

MECHANICAL TECHNOLOGY: WELDING AND METALWORK

Time: 3 hours

200 marks

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This question paper consists of 12 pages and a Formula Sheet of 1 page (i). Please check that your question paper is complete.
2. Read the questions carefully.
3. Answer ALL the questions.
4. Number your answers exactly as the questions are numbered.
5. Start EACH question on a NEW page.
6. Show ALL calculations and units. Round off final answers to TWO decimal places.
7. Candidates may use non-programmable scientific calculators and drawing instruments.
8. Take the value of gravity to be 10 m/s^2 .
9. All dimensions are in millimetres, unless stated otherwise in the question.
10. It is in your own interest to write legibly and to present your work neatly.
11. Use the criteria below to help you manage your time.

QUESTION	CONTENT	MARKS	TIME (minutes)
GENERIC QUESTIONS			
1	Multiple-choice questions	6	6
2	Safety	10	10
3	Materials	14	14
SPECIFIC QUESTIONS			
4	Multiple-choice questions	14	10
5	Terminology (Templates)	23	20
6	Tools and Equipment	18	10
7	Forces	45	40
8	Joining Methods (Inspection of welds)	23	20
9	Joining Methods (Stress and distortion)	18	20
10	Maintenance	8	10
11	Terminology (Development)	21	20
TOTAL		200	180

QUESTION 1 MULTIPLE-CHOICE QUESTIONS (GENERIC)

Various options are provided as possible answers to the following questions. Choose the correct answer and write the letter (A–D) next to the question number (1.1–1.6) in your ANSWER BOOK. Example: 1.7 A.

1.1 If an injured person has an object stuck in a wound, the following step must be taken:

- A Cover it with a sticky plaster.
- B Cover it with an oily liquid.
- C The object must not to be removed.
- D The wound must be cleaned with an antiseptic medium.

(1)

1.2 Identify the type of workshop layout in Figure 1.2.

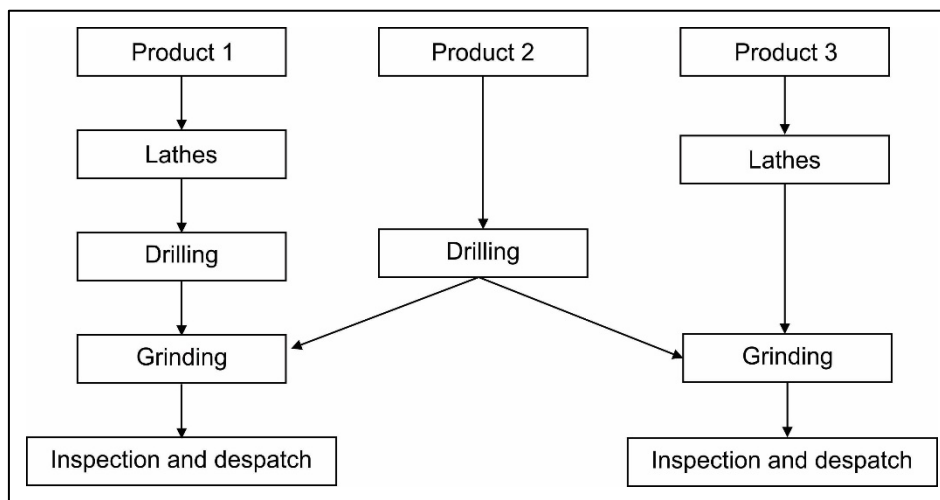


FIGURE 1.2

- A Machine layout.
- B Product layout.
- C Process layout.
- D Inspection layout.

(1)

1.3 Which ONE of the following is a reason why oil and grease must NOT be allowed to come into contact with oxygen and acetylene fittings? It will ...

- A cause a blockage.
- B form a flammable mixture.
- C make the oxygen fittings slippery.
- D accumulate dust.

(1)

1.4 Which heat treatment process is used to soften steel for easier machining?

- A Annealing.
- B Tempering.
- C Case hardening.
- D Normalisation.

