Trade of Metal Fabrication	
Module 1:	Basic Fabrication
Unit 11:	Grinding
	Phase 2

Table of Contents

List of Figures

List of Tables

Document Release History

Date	Version	Comments
23/08/06	First draft	
13/12/13	SOLAS transfer	

Module 1 – Basic Fabrication

Unit 11 – Grinding

Duration – 3 Hours

Learning Outcome:

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

- Safely set up and operate various grinding machines
- Set workrest in accordance with specification

Key Learning Points:

Rk	Types of grinding machines - electrical, pneumatic, pedestal, strong/belt. Portable stone/belt. Portable angle/pencil. Composition and use of different types of stone - discs.
Sk	Use of grinding machines. Changing grind wheels.
Sc	Dressing of stones and care and maintenance of wheels in use.
Rk H Sk	Eye protection. Loose clothing. Guard. Ratio of speeds between machine and wheels. Precautions to be taken when using the above, i.e. screening, clamping.
P	Communication - safe work practice and attitude.

Training Resources:

Fabrication workshop facilities.

Grinding machines and wheels. Grind wheel dressing tool. Goggles- visors, P.P.E..

Texts and notes.

Exercise:

As used in the demonstration of the above.

Key Learning Points Code:

M = Maths D= Drawing RK = Related Knowledge Sc = Science

P = Personal Skills Sk = Skill H = Hazards

The Wheel

Due to the nature of its construction the wheel can, if not carefully treated, crack or shatter during use. To reduce the dangers of flying particles causing injury the wheel must be guarded with only the work area exposed. Examine the wheel frequently for cracks or other defects.

When grinding, move the work from side to side to avoid cutting grooves in the wheel. Use the front of the wheel as much as possible. If the side of the wheel is used, avoid using too much force.

Wheel Inspection

Vitrified bond wheels can be checked with a procedure called the ring test:

- Tap the wheel with a non-metal object
- If the wheel is in good condition it will ring clearly
- Damaged wheels give a dull or chattering sound

Safe Grinding Procedures

- Stand to one side of the grinder when you turn it on, until the wheel reaches operating speed
- Slowly and smoothly bring material into contact with the grinding wheel. Avoid bumping
- Do not jam work between the wheel and the tool rest
- Gradually apply pressure to the wheel. Do not use more pressure than is required for the task
- Do not press hard on a dull wheel as this can produce excessive heat which can weaken the wheel, making it more susceptible to shattering
- Move the material back and forth over the face of the wheel. This helps prevent grooves from forming
- Remember to use the right wheel for the job. If you apply the wrong material to a wheel you may damage it
- Do not grind on the side of a wheel unless you are using a machine and wheel designed for side grinding

Personal Protective Equipment

- Eye protection such as safety glasses or goggles must always be worn when using a grinder
- Dust masks and hearing protection should also be used
- When hot metal is involved face protection and a leather apron may be required
- Overalls can be helpful in keeping loose clothing out of the way. Long hair should be tied back and dangling jewellery removed

The Abrasive Wheel

The abrasive wheel or grinding wheel consists of two constituents:

1. The abrasive that does the cutting.
2. The bond that holds the abrasive particles together.

The specification of a grinding wheel gives a clue as to its construction and suitability for a particular operation. For example a wheel carrying the marking:

38A60-J5VBE

would indicate that the wheel has an aluminium oxide abrasive; that the abrasive grit is medium to fine in grain size; that the grade is soft; that the structure shows medium spacing; that a vitrified bond is used. How the code marked on the wheel can indicate all this information required in selecting the correct wheel for a particular job will now be examined in some detail.

Manufacturer's Type Code	BS Code	Abrasive	Application
-	A	Aluminium oxide	A high strength
32	A	Aluminium oxide	Cool; fast cutting,
38	A	Aluminium oxide	Light grinding of
19	A	Aluminium oxide	A milder abrasive
37	C	Silicon carbide	For hard, brittle
39	C	Silicon carbide	For hard, brittle

Table 1 - Manufacturer's Type Code

Grade

This indicates the strength of the bond and therefore the 'hardness' of the wheel. In a hard wheel the bond is strong and securely anchors the grid in place and therefore reduces the rate of wear. In a soft wheel the bond is weak and the grit is easily detached resulting in a high rate of wear.

