

3.3 METAL WORK (445)

The 2012 KCSE examinations for Metalwork consisted of two papers namely Paper 1 (theory) and Paper 2 (Practical Project). The theory was worth 60% while practical was worth 40% of the final mark. The revised syllabus was tested for the first time but the format and weighting of the two papers was the same as in the previous years.

Candidates General Performance

Table 10: Candidates' overall performance for the period 2008 up to 2012

Year	Paper	Candidature	Maximum Score	Mean Score	Standard Deviation
2008	1		60	23.62	6.96
	2		40	35.62	4.57
	Overall	89	100	59.24	9.38
2009	1		60	25.38	9.09
	2		40	35.34	3.38
	Overall	231	100	58.74	13.32
2010	1		60	22.60	9.09
	2		40	15.25	4.32
	Overall	222	100	37.70	12.58
2011	1		60	30.92	9.55
	2		40	20.65	4.29
	Overall	170	100	51.57	12.43
2012	1		60	32.01	10.85
	2		40	21.43	5.48
	Overall	194	100	53.43	15.49

From the table above, the following observations can be made.

- (i) The mean score for the year 2012 improved compared to that of the year 2011. This is an indication that the paper's performance in 2012 improved as compared to 2011.
- (ii) The candidature increased from 170 in the year 2011 to 190 in the year 2012.

3.3.1 Metalwork Paper 1 (445/1)

The questions which were reported to have been poorly performed have been analyzed with a view to pointing out candidates' weaknesses and proposed suggestions on some remedial measures that would be taken in order to improve performance in future. The questions for discussions include 2 a, 9, 11 and 12(a).

Question 2 a

State **four** safety precautions to be observed when using bench shears in the workshop.

Candidates were expected to state the safety precautions to be observed when using bench shears in the workshop.

Weaknesses

Some candidates had problems of mistaking a tin snip for bench shears.

Advice to Teachers

They need to explain to students the safety precautions for each particular machine or hand tool in the workshop.

Expected Responses

Safety precautions to be observed when using bench shears:

- Always return hand to its normal position so as not to obstruct workshop users.
- Use to cut the recommended size of materials.
- The shears should be firmly fixed onto the bench
- The jaws of the shears should be sharp enough

Question 9

Use labeled sketches to show the following operations on a lathe machine:

a) parallel turning

b) facing off

Candidates were expected to sketch the stated lathe operations.

Weaknesses

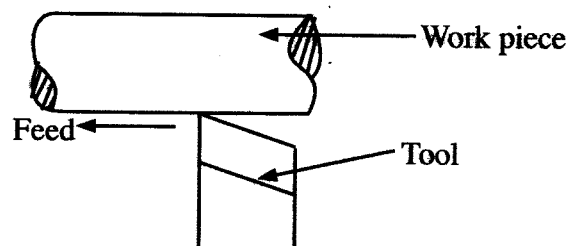
Most candidates had no idea about the stated operations.

Advice to Teachers

They should teach the new syllabus in totality.

Expected Responses

(i) **Parallel turning**



$3 \times \frac{1}{2} = 1\frac{1}{2}$ marks

(ii) **Facing**

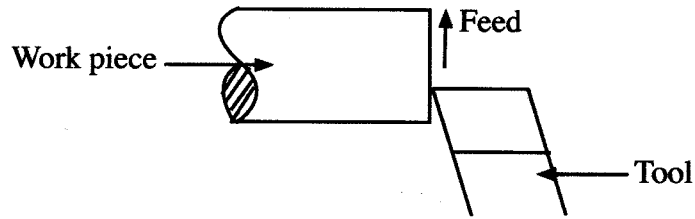


Figure 5

Question 11

Figure 1 shows a truncated pipe of diameter 24 mm. Draw the development of part B.

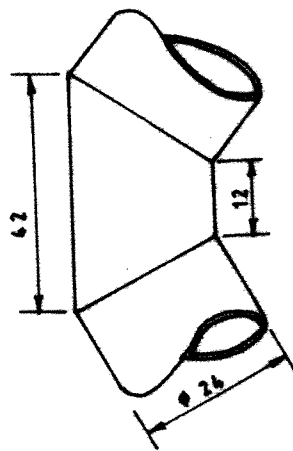


Fig. 1

Candidates were expected to draw the development of part B as shown in the figure.