(1)

1.5 The purpose of hardening steel is to ...

- A increase the resistance against denting.
- B reduce the toughness.
- C soften it.
- D improve the welding results. (1)

1.6 Which ONE of the following sounds will indicate cast iron when a sound test is carried out?

- A Loud and clear sound
 - B Very dull sound
 - C High, ringing sound
 - D High-frequency sound (1)
- [6]**

QUESTION 2 SAFETY (GENERIC)

- 2.1 What is the employer's duty in terms of the law (OHS Act No 85 of 1993) regarding first-aid boxes in the workplace? (2)
- 2.2 Give TWO reasons why it is important to wear welding goggles during gas welding. (2)
- 2.3 Name TWO items of personal protective equipment (PPE) that one will use when working with a bench grinder. (2)
- 2.4 Discuss safety precautions that must be observed with the use of electric arc-welding equipment in terms of the gases that are emitted during the welding process. (2)
- 2.5 Give TWO reasons why you must use surgical gloves when treating a co-worker with an open wound. (2)
- [10]**

QUESTION 3 MATERIALS (GENERIC)

- 3.1 Define the term *heat treatment of steel*. (4)
- 3.2 Why is case hardening performed on steel? (3)
- 3.3 When referring to a quenching medium for high-carbon steels.
- 3.3.1 What is the ideal quenching medium for rapid cooling? (1)
 - 3.3.2 What quenching medium is used for extreme cooling? (1)
- 3.4 What type of quenching medium is normally used for low-carbon and medium-carbon steels? (1)
- 3.5 Why should ferrous metals be normalised? (4)
- [14]**

QUESTION 4 MULTIPLE-CHOICE QUESTIONS (SPECIFIC)

Various options are provided as possible answers to the following questions. Choose the correct answer and write the letter (A–D) next to the question number (4.1–4.14) in your ANSWER BOOK. Example: 4.15 A.

4.1 What does **12** on the weld symbol in Figure 4.1 represent?

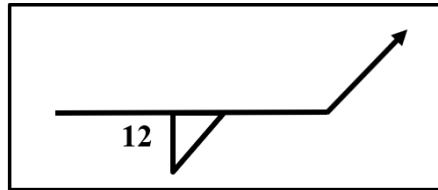


FIGURE 4.1

- A Length
- B Size
- C Pitch
- D Root

(1)

4.2 Identify the template shown in Figure 4.2.

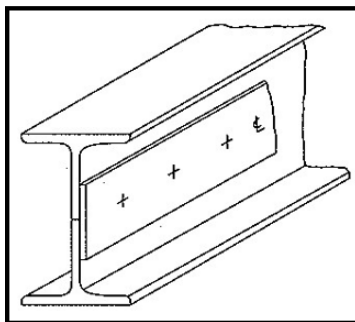


FIGURE 4.2

- A Left-hand flange template
- B Right-hand flange template
- C Strip template
- D Web template

(1)

4.3 Which of the following components is not part of a bench grinder?

- A Wheel guard
- B Cutting disk
- C Electric motor
- D Tool rest

(1)

4.4 What is the purpose of a punch-and-shearing machine?

- A To fold sheet metal.
- B To cut steel profiles.
- C To join steel.
- D To bend a plate.

(1)

4.5 Safe working stress is defined as ...

- A internal resistance in a body to an external load.
- B internal force present in a material with external traction applied.
- C minimum allowable stress in a material that prevents it from giving way.
- D maximum allowable stress in a material that prevents it from giving way. (1)

4.6 What is understood by *Hooke's law*?

- A The ratio between stress and strain in a metal, provided that the limit of elasticity is not exceeded.
- B A measurement of the extension or contraction of material due to the load experienced.
- C Strain is directly proportional to the stress it causes, provided the limit of proportionality is not exceeded.
- D The ratio of the deformation because of the application of an external force. (1)

4.7 Ultrasonic inspection techniques use ... to detect flaws in welded joints.

- A sound
- B liquid
- C film
- D light (1)

4.8 Which welding defect can be prevented if there is no rust on the MIG wire electrode?

- A Undercutting
- B Porosity
- C Cracks
- D Splatter (1)

4.9 The first effect obtained when cold-worked metal is heated will be ...

- A hardening.
- B relief of internal stress.
- C softening.
- D melting. (1)

4.10 AC^3 for a steel with a carbon content of 0,2% is the point where ...

- A Ferrite and Cementite change to Austenite and Cementite.
- B Ferrite and Pearlite change to Austenite and Cementite.
- C Ferrite and Pearlite change to Ferrite and Austenite.
- D Ferrite and Austenite change to Austenite. (1)

4.11 Friction due to a too fast drilling speed generates excessive heat. What happens to the drill bit in this case?

- A It becomes sharper.
- B It is forged.
- C It becomes softer.
- D It gets harder.

