and typing labels for parts. The marking must not deface any external surface, and you need to consider whether the marking is likely to be unintentionally removed during the servicing process (for example, markings made with a felt pen could be removed if the parts are to be cleaned in solvent).

e. Obtain a suitable parts tray to hold the parts as they are removed.

f. Assemble the necessary hand tools and make sure they are in a serviceable condition.

g. Dismantle the component paying careful attention to the relationship between the parts. Where possible circlips, keys, screws, bolts, nuts and washers should be temporarily replaced to reduce the possibility of them being lost. Watch out for screws or bolts which have the same thread but different lengths. Pieces of copper wire are often useful for keeping related parts together (such as spacing washers on a shaft or for wiring cable lugs together). Sensitive parts should be protected where necessary - for example brushes should be placed in a container, commutators should be covered with brown paper, ball and roller bearings should be covered with clean cloth and close-fitting machined parts should be placed where they are not likely to be damaged.

h. When dis-assembling precision parts, a light force may be applied using a soft-head hammer to dislodge them from their seated position.

6. It is sometimes necessary to leave a component in a dismantled condition for a prolonged period while spare parts are obtained, or the person who dismantles the component may not be the person who re-assembles it. Under these conditions problems associated with re-assembly are reduced if careful attention has been paid to the identification of individual parts during dismantling.

**Inspection**

7. When the component has been dismantled the parts should be thoroughly cleaned and inspected for damage or excessive wear.

**Re-assembly**

8. The procedure for re-assembly is basically the reverse of the dismantling procedure. If careful attention has been paid to the procedures for identifying related parts, assembly should be relatively straight forward. All gaskets and seals should be replaced if possible.

9. Always take care not to damage or “bruise” machined parts on re-assembly, use a soft-head hammer or drift to prevent damage.

10. If the component is to be subjected to severe vibration during service it is desirable to replace all spring washers during a major overhaul.

11. Most of the screws, nuts and bolts on a typical machine can be tightened to an appropriate tension by hand if the person has been adequately trained. However, in some cases such as bolts for bearings or busbars, a torque wrench (tension wrench) is required. Most hand tools used for tightening screws, nuts and bolts are designed in such a way that the possibility of over-tightening is minimised if they are used by a trained person; it is an unsafe practice to use non-standard accessories to increase the leverage on a spanner.

12. It is unacceptable to have spare parts such as screws, nuts and washers left over after a component has been re-assembled.

13. The final stage of the re-assembly procedure is to clean up all work-marks off the component and to record details of all work done on the service record card.

14. Return all tools to their respective storage place and thoughtfully dispose of waste materials.

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**Component Dismantling and Assembly**

1. Why should all parts of a component be placed in a parts tray if the component is being dismantled?

2. What action can be taken to reduce the possibility of screws, nuts and bolts being misplaced during dismantling of a component?

3. What action can be taken to reduce the possibility of several adjacent spacing washers being re-assembled in the wrong sequence during a servicing operation?

4. What action should be taken to reduce the possibility of damage to sensitive components such as commutators, bearings and brushes during dismantling of a component?

5. What is the disadvantage of temporarily marking parts with a felt pen during dismantling of a component?

6. What action should be taken if you are unsure about how to proceed with a particular task?

7. What is the purpose of a JSA?

| | | | |
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**Dismantle and Assemble a Component**

**Objective**

To dismantle and assemble a given component using hand tools.

**Equipment**

A typical component found in the electrical industry, for example:

An electric motor or generator.
A magnetic contactor or motor starter.
A portable power tool.
A small petrol engine.
A small machine.

Hand tools and sundry items as required.
Parts tray.
Manufacturer's information if applicable.
Sample Service Record Card.

**Procedure**

1. Examine the component supplied (or provide you own if you wish), and enter the identifying information on the Service Record Card.

2. Plan the job. Discuss the job with your Lecturer.

3. Dismantle the component using hand tools. Make sure that you place all components in the parts tray, and use appropriate marking procedures where applicable.

