



# basic education

Department:  
Basic Education  
**REPUBLIC OF SOUTH AFRICA**

**NATIONAL  
SENIOR CERTIFICATE**

**GRADE 11**

**MECHANICAL TECHNOLOGY**

**EXEMPLAR 2017**

**MARKS: 200**

**TIME: 3 hours**

**This question paper consists of 29 pages and a 2-page formula sheet.**

**INSTRUCTIONS AND INFORMATION**

1. Write your NAME on the ANSWER BOOK.
2. This question paper consists of FOUR sections:  
SECTION A: COMPULSORY.  
SECTION B: FITTING AND MACHINING  
SECTION C: AUTOMOTIVE  
SECTION D: WELDING AND METALWORK
3. Answer SECTION A (COMPULSORY) and then answer SECTION B or C or D, according to your choice of specialisation.
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 millimetres, unless stated otherwise in the question.
10. Write neatly and legibly.
11. A formula sheet is attached to the question paper.
12. Use the criteria at the beginning of each section to assist you to manage your time.

**SECTION A (GENERIC)**

QUESTION	CONTENT	MARKS	TIME
1	Multiple-choice Questions	20	15 minutes
2	Safety	24	15 minutes
3	Tools and Equipment	16	10 minutes
4	Maintenance	8	10 minutes
5	Materials	32	25 minutes
<b>TOTAL FOR SECTION A</b>		<b>100</b>	<b>75 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 number (1.1–1.20) in your ANSWER BOOK, for example 1.21 A

- 1.1 In terms of the Occupational Health and Safety Act, what safety measure is applicable when the bench grinder is used?
- A The tool rest must not be more than 3 mm away from the grinding wheel surface.  
 B Remove all guards before grinding.  
 C Grind on the side of the grinding wheel.  
 D The grinder can be forced to grind thick metal. (1)
- 1.2 Which ONE of the following safety procedures is applicable when using the drill press?
- A Leave the chuck key in the chuck.  
 B Do not hold small work pieces by hand, use a machine vice.  
 C The drill bit can be adjusted while the machine is in motion.  
 D Always use goggles with dark lenses to protect your eyes. (1)
- 1.3 What safety measure is applicable when using the angle grinder?
- A Do not force grinding.  
 B Guards can be removed while cutting materials.  
 C The machine can be used in wet conditions.  
 D Always wear goggles with dark lenses to protect your eyes. (1)
- 1.4 What colour is the acetylene gas cylinder?
- A Red  
 B Black  
 C Green  
 D Maroon (1)

- 1.5 What substance is used for the operation of a pneumatic system?
- A Oil
  - B Fuel
  - C Air
  - D Electricity
- (1)
- 1.6 What will be the tap drill size for a M10 x 1,5 screw thread?
- A 10 mm
  - B 11,5 mm
  - C 8,5 mm
  - D 10,5 mm
- (1)
- 1.7 What is the function of an angle grinder?
- A To do precision grinding of a surface
  - B To sharpen drill bits
  - C To grind off sharp edges
  - D To grind a perfect flat surface
- (1)
- 1.8 Which drilling machine is used for heavy drilling processes?
- A Portable drilling machine
  - B Sensitive drill press
  - C Upright drill press
  - D Radial drilling machine
- (1)
- 1.9 What is a guillotine used for in the mechanical workshop?
- A To roll sheet metal
  - B To bend sheet metal
  - C To cut sheet metal
  - D To join sheet metal
- (1)
- 1.10 A hydraulic press employs the principle of the multiplication of a force within a closed system by using ...
- A air under pressure
  - B fluid under pressure
  - C electric current
  - D lever advantage
- (1)
- 1.11 Which ONE of the following methods is used to reduce friction between two moving parts?
- A Use two different types of metal
  - B Increase the temperature between the two metals
  - C Add abrasives to the contact area
  - D Increase the speed
- (1)

- 1.12 Which ONE of the following is a cause of excessive wear of the belt on the belt drive of a pedestal drilling machine?
- A Lack of lubrication
  - B Misalignment of the pulleys
  - C Frequent change of speed
  - D Continuous drilling procedures
- (1)
- 1.13 Lack of lubrication in any type of machinery is caused by...
- A overloading.
  - B low operating speed.
  - C undercutting.
  - D high volatility.
- (1)
- 1.14 Which ONE of the following fluids can be used to reduce friction in mechanical machinery?
- A Water
  - B Grease
  - C Thinners
  - D Anti-freeze fluid
- (1)
- 1.15 A lack of maintenance on the bench grinder will result in ...
- A inaccurate grinding results.
  - B sharp edges on the work piece.
  - C insufficient lubrication of the grinding wheel.
  - D high speed grinding.
- (1)
- 1.16 What is smelted in a blast furnace?
- A Rocks
  - B Iron ore
  - C Pig iron
  - D Carbon
- (1)
- 1.17 What are the electrodes of an electric-arc furnace made of?
- A Copper
  - B Stainless steel
  - C Carbon
  - D Cast iron
- (1)
- 1.18 Which ONE of the following is an advantage of using an electric-arc furnace?
- A Steel is manufactured from 100% scrap metal
  - B Steel is manufactured from 50% scrap metal
  - C Steel is manufactured from 75% scrap metal
  - D Steel is manufactured from 45% scrap metal
- (1)

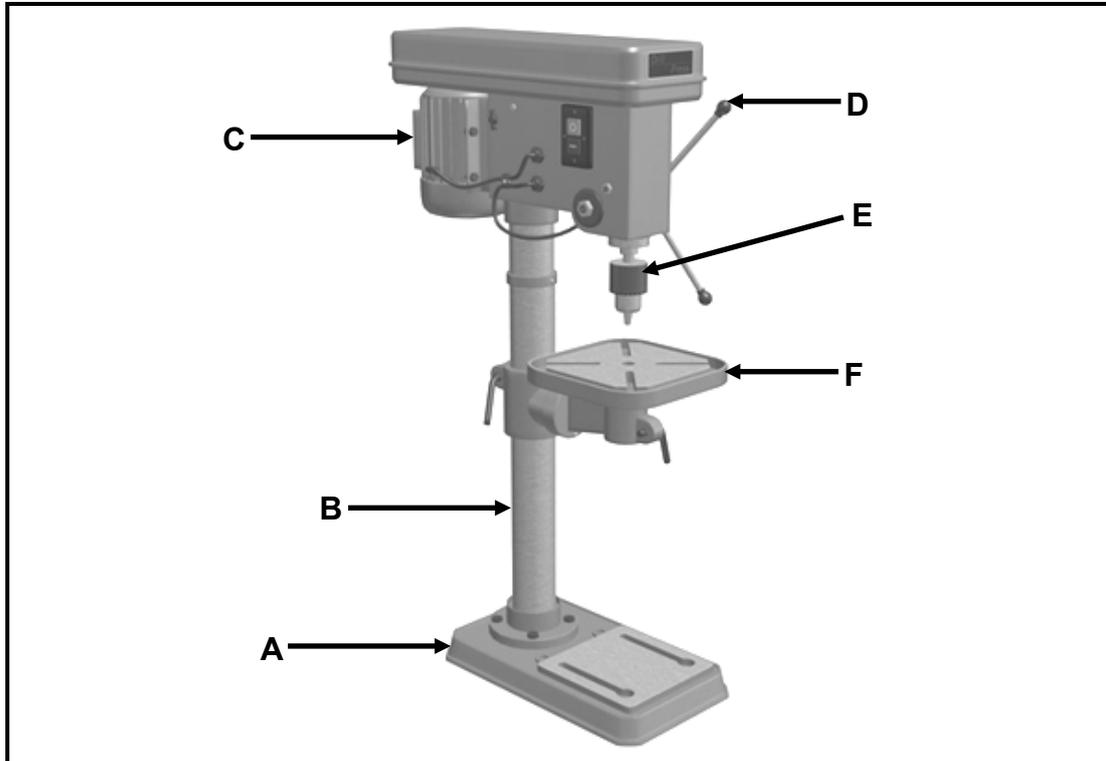
- 1.19 Which ONE of the following is an important property of material used to manufacture a hammer head?
- A Plasticity
  - B Malleability
  - C Brittleness
  - D Toughness
- (1)
- 1.20 Which element is used to make coke used in a blast furnace?
- A Limestone
  - B Dolomite
  - C Coal
  - D Iron ore
- (1)  
**[20]**