The bond must be carefully related to the use of the wheel. If it is too hard the wheel will glaze and become blunt, if it is too soft it will wear away too quickly. This would be uneconomical and also cause loss of accuracy.

Very Soft	Soft	Medium	Hard	Very Hard
EFG	HIJK	LMNO	PQRS	TUWZ

Table 2 – Grade

Wheel Selection

The correct selection of a grinding wheel depends upon many factors.

Material to be Ground

(a) An aluminium oxide abrasive should be used on materials with a high tensile strength.

(b) A silicon carbide abrasive should be used on materials with a low tensile strength.

(c) A fine grain wheel can be used on hard brittle materials.

(d) A coarser grain wheel should be used on soft ductile materials. (e) Grade. Use a hard wheel for soft materials and a soft wheel for hard materials.

(f) Structure. A close structured wheel can be used on hard, brittle materials. An open structured wheel should be used on soft, ductile materials.

(g) The bond is seldom influenced by the material being ground.

Arc of Contact

(a) Figure 1 shows what is meant by 'arc of contact'.

(b) *Grain size*. For a small arc of contact a fine grain can be used. For a large arc of contact a coarse grain should be used.

(c) *Grade*. For a small arc of contact a 'hard' wheel can be used. For a large arc of contact a 'soft' wheel should be used.

(d) *Structure.* For a small arc of contact a close grained wheel can be used. For a large arc of contact an open structured wheel should be used.

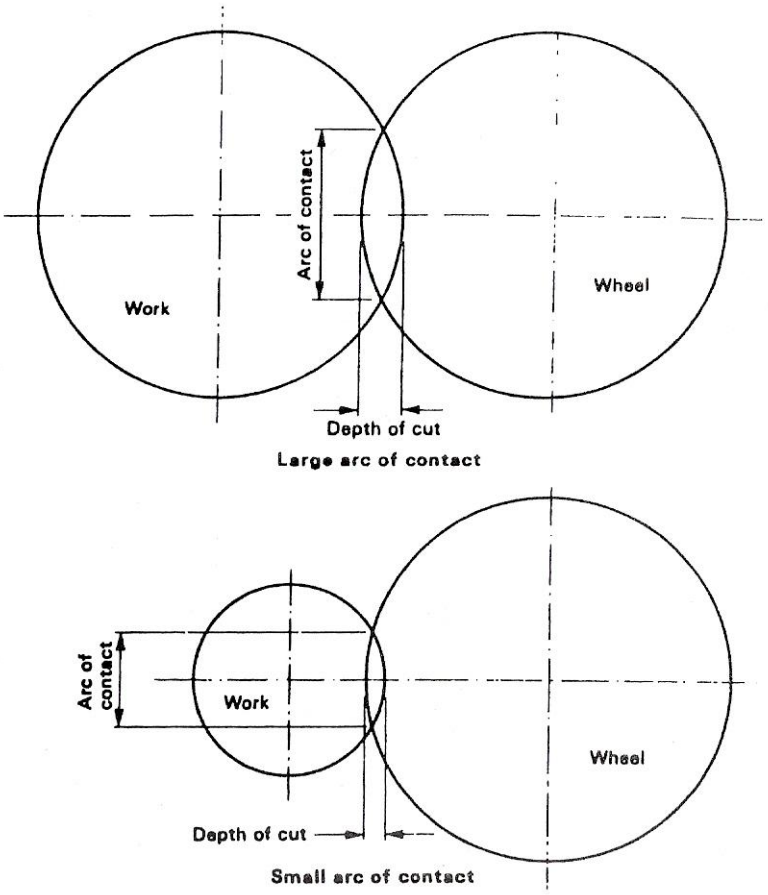


Figure 1 - Arc of Contact

Type of Grinding Machine

A heavy, rigidly constructed machine can produce accurate work using softer grade wheels. This reduces the possibility of 'burning' the workpiece.