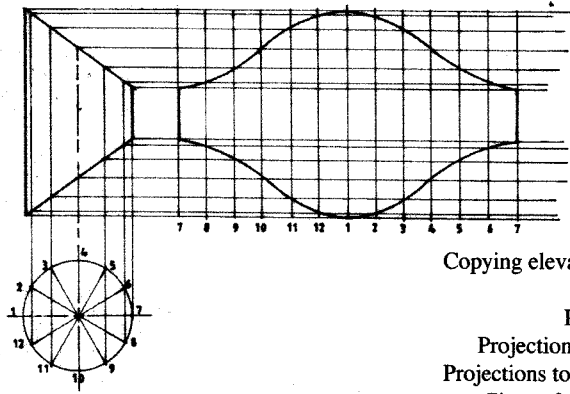
Weaknesses

Most candidates had problems in drawing the development.

Advice

Teachers are advised to give students more practice on drawing the developments of solids including cylinders, pyramids, cones and prisms.

Expected response:



- Copying elevation B - 1
- Plan - 1
- Plan divisions - 2
- Projections to elevation - 2
- Projections to development - 2
- Circumference marked - 2
- Points of intersection - 2
- Joining of points - 3
- 15 marks

ACCEPT ALTERNATIVE OPENING POINT

Question 12 a (ii)

Figure 2 shows an arc welding set-up

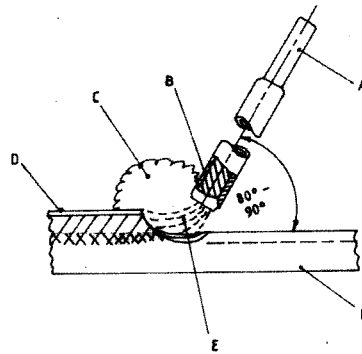


Fig. 2

State the function of each of the parts B and C.

Candidates were expected to state the function of the parts B and C as shown in the drawing.

Weaknesses

Most candidates could not state the functions of the given parts

Advice

Teachers are advised teach both Arc welding and Gas welding as outlined in the syllabus.

Expected Responses

- (i) **The flux has the following functions:**
- Enable the arc to be struck and maintained easily
 - Floats the impurities out of the molten metal to form slag
 - Provides iron powder to increase the rate of depositing
 - It forms a layer that helps the joint to cool slowly.

(ii) **The gaseous shield has the following functions:**

- It helps protect the weld
- It slows down the cooling of the joint.

3.3.2 Metalwork Paper 2 (445/2)

As in the previous years, the council designed a suitable project for this level together with a comprehensive marking scheme. The subject teachers used the working drawings to supervise the fabrication of the project and the marking scheme to mark the candidates' projects. The marks were then sent to the Council through the D.E.O's offices.

4.3 METALWORK (445)

4.3.1 Metalwork Paper 1 (445/1)



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SECTION A (40 marks)

Answer all the questions in this section.

- 1 (a) State **one** reason for teaching metalwork at secondary school level. (1 mark)
- (b) List **four** components of a business plan. (2 marks)
- 2 (a) State **four** safety precautions to be observed when using bench shears in a workshop. (2 marks)
- (b) Explain the importance of technical drawing in metalwork industry. (1 mark)
- 3 (a) (i) Sketch and label an odd-leg calipers. (3 marks)
- (ii) State **two** uses of an odd-leg calipers. (3 marks)
- (b) State **five** uses of the square head of a combination set. (2½ marks)
- 4 (a) Name **three** types of snips used in sheet metal and state the use of each. (3 marks)
- (b) (i) State **four** specifications to be considered when purchasing a rivet. (2 marks)
- (ii) Sketch a bifurcated rivet and state one use of the rivet. (1 mark)
- 5 (a) For each of the following items, name the material used and state one property of the material:
- (i) ball pein hammer head; (1 mark)
- (ii) twist drill bit; (1 mark)
- (iii) body of an aircraft. (1 mark)
- (b) List **five** methods of finishing metal articles. (2½ marks)
- 6 (a) Explain the term “file cut”. (1 mark)
- (b) Name and sketch **two** types of file cuts. (2 marks)
- 7 (a) State **two** disadvantages of cooling a brazed joint rapidly. (2 marks)
- (b) Explain the reason for tempering a cutting tool and outline the procedure of tempering. (3 marks)

- 8 (a) Explain **one** advantage of a forged hole over a drilled hole. (1 mark)
- (b) Use a sketch to show the effect on the grain structure of a forged hole and a drilled hole. (2 marks)
- 9 Use labelled sketches to show the following operations on a lathe machine:
- (a) parallel turning; (1 ½ marks)
- (b) facing off. (1 ½ marks)
- 10 Explain each of the following terms as applied in arc-welding:
- (a) scratching; (1 mark)
- (b) tapping; (1 mark)
- (c) freezing. (1 mark)

SECTION B (60 marks)

Answer question 11 and any other three questions from this section. Candidates are advised to spend not more than 25 minutes on question 11.

