



**NATIONAL  
SENIOR CERTIFICATE**

**GRADE 11**

**NOVEMBER 2022**

**MECHANICAL TECHNOLOGY: WELDING AND  
METALWORK  
(EXEMPLAR)**

**MARKS: 200**

**TIME: 3 hours**

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This question paper consists of 15 pages, including a formula sheet.

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**INSTRUCTIONS AND INFORMATION**

1. Write your NAME on the ANSWER BOOK.
2. Read ALL the questions carefully
3. Answer ALL the questions.
4. Number the answers 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. You may use a non-programmable scientific calculator and drawing instruments.
8. The value of gravitational force should be taken as  $10 \text{ m.s}^{-2}$ .
9. All dimensions are in millimeters, unless stated otherwise in the question.
10. A formula sheet is attached to the question paper.
11. Write neatly and legibly.
12. Use the criteria below to assist you in managing your time.

QUESTION	CONTENT	MARKS	TIME
<b>(GENERIC)</b>			
1	Multiple-choice questions	20	18 minutes
2	Safety	20	18 minutes
3	Tools and Equipment	20	18 minutes
4	Materials	25	22 minutes
5	Maintenance	10	9 minutes
<b>(SPECIFIC)</b>			
6	Tools and Equipment	20	18 minutes
7	Forces	25	31 minutes
8	Joining Methods-Welding and Steel	15	14 minutes
9	Joining Methods-Heat Treatment	15	14 minutes
10	Joining Methods-Development	20	18 minutes
<b>TOTAL</b>		<b>200</b>	<b>180 minutes</b>

**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 numbers (1.1 to 1.20) in your ANSWER BOOK, for example 1.21 A.

- 1.1 The legal responsibilities of an employer with regards to health and safety include:
- A Making employees pay for replacing damaged or lost PPE.
  - B Providing safe working conditions for all employees.
  - C Taking out additional insurances for dangerous work.
  - D Ensuring that only one member of staff works on a dangerous job. (1)
- 1.2 Which ONE of the following safety procedures applies to the maintenance of a hydraulic press?
- A Do not apply a wrench to a revolving part.
  - B Guards could be removed when pressing soft material.
  - C Pressure gauges must be tested regularly and adjusted or replaced if any malfunction occurs.
  - D Use the machine table as an anvil. (1)
- 1.3 Which of the following is a safety device used in conjunction with guillotines?
- A Fixed guard
  - B Self adjusting guard
  - C Auto push-away guard
  - D All of the above. (1)
- 1.4 Which of the responsibilities of the OHS Act No. 85 of 1993, are NOT Applicable to a person in charge of machines?
- A Installing and properly maintaining machinery.
  - B Repairing machinery.
  - C Ensuring that safety appliances and guards are in a good condition.
  - D Running in the workshop. (1)
- 1.5 Welding or flame cutting operations may be undertaken, unless ...
- A an operator has been refused permission to check the equipment.
  - B an operator has been instructed on how to use the equipment safely
  - C a workplace is under surveillance.
  - D an operator is intoxicated. (1)
- 1.6 The definition for case hardening will be ...
- A to produce a wear resistant surface over a tough core.
  - B to produce an extreme hard surface over a soft core.
  - C to produce a high carbide surface over a hard core.
  - D Not one of the above-mentioned. (1)

- 1.7 Inside the blast furnace, impurities from the ore become trapped in which element?
- A Cupola
  - B Stove
  - C Molten limestone
  - D Carbon monoxide
- (1)
- 1.8 Linear motion is the motion along a ...
- A flywheel.
  - B y-axis.
  - C straight line.
  - D grinding wheel.
- (1)
- 1.9 The set of taps comprise of the following:
- A The taper tap.
  - B The intermediate tap.
  - C The plug/bottoming tap
  - D All of the above
- (1)
- 1.10 Which of the following is NOT a property of metals?
- A Metallurgy
  - B Machinability
  - C Malleability
  - D Ductility
- (1)
- 1.11 The hydraulic press is a device that uses a hydraulic cylinder to generate a ... force.
- A tensile
  - B shear
  - C compressive
  - D advance
- (1)
- 1.12 Which ONE of the following fluids can be used to reduce friction in mechanical engineering?
- A Water
  - B Grease
  - C Thinners
  - D Anti-freeze fluid
- (1)
- 1.13 What is understood by the term *viscosity regarding liquids*? It is the resistance to ...
- A flow.
  - B boil.
  - C cool.
  - D foam.
- (1)

