

**NATIONAL
SENIOR CERTIFICATE**

GRADE 12

SEPTEMBER 2018

**MECHANICAL TECHNOLOGY: WELDING AND
METAL WORK**

MARKS: 200

TIME: 3 hours

This question paper consists of 13 pages, including a 1-page formula sheet.

INSTRUCTIONS AND INFORMATION

1. Write your NAME on your ANSWER BOOK.
2. Read ALL the questions carefully.
3. Answer ALL the questions.
4. Number the questions correctly according to the numbering system used in this question paper.
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. The value of gravitational acceleration should be taken as 10 m/s^2 .
9. All dimensions are in millimetres, unless stated otherwise in the question.
10. A formula sheet for your use is attached at the back of this question paper.
11. Write neatly and legibly.
12. Use the criteria below to assist you in managing your time management.

QUESTION	CONTENT COVERED	MARKS	TIME
Generic			
1	Multiple-choice questions	6	6 minutes
2	Safety	10	10 minutes
3	Materials	14	14 minutes
Specific			
4	Multiple-choice questions	14	10 minutes
5	Terminology (Templates)	23	20 minutes
6	Tools and Equipment	18	15 minutes
7	Forces	33	40 minutes
8	Joining Methods (Inspection of Weld)	23	20 minutes
9	Joining Methods (Stress and Distortion)	18	20 minutes
10	Maintenance	8	10 minutes
11	Terminology (Development)	33	15 minutes
	TOTAL	200	180 minutes

QUESTION 1: MULTIPLE-CHOICE QUESTIONS (GENERIC)

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

- 1.1 Which of the following laws in South Africa protect the people living with HIV/Aids?
- A Occupational Health and Safety Act (OHS)
 - B The Bill of Rights
 - C The Labour Relations Act
 - D All of the above
- (1)
- 1.2 Identify the safety measure below that is applicable to the bench grinder in terms of the Occupational Health and Safety Act.
- A All surfaces of the machine must be well oiled.
 - B Guards must be removed when grinding.
 - C Wear safety goggles when grinding.
 - D Ensure that the machine is running.
- (1)
- 1.3 The following safety precautions must be followed when handling gas bottles.
- A Wear approved PPE to shield the skin from the arc rays.
 - B Use completely insulated electrode holders.
 - C Wear leather spats and safety boots when welding.
 - D Never stack cylinders on top of one another.
- (1)
- 1.4 The process of relieving stresses, set up by cold working is termed ...
- A annealing.
 - B hardening.
 - C tempering.
 - D normalising.
- (1)
- 1.5 Materials can be tested differently in the workshop and industry. How can metals be tested?
- A Sound test
 - B Bend test
 - C Filing test
 - D All of the above
- (1)

- 1.6 Which of the following carbon steels has short, very white or light yellow carrier lines with forking and considerable many star- like bursts?

- A Low carbon steel
- B High carbon steel
- C Cast iron
- D Medium carbon steel

(1)

[6]

QUESTION 2: SAFETY (GENERIC)

- 2.1 List FOUR unsafe conditions in a mechanical workshop. (4)

- 2.2 Describe at least some of the procedures to follow when assessing a first-aid situation. (2)

- 2.3 Give the advantages of the following workshop layouts:

- 2.3.1 Product layout of machines (2)

- 2.3.2 Process layout of machines (2)

[10]

QUESTION 3: MATERIALS (GENERIC)

- 3.1 State the purpose of case-hardening mild steel. (2)

- 3.2 The hardness that can be achieved with a given heat treatment depends on three factors. Mention the THREE factors. (3)

- 3.3 List FOUR kinds of quenching mediums. (4)

- 3.4 Why is it important that hardened steel be tempered during the heating process, as soon as possible? (2)

- 3.5 Tabulate the findings on the different tests on the materials indicated below.