- 11 **Figure 1** shows a truncated pipe of diameter 24 mm. Draw the development of part B. (15 marks)

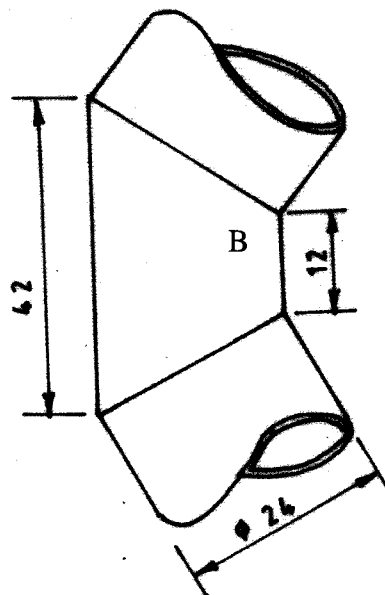


Fig. 1

(Use A3 paper provided)

12 Figure 2 shows an arc welding set-up.

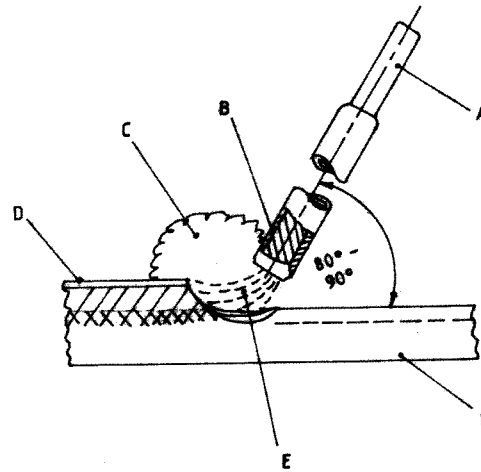


Fig. 2

- (a) (i) Name the parts labelled A, B, C, D, E and F. (3 marks)
- (ii) State the function of each of the following parts:
- B;
C;
D. (3 marks)
- (b) With reference to arc welding;
- (i) Define the term bead; (1 mark)
- (ii) Outline the procedure of starting a bead. (5 marks)
- (c) Use sketches to show the following defects in arc welding and state **one** cause of each. (3 marks)
- (i) undercut;
- (ii) porosity.

13 Figure 3 shows a drawing of a lathe machine.

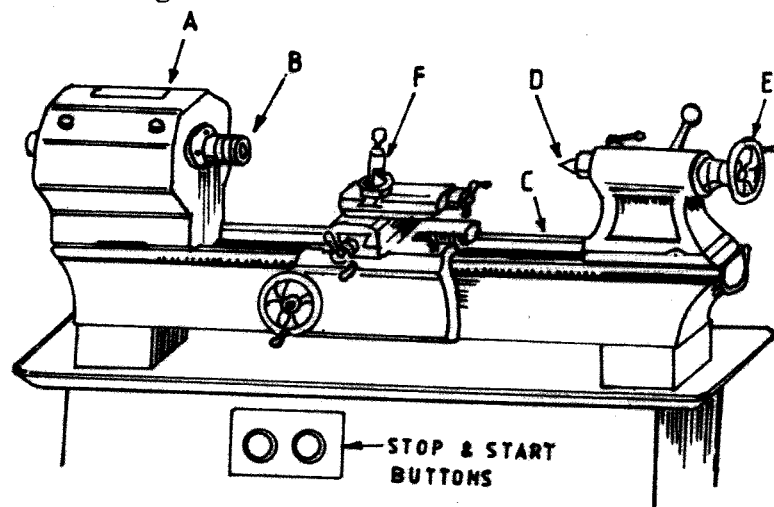


Fig. 3

- (a) Name the parts labelled A, B, C, D, E and F and state **one** function of each part. (9 marks)