**QUESTION 2: SAFETY (GENERIC)**

- 2.1 After welding a joint it needs to be grinded with an angle grinder to obtain a smooth surface. State THREE safety measures to observe before switching on the angle grinder. (3)
- 2.2 Give THREE reasons why it is important to wear a welding helmet during arc welding. (3)
- 2.3 State THREE safety rules to apply when using a portable hand drill machine. (3)
- 2.4 What safety rule must be adhered to after working procedures on any machine have been completed? (1)
- 2.5 State THREE safety rules one must adhere to before switching on the horizontal band saw. (3)
- 2.6 What safety precaution should be adhered to when drilling a small work piece on a drill press? (1)
- 2.7 State THREE safety rules to be observed when using a hydraulic press. (3)
- 2.8 Name THREE types of personal protective equipment (PPE) needed when using gas welding equipment. (3)
- 2.9 Why are you only allowed to light the acetylene with a flint lighter, not with a match or cigarette lighter? (2)
- 2.10 Give TWO reasons why is it important to wear surgical gloves when treating a co-worker with open wounds. (2)  
**[24]**

**QUESTION 3: TOOLS AND EQUIPMENT (GENERIC)**

3.1 FIGURE 3.1 below shows a type of cutting machine. Answer the questions that follow.



**FIGURE 3.1**

- 3.1.1 Identify the machine in FIGURE 3.1 above. (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 a tap and die set? (2)
- 3.3 What is the difference between a *power saw* and a *horizontal band saw*? (2)
- 3.4 What is the function of the following equipment?
- 3.4.1 Roller machine (2)
- 3.4.2 Hydraulic press (2)

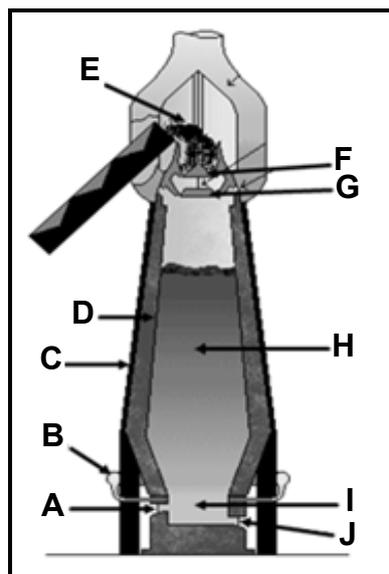
**[16]**

**QUESTION 4: MAINTENANCE (GENERIC)**

- 4.1 Explain, with the aid of freehand sketches, the effect of a lubricant between two surfaces in contact. (2)
- 4.2 State TWO results of a lack of lubrication in a gear system. (2)
- 4.3 Define the term *friction*. (2)
- 4.4 What do you understand by the term *overloading*? (2)
- [8]**

**QUESTION 5: MATERIALS (GENERIC)**

- 5.1 Distinguish between the following properties of engineering materials:
- 5.1.1 Hardness (3)
- 5.1.2 Elasticity (3)
- 5.1.3 Malleability (3)
- 5.1.4 Toughness (3)
- 5.2 Name the product produced by a blast furnace. (1)
- 5.3 State ONE function of EACH of the following elements used in a blast furnace:
- 5.3.1 Iron ore (2)
- 5.3.2 Coke (2)
- 5.3.3 Limestone or dolomite (2)
- 5.4 FIGURE 5.1 below shows a cross-sectional view of a blast furnace. Label **A–J**.

**FIGURE 5.1**

- 5.5 Describe the operation of an electric-arc furnace. (3)
- [32]**

**TOTAL SECTION A: 100**

**SECTION B: FITTING AND MACHINING (SPECIFIC)**

Use the criteria below to assist you to manage your time.

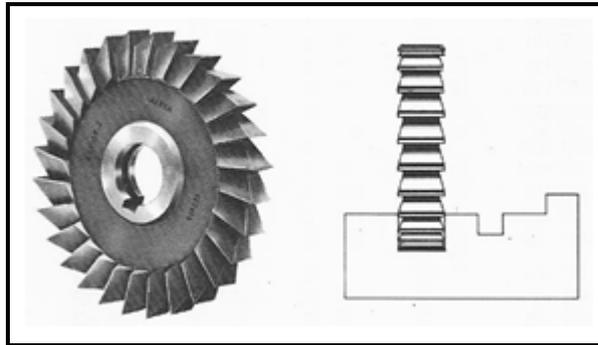
QUESTION	CONTENT	MARKS	TIME
6	Terminology (Specific)	25	30 minutes
7	Tools and Equipment (Specific)	8	8 minutes
8	Forces (Specific)	19	19 minutes
9	Maintenance (Specific)	8	8 minutes
10	Joining Methods (Specific)	12	12 minutes
11	Systems and Control (Specific)	16	16 minutes
12	Pumps (Specific)	12	12 minutes
<b>TOTAL FOR SECTION B</b>		<b>100</b>	<b>105 minutes</b>
<b>TOTAL FOR SECTION A + B</b>		<b>200</b>	<b>180 minutes</b>

**QUESTION 6: TERMINOLOGY (SPECIFIC)**

- 6.1 Describe the function of EACH of the following types of equipment on a centre lathe:
- 6.1.1 Four-jaw chuck (2)
- 6.1.2 Lathe steadies (2)
- 6.1.3 Lathe mandrels (2)
- 6.2 You are required to cut a taper on a lathe using the compound slide. The length of the taper is 105 mm, the large diameter is 78 mm and the small diameter is 62 mm. Calculate the angle at which the compound slide must be set to cut the taper. (3)
- 6.3 A 7 mm pitch, three-start thread is to be cut on a lathe with a 5 mm pitch lead screw. If the pitch diameter of the thread is 90 mm and a clearance angle of  $3^\circ$  is used, calculate the following:
- 6.3.1 The helix angle of the thread (4)
- 6.3.2 The leading tool angle (2)
- 6.3.3 The following tool angle (2)
- 6.4 A parallel key needs to be manufactured to secure a pulley onto a 60 mm diameter shaft. Calculate the following dimensions of the key:
- 6.4.1 The width (2)
- 6.4.2 The thickness (2)
- 6.4.3 The length (2)

6.5 Identify the milling cutters in FIGURES 6.1 and 6.2 below.

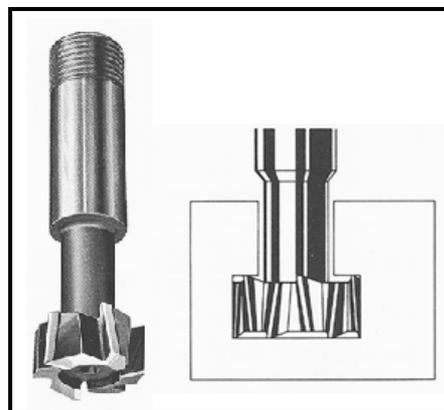
6.5.1



**FIGURE 6.1**

(1)