Material			
Type of test	Mild Steel	High Speed Steel	Cast Iron
Sound Test	3.5.1	3.5.2	3.5.3

(3)

[14]

QUESTION 4: MULTIPLE-CHOICE QUESTIONS (SPECIFIC)

- 4.1 Which ONE of the following statements is a basic rule for safe handling of a press machine?
- A Use a hammer to get the work piece into position.
 - B The safety guard must be in place before you can start the press machine.
 - C Never leave the machine running if it is unattended.
 - D The safe working pressure must never be exceeded. (1)
- 4.2 Template makers have their own hand tools, such as ...
- A spanners.
 - B micrometres.
 - C chalk line and reel.
 - D sockets. (1)
- 4.3 What is a plate girder?
- A Hollow tubing welded together
 - B Combination of plates and angle iron welded together
 - C Retro grids welded together
 - D Combination of plates and round bar welded together (1)
- 4.4 All symbols that appear above the reference line refer to welding to be done on ... of the joint to which the arrow head is pointing.
- A this side
 - B the right side
 - C the left side
 - D the other side (1)
- 4.5 Supplementary symbols indicate ... information about a weld.
- A additional
 - B calculated
 - C difficult
 - D easy (1)
- 4.6 The pitch is the distance from a reference point on the thread to a corresponding point on the thread ahead of it, measuring parallel as to the ... of the shaft.
- A root
 - B crest
 - C axis
 - D screw (1)

- 4.7 A die is used for cutting or forming external threads on round bars and ...
A square tubing.
B shafts.
C plates.
D angle iron. (1)
- 4.8 Arc welding is a type of welding that uses a welding supply to create an electric arc between a/an ...
A earth terminal and electrode.
B electrode and base metal.
C electrode and electrode terminal.
D base metal and earth terminal. (1)
- 4.9 What is the function of spot welding?
A It is very quick and easy.
B It is safe.
C It converts AC to DC.
D The electrical resistance is very low. (1)
- 4.10 What are the individual members of steel frameworks such as roof trusses called, that make up the structure to support the frame structure?
A Columns
B Struts and ties
C Rafters
D Purlins (1)
- 4.11 A UDL is a load that is spread over a certain distance. Give the meaning of UDL.
A Uniformly decreased load
B Uniformly deliberate load
C Uniformly disinclined load
D Uniformly distributed load (1)
- 4.12 Which of the following guidelines should be followed during oxy-acetylene welding?
A Correct flame for the work at hand
B Correct angle of the blow torch and rod
C The rate of progress along the joint
D All of the above (1)
- 4.13 What is the most common cause of heat-affected zone (HAZ) cracks in a weld?
A Excessive oxygen
B Excess hydrogen
C Excess carbon
D Excess nitrogen (1)

4.14 How can friction be reduced when drilling holes?

- A Reduce feed speed
- B Reduce drill speed
- C Apply lubrication
- D All of the above

(1)

[14]

**QUESTION 5: TERMINOLOGY (TEMPLATES, ROLLING AND BENDING)
(SPECIFIC)**

5.1 State the advantages of using a lattice girder, shown in FIGURE 5.1 below.

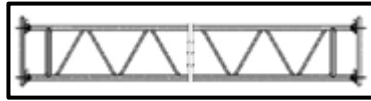


FIGURE 5.1

(2)

5.2 Calculate the length of a 16 mm round bar required to roll a basketball hoop with an internal diameter of 380 mm, using the roll machine in FIGURE 5.2 below.



FIGURE 5.2

(4)

5.3 Make a neat sketch of the weld symbol that represents the following welded joint in FIGURE 5.3 below.

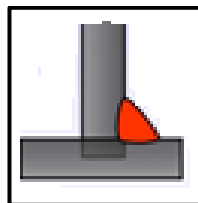


FIGURE 5.3

(2)

5.4 What is a *template loft*? (2)

5.5 Explain the purpose of purlins in roof trusses. (2)

5.6 Describe, with the aid of sketches, the following:

5.6.1 Flange templates (3)

5.6.2 Strip templates (3)






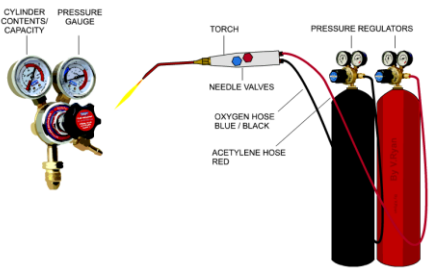
5.6.3 Web templates (3)

5.7 Mention TWO basic principles of marking-off in the workshop. (2)

[23]

QUESTION 6: TOOLS AND EQUIPMENT (SPECIFIC)

6.1 Identify the machines as illustrated below and give ONE function of each.

 <p>6.1.1</p>	 <p>6.1.2</p>
 <p>6.1.3</p>	 <p>6.1.4</p>
 <p>6.1.5</p>	 <p>6.1.6</p>

(12)

6.2 What is the drill sizes for the following holes that need to be tapped for a Metric-ISO thread course pitch?

6.2.1 8 mm (1)

