Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 12

SEPTEMBER 2022

MECHANICAL TECHNOLOGY: WELDING AND METALWORK

MARKS: **200**

TIME: **3 hours**

This question paper consists of 18 pages, including a 1-page formula sheet.

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 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 in minutes
GENERIC			
1	Multiple-choice questions	6	6
2	Safety	10	10
3	Materials	14	14
SPECIFIC			
4	Multiple-choice questions	14	10
5	Terminology (Templates)	23	20
6	Tools and equipment	18	15
7	Forces	45	40
8	Joining methods (Inspection)	23	20
9	Joining methods (Stresses and distortion)	18	20
10	Maintenance	8	10
11	Terminology (Developments)	21	15
	TOTAL	**200**	**180**

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

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 1.6) in your ANSWER BOOK, for example 1.7 A.

1.1 What is the purpose of the Employment Equity Act (EEA No. 55 of 1998)?

A To create an environment of equality in the workplace.
B To promote non-discrimination in the workplace.
C Employer may not demote or promote an employee because of his/her HIV status.
D All of the above. (1)

1.2 Which ONE of the following options does NOT constitute the responsibility of the employer when applying first aid in the workplace

A Provision of first aid equipment.
B Keeping record of daily activities in the workplace.
C Provision of first aid training.
D Provision of first aid service by qualified personnel. (1)

1.3 Which ONE of the following is an advantage of product workshop layout?

A Minimum material handling
B Low equipment cost
C Greater flexibility
D High production time (1)

1.4 Which ONE of the following is a reason why oil and grease must NOT come in contact with the oxygen fitting?

A It will extinguish the flame.
B It makes the oxygen fittings slippery.
C It will form a flammable mixture.
D It accumulates dust. (1)

1.5 Safety devices of a power-driven guillotine are used to prevent accidents during the cutting stroke of the machine. Which ONE of the following is NOT among the guillotine safety devices?

A Automatic sweep away
B Revolving warning light
C Pressure gauge
D Rear view mirror (1)

1.6 Which factor is important in the heat treatment of steel?

A Colour
B Temperature
C Length
D Shape (1)

[6]

QUESTION 2: SAFETY (GENERIC)

2.1 State THREE personal protective equipment (PPE) that must be worn before an arc welding operation is carried out. (3)

2.2 State THREE safety measures that must be observed, before using an arc welding machine. (3)

2.3 Give ONE reason why you must not force a drill bit into a workpiece during drilling operations. (1)

2.4 It is very important to clamp a small workpiece securely before drilling commences. Give ONE reason why it is important to do this. (1)

2.5 State TWO safety precautions that must be observed when handling gas cylinders. (2)

[10]

QUESTION 3: MATERIALS (GENERIC)

3.1 State ONE test required to identify each of the following properties of metals.

3.1.1 Carbon content (1)

3.1.2 Ductility (1)

3.2 Metals are usually marked or colour coded on the ends in order to know the carbon content or the type of steel they are. Why is it important to cut from the unmarked end of the metal? (1)

3.3 List the THREE types of case-hardening used in the metallurgical industry. (3)

3.4 Why is it impossible to use medium or high carbon steel in case-hardening? (1)

3.5 Briefly explain the heat treatment process of metal. (3)

3.6 State THREE factors that determine the hardness of steel during the heat treatments of metals. (3)

3.7 Give ONE property that can be achieved by annealing steel. (1)

[14]

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

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 (4.1 to 4.14) in your ANSWER BOOK, for example 4.15 A.

4.1 Which ONE of the following personal protective equipment is applicable when performing arc welding?

A Welding goggles
B Welding helmet
C Dust pan
D Hard hat (1)

4.2 With reference to safety, the colour green indicates ...

A a fire warning.
B first aid equipment.
C electrical appliance.
D hazards. (1)

4.3 What is the maximum thickness of sheet metal that can be cut using a hand guillotine?

A 3,5 mm
B 1,8 mm
C 1,2 mm
D 2,5 mm (1)

4.4 During the deposition of manual metal arc electrodes, a certain percentage of the core wire is lost:

A Excessive build up
B Blow holes
C Short arc length
D Spatter (1)