(1)

4.12 Figure 4.12 shows marks on a grinding wheel that must be struck with a non-metal object. As what is the test known?

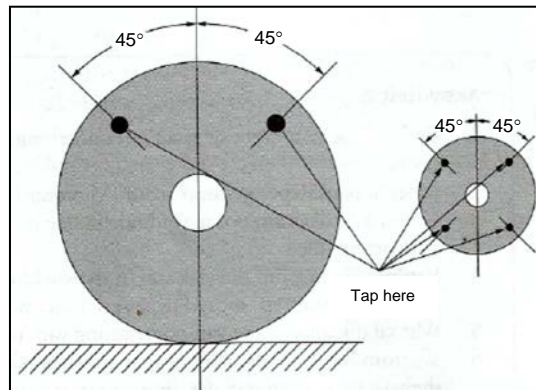


FIGURE 4.12

- A Roll test
- B Hit test
- C Adjustment test
- D Ring test

(1)

4.13 What is the value of **X** in Figure 4.13?

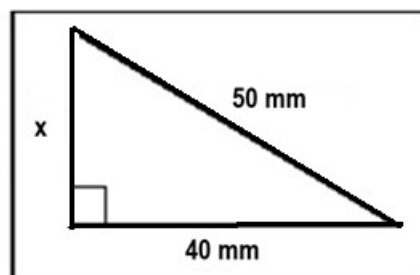


FIGURE 4.13

- A 90 mm
- B 60 mm
- C 30 mm
- D 120 mm

(1)

4.14 What is the size of the base circumference of the cone shown in Figure 4.14?

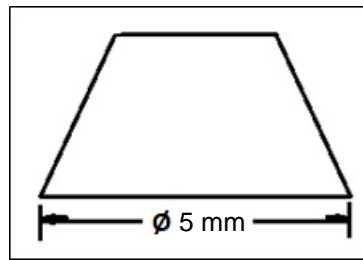


FIGURE 4.14

- A 21,9 mm
- B 4,7 mm
- C 15,7 mm
- D 9,4 mm

(1)
[14]

QUESTION 5 TERMINOLOGY (TEMPLATES) (SPECIFIC)

5.1 What is the purpose of supplementary weld symbols? (1)

5.2 Calculate the length of an 8 mm steel plate that is to be rolled into a cylinder with an internal diameter of 550 mm. (6)

5.3 State FOUR examples of fusion welds. (4)

5.4 Draw a neat sketch of a welding symbol indicating the following information for a T-joint done with arc welding:

The fillet weld on both sides is 6 mm in size. The length of the weld beads is 40 mm each and the pitch of the weld is 90 mm. (8)

5.5 Identify the following supplementary weld symbols:

5.5.1 G (1)

5.5.2 F (1)

5.5.3 M (1)

5.5.4  (1)
[23]

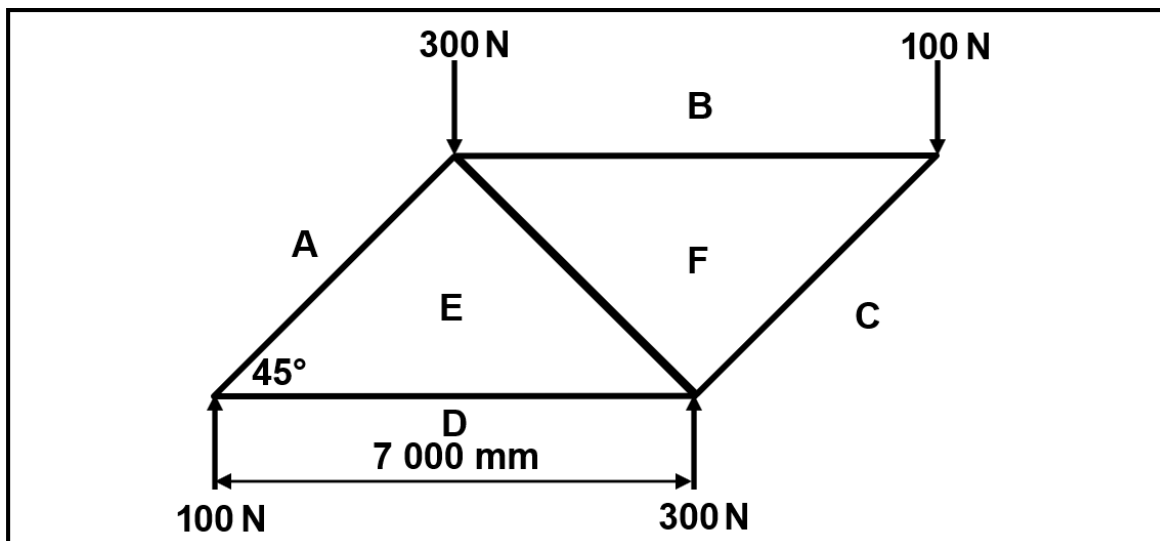
QUESTION 6 TOOLS AND EQUIPMENT (SPECIFIC)

- 6.1 Explain the operating principle of the following machines, used in the welding workshop:
- 6.1.1 Power saw (4)
- 6.1.2 Manual guillotine (4)
- 6.2 What is used to fill an acetylene cylinder to ensure safe storage of the acetylene. (3)
- 6.3 Name THREE types of material that can be cut with a plasma cutter. (3)
- 6.4 Explain what is meant by resistance welding. (4)
- [18]**

QUESTION 7 FORCES (SPECIFIC)

- 7.1 Graphically determine the magnitude and type of member in the framework shown in Figure 7.1. Members: **AE, BF, CF, DE** and **EF**.