6.5.2



**FIGURE 6.2**

(1)  
**[25]**

**QUESTION 7: TOOLS AND EQUIPMENT (SPECIFIC)**

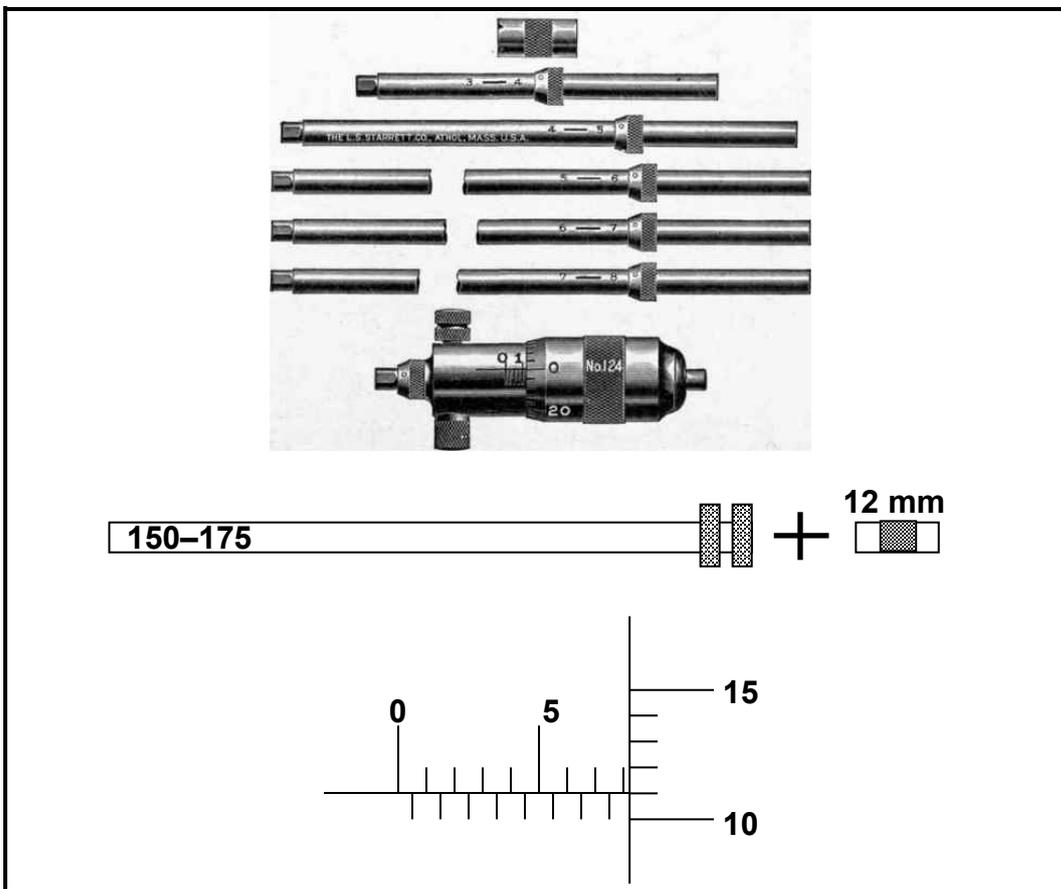
7.1 State ONE purpose of the following tools:

7.1.1 Dial indicator (1)

7.1.2 Telescopic gauge (1)

7.2 Give THREE reasons for using a torque wrench. (3)

7.3 Determine the reading displayed on the inside micrometer shown in FIGURE 7.1 below.

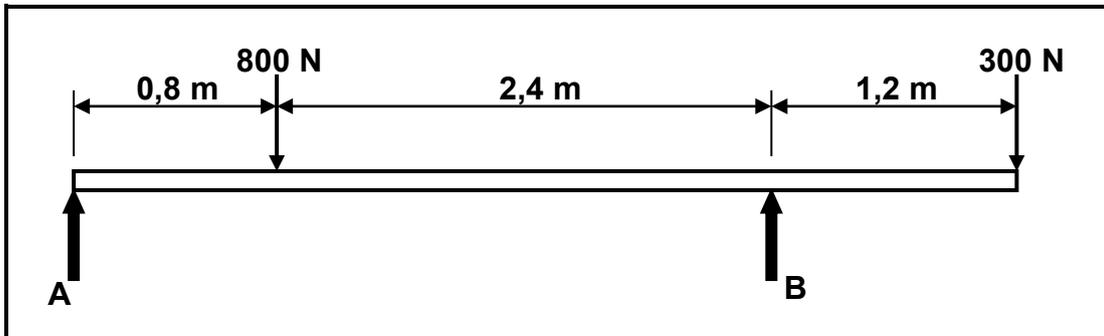


**FIGURE 7.1**

(3)  
[8]

**QUESTION 8: FORCES (SPECIFIC)**

- 8.1 The diagram in FIGURE 8.1 below shows a beam supported by two vertical supports, A and B. Two vertical point loads of 800 N and 300 N are exerted onto the beam. Calculate the magnitude of the reactions in supports A and B.

**FIGURE 8.1**

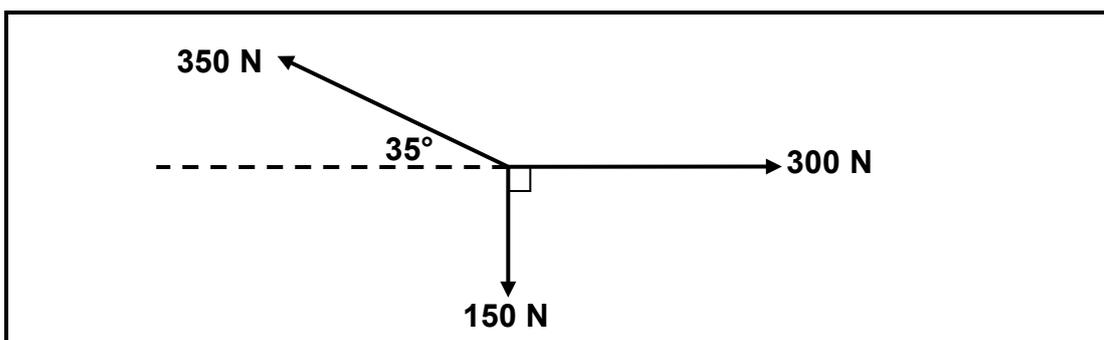
(4)

- 8.2 Calculate the compressive stress in a brass bush caused by a load of 60 kN. The bush has an outside diameter of 60 mm and an inside diameter of 54 mm. Give your answer in MEGA magnitude.

(5)

- 8.3 FIGURE 8.2 below shows a system of forces with three coplaner forces acting on the same point. Use calculations and determine the magnitude and direction of the resultant force of this system of forces.

**(Draw and complete the diagram in FIGURE 8.2. Show ALL the horizontal and vertical components before you do the calculations.)**

**FIGURE 8.2**(10)  
[19]

**QUESTION 9: MAINTENANCE (SPECIFIC)**

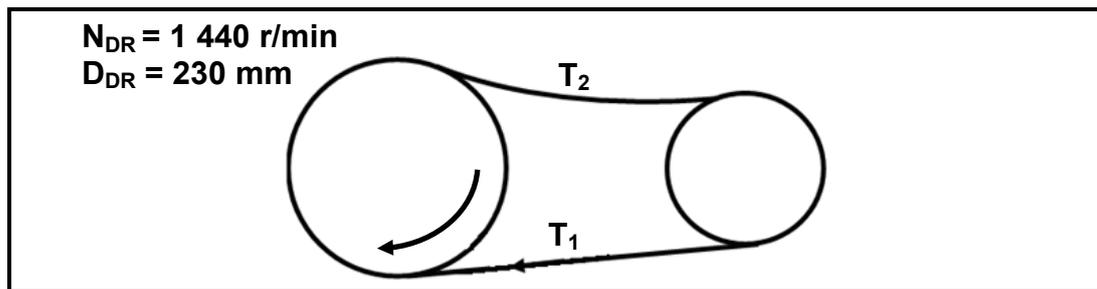
- 9.1 State THREE causes of the malfunctioning of lathes and milling machines. (3)
- 9.2 Explain overheating that causes friction on a machine when lubrication is inadequate: (2)
- 9.3 State ONE procedure that may be followed to reduce physical wear on the milling cutter of a milling machine. (1)
- 9.4 State TWO results of an unbalanced work piece in a lathe. (2)
- [8]**

**QUESTION 10: JOINING METHODS (SPECIFIC)**

- 10.1 Draw a neat sketch of an isometric V-screw thread and indicate the following on the sketch:
- 10.1.1 Pitch (1)
- 10.1.2 Screw-thread angle (1)
- 10.1.3 Effective diameter (1)
- 10.1.4 Crest (1)
- 10.2 The pitch of a M20 V-screw thread is 2,5 mm.  
Calculate the following:
- 10.2.1 The depth of the screw thread (2)
- 10.2.2 The effective diameter of the screw thread (2)
- 10.3 Explain, with the aid of simple sketches, the difference between *single-* and *multiple-start screw threads*. (4)
- [12]**