6.2.3 10 mm (1)

6.3 Why is a power saw referred to as a *reciprocating saw*? (1)

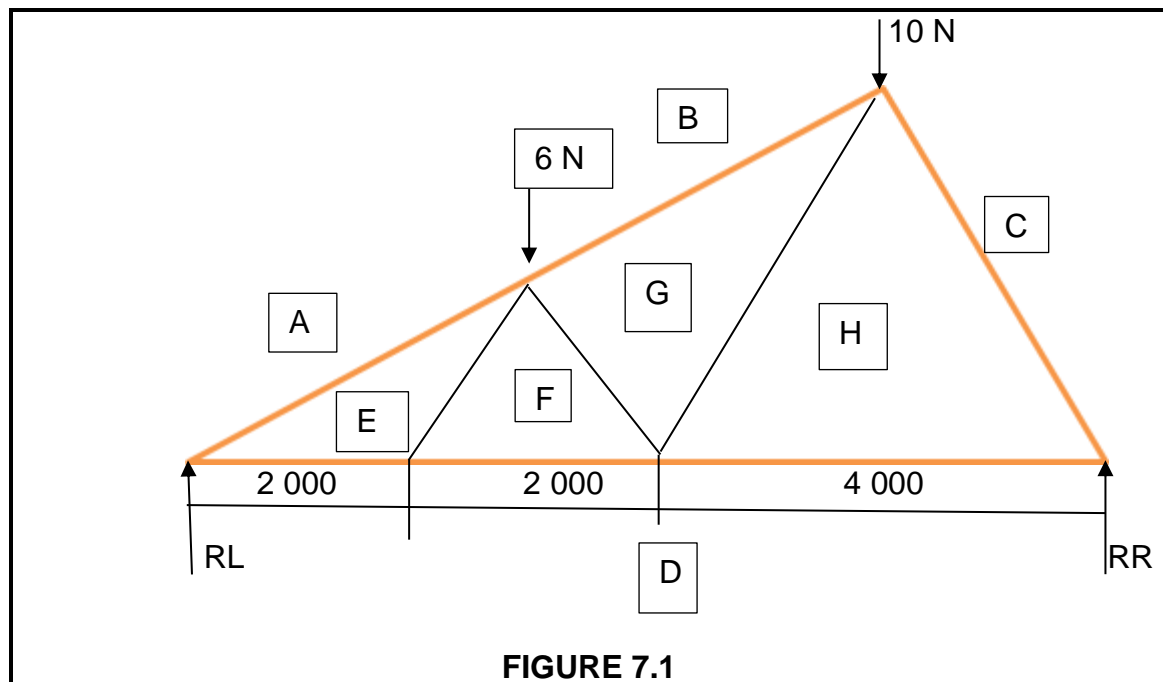
6.4 Which roller is used to roll heavy steel plates (rolling machine)? (1)

6.5 What are the cutting limitations of plasma cutters? (2)

[18]

QUESTION 7: FORCES (SPECIFIC)

- 7.1 FIGURE 7.1 below shows a roof truss with two vertical point loads, 6 N and 10 N respectively, as well as two supports **RL** and **RR** at its ends.



- 7.1.1 Calculate the reactions at **RL** and **RR**. (6)

- 7.1.2 Draw the force diagram. Marks will be deducted for incorrect scale.

SCALE:	SPACE DIAGRAM:	1 : 1000	
	FORCE DIAGRAM:	10 mm : 1 N	(10)

- 7.2 Define the following terms:

- 7.2.1 Strain (2)

- 7.2.2 Stress (2)

- 7.3 A solid steel square bar has one side equal to 45 mm.
The bar is 2 m long and is subjected to a tensile load of 60 kN.

Calculate the change in length of the bar if the value of young's modulus of elasticity is 150 GPa.