Process

As well as being used for tool sharpening and precision grinding, the abrasive wheel is also used for the following processes:

(a) Dressing the weld and grinding the weld bead flush.

(b) Edge preparation.

(c) Cutting off awkward sections.

Abrasive wheels used for these purposes are subject to far more abuse than those used for precision grinding. They are also required to remove metal more quickly, but they do not have to leave such a good finish or work so accurately as precision grinding wheels.

Cutting Off

A suitable cutting-off wheel for mild steel would be:

A 24 Q 8 B or R

Reference to the earlier sections of this chapter will show that such

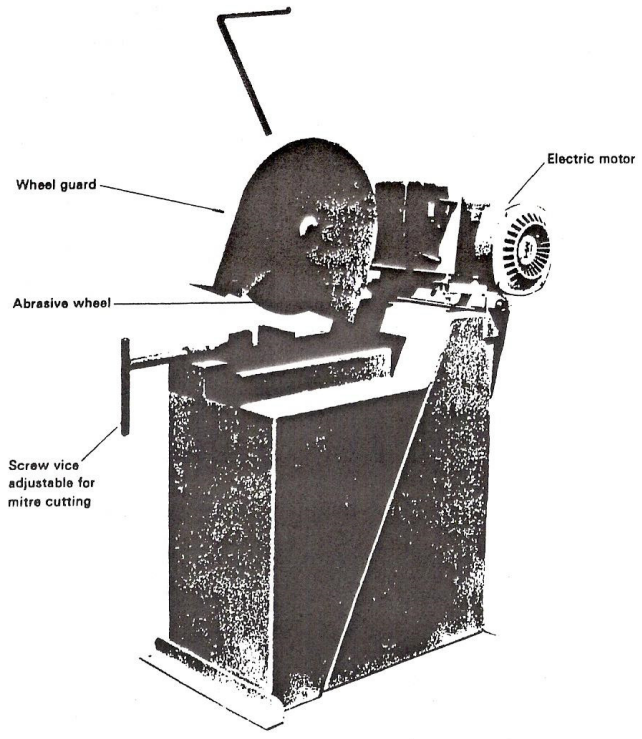


Figure 2 - Abrasive Wheel Cutting-Off Machine

Abrasive Wheel Cutting-Off Machines

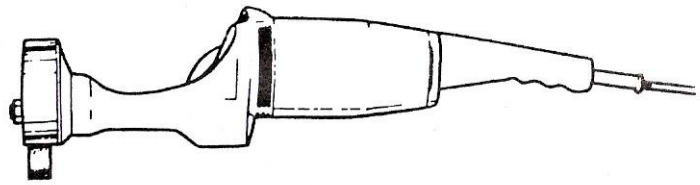
A typical abrasive wheel cutting-off machine is illustrated in Figure 2.

These machines are driven by high power electric motors, the abrasive wheel revolving at speeds in excess of 3000 rev/min.

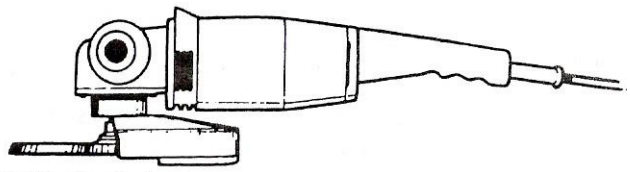
An adjustable stop is fitted to the counterbalanced head to compensate for wheel wear. A 'vee' belt drives the cutting head from the motor. The diameter of the abrasive wheel is generally about 400 mm and its thickness approximately 3 mm. The section to be cut is clamped in a screw vice, which has a swivelling back-plate for mitre cutting. The head is brought down by hand to sever the material. The high-speed abrasive wheel cuts through steel sections like a knife cutting through butter. Table shows typical cutting speeds.