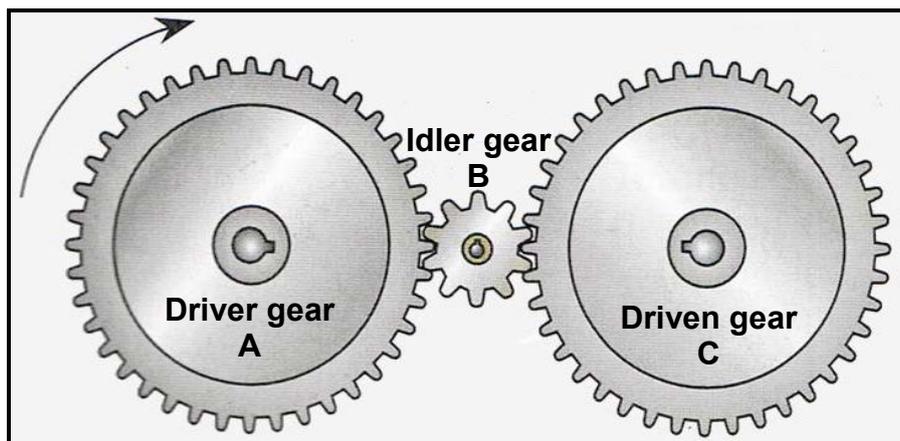
**QUESTION 11: SYSTEMS AND CONTROL (SPECIFIC)**

- 11.1 State THREE advantages of a belt drive compared to a gear drive (3)
- 11.2 Calculate the force on a piston rod, 25 mm in diameter, during the forward stroke. The diameter of the piston is 120 mm and the pressure in the cylinder is 1,2 MPa. (4)
- 11.3 FIGURE 11.1 below shows a belt-drive system with a 230 mm driver pulley rotating at 1 440 r/min. The effective tensile force in the system is 165 N.

**FIGURE 11.1**

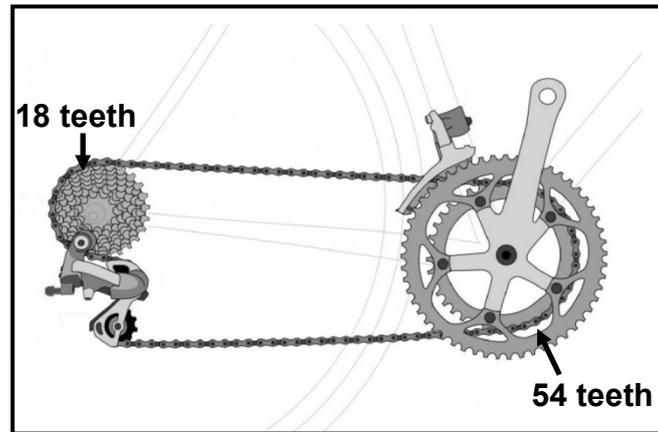
Determine, by means of calculations:

- 11.3.1 The belt speed in  $\text{m}\cdot\text{s}^{-1}$  (2)
- 11.3.2 The power transmitted in kW (2)
- 11.4 FIGURE 11.2 illustrates a gear system in a gearbox. Gear A, with 102 teeth, rotates clockwise at 120 r/min.

**FIGURE 11.2**

- 11.4.1 Identify the direction of rotation of gear C (1)
- 11.4.2 Calculate the number of teeth on gear C if it must rotate at 80 r/min. (2)

- 11.5 The chain-drive system of a bicycle is shown in FIGURE 11.3 below. Calculate the gear ratio of the system.



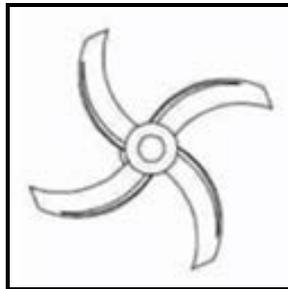
**FIGURE 11.3**

(2)  
[16]

**QUESTION 12: PUMPS (SPECIFIC)**

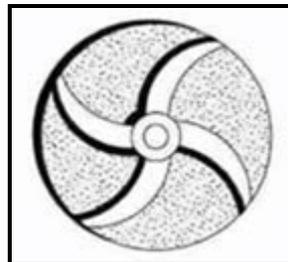
- 12.1 Name TWO applications of a monopump. (2)
- 12.2 State TWO advantages of centrifugal pumps. (2)
- 12.3 Name the THREE main moving parts of a reciprocating pump. (3)
- 12.4 State TWO disadvantages of a gear pump. (2)
- 12.5 Different types of impellers are selected according to the use of the centrifugal pump. Identify the THREE impellers shown in FIGURES 12.1, 12.2 and 12.3 below.

12.5.1

**FIGURE 12.1**

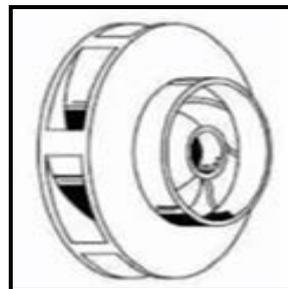
(1)

12.5.2

**FIGURE 12.2**

(1)

12.5.3

**FIGURE 12.3**

(1)

**[12]****TOTAL SECTION B: 100**

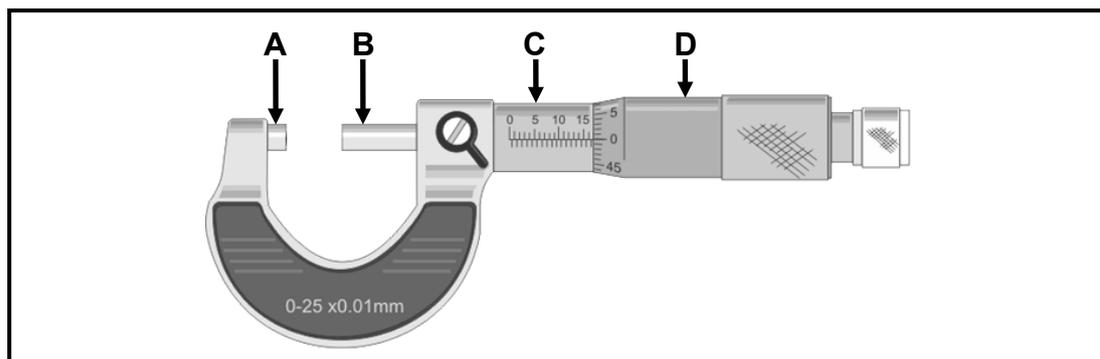
**SECTION C: AUTOMOTIVE (SPECIFIC)**

Use the criteria below to assist you to manage your time.

QUESTION	CONTENT	MARKS	TIME
13	Tools and Equipment (Specific)	9	10 minutes
14	Engines (Specific)	15	15 minutes
15	Systems and Control (Specific)	29	30 minutes
16	Maintenance (Specific)	11	10 minutes
17	Forces (Specific)	30	35 minutes
18	Terminology (Specific)	6	5 minutes
<b>TOTAL FOR SECTION C</b>		<b>100</b>	<b>105 minutes</b>
<b>TOTAL FOR SECTION A + C</b>		<b>200</b>	<b>180 minutes</b>

