NATIONAL SENIOR CERTIFICATE EXAMINATION
NOVEMBER 2022

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 in your Answer Book.
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 What is the purpose of the Occupational Health and Safety Act, 1993 (Act 85 of 1993), regarding HIV/Aids awareness?

A The safety laws state that all employers must make sure that the workplace is safe, and that employees are not at risk of becoming infected with HIV at work.
B It contains common guidelines on how employers, employees and trade unions should respond to HIV in the workplace.
C Employers may not demote or promote an employee based on his/her HIV status.
D Employers cannot simply dismiss a person who is infected with HIV. (1)

1.2 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 blockages.
B form a flammable mixture.
C make the oxygen fittings slippery.
D accumulate dust. (1)

1.3 Which ONE of the following safety regulations applies to the MAGS/MIGS welding process?

A Check the colour coding on cylinders.
B Hold the work piece in your hand during the welding process.
C Turn the relief valve very slowly.
D Ensure that the welding area is well ventilated. (1)

1.4 What is the first step in the production of high-strength steel?

A Normalising
B Annealing
C Tempering
D Hardening (1)

1.5 Which of the following tests can be classified as a non-destructive test?

A Bend
B Machinability
C X-ray
D Nick break test (1)

1.6 Which ONE of the following factors is important in the heat treatment of steel?

A Temperature
B Colour
C Length
D Shape (1)

[6]

QUESTION 2 SAFETY (GENERIC)

2.1 Why is it so important to determine an injured person's vital signs after an injury? (2)

2.2 A welded joint needs to be ground using an angle grinder. State TWO safety measures to be observed when using the angle grinder. (2)

2.3 Why should a work piece be clamped securely when using a drill press? (2)

2.4 Name TWO advantages of a product layout. (2)

2.5 State TWO responsibilities of an **employer** regarding the safety in the workplace. (2)

[10]

QUESTION 3 MATERIALS (GENERIC)

3.1 What is the purpose of the heat treatment of steel? (1)

3.2 Why should ferrous metals be normalised? (3)

3.3 Explain how you would identify the type of metal by using the sound test. (3)

3.4 The hardness achieved by a specific heat treatment process depends on THREE factors. Name these factors. (3)

3.5 Explain the annealing process of steel and why it is used. (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 the abbreviation *O.S.U.* stand for?

A Open side up
B Other side up
C Other side under
D Open side under (1)

4.2 Identify the correct instruction for the welding symbol in Figure 4.2.

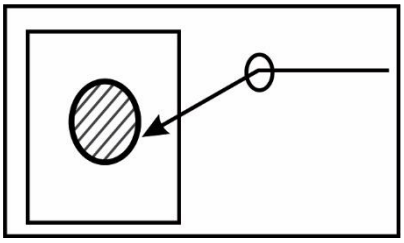

FIGURE 4.2

A Weld through the middle
B Weld all around
C Site welding
D Work around (1)

4.3 The thread of the regulator for the acetylene cylinder is:

A A right-hand thread.
B A left-hand thread.
C A square thread.
D None of the above. (1)

4.4 What is the purpose of an electric guillotine?

A To cut sheet metal.
B To cut the steel profiles.
C To weld steel.
D To bend plate. (1)

4.5 What is understood by the term *Young's Modulus*?

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 A ratio of the deformation due to the application of an external force. (1)

4.6 What is the unit of measurement for strain?

A Meter (m)
B Pascal (Pa)
C Newton (N)
D No unit value (1)

4.7 Which ONE of the following tests is an example of a *destructive test*?

A X-ray test
B Liquid dye penetrant test
C Guided bend test
D Ultrasonic test (1)

4.8 Ultrasonic inspection techniques use … to detect flaws in welded joints.

A sound
B liquid
C film
D light (1)

4.9 What welding defect is prevented if there is no rust on MIG wire electrodes?

A Undercutting
B Porosity
C Cracks
D Splatter (1)

4.10 What is the main contributing factor to distortion?

A Welding current
B Heat
C Operator skill
D Type of welding rods (1)

4.11 What type of procedure is *locking out and tagging*?

A Safety
B Locking machine after work
C To lock a machine for lunch time
D Locking a tool in place (1)

4.12 What is the responsibility of the employer who provides equipment for maintenance?

A The employer is required to supply only basic equipment so that the employees can do a task.
B Switches are unlocked and not tagged to inform other workers that maintenance work is incomplete.
C All equipment supplied by the employer must be certified that it is safe to use and properly maintained.
D None of the above. (1)