4.5 Slow cooling of a heated/welded steel will result in the grain structure …

A enlarging.
B becoming smaller.
C separating.
D melting. (1)

4.6 When using the hydraulic press, at what angle (in degrees) must the load be applied to the workpiece?

A 45 degrees
B 180 degrees
C 90 degrees
D 60 degrees (1)

4.7 Which ONE of the following machines uses a reciprocating motion in its cutting processes?

A Manual guillotines
B Horizontal band saw
C Vertical band saw
D Power saw (1)

4.8 Which of the following is the most common used wheel dresser?

A Round dresser
B Flat dresser
C Square dresser (1)
D Huntington dresser

4.9 An oxygen cylinder regulator used in flame cutting, may freeze because the ...

A gas withdrawal rate is exceeded.
B cylinder content is too low.
C cylinder is on its side.
D needle valve on the regulator is not fully opened. (1)

4.10 The ability of a material to return to its original shape after deformation is known as …

A malleability.
B plasticity.
C elasticity. (1)
D ductility.

4.11 This is NOT a destructive test for a welded joint:

A Tensile test
B Impact test
C Ultrasonic test (1)
D Compressive test

4.12 Porosity is the cause of a weld defect due to …

A too rapid cooling of the weld.
B impaired parent metal.
C inferior electrode.
D All of the above (1)

4.13 Which ONE of the following is a method used to reduce distortion during the welding process?

A Intermittent welding
B Round-step welding
C Continuous welding
D Controlled cooling (1)

4.14 Which ONE of the following is a reason for lock-out and tagging of equipment?

To inform other workers that …

A there is a power failure.
B maintenance work is in progress.
C an accident has happened.
D maintenance work has been completed. (1)

[14]

QUESTION 5: TERMINOLOGY (TEMPLATES) (SPECIFIC)

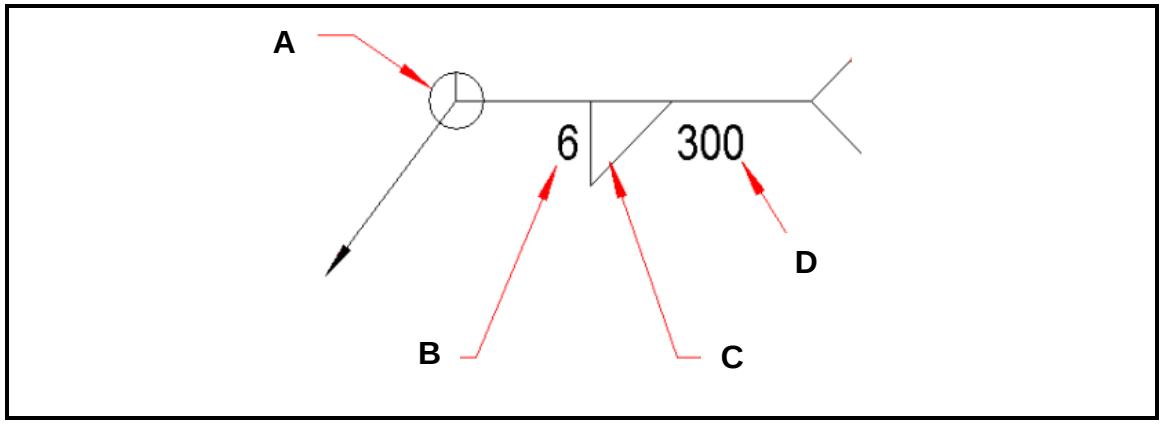
5.1 Identify THREE tools necessary to layout a roof truss in the template loft. (3)

5.2 Make a neat sketch of a roof truss showing purlins, ridging, roof covering, rafter and the main tie. (5)

5.3 Make a neat sketch of a rectangular lattice girder, using angle iron and gusset plates. (4)

5.4 Calculate the dimensions of the material required to fabricate a basketball ring set (x2) from 30 x 2 mm round bar with an outside diameter of 320 mm. (7)

5.5 The sketch below indicates a T-joint done with arc welding.
Identify labels **A–D**.



(4)
[23]

QUESTION 6: TOOLS AND EQUIPMENT (SPECIFIC)

