



# basic education

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

## **NATIONAL SENIOR CERTIFICATE**

**GRADE 12**

**MECHANICAL TECHNOLOGY: WELDING AND METALWORK**  
**NOVEMBER 2022**

**MARKS: 200**

**TIME: 3 hours**

**This question paper consists of 15 pages and a 2-page formula sheet.**



**INSTRUCTIONS AND INFORMATION**

1. Write your centre number and examination number in the spaces provided 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. Candidates may use non-programmable scientific calculators and drawing instruments.
8. The value of gravitational acceleration 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 at the end of the question paper.
12. Use the criteria below to assist you in managing your time.

QUESTION	CONTENT	MARKS	TIME IN MINUTES
<b>GENERIC</b>			
1	Multiple-choice Questions	6	6
2	Safety	10	10
3	Materials	14	14
<b>SPECIFIC</b>			
4	Multiple-choice Questions	14	10
5	Terminology (Templates)	23	20
6	Tools and Equipment	18	10
7	Forces	45	40
8	Joining Methods (Weld Inspection)	23	20
9	Joining Methods (Stresses and Distortion)	18	20
10	Maintenance	8	10
11	Terminology (Development)	21	20
<b>TOTAL</b>		<b>200</b>	<b>180</b>



**QUESTION 1: MULTIPLE-CHOICE QUESTIONS (GENERIC)**

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

- 1.1 Which ONE of the following is the last stage when applying first aid?
- A Examination
  - B Treatment
  - C Diagnosis
  - D Transport
- (1)
- 1.2 What is the maximum thickness of sheet metal that a manual guillotine can cut?
- A 0,2 mm
  - B 1,2 mm
  - C 2,2 mm
  - D 3,2 mm
- (1)
- 1.3 Which part of a hydraulic press is used to safely keep the platform at a desired height?
- A Return spring
  - B Plunger
  - C Supporting pin
  - D Base
- (1)
- 1.4 Which ONE of the following tests is used to determine resistance to penetration?
- A File test
  - B Machining test
  - C Hardness test
  - D Sound test
- (1)
- 1.5 Which machine is used to conduct a spark test on carbon steels?
- A Bench grinder
  - B Drilling machine
  - C Lathe machine
  - D Milling machine
- (1)
- 1.6 Which ONE of the following materials will have a high ringing sound when tapped with a hammer during a sound test?
- A Cast iron
  - B Cast steel
  - C Mild steel
  - D Aluminium
- (1)

**[6]**

**QUESTION 2: SAFETY (GENERIC)**

- 2.1 Name TWO vital functions of an injured person that must be checked when first aid is applied. (2)
- 2.2 Give a reason why safety goggles must be worn when working with an angle grinder. (1)
- 2.3 Name TWO types of safety guards that are used when the opening at the guillotine shears is greater than 10 mm. (2)
- 2.4 State THREE safety precautions that must be adhered to before gas welding is undertaken. (3)
- 2.5 State TWO disadvantages of the product layout of machines. (2)
- [10]**

**QUESTION 3: MATERIALS (GENERIC)**

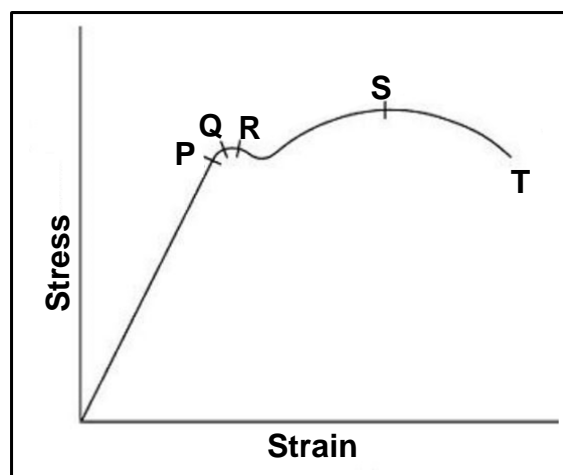
- 3.1 State THREE properties that can be obtained from heat-treatment processes. (3)
- 3.2 Describe the following heat-treatment processes:
- 3.2.1 Tempering (4)
- 3.2.2 Hardening (3)
- 3.3 Give TWO examples of case-hardened products used in the industry. (2)
- 3.4 Why is steel cooled in still air, away from a draught, during the normalising process? (2)
- [14]**



**QUESTION 4: MULTIPLE-CHOICE QUESTIONS (SPECIFIC)**

Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question numbers (4.1 to 4.14) in the ANSWER BOOK, e.g. 4.15 E.