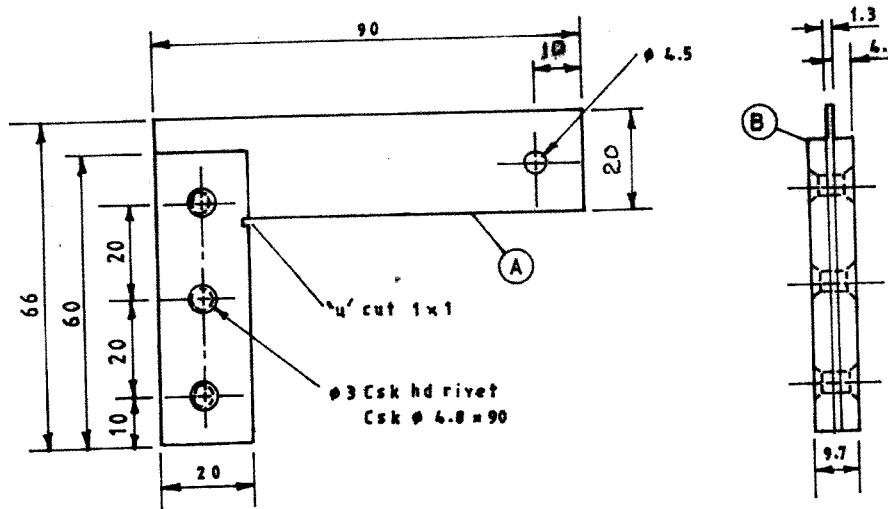
(b) State and explain **four** factors which determine the rate of material removal when turning on a lathe. (6 marks)

14 With the aid of sketches, outline the steps followed in making a grooved seam joint of an open cylinder and name **two** tools used in each case. (15 marks)

15 (a) State **four** possible causes for each of the following:

- (i) drill bit breakage; (2 marks)
- (ii) weak riveted joint. (2 marks)

(b) **Figure 4** shows a working drawing of an engineer's try-square drawn in first angle projection.



Given the cutting list below, outline the procedure of making the try-square.

PART	NO. OFF	LENGTH (mm)	WIDTH (mm)	THICKNESS (mm)	MATERIAL
Stock (B)	2	63	22	4.5	BDMS
Blade (A)	1	95	70	1.5	BDMS
Rivets	3	14.5	-	Ø3	BDMS

(11 marks)

5.3 METALWORK (445)

5.3.1 Metalwork Paper 1 (445/1)

1. (a) **Reasons for teaching metalwork Secondary school level.**
- (i) To equip learners with knowledge, skills and attitudes relevant to the field to enable them pursue further training.
 - (ii) To enable the graduate/ student enter into gainful self or salaried employment after training.

Any 1 x 1 = 1 mark

(b) **Components of a business plan.**

- Executive summary
- Marketing
- Management and organizational
- Production/ operation
- Financial plan/ budget

Any correct 4 x $\frac{1}{2}$ = 2 marks

2. (a) **Safety precautions to be observed when using bench shears:**

- Always return hand to its normal position so as not to obstruct workshop users.
- Use to cut the recommended size of materials.
- The shears should be firmly fixed onto the bench.
- The jaws of the shears should be sharp enough.

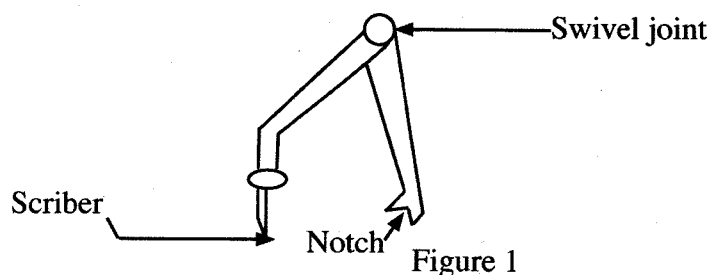
4 x $\frac{1}{2}$ = 2 marks

(b) **Importance of technical drawing in metalwork industry.**

- To enable the design and fabrication of articles.
- To enable people in the industry interpret existing drawings.

Any 1 x 1 = 1 mark

3. (i) **Odd-leg callipers**



Sketch - 1 mark

Labelling any 2 x $\frac{1}{2}$ = 1 mark

(ii) **Uses of odd-leg callipers**

- Scribing parallel lines
- Locating centres

2 x $\frac{1}{2}$ = 1 marks

Total = 3 marks

(b) **Uses of square head of a combination set.**

- Marking lines square to an edge.
- Testing for squareness.