6.1 Describe what the consequences would be if you were to grind soft material such as aluminium or pewter on a grinding wheel. (2)

6.2 What is the function of the following equipment:

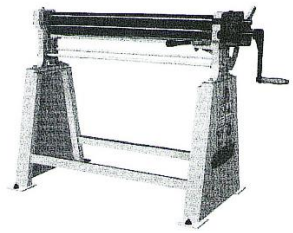
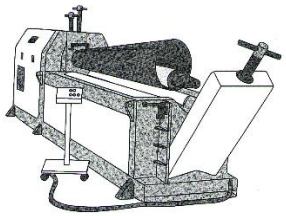
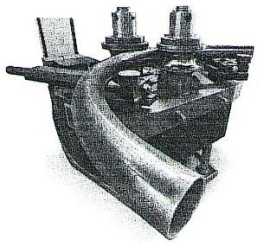
6.2.1 Angle grinder (2)

6.2.2 Guillotine (2)

6.3 Name TWO types of press machines. (2)

6.4 Explain the principles of the arc welding equipment (inverters). (5)

6.5 Identify the types of rolling machines (**A**, **B** and **C**) as shown below. (3)

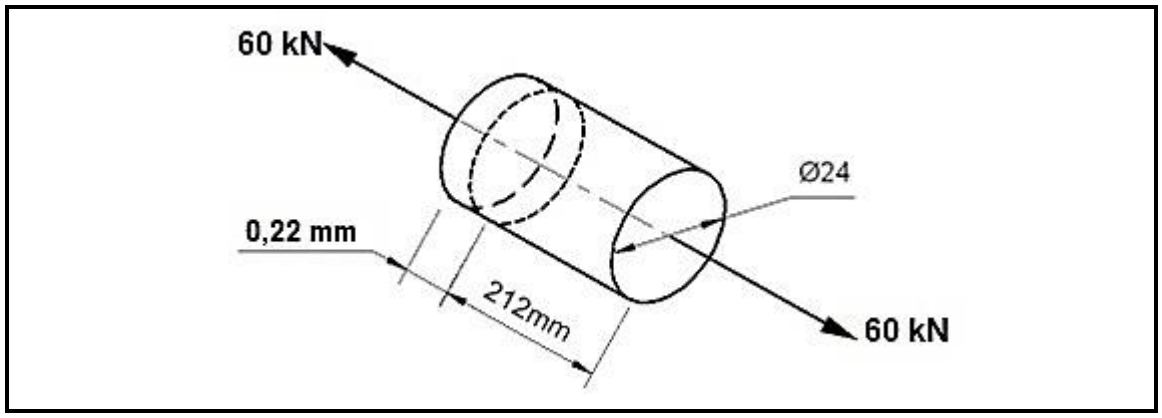
		
A	**B**	**C**

6.6 What is the purpose of a plasma cutter? (2)

[18]

QUESTION 7: FORCES (SPECIFIC)

7.1 Your Welding and Metalwork group is performing a tensile test using a mild steel bar with a diameter of 24 mm. When you applied a load of 60 kN it caused an extension of 0,22 mm when the original length was 212 mm.



Calculate the following:

7.1.1 Stress in the mild steel bar (6)

7.1.2 Strain in the mild steel bar (4)

7.1.3 Young's Modulus (6)

7.1.4 If the same test is carried out on a softer material, how will this affect Young's Modulus? (4)

7.2 FIGURE 7.2 shows a uniform beam that is supported by two vertical supports, **A** and **B**. A uniformly distributed force is exerted on the beam over a distance of 4 m from the left side of the beam. Determine by means of calculations the magnitudes of the reactions in supports **A** and **B**.