- 4.1 Which ONE of the following pieces of equipment is used when gas welding is done?
- A Welding goggles
  - B Earth clamp
  - C Cables
  - D AC welding machine
- (1)
- 4.2 Which ONE of the following tools is used to cut external threads?
- A Taper tap
  - B Oval die
  - C Circular split die
  - D Second tap
- (1)
- 4.3 What is the purpose of permanent markings on the floor in a template loft?
- A Keeps the floor clean
  - B Saves time when marking out
  - C Prevents accidents
  - D Helps when drilling holes
- (1)
- 4.4 Identify **S** in the stress-strain diagram in FIGURE 4.4 below.



**FIGURE 4.4**

- A Break stress
  - B Maximum stress
  - C Yield point
  - D Limit of proportionality
- (1)



4.5 Which ONE of the following machines is used by template makers?

- A Sanding machine
- B Stock and dies
- C Chain saw
- D Sewing machine

(1)

4.6 What does **F** stand for regarding supplementary welding symbols?

- A Finish
- B File
- C Flame
- D Flash

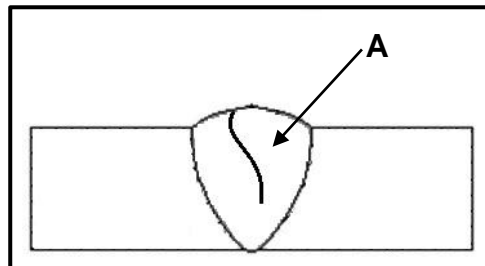
(1)

4.7 Which ONE of the following components is part of a band saw?

- A Magnetic chuck
- B Activation pedal
- C Spring-loaded pedal
- D Wheel guard

(1)

4.8 FIGURE 4.8 below shows a welding defect. Identify defect **A**.



**FIGURE 4.8**

- A Undercut
- B Crack
- C Blow hole
- D Worm hole

(1)

4.9 Which ONE of the following non-destructive tests uses sound waves to detect defects in a welded joint?

- A X-ray test
- B Liquid dye penetration test
- C Visual inspection
- D Ultrasonic test

(1)



- 4.10 Stress can be defined as an internal force in a material resisting a/an ... load.
- A external
  - B spin
  - C moving
  - D internal
- (1)
- 4.11 Which ONE of the following consumable parts is contained in the MIG/MAGS welding gun?
- A Positive cable
  - B Earth cable
  - C Nozzle
  - D Gauge
- (1)
- 4.12 Which ONE of the following is an example of a destructive test?
- A Visual inspection
  - B Liquid penetration test
  - C Nick-break test
  - D Ultrasonic test
- (1)
- 4.13 Lock-out and tagging inform workers that ...
- A the machine is ready to operate.
  - B there are visitors at the plant.
  - C repair work has been completed.
  - D repair work is being carried out.
- (1)
- 4.14 The ability of a material to regain its original size after deformation is known as ...
- A hardness.
  - B elasticity.
  - C ductility.
  - D plasticity.
- (1)

**[14]**

**QUESTION 5: TERMINOLOGY (TEMPLATES) (SPECIFIC)**

5.1 A steel ring with an outside diameter of 920 mm must be manufactured from a 45 x 45 square steel bar.

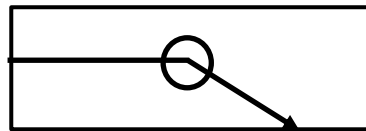
5.1.1 Calculate the mean diameter of the ring. (2)

5.1.2 Calculate the mean circumference of the ring and then round off the answer to the nearest whole number. (3)

5.1.3 Sketch and label the steel ring indicating the mean diameter, outside diameter and the thickness of the material. (4)