- Marking out and checking depths.
- Marking of 45°
- Checking for 45°
- Checking the flatness of a workpiece using its spirit level.

5 x $\frac{1}{2}$ = 2 $\frac{1}{2}$ marks

4. (a) **Types of snips and their use:**

- Straight type - used for cutting straight edges
- Curved type - used for cutting internal curves
- Universal type - used for cutting almost any shape.

Types - 1 $\frac{1}{2}$ marks

Uses - 1 $\frac{1}{2}$ marks

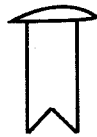
Total = 3 marks

(b) (i) **Specifications to be considered when purchasing a rivet**

- (i) shank diameter
- (ii) shank length
- (iii) material used
- (iv) type of head

4 x $\frac{1}{2}$ = 2 marks

(ii) **Sketch a bifurcated rivet.**



Used for leather work

Sketch - $\frac{1}{2}$ mark

Use - $\frac{1}{2}$ mark

Total = 1 mark

5. (a) **Materials used for:**

- (i) ball peen hammer - medium carbon steel (M.C.S)
Property - it is tough
- (ii) twist drill bit - high carbon steel (H.C.S)
Property - it is hard and resists wear
- (iii) Body of aircraft - Aluminium alloy
Property - it is light, strong and non-corrosive.

Naming material - 3 x $\frac{1}{2}$ = 1 $\frac{1}{2}$

Property - 3 x $\frac{1}{2}$ = 1 $\frac{1}{2}$

Total = 3 marks

(b) **Methods of finishing metal articles**

- (i) brush painting
- (ii) spray painting
- (iii) bluing
- (iv) oil blacking
- (v) laquering
- (vi) etching
- (vii) planishing

Any 5 x $\frac{1}{2}$ = 2 $\frac{1}{2}$ marks

6. (a) File cut means the formation of the teeth of a file. (1 mark)

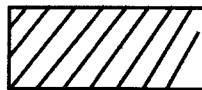
(b) Types of file cuts



Double cut



Rasp



Single cut

Naming any 2 x $\frac{1}{2}$ = 1 mark
Sketching any 2 x $\frac{1}{2}$ = 1 mark

(other types not shown to be accepted) Total = 2 marks

7. (a) Disadvantages of cooling a brazed joint rapidly:

- The joint ends up being weak
- Scaling is caused
- The joint may crack
- There is interference with the grain structure.

Any 2 x 1 = 2 marks

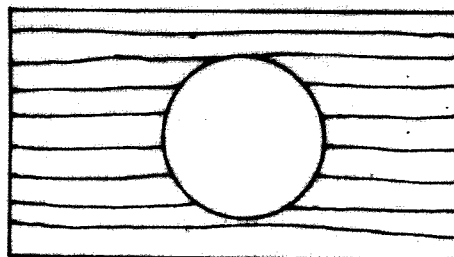
(b) Reasons for tempering a cutting tool is to remove brittleness/ excessive hardness and increase toughness. (1 mark)

Procedure for tempering:

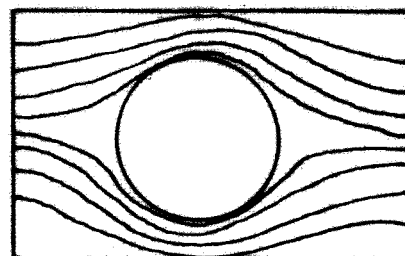
- Clean the work piece
- Heat the tool away from the cutting edge/point
- Observe the tempering colour while heating
- Quench appropriately

4 x $\frac{1}{2}$ = 2 marks

8. (a) Advantage of a forged hole over a drilled one - The grain flow strengthens the hole structure. 1 x 1 = 1 mark