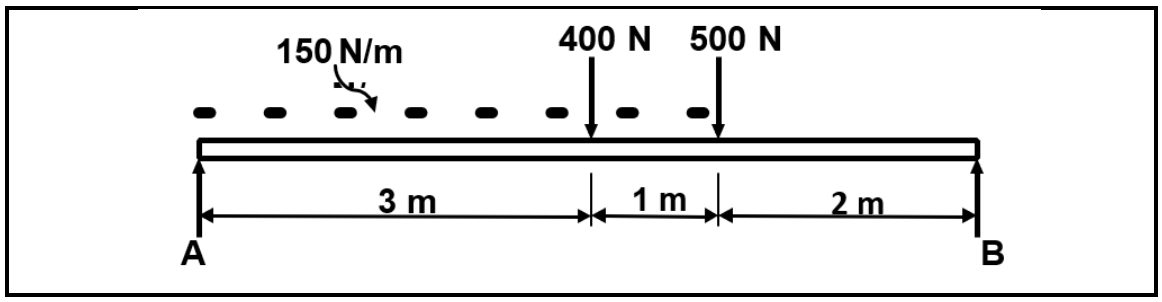


FIGURE 7.2 (6)

7.3 A compressive force causes internal stress of 16 MPa in a round bar made of an unknown metal. The resistance area of the round bar is 1,26 x 10^{-3} m^2 and the original length is 80 mm. The force causes the round bar to shorten by 14,4 x 10^{-3} mm.

Determine by means of calculations the:

7.3.1 Strain in the metal caused by the force (3)

7.3.2 Elasticity modulus for this metal (3)

7.4 With the aid of sketches, explain the following terms:

7.4.1 Shearing Stress (3)

7.4.2 Tensile Stress (3)

7.5 What is the purpose of the tensile test on steel? (2)

7.6 Define the following terms:

7.6.1 Hook's Law (3)

7.6.2 Safety factor (2)

[45]

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

8.1 List FOUR important welding processes on a checklist to inspect a completed weld. (4)

8.2 Name THREE uses of weld gauges during the checking of weld preparations, butt welds and fillet welds. (3)

8.3 Explain when incomplete penetration occurs. (3)

8.4 What does the 'presence of pits' refer to in the welding bead? (1)

8.5 Make a neat sketch of undercutting in a V-butt weld. (2)

8.6 What is welding spatter? (2)

8.7 Name the THREE welding flames used in the oxy-acetylene torch. (3)

8.8 Describe THREE different types of cracks in welded joints. (3)

8.9 Identify TWO types of destructive tests during the examination of welded joints. (2)

[23]

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

9.1 Explain what is meant by *weld distortion*. (2)

9.2 Name THREE methods used to reduce distortion. (3)

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

9.4 What is the effect of the electrode size during welding? (3)

9.5 State THREE chief factors responsible for setting up residual stress. (3)

9.6 List THREE examples to be used of opposing mechanical forces to counteract distortion due to welding. (3)

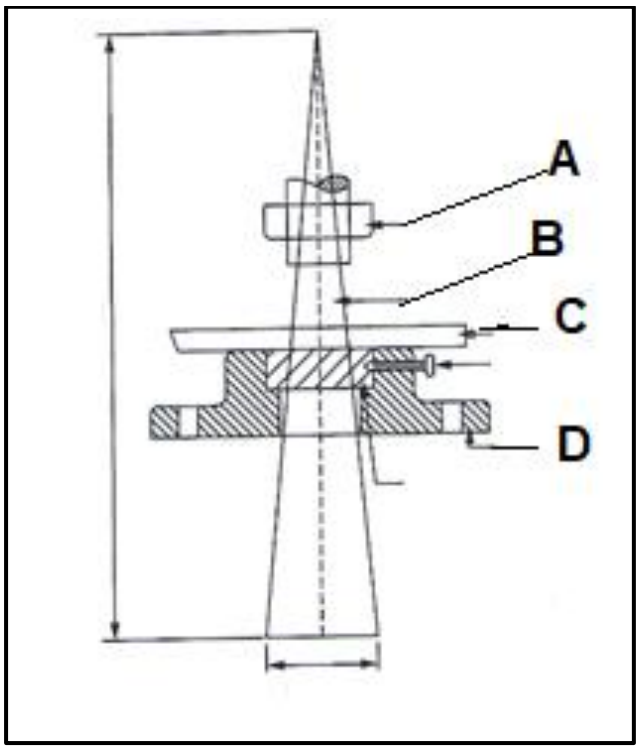
[18]

QUESTION 10: MAINTENANCE

10.1 What is the responsibility of the employer with regards to machine maintenance to make sure that they are maintained in a safe condition? (2)

10.2 Name TWO possible causes of malfunction. (2)

10.3 Identify the parts labelled **A–D** of the alignment of the punch and die on the punching and shearing machine below.