Material Section in.	Material Section mm.		Cutting Time (in seconds)
Tube	$1\frac{1}{2}$ O.D.	38 O.D.	2.5
Angle	3 x 3 x $\frac{1}{4}$	76 x 76 x 6.35	5
R.S.J.	3 x 1 $\frac{1}{2}$ x $\frac{3}{16}$	76 x 38 x 4.76	5
Flat bar	$2\frac{1}{4}$ x $\frac{3}{8}$	57.2 x 9.53	2
Round bar	1 Diameter	25.4 Diameter	2.5
Channel	4 x 2 x $\frac{1}{4}$	101.6 x 50.8 x 6.35	9

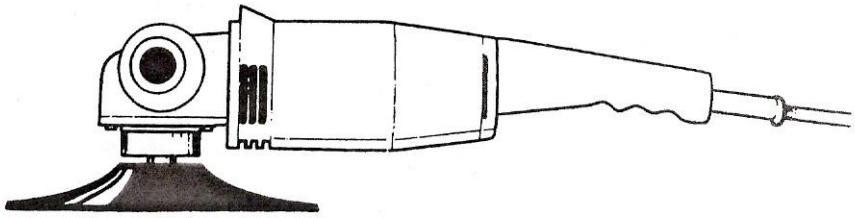
Table 3 - Typical Cutting Times (Abrasive Cutting-Off Machine)



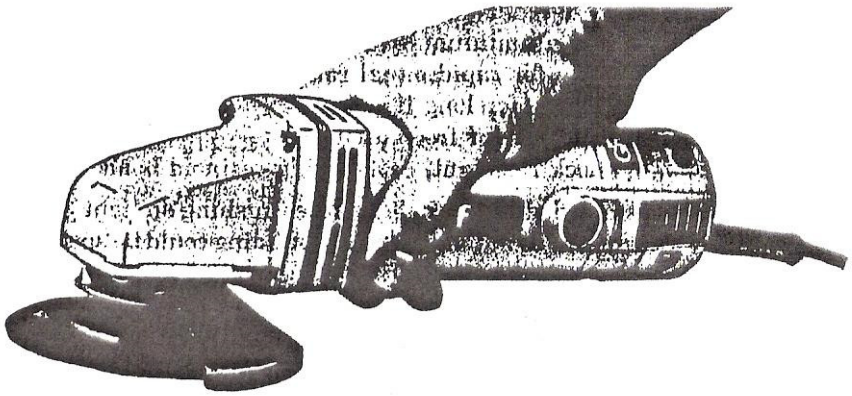
(a) **Straight grinder**



(b) **Angle grinder**



(c) **Angle sander**



(d) **Lightweight general duty high-speed 'grinderette'**

Figure 3 - Portable Electric Grinding Machines

Portable Grinding Machines

Portable grinding machines are often used for smoothing down welded joints and seams and generally do much of the fabrication workshop jobs which would otherwise be done by the laborious methods of chiselling and filing.

These portable tools are basically of two types, ELECTRIC and PNEUMATIC, and the three most commonly used variations of portable grinders are:

1. THE STRAIGHT GRINDER
2. THE ANGLE GRINDER
3. THE SANDER GRINDER

Figure 3 and Figure 4 illustrates electrically-powered portable grinders. Figure 3(a) shows a 'straight' portable grinder. This uses an ordinary grinding wheel, cutting on its periphery as in tool grinding.