Drilled hole

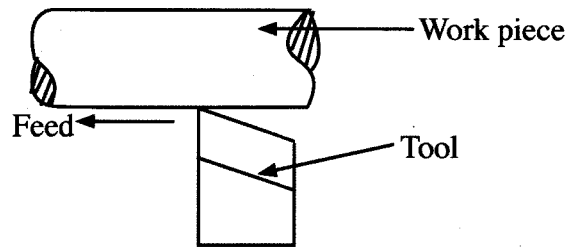


Forged hole

Fig. 4

9. **Operations on a lathe machine**

(i) **Parallel turning**



$3 \times \frac{1}{2} = 1\frac{1}{2}$ marks

(ii) **Facing**

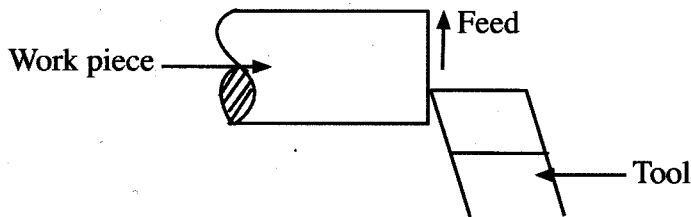


Figure 5

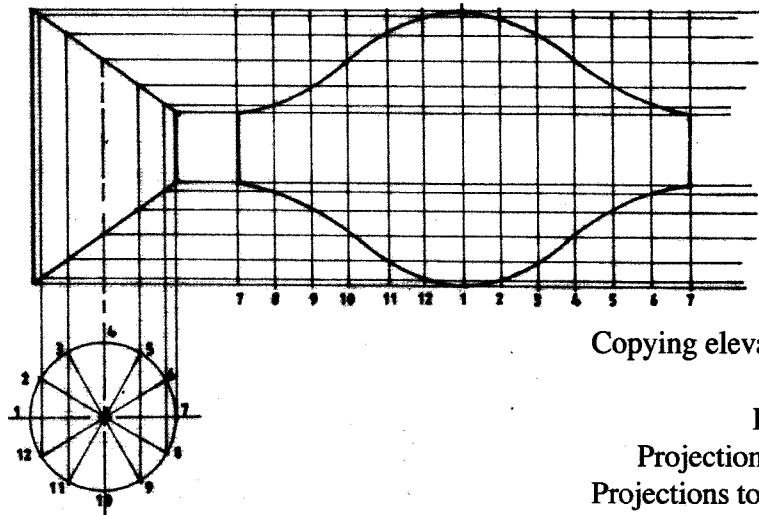
10. **Terms of arc-welding**

- (a) Scratching is a method of striking an arc by scratching
- (b) Tapping is a method of starting an arc where the electrode is brought down until it is in contact with the metal to be welded.
- (c) Freezing is the tendency of the electrode to stick on the metal being welded.

1 x 3 = 3 marks

SECTION B

Figure shows a truncated pipe of diameter 24 mm.



Copying elevation B - 1

Plan - 1

Plan divisions - 2

Projections to elevation - 2

Projections to development - 2

Circumference marked - 2

Points of intersection - 2

Joining of points - 3

15 marks

ACCEPT ALTERNATIVE OPENING POINT

12. (a) (i) **Naming parts labelled**
 A - metal core
 B - Flux/electrode covering
 C - Gaseous shield
 D - Slag
 E - Globules of molten core wire
 F - Parent metal

$6 \times \frac{1}{2} = 3$ marks

(ii) **The flux has the following functions:**

- (I) enable the arc to be struck and maintained easily.
- (II) floats the impurities out of the molten metal to form the slag.
- (III) provides iron powder to increase the rate of depositing.
- (IV) it forms a layer that makes the joint to cool slowly.

Any 1 x 1 = 1 mark

(iii) **The gaseous shield has the following functions:**

- (I) it helps protect the weld.
- (II) it slows down the cooling of the joint.

Any 1 x 1 = 1 mark

- (iv) The slag is the uniformly deposited molten electrode which forms the joint for decorative purposes. (1 mark)

- (b) (i) The term bead refers to the pattern formed in the welding process.

1 x 1 = 1 mark

- (ii)
- (I) Prepare the plate to be welded
 - (II) Draw the required path of the bead with a piece of chalk
 - (III) Position the work ready for welding - earth the workpiece
 - (IV) Select the correct electrode.
 - (V) Set the correct welding current.
 - (VI) Add the electrode slanting at an angle of 75° in the direction of travel.
 - (VII) Wear protective gear.
 - (VIII) Strike the arc.
 - (IX) Momentarily raise the electrode after establishing the arc.
 - (X) Lower the electrode to the correct arc length.
 - (XI) Start building up the desired bead.