- 1.14 Which of the following colours are used with oxygen cylinders?
- A Red
  - B Orange
  - C Green
  - D Black
- (1)
- 1.15 What are the electrodes of an electric-arc furnace made off?
- A Copper
  - B Stainless steel
  - C Carbon
  - D Cast iron
- (1)
- 1.16 The aim for maintenance of mechanical equipment is ...
- A to stop machinery regularly.
  - B to increase the lifespan of the equipment.
  - C to operate at a higher speed.
  - D to operate at average speed.
- (1)
- 1.17 The most important method of extracting iron from iron ore is ...
- A smelting.
  - B charging.
  - C alloying.
  - D tempering.
- (1)
- 1.18 To determine the drilling speed on a drill press, you need to take into account various factors. Which of the following must be considered?
- A Type of material
  - B Diameter of drill bit
  - C Material that the drill bit is made
  - D All of the above.
- (1)
- 1.19 A 15 mm diameter hole need to be drilled into a piece of sheet metal, with a cutting speed of 600 mm per second. What will the drill speed be in revolutions per minute?
- A 380 revs/minutes
  - B 674 revs/minutes
  - C 764 revs/minutes
  - D 830 revs/minutes
- (1)
- 1.20 What does lockout refer to in machine maintenance?
- A To open the machines.
  - B To enlarge the locks on the machines.
  - C To isolate the machine completely.
  - D To switch off the machine.
- (1)

**[20]**

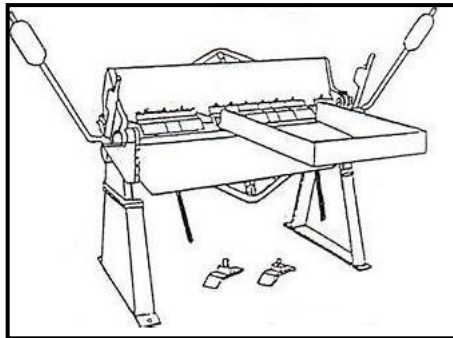
**QUESTION 2: SAFETY (GENERIC)**

- 2.1 State THREE safety measures to observe when using the arc welding equipment. (3)



- 2.2 Give THREE basic rules that apply to machine guards in the workshop. (3)

- 2.3 State THREE safety precautions to apply when using a bending press (Box and Pan folder)



- 2.4 What does the regulation under the OHS Act (clause C3) refers to in terms of reporting to persons in charge of a workshop? (1)

- 2.5 Name THREE general safety rules one must adhere to before switching on the portable grinder. (3)



- 2.6 What safety precautions should be adhered to when drilling a flat steel plate on a drill press? (1)

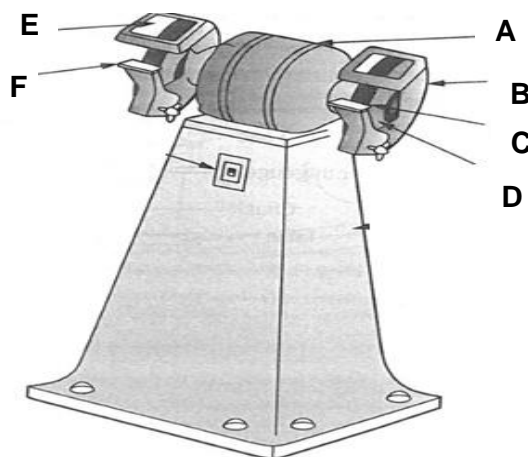
- 2.7 State THREE safety rules to be observed when using a surface grinder. (3)

- 2.8 Identify any THREE types of personal protective equipment (PPE) needed when using gas welding equipment. (3)

**[20]**

**QUESTION 3: TOOLS (GENERIC)**

- 3.1 FIGURE 3.1 below shows a type of cutting machine that removes material in which abrasive particles are rotated at high speed against the material being grounded. Answer the questions that follow.