Usually two sizes are available:

1. Grinding wheel diameter 102 mm
   Grinding wheel thickness 19 mm
   Spindle speed (running light) 8400 rev/min
2. Grinding wheel diameter 127 mm
   Grinding wheel thickness 19 mm
   Spindle speed (running light) 6600 rev/min

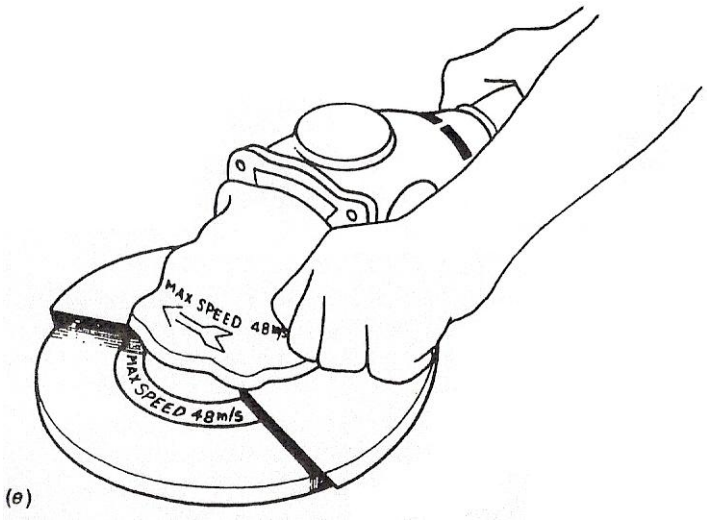


Figure 4 - Portable Electric Grinding Machines (continued)

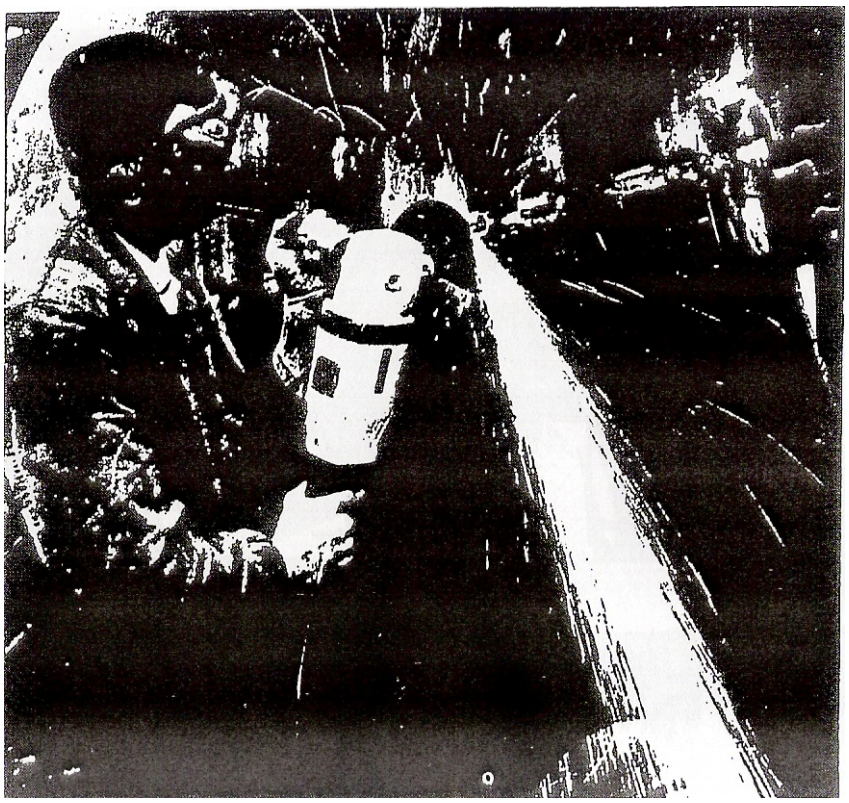


Figure 5 – (a) Grinding Welds with Angle Grinder

Safety

Hand-powered tools with exposed rotating heads must be switched off and have stopped revolving before being laid down. Otherwise, they can spin themselves off scaffolding, for instance, causing damage and injury.

Power grinders and cutting-off wheels must have guards for protection and to prevent oversize wheels being used.

ALWAYS USE THE CORRECT SIZE AND TYPE OF WHEEL FOR THE JOB - if it is too hard or too fine it becomes glazed. The operator must then use excessive pressure resulting in more breakages and reduced productivity.

Pneumatic grinders must have a mechanical governor to prevent the spindle exceeding its maximum speed.