**QUESTION 13: TOOLS AND EQUIPMENT (SPECIFIC)**

13.1 FIGURE 13.1 below shows an outside micrometer. Label **A–D** in the figure.

**FIGURE 13.1****(4)**

13.2 Give TWO reasons for using a torque wrench on an engine. **(2)**

13.3 Explain TWO instances where you would use a dial gauge indicator. **(2)**

13.4 Explain the function of a telescopic gauge. **(1)**

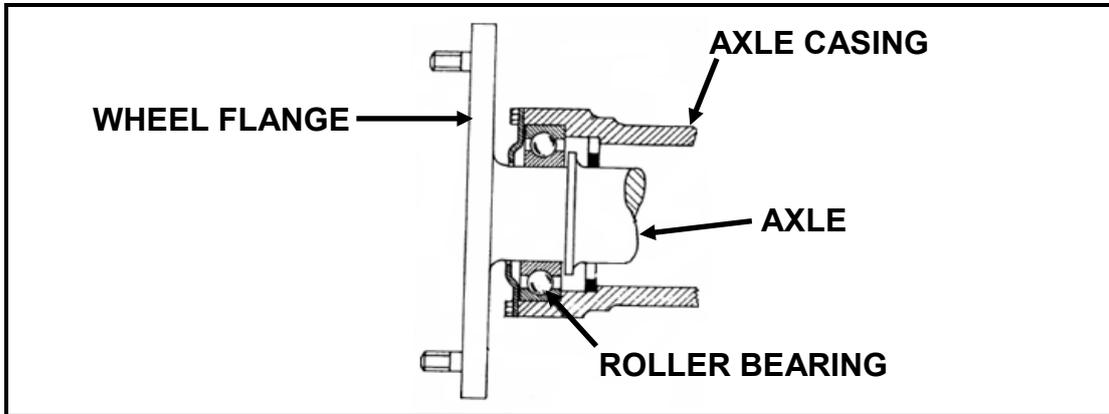
**[9]**

**QUESTION 14: ENGINES (SPECIFIC)**

- 14.1 What do you understand by the term *direct ignition* for a compression ignition engine? (1)
- 14.2 State the function of the injector in a compression ignition engine. (1)
- 14.3 Name TWO types of injector nozzles. (2)
- 14.4 Give TWO advantages of hydraulic valve lifters. (2)
- 14.5 Draw a valve-timing diagram for a four-stroke engine using the following information: (4)
- |                       |          |
|-----------------------|----------|
| Inlet valve opens:    | 18° BTDC |
| Inlet valve closes:   | 42° ABDC |
| Exhaust valve opens:  | 48° BBDC |
| Exhaust valve closes: | 12° ATDC |
| Injection:            | 20° ATDC |
- Use the diagram and calculate the following:
- 14.5.1 Inlet-valve period (1)
- 14.5.2 Exhaust-valve period (1)
- 14.5.3 Power period (1)
- 14.5.4 Valve overlap (1)
- 14.6 Describe the purpose of the tensioner in the timing belt assembly. (1)
- [15]**

**QUESTION 15: SYSTEMS AND CONTROL (SPECIFIC)**

15.1 Identify the type of axle shown in FIGURE 15.1 below.



**FIGURE 15.1**

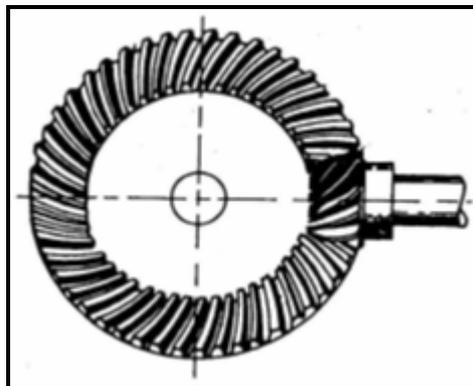
(1)

15.2 Describe the function of the spark plug in the ignition system of an internal combustion engine.

(2)

15.3 Identify the final drive systems shown in FIGURE 15.2 and FIGURE 15.3 below.

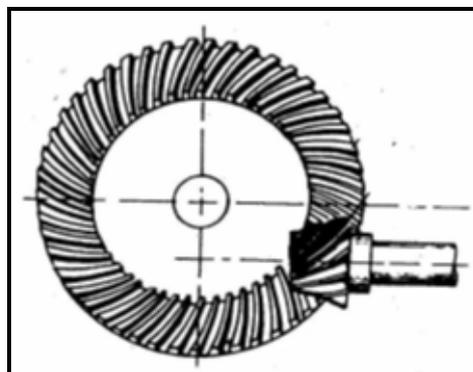
15.3.1



**FIGURE 15.2**

(1)

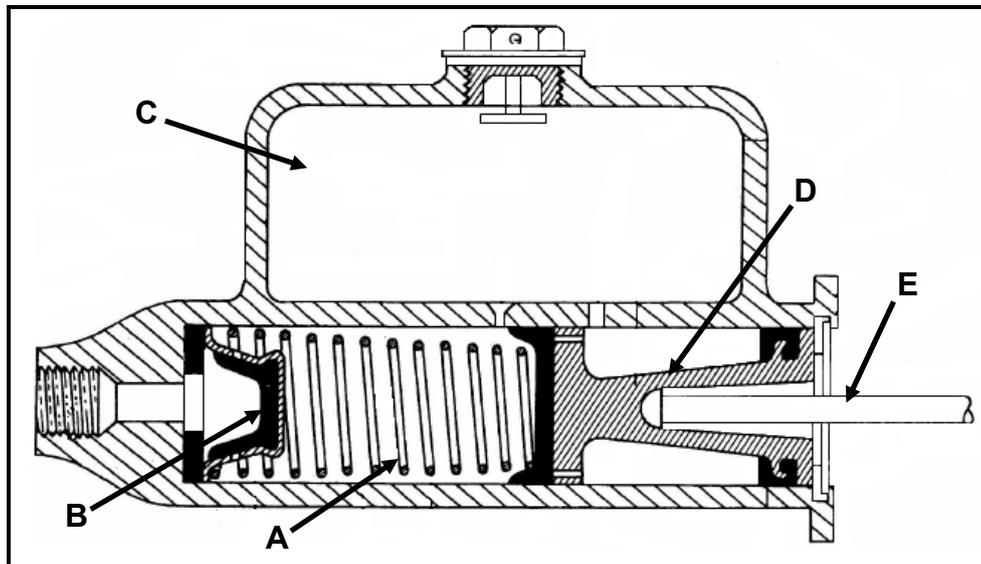
15.3.2



**FIGURE 15.3**

(1)

15.4 FIGURE 15.4 below shows the hydraulic brake master cylinder unit of a motor vehicle. Label **A–E** in the diagram.



**FIGURE 15.4**

(5)

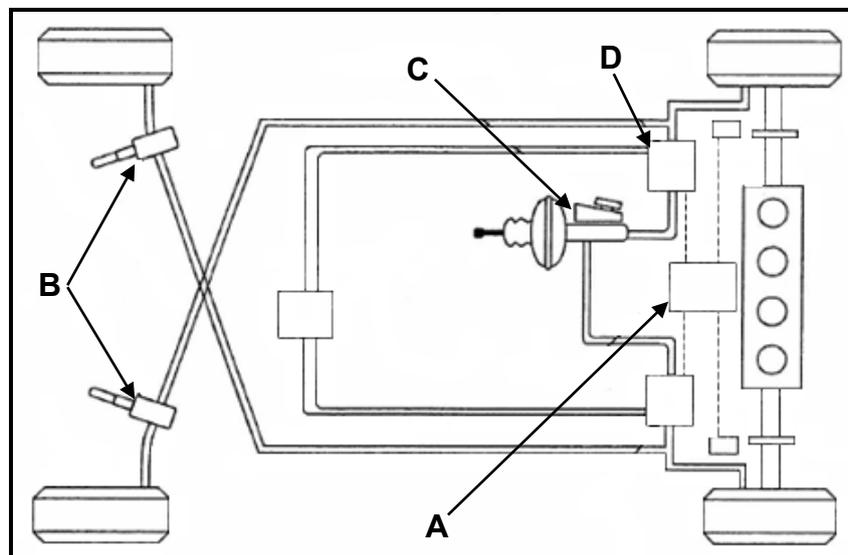
15.5 Describe the purpose of the servo-brake unit.