(4)
[8]

QUESTION 11: TERMINOLOGY (SPECIFIC)

11.1 FIGURE 11.1 below indicates a conical hopper.

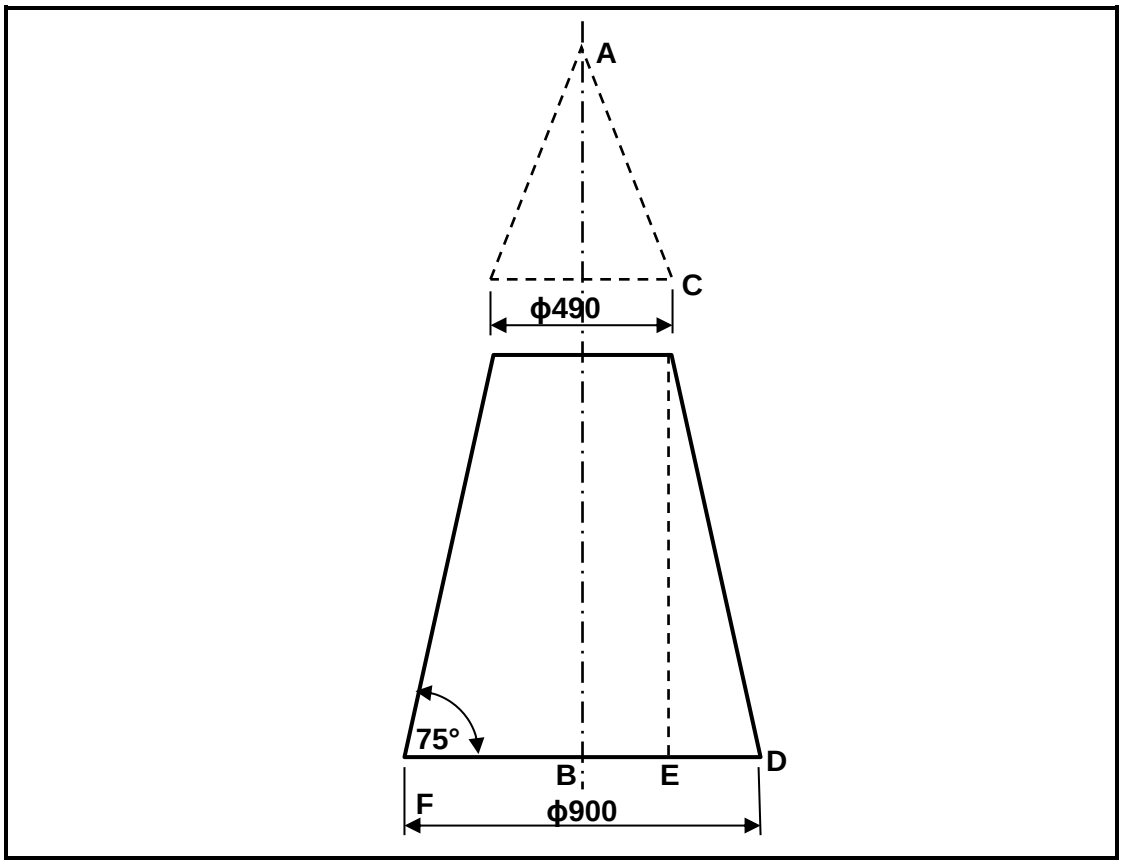


FIGURE 11.1

Calculate the following:

11.1.1 The vertical height CE (3)

11.1.2 The main radius AD (3)

11.1.3 The small radius AC (5)

11.1.4 The circumference FD (2)

[13]

11.2 FIGURE 11.2 below shows a Square-to-Square transition piece. In order to develop the transition, the true lengths must be calculated.