4.13 Calculate the value of **X** as indicated in Figure 4.13.

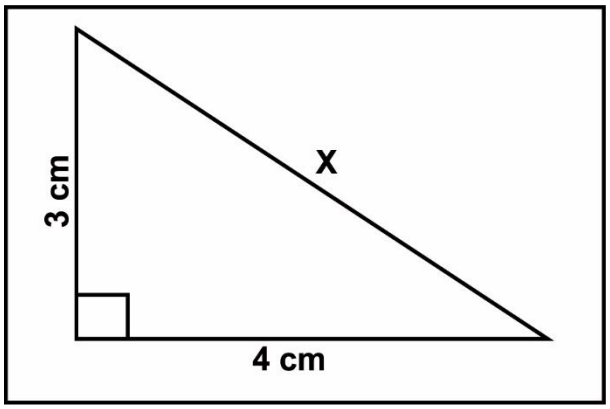

FIGURE 4.13

A 7 cm
B 5 cm
C 6 cm
D 25 cm (1)

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

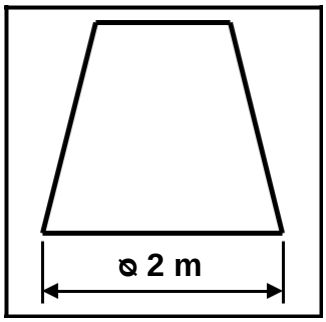

FIGURE 4.14

A 3,10 m
B 3,14 m
C 5,28 m
D 6,28 m (1)

[14]

QUESTION 5 TERMINOLOGY (TEMPLATES) (SPECIFIC)

5.1 Give TWO reasons why the template loft is separated from the workshop in most cases. (2)

5.2 Describe the purpose of purlins as used on roof trusses. (2)

5.3 A mild steel ring with an outer diameter of 424 mm must be bent out of a flat iron as shown in Figure 5.3. Calculate the material length if 30 × 60 mm flat bar is used.

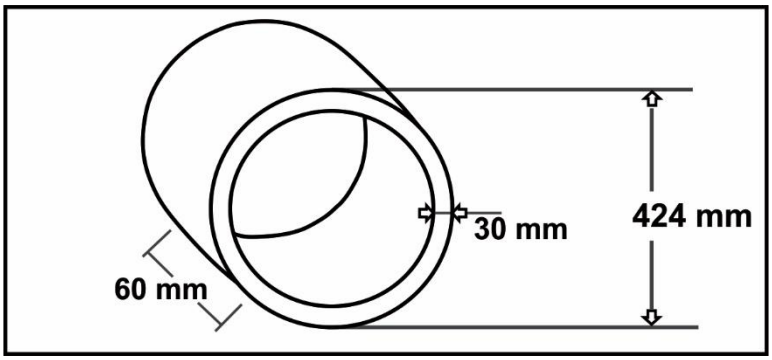

FIGURE 5.3

(7)

5.4 Figure 5.4 shows a weld with additional information. Draw a welding symbol for the weld. The weld on the arrow side must be finished round with a chisel. The weld on the other side must be finished hollow with a grinder. It must be welded on site. Use arrow A as reference.

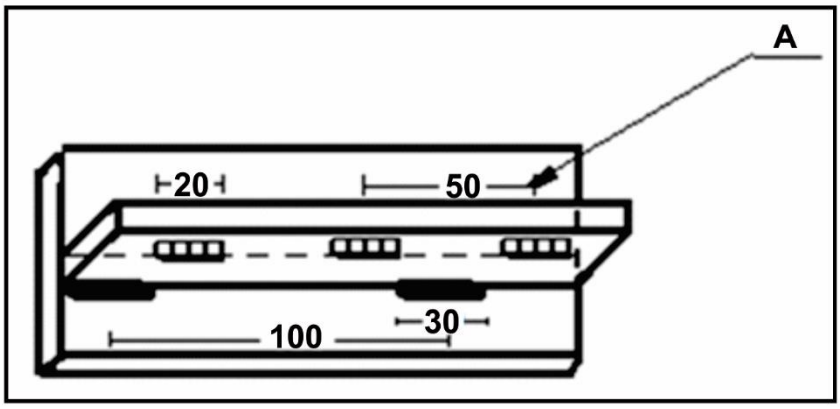

FIGURE 5.4

(8)

5.5 Name TWO advantages of using templates. (2)

5.6 What does the abbreviation SANS stand for? (2)

[23]

QUESTION 6 TOOLS AND EQUIPMENT (SPECIFIC)