5.2 Identify the supplementary weld symbols in FIGURES 5.2.1 to 5.2.4 below.

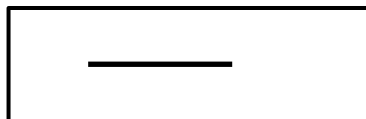
5.2.1



**FIGURE 5.2.1**

(1)

5.2.2



**FIGURE 5.2.2**

(1)

5.2.3



**FIGURE 5.2.3**

(1)

5.2.4



**FIGURE 5.2.4**

(1)

5.3 Name TWO hand tools that are used by template makers. (2)

5.4 Draw a neat sketch of a welding symbol indicating the following information:

- T-joint
- Arc welding
- The fillet weld on both sides is 10 mm in size.
- The lengths of the weld beads are 40 mm each.
- The pitch of the weld is 90 mm.

(8)

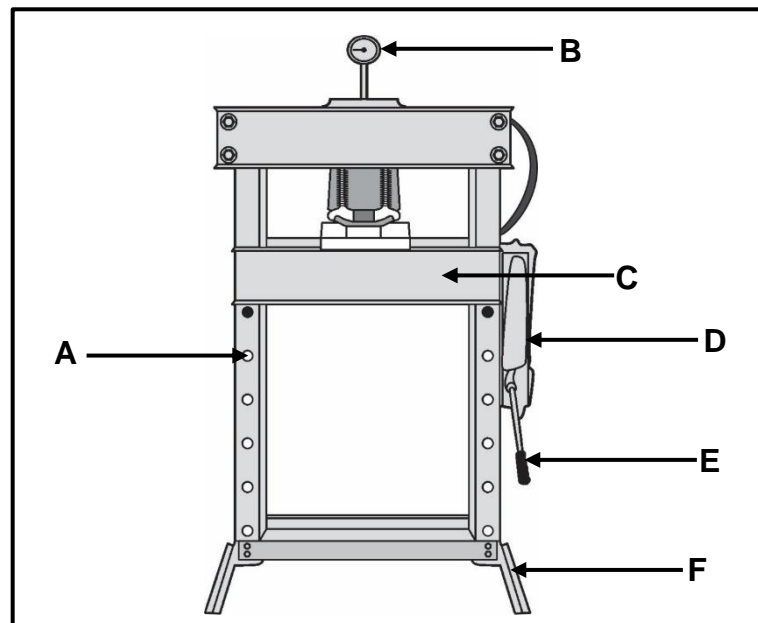
**[23]**





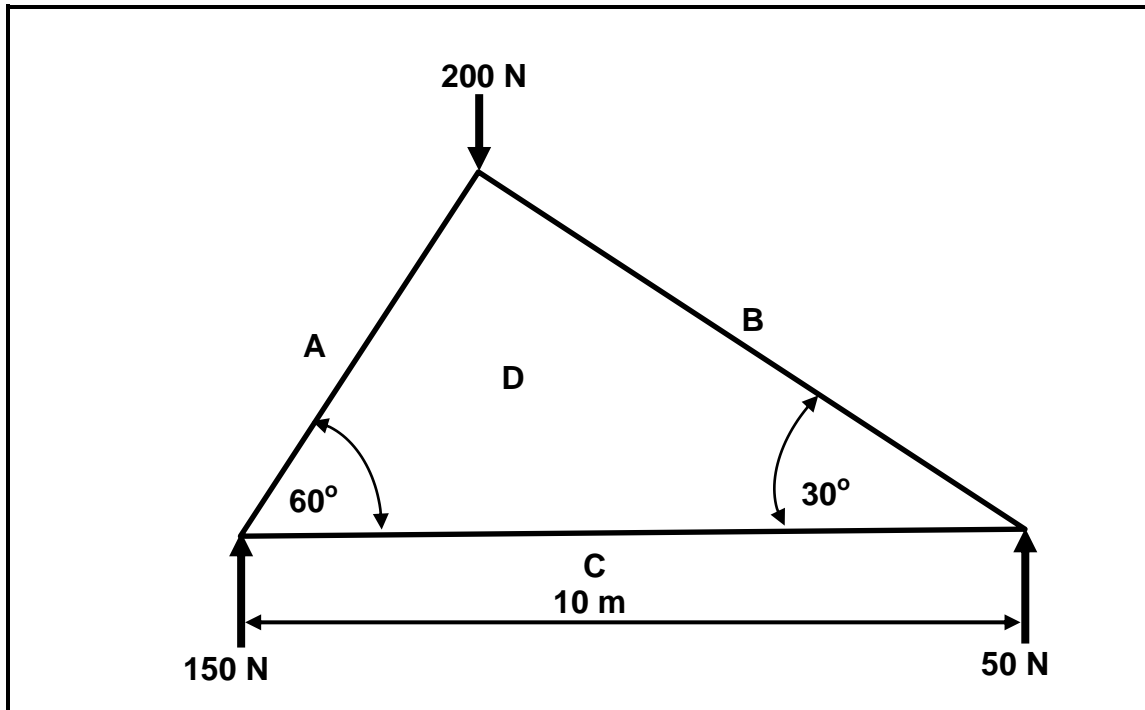
**QUESTION 6: TOOLS AND EQUIPMENT (SPECIFIC)**

- 6.1 Describe TWO functions of a punch and shear machine. (2)
- 6.2 Give TWO reasons for using inert gas while doing MIGS/MAGS welding. (2)
- 6.3 State TWO advantages of using MIGS/MAGS welding when compared to arc/stick welding (GMAW). (2)