(2)

15.6 What does the abbreviation *ABS* stand for in respect of brake systems in a motor vehicle?

(1)

15.7 FIGURE 15.5 below shows an *ABS* system in a motor vehicle. Label **A–D**.



**FIGURE 15.5**

(4)

15.8 In what type of suspension are coil springs generally used?

(1)

15.9 Which suspension system unit controls the following?

15.9.1 Rolling or swaying of the body

(1)

15.9.2 Sideways movement of the wheels

(1)

15.10 Describe the function of each of the following control systems:

15.10.1 Traction control (2)

15.10.2 Airbag control (2)

15.11 FIGURE 15.6 below shows the drive system of a motor vehicle. Answer the questions that follow.

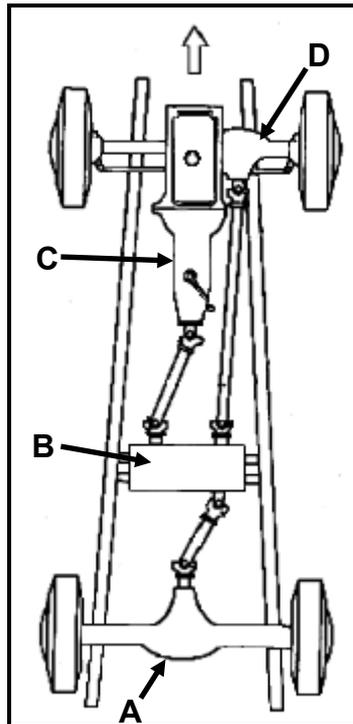


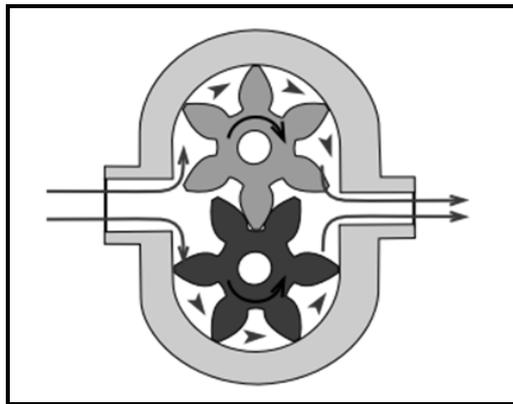
FIGURE 15.6

15.11.1 Identify the type of drive system shown in FIGURE 15.6. (1)

15.11.2 Label A–D. (4)  
[29]

**QUESTION 16: MAINTENANCE (SPECIFIC)**

- 16.1 State the main function of an oil pump in an internal combustion engine. (2)
- 16.2 State THREE ways to detect oil loss in an internal combustion engine. (3)
- 16.3 Distinguish between TWO types of oil filtration systems. (2)
- 16.4 State ONE function of oil seals in a lubrication system. (1)
- 16.5 FIGURE 16.1 below shows a gear pump used in the lubrication system of an internal combustion engine. Briefly explain the operating principle of this pump. (3)

**FIGURE 16.1**(3)  
[11]**QUESTION 17: FORCES (SPECIFIC)**

- 17.1 The data below refers to a four-stroke petrol engine:
- |                          |             |
|--------------------------|-------------|
| Mean effective pressure: | 900 kPa     |
| Stroke length:           | 80 mm       |
| Bore diameter:           | 90 mm       |
| Revolutions per minute:  | 3 600 r/min |
| Number of cylinders:     | 4           |
- Calculate the *indicated power*. (8)
- 17.2 Define the following automotive terms:
- 17.2.1 Work done (4)
- 17.2.2 Power (3)
- 17.2.3 Torque (3)
- 17.2.4 Compression ratio (4)
- 17.2.5 Indicated power (3)
- 17.3 Calculate the compression ratio of an engine with a bore diameter of 80 mm, a stroke of 90 mm and combustion chamber volume of 50 cc. (5)

[30]

**QUESTION 18: TERMINOLOGY (SPECIFIC)**

18.1 You are requested to service the lubrication system of a vehicle. Use the job card shown in TABLE 18.1 below and state the items you will attend to, to change only the engine oil. Do NOT include personal details.

M.		Date:		Cash	
				Account	
		Account No.:			
Code					
Cell:		Lube chassis			
Reg. No.		Change engine oil			
Make		Change TR oil			
Model		Change diff. oil			
Odometer		Change air filter			
Chassis No.		Change oil filter			
Engine No.		Wash engine			
Colour		Balance wheels			
Parts	Order No.	Requested by:			
Requisition No.	Description			Amount	
I agree to the terms and conditions set out on the reverse side of the order.					
Customer's signature:					
Order No.	Outwork	Amount	Internal	Amount	
			Labour		
			Oil		
			Lube		
			Parts		
Comment:			Outwork		
			Wash		
			Sundries		
			Subtotal		
			VAT		
			Total		

**TABLE 18.1**

(4)

18.2 What does a manufacturer's specification manual contain?

(1)

18.3 Why is it important to work according to the manufacturer's specifications?

(1)

**[6]**

**TOTAL SECTION C: 100**

**SECTION D: WELDING AND METALWORK (SPECIFIC)**

Use the criteria below to assist you to manage your time.

QUESTION	CONTENT	MARKS	TIME
19	Welding Terminology (templates, trusses, cost calculations, terms, welding symbols) (Specific)	18	18 minutes
20	Tools and Equipment (Specific)	7	5 minutes
21	Forces (Specific)	17	15 minutes
22	Maintenance (Specific)	6	5 minutes
23	Joining Methods (Specific)	15	15 minutes
24	Terminology (development) (Specific)	19	27 minutes
25	Terminology (steel sections) (Specific)	18	20 minutes
<b>TOTAL FOR SECTION D</b>		<b>100</b>	<b>105 minutes</b>
<b>TOTAL FOR SECTION A + D</b>		<b>200</b>	<b>180 minutes</b>

**QUESTION 19: WELDING TERMINOLOGY (SPECIFIC)**

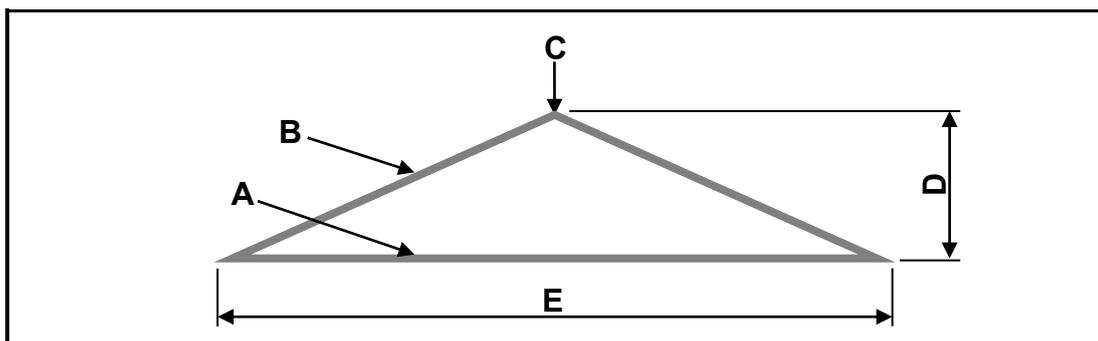
19.1 State TWO uses of templates. (2)

19.2 Identify the following supplementary welding symbols:

19.2.1  (Weld face) (1)

19.2.2 **M** (Finish) (1)

19.3 FIGURE 19.1 below shows a simple roof truss. Label A–E.



**FIGURE 19.1**

(5)

19.4 The span of a simple roof truss is 10 m and the rise is 2 m. Calculate the truss rafter. (5)

19.5 FIGURE 19.2 below shows a multiple welded run in a butt joint. Label **A–D**.

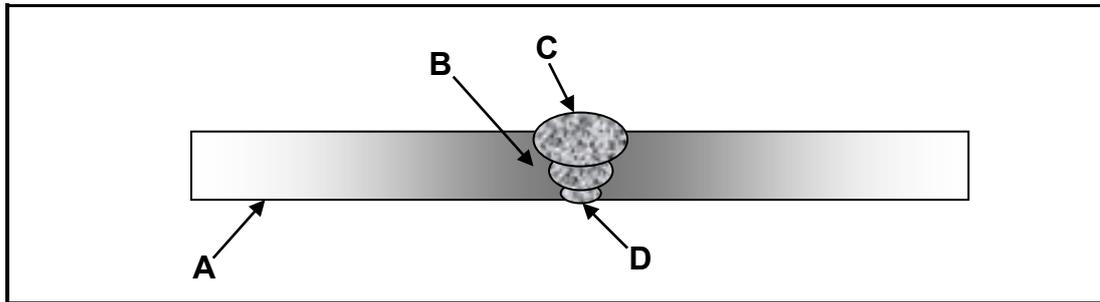


FIGURE 16.1

(4)  
[18]

### QUESTION 20: TOOLS AND EQUIPMENT (SPECIFIC)

20.1 Briefly describe the working principle of the cropper on a punch and shearing machine. (3)

20.2 Describe the use of the punching machine. (2)

20.3 Describe the function of EACH of the following machines:

20.3.1 Guillotine (1)

20.3.2 Rolling machine/Bending roll (1)

[7]

**QUESTION 21: FORCES (SPECIFIC)**

- 21.1 A round mild steel tube, 80 mm long, with an inner diameter of 34 mm and an outer diameter of 38 mm, is used in a steel framework. A compressive force of 50 kN is exerted on the tube.