6.1 Label **only** parts **A, E** and **H** of the screw thread in Figure 6.1.

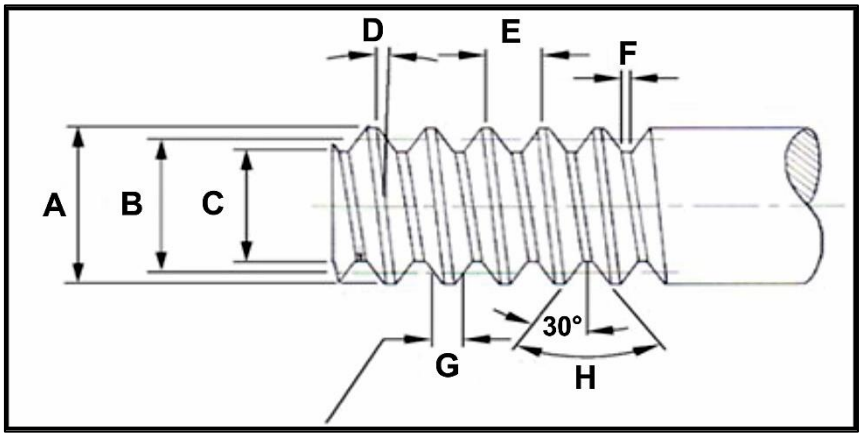

FIGURE 6.1

(3)

6.2 Figure 6.2 shows a component of the oxy-acetylene gas-welding device. Answer the questions that follow:

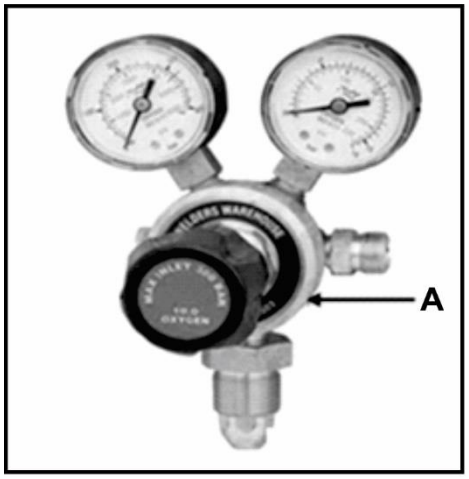

FIGURE 6.2

6.2.1 Identify the component in Figure 6.2. (1)

6.2.2 What is the primary function of the component? (2)

6.2.3 What would indicate that this component is used for **oxygen** and not for acetylene? (4)

6.3 What type of metal is cut with a punch and shear machine? (2)

6.4 Figure 6.4 shows the MIG/MAGS welding process. Label **A** to **D**.

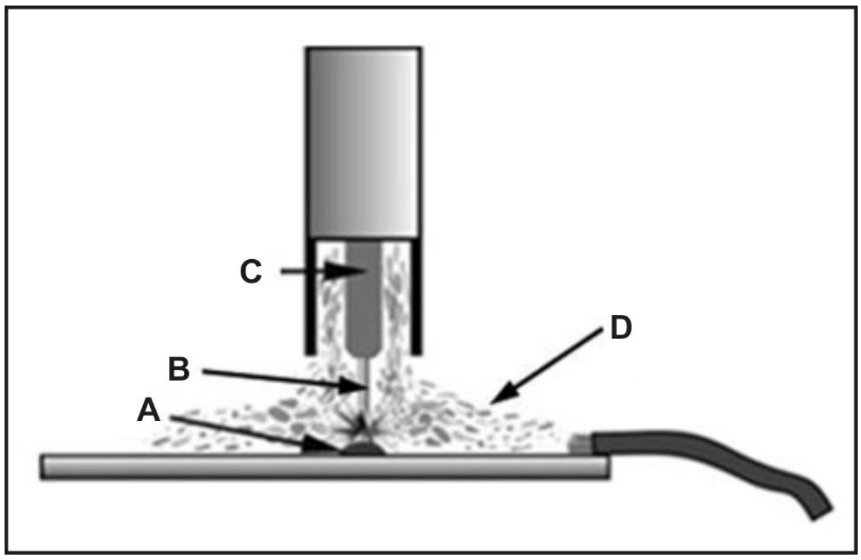

FIGURE 6.4

(4)

6.5 What is the function of the flashback arrestor fitted on the torch end? (2)

[18]

QUESTION 7 FORCES (SPECIFIC)

7.1 Figure 7.1 shows a steel frame. Using Bow's notation, graphically determine the magnitude and nature of the forces in parts AE; BF; CG; DG; DE; EF and FG.