- 6.4 Give TWO reasons for conducting a bending test on a beam. (2)
- 6.5 Describe how a power-driven guillotine operates. (4)
- 6.6 FIGURE 6.6 below shows a hydraulic press. Label parts A–F. (4)

**FIGURE 6.6****(6)**  
**[18]**

**QUESTION 7: FORCES (SPECIFIC)**

- 7.1 FIGURE 7.1 below shows a simple frame. Study the diagram and answer the questions that follow.

**FIGURE 7.1**

- 7.1.1 Draw the space diagram to scale 10 mm = 1 m. (3)
- 7.1.2 Draw the force diagram to scale 1 mm = 2 N. (4)
- 7.1.3 Determine the magnitude of forces in members **AD**, **BD** and **CD**. (3)
- 7.1.4 Identify members **AD**, **BD** and **CD** as a strut or a tie. (3)



- 7.2 FIGURE 7.2 below shows a uniform beam that is supported by two vertical supports, **RL** and **RR**. The beam is subjected to two point loads and a uniformly distributed load (**UDL**).

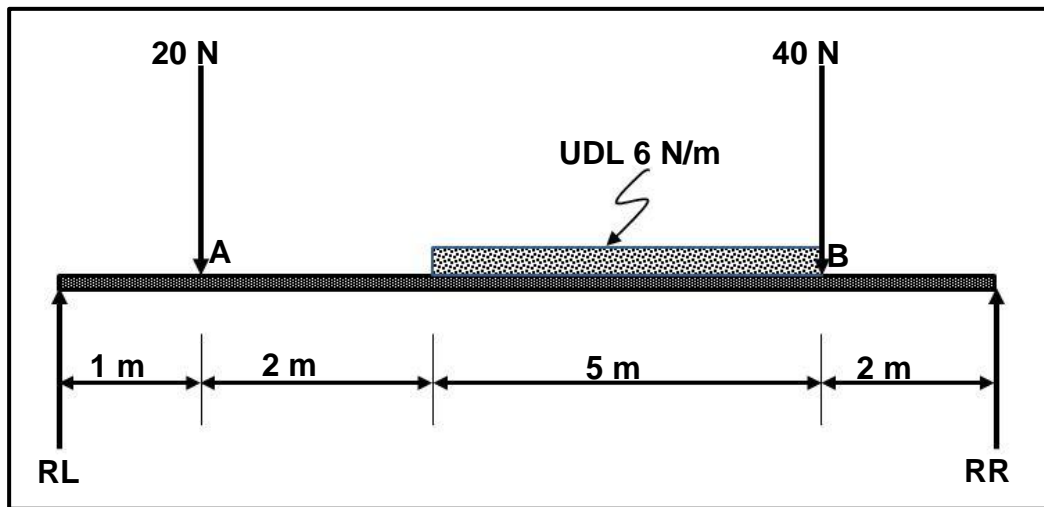


FIGURE 7.2

Calculate the following:

- 7.2.1 The magnitude of the point load representing the **UDL** (1)
- 7.2.2 The magnitude of the reaction at support **RL** (5)
- 7.2.3 The magnitude of the reaction at support **RR** (5)
- 7.2.4 The shear forces at points **A**, **UDL** and **B** (6)
- 7.2.5 Draw a shear force diagram of the beam.
- Scale: Shear force diagram: 2 mm = 1 N  
Space diagram: 1 : 100 (7)

- 7.3 A round steel bar with a cross-sectional area of  $0,8 \times 10^{-5} \text{ m}^2$  is subjected to a maximum tensile load of 45 kN.

Calculate the following:

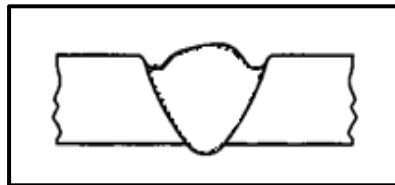
- 7.3.1 The maximum stress in MPa (2)
- 7.3.2 The safe working stress in MPa if the safety factor is 4 (3)
- 7.3.3 The diameter of the steel bar in mm (3)
- [45]



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

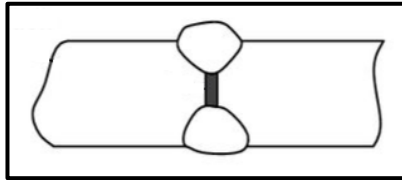
- 8.1 State THREE factors that should be observed during the arc welding process to ensure a good welded joint. (3)
- 8.2 State TWO factors that should be taken into account during oxyacetylene welding to ensure a good welded joint. (2)
- 8.3 Identify the arc welding defects in the butt joint shown in FIGURES 8.3.1 and 8.3.2 below.

8.3.1

**FIGURE 8.3.1**

(1)

8.3.2

**FIGURE 8.3.2**

(1)

- 8.4 State TWO precautions to prevent each of the following defects during MIG/MAGS and stick welding (GMAW):
- 8.4.1 Welding spatter (2)
- 8.4.2 Porosity (2)
- 8.5 State TWO welding defects that are revealed when performing the following tests on a welded joint:
- 8.5.1 Nick-break test (2)
- 8.5.2 Bend test (2)
- 8.6 Explain how to conduct a liquid dye penetration test on a welded joint. (6)
- 8.7 State TWO welding flaws that can be detected when using an ultrasonic test on a welded joint. (2)

**[23]**

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

- 9.1 How will the electrode size affect shrinkage in a welded joint? (3)
- 9.2 State TWO methods used to reduce distortion in a welded joint. (2)
- 9.3 State TWO disadvantages of using jigs, fixtures and clamps when welding. (2)
- 9.4 Define *elastic deformation*. (2)
- 9.5 State THREE factors that cause residual stress. (3)
- 9.6 FIGURE 9.6 below shows an iron-carbon equilibrium diagram. Label A–F. (6)