SCALE: Space diagram: 1:100
Force diagram: 1 mm = 5 N

**FIGURE 7.1****(19)**

7.2 Figure 7.2 shows a beam 9 m long, which is subjected to 3 vertical forces.

A force of 4 kN is 2 m from point A.

A force of 2 kN is 7 m from point A.

A force of 2 kN is 8 m from point A.



FIGURE 7.2

7.2.1 Calculate the reactions at LR and RR. (6)

7.2.2 Suppose the bending moments at A and E are calculated as 0 N.m.

Calculate the bending moments (BM) at points B, C and D on the beam. (3)

7.2.3 Suppose the shear forces at A and E are calculated as 0 kN.

Calculate the shear forces at B, C and D. (3)

7.2.4 Draw to scale the shear force diagram for the beam.

Scale: 1 cm = 1 kN (4)

7.2.5 Draw to scale the bending-moment diagram for the beam.

Scale: 1 cm = 1 kN.m
Space diagram 1:100 (4)

7.3 The original length of a 10 mm round bar is 6 m. It extends by 0,6 mm when a 150 kN tensile load is applied to it.

7.3.1 Calculate the stress in the round bar. (3)

7.3.2 Calculate the strain in the round bar (answer in full decimal). (3)

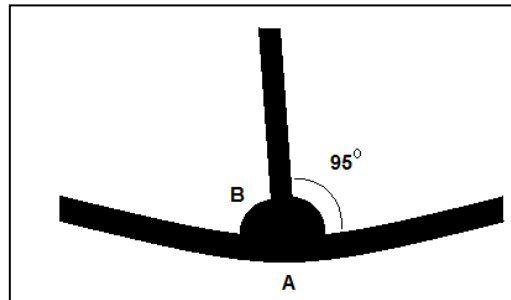
[45]

QUESTION 8 JOINING METHODS (INSPECTION OF WELD) (SPECIFIC)

- 8.1 State TWO precautions to eliminate the following welding defects:
- 8.1.1 Slag inclusion (2)
 - 8.1.2 Centre-line cracks (2)
- 8.2 A free-bend test is performed on a weld.
- 8.2.1 Why is this type of test done on a weld? (1)
 - 8.2.2 Explain step by step how the test is done. (4)
 - 8.2.3 What indication would there be in this test to classify a weld as unfit for work? (2)
- 8.3 Name THREE types of flames used with the Oxy-Acetylene torch. (3)
- 8.4 Describe the steps to be followed when performing a nick-break test on a welded joint. (5)
- 8.5 State TWO preventative measures for the following welding defects during arc welding:
- 8.5.1 Porosity (2)
 - 8.5.2 Incomplete penetration (2)
- [23]**

**QUESTION 9 JOINING METHODS (STRESSES AND DISTORTION)
(SPECIFIC)**

- 9.1 What is *distortion* on a welded joint? (2)
- 9.2 Figure 9.2 shows a T-joint made of 6 × 30 mm flat bar. The figure shows that shrinkage was present on metal A and deformation occurred at weld B.

**FIGURE 9.2**

- 9.2.1 State what influence the type of electrode had on causing the distortion in A. (2)
- 9.2.2 Name TWO factors that might have contributed to residual stress at B. (2)
- 9.2.3 Name FOUR methods to reduce distortion in the load. (4)
- 9.3 Describe the effect of cold working on steel. (4)
- 9.4 What happens when Austenite is allowed to cool slowly? (2)
- 9.5 Name TWO quenching media used to cool down steel. (2)
- [18]**

QUESTION 10 MAINTENANCE (SPECIFIC)

- 10.1 State ONE effect of overloading on EACH of the following machines:
- 10.1.1 Power saw (1)
- 10.1.2 Bench grinder (1)
- 10.2 What negative effect does friction have on a drill bit? (1)
- 10.3 Discuss the starting-up procedure that needs to be followed after maintenance of plant and equipment. (5)
- [8]**