Scale: Space diagram 10 mm = 1 m
Force diagram 1 mm = 4 N

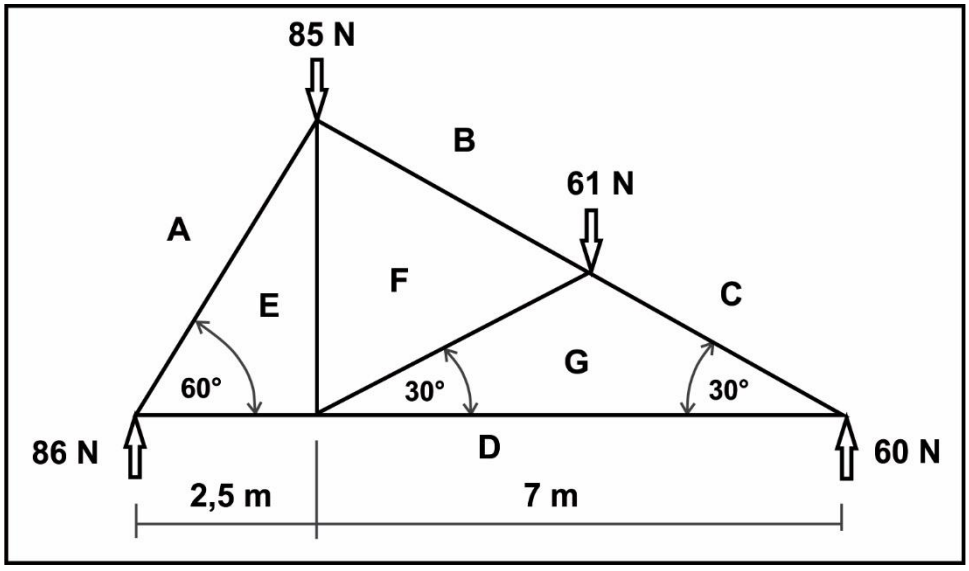

FIGURE 7.1

(21)

7.2 Figure 7.2 shows a beam in equilibrium that is subjected to two-point loads and a uniformly distributed load. It is supported at both points with LR and RR. Answer the questions that follow:

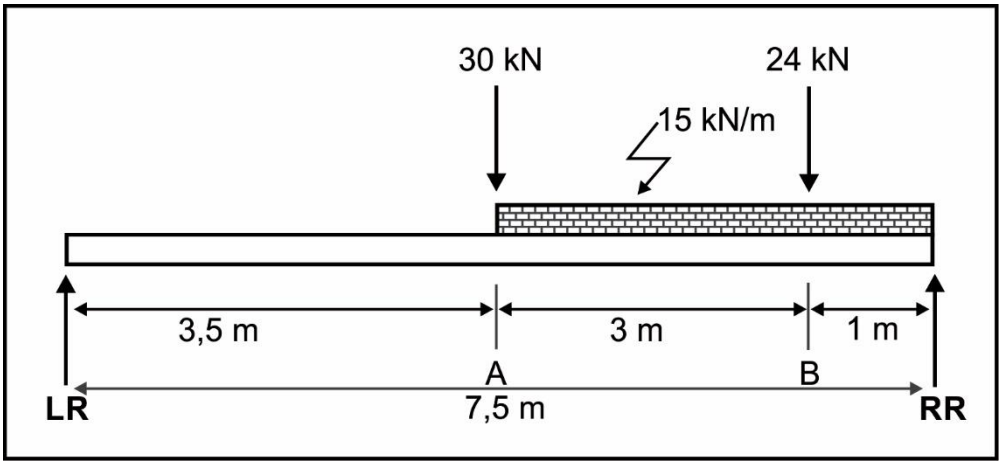

FIGURE 7.2

7.2.1 Calculate the reactions at LR and RR. (4)

7.2.2 Calculate the bending moments (BM) at points A and B on the beam. (2)

7.2.3 Calculate the shear forces at A and B. (2)

7.2.4 Draw the shear force diagram for the beam to scale.
Scale: 1 mm = 1 kN and 10 mm = 1 m (6)

7.3 The original length of a 10 mm round bar is 20 m. It stretches by 0,6 mm when subjected to a tensile load of 50 kN.

7.3.1 Calculate the stress in the round bar. (5)

7.3.2 Calculate the strain in the round bar. (Answer in full decimals.) (3)

7.3.3 Calculate the final length of the round bar. (Answer in full decimals.) (2)

[45]