3.1.1 Identify the machine in FIGURE 3.1 below. (1)

3.1.2 Label **A–F**. (6)

3.1.3 What is the purpose of part **E**? (1)

3.2 What is the function of the manual guillotine? (2)

3.3 Name the TWO main categories that presses fall into. (2)

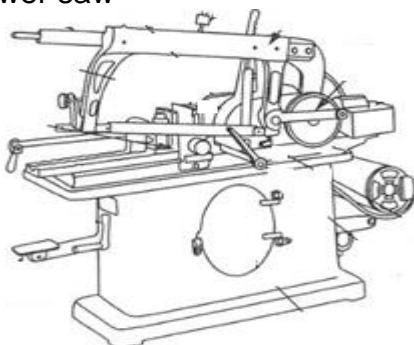
3.4 What is the function of the following equipment?

3.4.1 Horizontal band saw



(2)

3.4.2 Power saw



(2)

3.5 Which FOUR processes require oxy-acetylene equipment? (4)

**[20]**

**QUESTION 4: MATERIALS (GENERIC)**

4.1 Distinguish between the following properties of engineering materials:

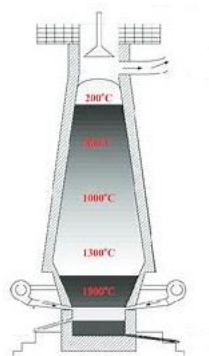
4.1.1 Plasticity (2)

4.1.2 Ductility (2)

4.1.3 Brittleness (2)

4.2 Which era is known as the Iron Age? (1)

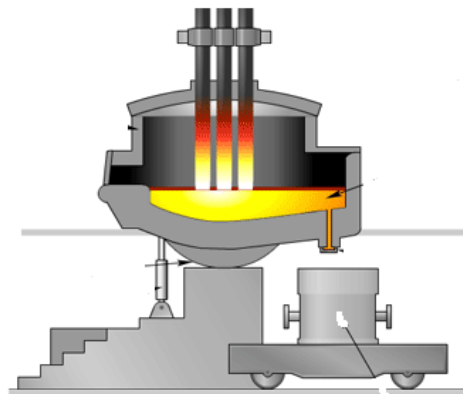
4.3 Explain the operational principle of the blast furnace.



(6)

4.4 Describe the function of the electric arc furnace.

(2)



4.5 Briefly explain how cold chisels are tempered.

(4)

4.6 Which procedure will you follow to determine whether steel has been heated to a hardening temperature? (2)

4.7 Explain the difference between *hardening* and *tempering*.

(4)