4. Discuss the dismantling procedure with your Lecturer.

5. Re-assemble the component.

6. Enter appropriate information on the Service Record Card.

7. Have your re-assembled component and your Service Record Card checked by your Lecturer.

8. Return all of the equipment to its proper place.

Assessment Task 3 (Dismantle and re-assemble a Component):

| | | | |
|---|---|---|---|
| Satisfactory: | | Not Satisfactory: | |

Lecturer: ____________________________ Date: ______________



 

**Service Record Card**

Technician: ______________________________ Date: ______________

Equipment Description: _______________________________________________________

Owner: _______________________________________________________

Enter N/A if not applicable and attach a separate sheet if required:

Reason for Service: _________________________________________________________

Symptoms of Fault: _________________________________________________________
_________________________________________________________

Work Required: _________________________________________________________

Nameplate Details: _________________________________________________________
_________________________________________________________
_________________________________________________________
_________________________________________________________
_________________________________________________________

Terminal Markings:

Connection Diagram:

Drive shaft diameter: ________________________________________________

Pulley diameter: ________________________________________________

Belt number and type: ________________________________________________

Coupling Type: ________________________________________________

Bearing Type and Number(s): ____________________________________________

Bearing Lubricant: ________________________________________________

Special Tools Required: ________________________________________________

Work Done: ________________________________________________
________________________________________________
________________________________________________

Total Hours: ________________________________________________

Spare Parts Used: ________________________________________________
________________________________________________

Additional Work Required: ______________________________________________

Additional Comments: ______________________________________________



 

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**Welding and Brazing**

1. When fabricated components are to be fixed in position permanently they can be welded or brazed together. The most common processes are:

a. **Arc Welding** Arc welding is the process of joining close fitting metals using an electric arc and a stick filler rod or filler wire on a reel. Ferrous metals such as mild steel can be arc welded in air, but other materials such as aluminium require the arc to be submerged in a gas (typically argon gas for aluminium). Arc welding requires the use of a special welding machine and emits intense heat and hazardous ultraviolet radiation. It also requires special personal protective equipment (PPE) such as eye protection, skin protection and protection from burns. Cotton clothing is preferred when performing welding or heating operations.

b. **Bronze Welding (Brazing)** Brazing is a process in which an intense flame from an oxy-acetylene plant is used to melt a bronze alloy filler rod which bonds to the parent metals to form a join without melting the parent metals. Bronze welding is typically used to join ferrous metals such as mild steel. Bronze welding requires special PPE similar to arc welding, but the eye protection is of a different type to arc welding. Bronze welding goggles most not be used for arc welding.

c. **Silver Brazing** Silver brazing (also known as hard soldering or silver soldering) is a similar process to bronze welding but it is done at a lower temperature and with a different alloy filler rod containing a small amount of silver. Silver solder is drawn into the space between the parent metals to form a much stronger join than soft soldering but it requires a higher temperature. Silver soldering is typically used in the electrotechnology industry to fabricate mild steel or brass components. Silver soldering requires the same type of PPE as bronze welding, but it can often be done with a less intense flame such as a propane burner.

2. There are many different variations on these welding processes, each requiring special training as a Welder or Boiler Maker.

**Soft Soldering**

3. Soft soldering is the process of permanently joining suitable metals together by melting a lead-tin alloy in such a way that the alloy bonds with the surface of the parent metals to form a rigid fillet. Soft soldering is done at a lower temperature than hard soldering and the solder is a different alloy. The solder can be applied using a flux and a ‘soldering iron’ or by direct application using a suitable flame.

4. The soft soldering process is commonly used in electrotechnology work to join sheet metals such as galvanised iron, brass, copper and mild steel. It is also used to make joints in copper cables such as earthing conductors, or to fit solder lugs to copper cables. For practical purposes aluminium parts cannot be soft or hard soldered using conventional processes.

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**Welding and Brazing**

1. What essential PPE must worn when using Welding and Brazing equipment?

2. Briefly describe the process of Electric arc Welding

3. Briefly describe the process of Bronze Welding or Brazing

4. Briefly describe the process of Silver Soldering

5. Briefly describe the process of Soft Soldering

6. What essential precautions must be taken when welding or brazing in a workshop or on site?

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Utilities Industry Components
Resource Book