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

8.1 State TWO causes for each of the following during arc welding:

8.1.1 Welding spatter (2)

8.1.2 Incomplete penetration (2)

8.2 Name THREE items that should be inspected during visual inspection of arc-welded joints. (3)

8.3 What non-destructive test uses photographic films? (2)

8.4 A free-bend test is performed on a weld.

8.4.1 Why is this type of test done on a weld? (1)

8.4.2 Explain step by step how the test is done. (4)

8.4.3 What in this test would indicate that a weld is unfit for work? (2)

8.5 Figure 8.5 shows a V-butt weld with several visible cracks.

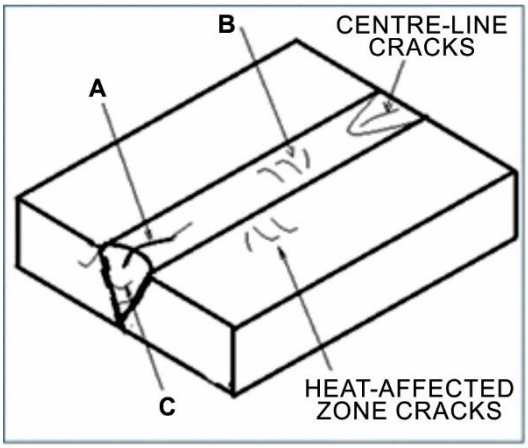

FIGURE 8.5

8.5.1 Identify the type of cracks at A, B and C. (3)

8.5.2 Discuss ways to reduce centre-line cracks. (2)

8.5.3 Name ONE possible cause for the crack at B. (2)
[23]

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

9.1 What is meant by residual stresses in a welded joint? (4)

9.2 Describe the difference between cold working and hot working of steel. (4)

9.3 A weld is first heated before welding takes place.

9.3.1 Why will preheating of steel result in less cracking and deformation during welding? (2)

9.3.2 Discuss THREE factors affecting distortion and residual stress in welds. (3)

9.3.3 One method of reducing deformation is to apply back-step welding. Discuss step by step how this is done. (3)

9.3.4 Name TWO other methods to reduce distortion. (2)
[18]

QUESTION 10 MAINTENANCE (SPECIFIC)

10.1 It is the duty of the workshop manager to ensure that electric guillotine maintenance technicians are safe. Discuss how this can be achieved. (3)

10.2 There are a lot of factors that need to be considered when selecting the drill cutting speed when drilling into steel. Name any THREE factors to be considered when selecting the cutting speed. (3)

10.3 Give TWO reasons for the maintenance of machines in the welding workshop. (2)
[8]

QUESTION 11 TERMINOLOGY (DEVELOPMENT) (SPECIFIC)

Calculate the relevant true lengths of a cone frustum with a base diameter of 800 mm, top diameter of 400 mm and a vertical height of 800 mm, as shown in Figure 11.1.

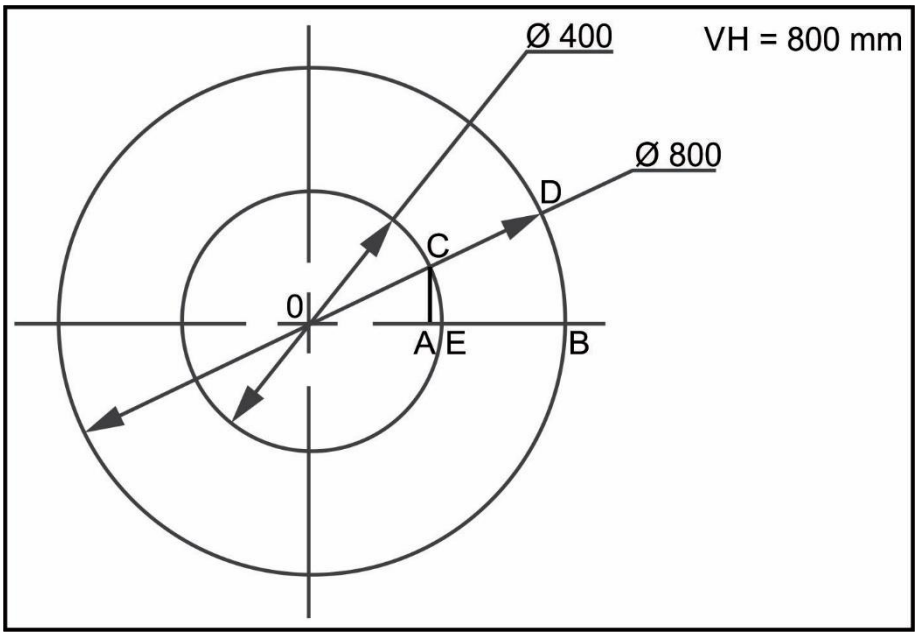

FIGURE 11.1

Calculate:

11.1 C – E (4)

11.2 B – D (4)

11.3 E – B (4)

11.4 C – B (9)
[21]

Total: 200 marks