**[25]**

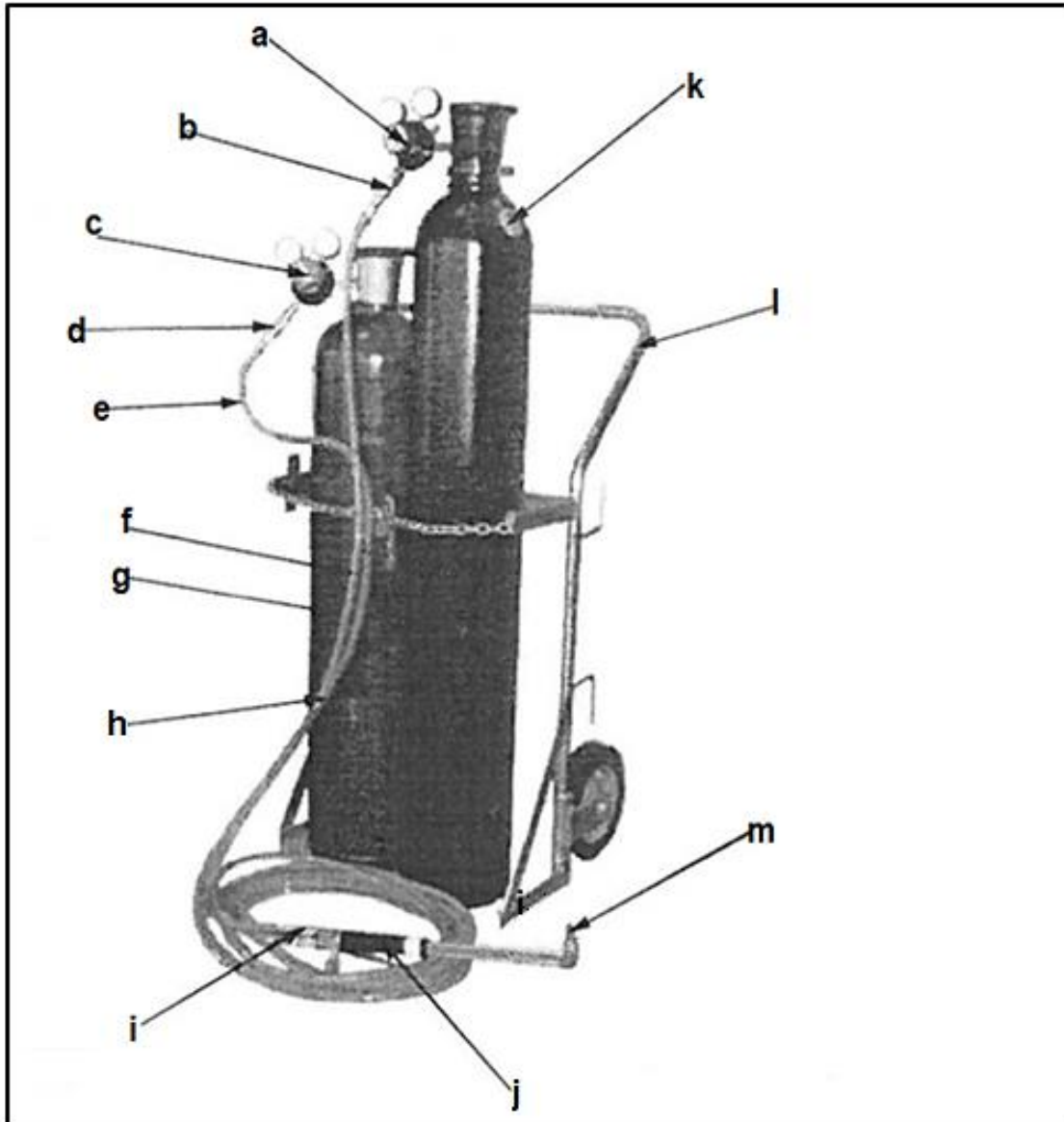


**QUESTION 5: MAINTENANCE (GENERIC)**

- 5.1 5.1.1 Explain the consequences of the lack of lubrication on the punch and shearing machine. (2)
- 5.1.2 Name an example of a machine where friction is not a relative factor. (1)
- 5.2 State TWO results of a lack of lubrication on the chuck of a drilling machine. (1)
- 5.3 Define the term overloading, w.r.t. the drilling machine. (2)
- 5.4 What do you understand by the causes of malfunction of power saws (horizontal and band saws)? (2)
- 5.5 Why is it important to keep service records of power machines? (2)
- [10]**

**QUESTION 6: TOOLS AND EQUIPMENT (SPECIFIC)**

- 6.1 Name THREE types of welding machines.
- 6.2 Explain the principle and function of the gas welding equipment. (3)
- 6.3 What is back firing (back feeding) w.r.t. oxy-acetylene welding? (2)
- 6.4 Label the components of the oxy-acetylene welding apparatus as shown in the picture below. (2)



(13)  
[20]

**QUESTION 7: FORCES (SPECIFIC)**

- 7.1 A round mild steel bar, 200 mm long, with a diameter of 70 mm, is used in a steel framework. A compressive force of 90 kN is exerted on the bar and shorten by 0,5 mm.