Calculate the following:

- 21.1.1 The stress in the material and state your answer in mega magnitude (3)
- 21.1.2 The change in length caused by the force ( $E = 90 \times 10^3 \text{ MPa}$ ) (3)
- 21.2 FIGURE 21.1 shows a system of forces acting on the same point. Determine graphically the magnitude and direction of the equilibrant for this system. Use the following scale with Bow's notation: 1 mm = 3 N. (3)

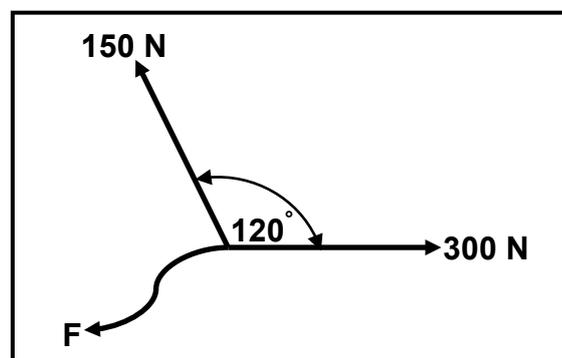


FIGURE 21.1

- 21.3 Determine the shear forces and bending moments of the beam indicated in FIGURE 21.2. Use scale: 1 mm = 10 N. (8)

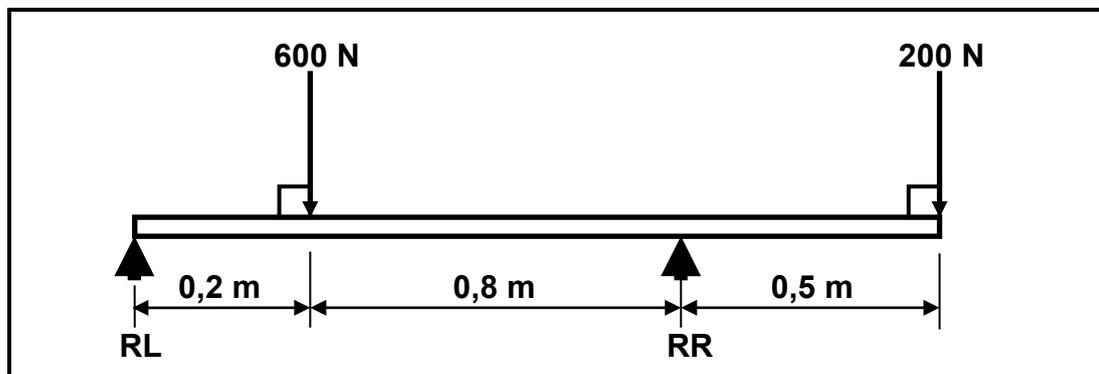


FIGURE 21.2

(8)  
[17]

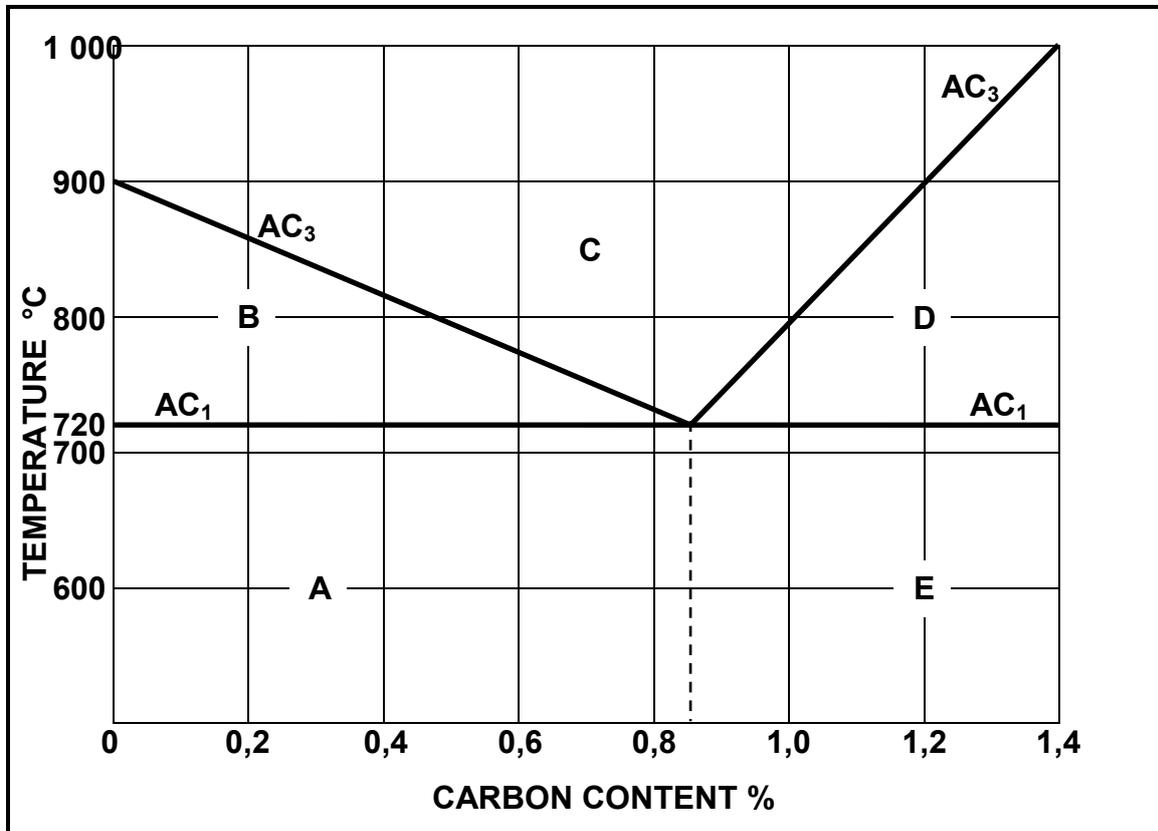
**QUESTION 22: MAINTENANCE (SPECIFIC)**

- 22.1 State a cause for the malfunctioning of cutting machines in the workshop. (1)
- 22.2 State TWO results of inadequate lubrication of the bearings of a roller machine. (2)
- 22.3 State ONE precaution to take to prevent excessive wear on a guillotine. (1)
- 22.4 A well-maintained shearing machine has a longer lifespan, enhances production and reduces cost. State TWO factors that extend the service life of a machine effectively. (2)

[6]