Figure 6 – (b) Angle Grinder used for Bevel Grinding

Preparation of internal surfaces of large diameter pipe ends for welding.

Figure 7 - (c) Grinding Edges of Flame-Cut Apertures with a Straight Grinder

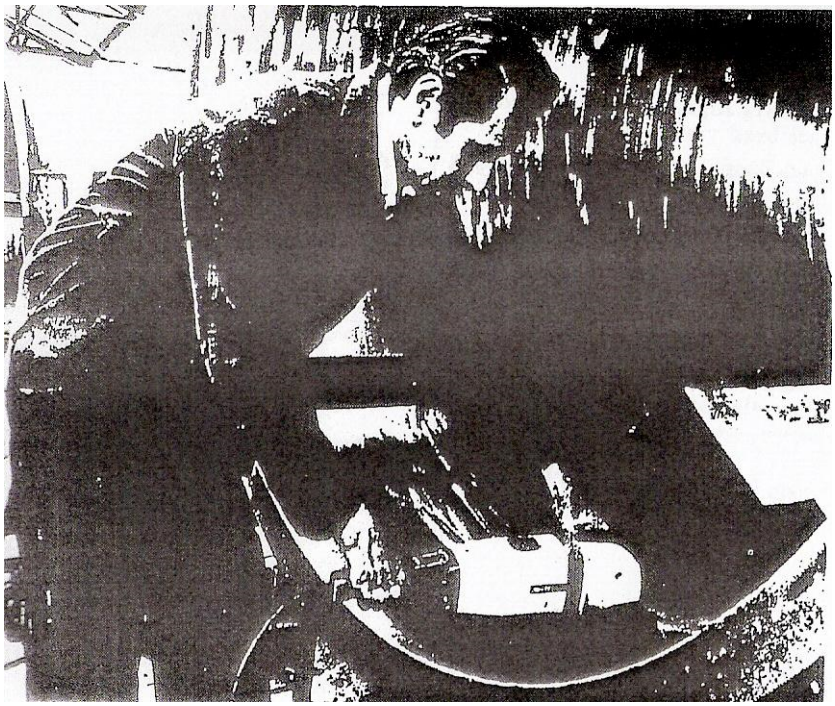


Figure 8 - (d) Use of Portable Sander for Metal Surface Finishing

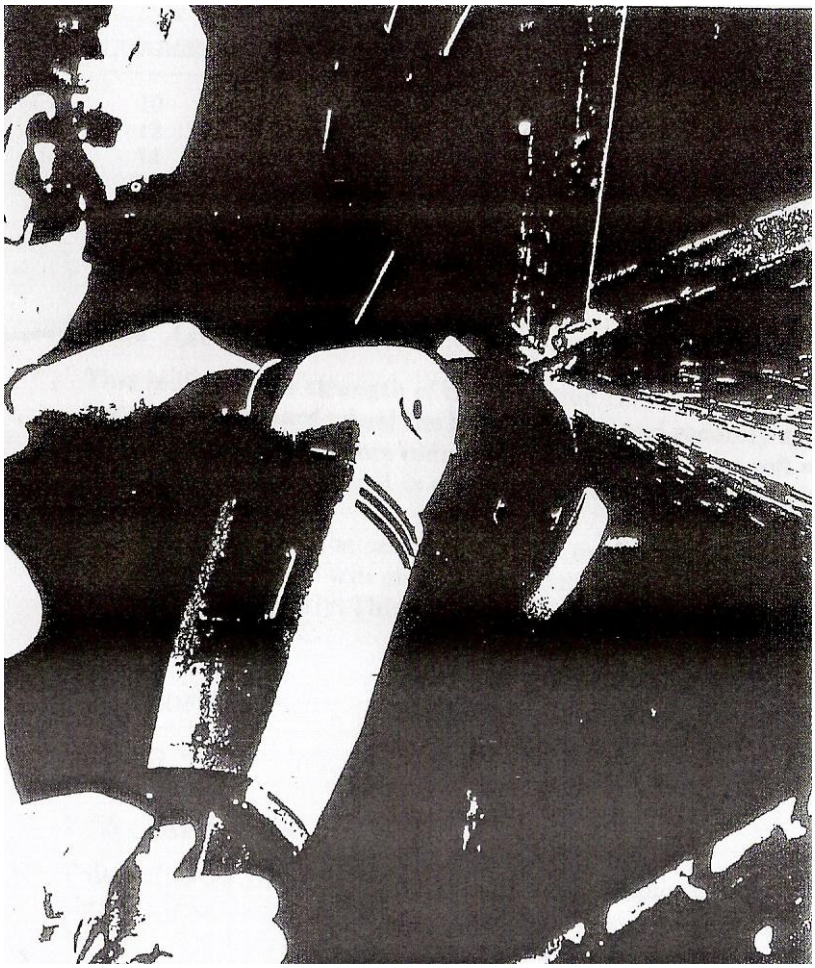


Figure 9 - (e) Use of Angle Grinder - Preparing Steel Balustrade Section for Welding on Site

Self Assessment

Questions on Background Notes – Module 1.Unit 11

1. Draw a Circle 60mm in Diameter.

Clearly show the following:

a. SECTOR

b. TANGENT (Shown by a line that is Tangential to Circle)

c. RADIUS

d. DIAMETER

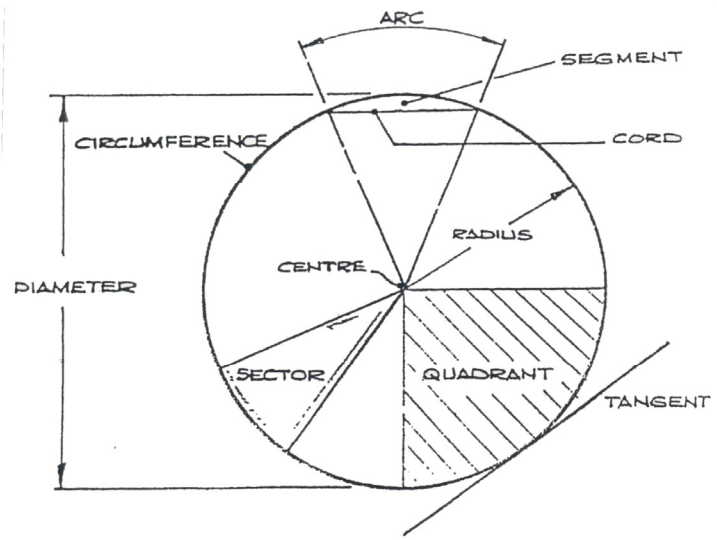
2. Construct an angle of 45° using a Compass and Rule, clearly show the intersecting arc's.

3. What are Templates? Give three useful pieces of information on them.

Answers to Questions 1-3. Module 1.Unit 11

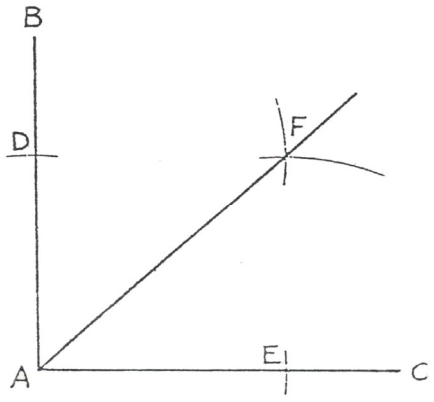
1.

Figure 8. Circle



2.

Figure 9. Angle of 45°



3.

Templates:

Templates are used to avoid repetitive measuring and marking-off of the dimensions, where a number of identical parts are required. They can also act as a guide for a cutting process or as a simple means of checking an angle, bend or curve. Templates can be made from Cardboard, Aluminium Timber, Perspex and so on. Typical information found on them would be a job or contact number, size and thickness of the plate drilling requirements, left hand or right hand section.

Index