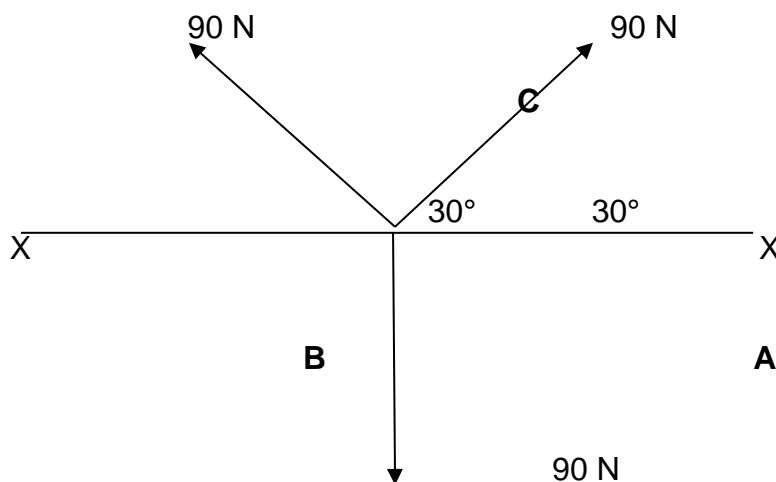
Calculate the following:

7.1.1 The stress in the material and state your answer in mega pascals. (5)

7.1.2 The strain caused by the force. (3)

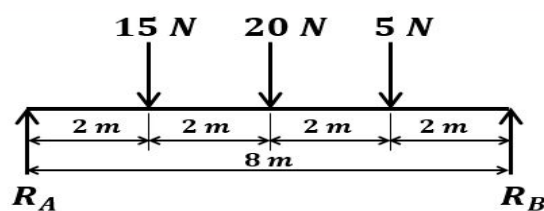
- 7.2 FIGURE 7.2 shows a system of forces acting on the same point. Use Bow's notation to construct a space diagram, depicting the lines of action and direction of all the forces in the system.

Use the following scale with Bow's notation: 1 mm = 1 N

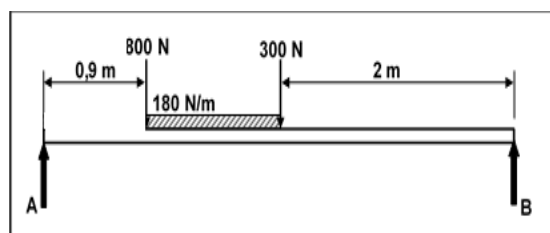


- 7.3 The beam in FIGURE 7.3 below is supported at two ends and is subjected to three point loads, 15 N, 20 N and 5 N respectively.

7.3.1 Calculate the reactions at the supports  $R_L$  and  $R_R$ .



- 7.4 The diagram in FIGURE 7.4 below shows a 4 m long beam supported by two vertical supports, **A** and **B**. Two vertical point loads of 800 N, 300 N and a uniformly distributed load of 180 N/m is exerted over the left half of the beam. Calculate the magnitude of the reactions in supports **A** and **B**.



(8)

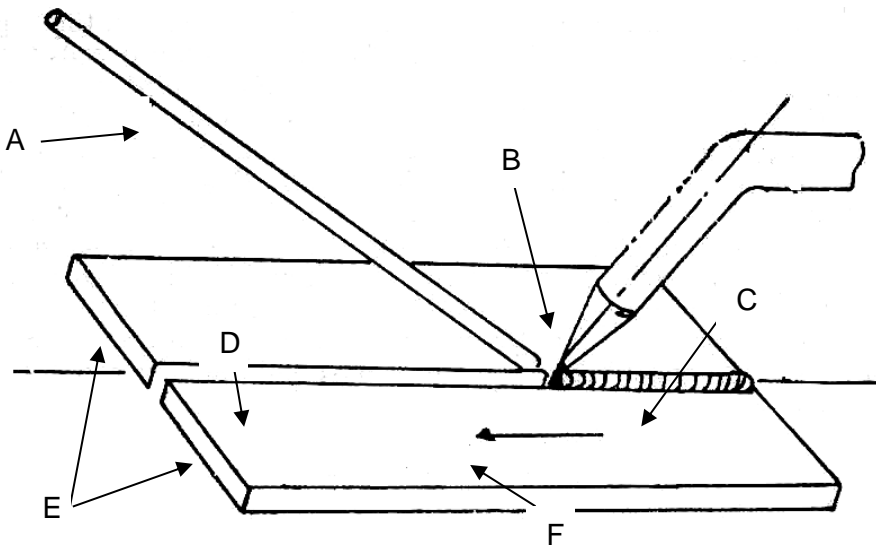
[25]