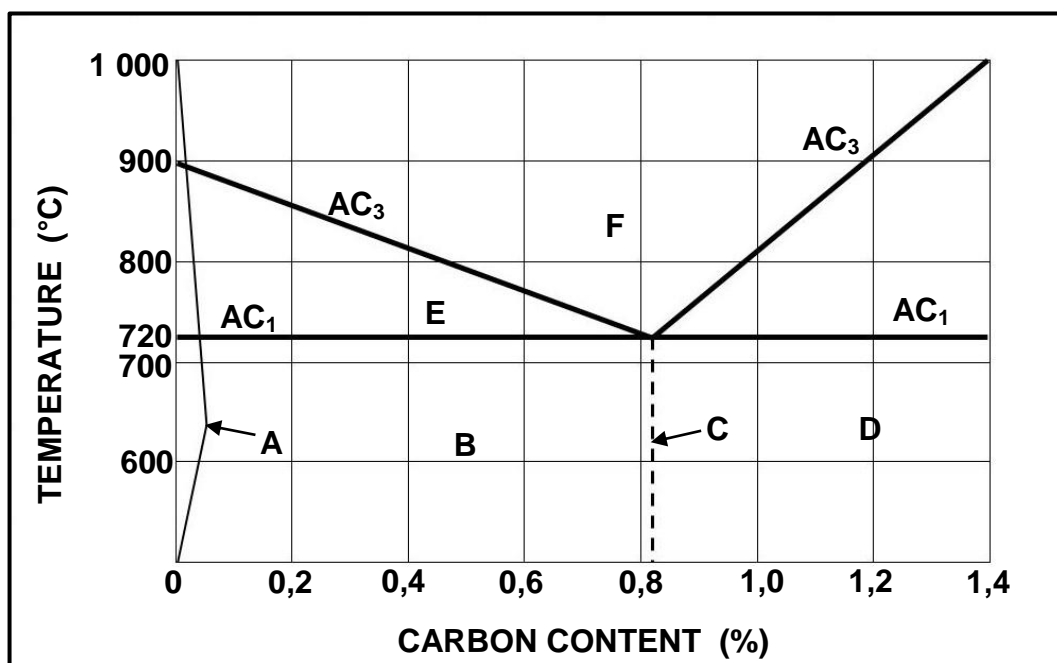


FIGURE 9.6

(6)  
[18]**QUESTION 10: MAINTENANCE (SPECIFIC)**

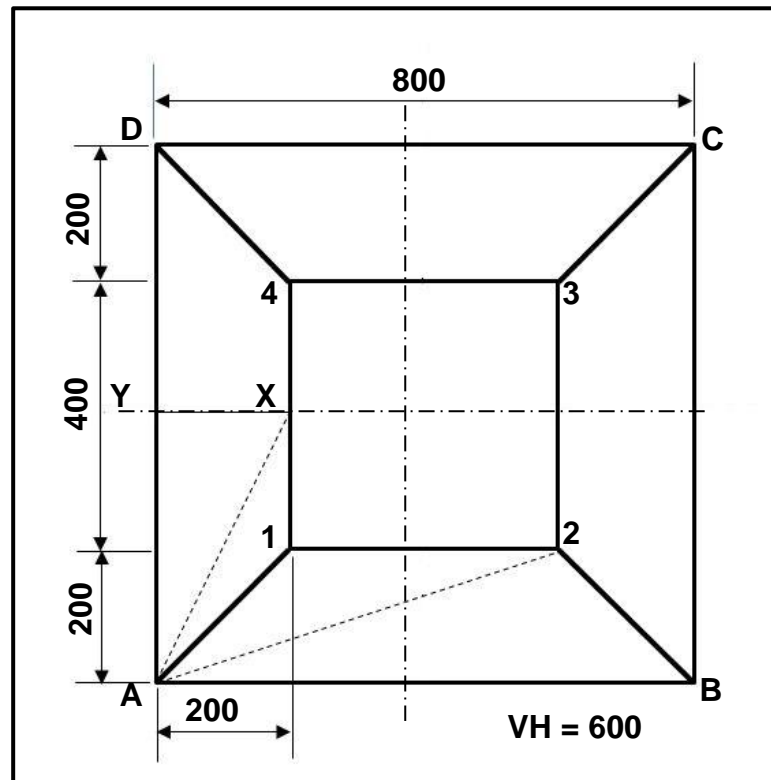
- 10.1 Give TWO reasons for the malfunctioning of rolling machines due to a lack of lubrication. (2)
- 10.2 State TWO general maintenance procedures for a drill press. (2)
- 10.3 Give TWO reasons for keeping service records of machines in a welding workshop. (2)
- 10.4 Differentiate between a *major* and a *minor service*. (2)

[8]



**QUESTION 11: TERMINOLOGY (DEVELOPMENT) (SPECIFIC)**

- 11.1 Give TWO examples of where hoppers are used. (2)
- 11.2 FIGURE 11.2 below shows the top view of a hopper. Answer the questions that follow.