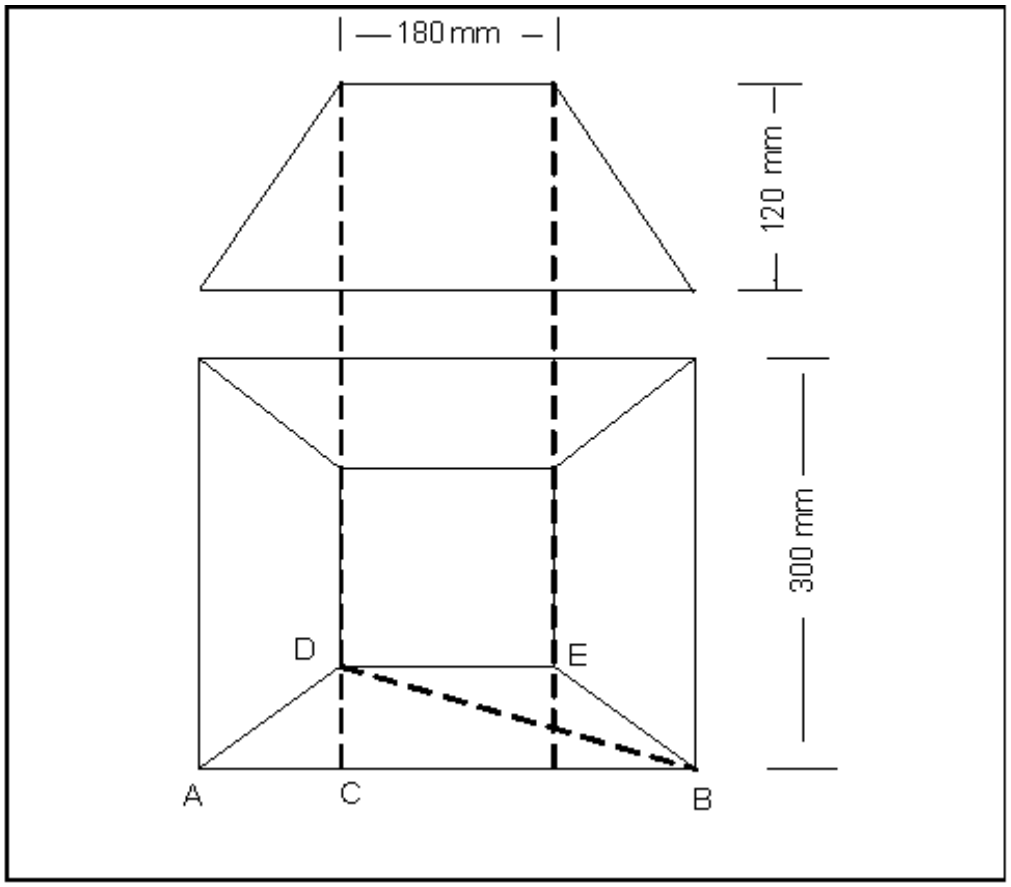


FIGURE 11.2

Determine the following true lengths with the help of calculations:

11.2.1 True length CD (2)

11.2.2 True length AD (3)

11.2.3 True length DB (3)

[21]

TOTAL: 200

FORMULA SHEET FOR MECHANICAL TECHNOLOGY (WELDING AND METALWORK)

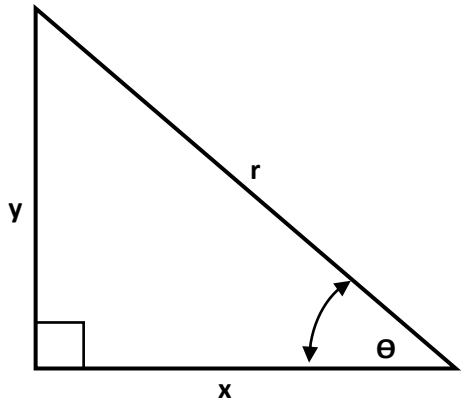
1. STRESS AND STRAIN

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

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

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

2. PYTHAGORAS' THEOREM AND TRIGONOMETRY



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

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

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

2.4 $r^2 = x^2 + y^2$ **or** $a^2 = b^2 + c^2$

3. TEMPLATES AND DEVELOPMENTS

3.1 $\text{Mean}\,\varphi = \text{Outside}\,\varphi - \text{Plate thickness}$ or
$\text{Mean}\varphi = \text{Inside}\,\varphi + \text{Plate thickness}$

3.2 $\text{Mean circumference} = \pi \times \text{Mean}\,\varphi$