**QUESTION 8: TERMINOLOGY (WELDING AND STEEL SECTIONS) (SPECIFIC)**

- 8.1 Identify the conventional template markings for the following shorthand forms.
- 8.1.1 TSU (1)
- 8.1.2 OSU (1)
- 8.2 With the aid of a sketch, identify the back mark of an angle iron.  
Calculate the magnitude of the reactions in supports. (2)
- 8.3 The span of the roof truss is 9 m and the rise is 3 m.  
Calculate the:
- 8.3.1 Rafter length of the truss (4)
- 8.3.2 Rafter angle (3)
- 8.3.3 Slope (2)
- 8.4 Describe the use of a flange template. (2)
- [15]**

**QUESTION 9: JOINING METHODS (SPECIFIC)**

9.1 FIGURE 9.1 shows the leftward welding in the flat position. Answer the questions that follow.



9.1.1 Label A–F. (6)

9.1.2 Mention THREE welding joints that require filler material during gas welding. (3)

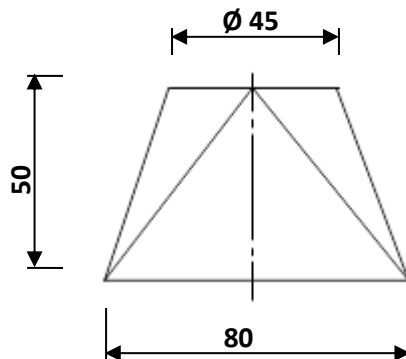
9.2 Give the THREE fundamentals to be controlled by a welder in order to deposit a good weld bead. (3)

9.3 Name THREE arc/gas welding defect. (3)

[15]

**QUESTION 10: TERMINOLOGY (DEVELOPMENT) (SPECIFIC)**

10.1 Develop the square to round transition piece, shown in FIGURE 10 below.



(20)

**QUESTION 11 TERMINOLOGY (STEEL SECTION)**

11.1 Explain by means of simple sketches the following types of steel bars:

11.1.1 Square bar (2)

11.1.2 Flat bar (2)

11.2 Describe the purpose of an assembly jig in a welding workshop. (2)

11.3 Illustrate by means of a neat sketch channel iron. (4)

**[10]**

**TOTAL: 200**

## FORMULA SHEET FOR MECHANICAL TECHNOLOGY (WELDING AND METALWORK.)

### 1. TERMINOLOGY.

$$\text{Depth of cutter} = \frac{\text{Diameter} - x}{2}$$

$$\sin \theta = \frac{x}{\text{Dia}}$$

Where x = depth of cut.

### 2. FORCES.

Clockwise moments = Anti clockwise moments

Upward forces = Downward forces

$$\text{Stress} = \frac{\text{Force / Load}}{\text{Area}}$$

$$\text{Cross Sectional Area} = \frac{\theta D^2}{4} \text{ for Round objects.}$$

Cross Sectional Area = s x s for Square objects

Cross Sectional Area = l x b for Rectangular objects

### 3. SYSTEMS AND CONTROL.

$$\pi D_A \times N_A = \pi D_B \times N_B$$

$$T_A \times N_A = T_B \times N_B = T_C \times N_C$$

$$\text{Pressure} = \frac{\text{FORCE}}{\text{AREA}}$$