$10 \times \frac{1}{2} = 5$ marks

(c) **Defects in arc welding**

(i) **Undercut**

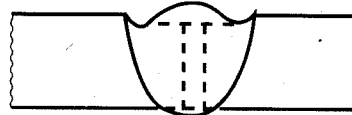


Figure 6

Causes:

- Use of excessive current
- Improper angle of electrode to the base metal.

Sketch - 1 mark

Any 1 cause - $\frac{1}{2}$ mark

$\frac{1}{2}$ marks

(ii) **Porosity**

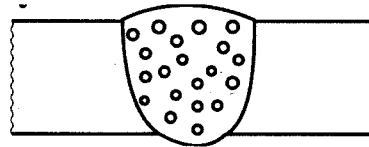


Figure 7

Causes

- Excessive moisture in the electrode or joint.
- High rate of metal freezing.
- Oil, paint or rust on the surface of the base metal.
- Improper arc length, current or manipulation.

Sketch - 1 mark

Any 1 cause - $\frac{1}{2}$ mark

$1\frac{1}{2}$ marks

13. (a)
- | | | | |
|---|-------------------|---|-------------------------------------|
| A | Head stock | - | carries the driving mechanism |
| B | Headstock spindle | - | hold the chuck or live centres |
| C | Bed | - | supports the carriage and tailstock |
| D | Dead centre | - | supports the tailstock |
| E | Tail stock | - | for feeding the drills |
| | | | for securing the work |
| F | Tool post | - | holds the cutting tool |

correct name $6 \times \frac{1}{2} = 3$

correct function $6 \times 1 = 6$

Total = 9 marks

- (b) TYPE OF FINISH - Fine finish will require slight cut.
Rough finish will require deep cut.

HARDNESS/SOFTNESS - Soft material require deep cut.

- Hard materials slight cut.

TOOL - ANGLE - round nosed up for heavy cut pointed tip for light cut.

MACHINE STABILITY - Stable allows deep cut unstable for light cut.

RIGIDITY OF CUTTING TOOL - Rigid for deep cut, unrigid for light cut.

Stating any $4 \times \frac{1}{2} = 2$ marks

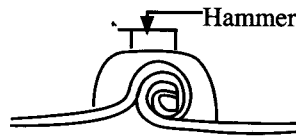
Explaining any $4 \times 1 = 4$ marks

6 marks

14. **Steps followed in making a grooved seam joint of an open cylinder.**

Steps	Sketch	Tools used
(i) Mark out seam allowances		- Try square - Steel rule - Scriber
(ii) Bend the flaps		- Folding bars - Mallet
(iii) Fold both sides to same size		- Anvil - Mallet
(iv) Hook the ends and tighten the joint		- mallet - anvil/stake

- (v) Close down or groove the joint



- Hammer
- Stake
- Groover

Steps well outlined = 5 marks

Sketches 5 x 1 = 5 marks

Tools 5 x 2 x $\frac{1}{2}$ = 5 marks

Total 15 marks

15. (a) (i) **Causes of drill breakages**
- too high feed rate.
 - speed too high.
 - incorrect alignment.
 - drill jamming in the hole.
 - workpiece not properly clamped.
- Any 4 x $\frac{1}{2}$ = 2 marks
- (ii) **Causes of weak riveted joint**
- too short rivet head allowance
 - too large hole diameter
 - gap between plates/failure to deburr close plates.
 - misaligned holes.
 - too long rivet allowance.
- Any 4 x $\frac{1}{2}$ = 2 marks
- (b) (i) **Stock**
- file datum edges
 - mark out rivet holes
 - centre punch holes position
 - debur
- 4 x $\frac{1}{2}$ = 2 marks
- (ii) **Blade**
- file datum edges
 - mark out profile
 - cut out profile
 - file profile to size
 - mark out blade hole
 - centre punch hole
 - drill hole
 - mark out stock position (6 mm)
- 8 x $\frac{1}{2}$ = 4 marks
- (b) **Assembling the parts**
- align and clamp the two parts together.
 - drill through and put the rivets in the holes.
 - drill the remaining rivet holes.
 - countersink the holes.
 - deburr the plates/parts.
 - insert rivets and close plates.
 - rivet to fill the countersunk holes.
 - file all surfaces to size.
 - mark and cut out notch.
 - finish with emery cloth.
- 10 x $\frac{1}{2}$ = 5 marks