**QUESTION 23: JOINING METHODS (SPECIFIC)**

23.1 FIGURE 23.1 shows the iron-carbon equilibrium diagram used for carbon steels. Answer the questions that follow.



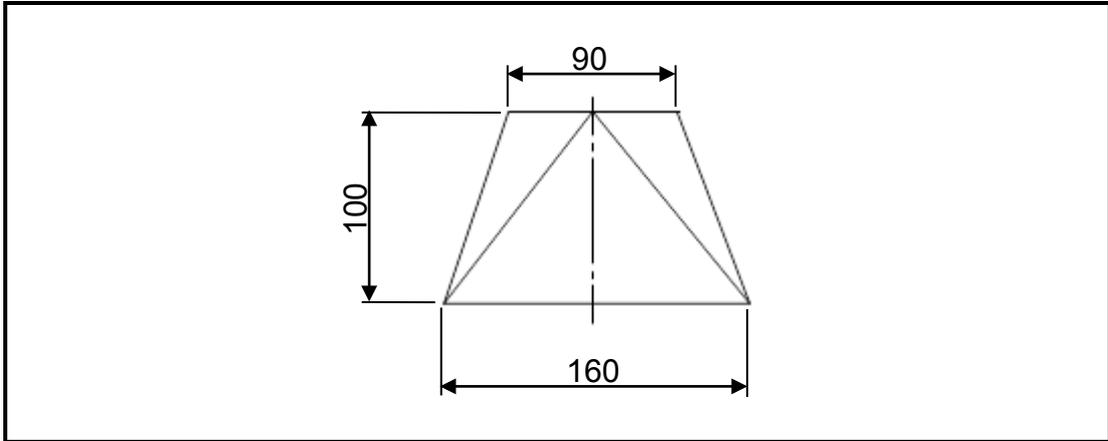
**FIGURE 23.1**

- 23.1.1 Label **A–E**. (5)
- 23.1.2 State **TWO** properties of structure **E** on the diagram. (2)
- 23.2 What is the purpose of case hardening steel? (2)
- 23.3 State **TWO** causes of slag inclusion as a welding defect found in arc welding. (2)
- 23.4 Describe the **TWO** functions of the flux on a welding electrode used for arc welding. (2)
- 23.5 Name **TWO** types of inert gases used for MIG/MAGS welding. (2)

**[15]**

**QUESTION 24: TERMINOLOGY (DEVELOPMENT) (SPECIFIC)**

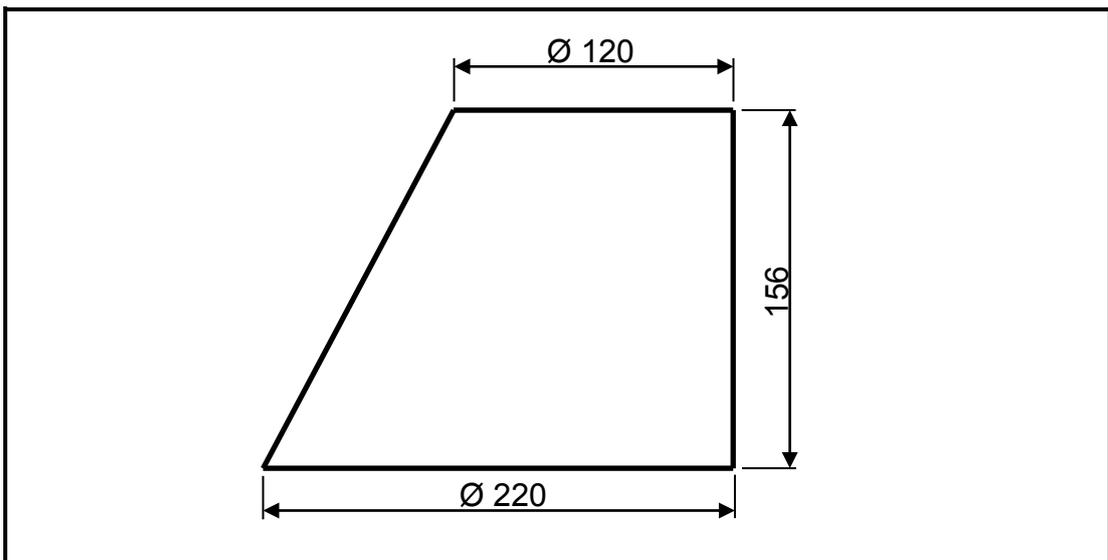
24.1 Develop the square-to-round transition piece shown in FIGURE 24.1 below.



**FIGURE 24.1**

(9)

24.2 Develop the oblique cone shown in FIGURE 24.2 below. Use scale 1 : 4.



**FIGURE 24.2**

(10)  
**[19]**

**QUESTION 25: TERMINOLOGY (STEEL SECTIONS) (SPECIFIC)**

- 25.1 Illustrate, with freehand isometric drawings, TWO preparation methods of the ends of two equal angle-iron bars that have to be welded at 90° to each other. (4)
- 25.2 Illustrate, with freehand drawings, THREE preparation methods of the ends of two equal-channel iron bars that have to be welded at 90° to each other. (6)
- 25.3 Describe the purpose of an assembly jig in a welding workshop. (2)
- 25.4 State THREE advantages of using a well-designed jig in a welding work shop. (3)
- 25.5 State THREE requirements of a well-designed welding jig in a welding work shop. (3)
- [18]**

**TOTAL SECTION D: 100**  
**GRAND TOTAL: 200**

**FORMULA SHEET****1. BELT DRIVES**

$$1.1 \quad N_1 D_1 = N_2 D_2 \quad \text{where } N = \text{rotational frequency}$$

$$D = \text{diameter of pulley}$$

$$1.2 \quad \text{Belt speed} = \frac{\pi D N}{60}$$

$$1.3 \quad \text{Speed ratio} = \frac{\text{Diameter of driven pulley}}{\text{Diameter of driver pulley}}$$

$$1.4 \quad \text{Power}(P) = \frac{(T_1 - T_2)\pi D N}{60} \quad \text{OR} \quad \text{Power}(P) = (T_1 - T_2)v$$

**2. STRESS AND STRAIN**

$$2.1 \quad \text{Stress} = \frac{\text{Force}}{\text{Area}} \quad \text{or} \quad (\sigma = \frac{F}{A})$$

$$2.2 \quad A_{\text{shaft}} = \frac{\pi d^2}{4}$$

$$2.3 \quad A_{\text{pipe}} = \frac{\pi(D^2 - d^2)}{4}$$

$$2.4 \quad A_{\text{square bar}} = \text{length} \times \text{length}$$

**3. KEYS**

$$3.1 \quad \text{Width of key} = \frac{\text{Diameter of shaft}}{4}$$

$$3.2 \quad \text{Thickness of key} = \frac{\text{Diameter of shaft}}{6}$$

$$3.3 \quad \text{Length of key} = 1,5 \times \text{Diameter of shaft}$$

$$3.4 \quad \text{Standard taper for taper key: 1 in 100 or 1 : 100}$$

**4. GEAR DRIVES**

$$4.1 \quad N_1 T_1 = N_2 T_2 \quad \text{where } N = \text{rotational frequency}$$

$$T = \text{number of teeth on the gear}$$

$$4.2 \quad \text{Power}(P) = \frac{2\pi NT}{60}$$

$$4.3 \quad \text{Gear ratio} = \frac{\text{Product of the number of teeth on driver gears}}{\text{Product of number of teeth on driven gears}}$$

$$4.4 \quad \frac{N_{\text{input}}}{N_{\text{output}}} = \frac{\text{Product of the number of teeth on driven gears}}{\text{Product of the number of teeth on driving gears}}$$

**5. POWER**

$$IP = pLANn$$

**6. SCREW THREAD**

$$6.1 \quad \text{Lead} = \text{number of starts} \times \text{pitch}$$

$$6.2 \quad \text{Helix angle: } \tan\theta = \frac{\text{lead}}{\pi \text{ diameter}}$$

$$6.3 \quad \text{Leading tool angle} = 90^\circ - (\text{clearance angle} + \text{helix angle})$$

$$6.4 \quad \text{Following tool angle} = 90^\circ + (\text{helix angle} - \text{clearance angle})$$

$$6.5 \quad \text{Depth of thread : } H = 0,866 P$$

$$6.6 \quad \text{Pitch diameter of thread : } = OD - 2 \times \left[ \frac{3 \times H}{8} \right]$$

**7. TAPER TURNING**

$$\text{Compound slide angle } \frac{\theta}{2} = \frac{D-d}{2l}$$

**8. HYDRAULICS**

$$8.1 \quad A_{\text{piston}} = \frac{\pi d^2}{4}$$

$$8.2 \quad \text{Pressure} = \frac{\text{Force}}{\text{Area}} \quad \text{or} \quad p = \frac{F}{A}$$