(13)
[33]

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

- 8.1 Name THREE most widely used non-destructive weld testing methods. (3)
- 8.2 Describe the *nick-break method* of testing a weld. (5)
- 8.3 List FOUR factors that a good arc weld depends on. (4)
- 8.4 Give FOUR welding defects that may occur after the welding process. (4)
- 8.5 List any TWO methods one can use to help reduce stress on a welded joint. (2)
- 8.6 Explain the terminology *welding spatter*. (2)
- 8.7 What is the main cause of welding spatter? (2)
- 8.8 Which flame in oxy-acetylene is normally used for welding mild steel? (1)
- [23]**

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

- 9.1 Make neat sketches of any THREE methods you would use to reduce distortion during welding. (9)
- 9.2 Mention FOUR different types of cracks in welding joints. (4)
- 9.3 What is the criteria when conducting a free bend test? (2)
- 9.4 Give THREE advantages of using liquid dye penetrant testing over X-ray or ultrasonic testing. (3)
- [18]**

QUESTION 10: MAINTENANCE (SPECIFIC)

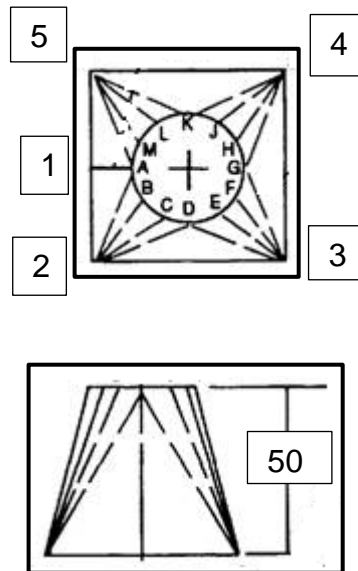
- 10.1 State TWO results for a lack of lubrication on a guillotine. (2)



- 10.2 Define the term *friction*. (2)
- 10.3 What do you understand by the term *overloading*? (2)
- 10.4 Explain the consequences of overloading a guillotine. (2)
- [8]**

QUESTION 11: TERMINOLOGY (DEVELOPMENT) (SPECIFIC)

- 11.1 FIGURE 11.1 below indicates a square to round development. The measurement of the square base is 90 mm x 90 mm and the diameter at the top is 30 mm. The perpendicular vertical height is 50 mm. Calculate the following true lengths:

**FIGURE 11.1**

- | | | |
|--------|--|------|
| 11.1.1 | AB | (3) |
| 11.1.2 | A1 | (3) |
| 11.1.3 | A2 | (4) |
| 11.1.4 | C2 | (4) |
| 11.1.5 | D2 | (4) |
| 11.2 | Using the lengths calculated in QUESTION 11.1.1–11.1.5, draw a full-size layout of the development to manufacture this hopper. | (15) |

[33]**TOTAL: 200**

FORMULA SHEET FOR MECHANICAL TECHNOLOGY (WELDING AND METALWORK)

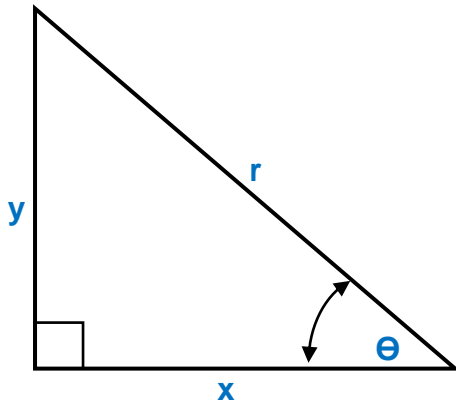
1. STRESS AND STRAIN

$$1.1 \quad \text{Stress} = \frac{\text{Force}}{\text{Area}} \quad \text{or} \quad \sigma = \frac{F}{A}$$

$$1.2 \quad \text{Young's modulus} = \frac{\text{Stress}}{\text{Strain}} \quad \text{or} \quad E = \frac{\sigma}{\varepsilon}$$

$$1.3 \quad \text{Strain} = \frac{\text{Change in length}}{\text{Original length}} \quad \text{or} \quad \varepsilon = \frac{\Delta l}{l}$$

2. PYTHAGORAS' THEOREM AND TRIGONOMETRY



$$2.1 \quad \sin \theta = \frac{y}{r}$$

$$2.2 \quad \cos \theta = \frac{x}{r}$$

$$2.3 \quad \tan \theta = \frac{y}{x}$$

$$2.4 \quad r^2 = x^2 + y^2 \quad \text{or} \quad a^2 = b^2 + c^2$$

3. TEMPLATES AND DEVELOPMENTS

$$3.1 \quad \begin{aligned} \text{Mean } \phi &= \text{Outside } \phi - \text{Plate thickness} \quad \text{or} \\ \text{Mean } \phi &= \text{Inside } \phi + \text{Plate thickness} \end{aligned}$$

$$3.2 \quad \text{Mean circumference} = \pi \times \text{Mean } \phi$$