**FIGURE 11.2**

- 11.2.1 Identify the hopper in FIGURE 11.2. (2)
- 11.2.2 Calculate the true lengths of the following:
- (a) **A-2** (4)
  - (b) **A-X** (4)
  - (c) **X-Y** (3)



11.3 FIGURE 11.3 below shows the top view of a cone frustrum.

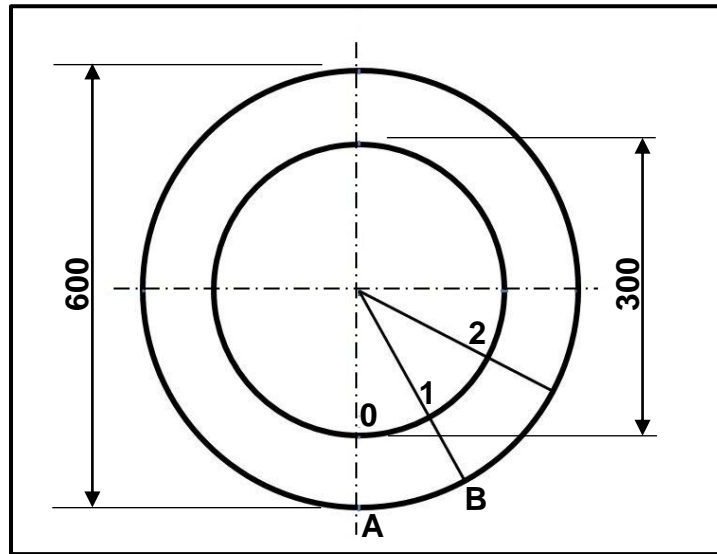


FIGURE 11.3

Calculate the true lengths of the following:

11.3.1 1–2

(3)

11.3.2 A–B

(3)

[21]

**TOTAL: 200**



**FORMULA SHEET FOR MECHANICAL TECHNOLOGY:  
WELDING AND METALWORK****1. STRESS AND STRAIN**

$$1.1 \quad A_{shaft} = \frac{\pi d^2}{4}$$

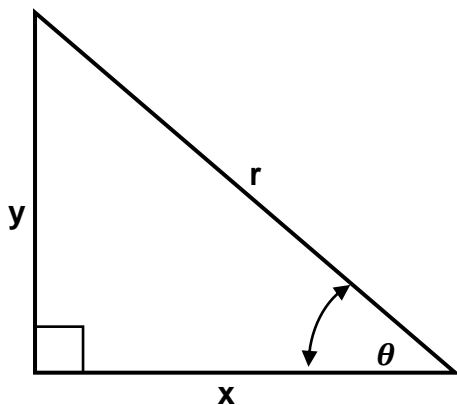
$$1.2 \quad A_{pipe} = \frac{\pi(D^2 - d^2)}{4}$$

$$1.3 \quad \text{Safety factor} = \frac{\text{Maximum stress/Break stress}}{\text{Safe working stress}}$$

$$1.4 \quad \text{Stress} = \frac{\text{Force}}{\text{Area}} \quad \text{OR} \quad \sigma = \frac{F}{A}$$

$$1.5 \quad \text{Strain} = \frac{\text{Change in length}}{\text{Original length}} \quad \text{OR} \quad \varepsilon = \frac{\Delta L}{oL}$$

$$1.6 \quad \text{Young's modulus} = \frac{\text{Stress}}{\text{Strain}} \quad \text{OR} \quad E = \frac{\sigma}{\varepsilon}$$

**2. PYTHAGORAS' THEOREM AND TRIGONOMETRY**

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

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

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

$$2.4 \quad r^2 = x^2 + y^2$$





### 3. TEMPLATES AND DEVELOPMENTS

3.1  $Mean \ \varnothing = Outside \ \varnothing - Plate \ thickness$

OR

$Mean \ \varnothing = Inside \ \varnothing + Plate \ thickness$

3.2  $Mean \ circumference = \pi \times Mean \ \varnothing$

(where  $\varnothing = diameter$ )

