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Maths Exam

Question 1

Section A

Q1

a) Find all sides and angles

Cosine - Triangle ABC

$$a^2 = b^2 + c^2 - 2bc \cos A$$

$$a^2 = 6.4^2 + 2.4^2 - 2 \times 6.4 \times 2.4 \times \cos(72)$$

$$a^2 = 37.22699793$$

$$a = \sqrt{37.22699793}$$

$a = 6.1$

Sine rule - Triangle BCD

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

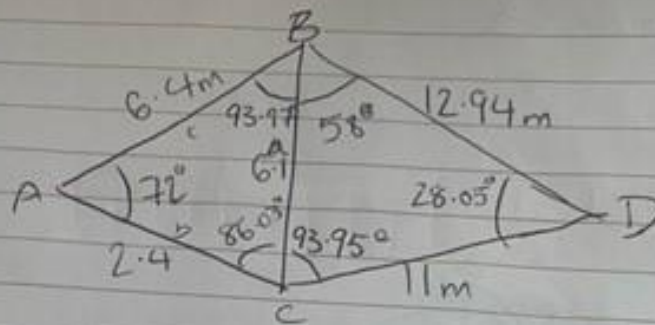
$$\frac{6.1}{\sin A} = \frac{11}{\sin 58} = \frac{c}{\sin C}$$

$$\frac{6.1}{\sin A} = \frac{11}{\sin 58}$$

$$\sin A = \frac{6.1 \times \sin 58}{11}$$

Q1-18

2



Area ABC

~~Area = 1/2 x b x h~~

$$A = \frac{1}{2} ab \sin C$$

$$A = \frac{1}{2} bc \sin A$$

$$A = \frac{1}{2} \times 2.4 \times 6.4 \times \sin(72)$$

$$A = 7.3 \text{ cm}^2$$

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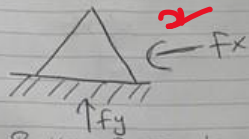
Question 2

Q2-18

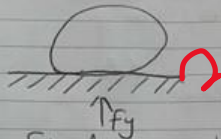
Section B

Q2) a) Name and illustrate 3 common types of supports.

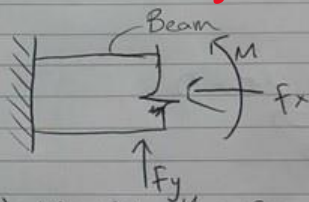
1. Pin Support



2. Roller Support



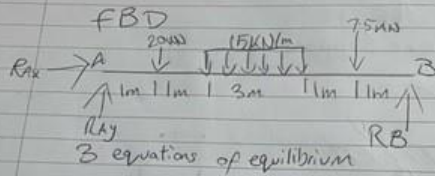
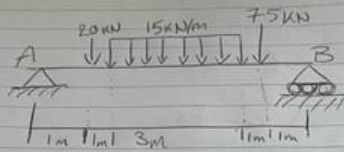
3. Fixed Support



b) Identify the Reaction forces.

Drawn on illustration 3

c) Calculate the support reactions



$$\sum H = 0$$

$$R_{Ax} = 0$$

$$\sum V = 0$$

$$R_{Ay} + R_B - 20 - 45 - 7.5 = 0$$

$$R_{Ay} + R_B - 72.5 = 0$$

$$R_{Ay} + R_B = 72.5$$

$$\sum M = 0$$

Take moment from B

$$(R_{Ay} \times 7) - (20 \times 6) - \left(\frac{15 \times 15}{2} \times 1.5 \right) - (7.5 \times 1) = 0$$

$$7R_{Ay} - 120 - 67.5 - 7.5 = 0$$

$$7R_{Ay} = 195 = 0$$

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3.5

$$R_{Ay} = \frac{195}{7}$$

$$R_{Ay} = 27.9$$

Use R_{Ay} to get R_B

$$72.5 - 27.9$$

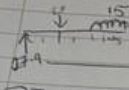
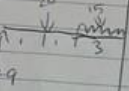
$$R_B = 44.6$$

Check by finding moment from A

$$(R_B \times 7) + (7.5 \times 6) + (15 \times 5 \times 1.5) - (20 \times 1) = 0$$

d) Using the support reactions calculated in 2c, draw the shear force and bending moments diagrams

Section	Shear force (kN)	Bending moments (kNm)
a) A	0 or 27.9	
2 metres from A	27.9 or 27.9 - 20 = 7.9	
22 metres from A	27.9 - 9 - 20 = 7.9	

Section	Shear force (kN)	Bending moment (kNm)
@ 5m from A 	$27.9 - 20 = 7.9$	
@ 5m from A 	$27.9 - 20 = 7.9$	

Question 3

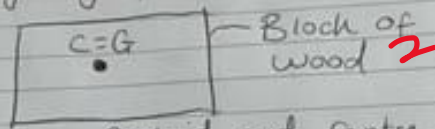
Q3-13

Q3

a) What is the difference between a centroid and a centre of gravity?

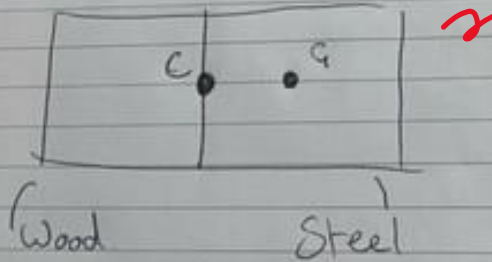
A centroid is the geometrical centre of a shape where as the centre of gravity of a shape is where it is assumed the entirety of the object's weight is assumed to be concentrated.

b) Illustrate the centroid and centre of gravity of an object of uniform material.



Centroid and centre of gravity is the same

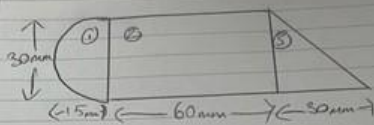
c) Illustrate the centroid and centre of gravity of an object with 2 different materials



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Centre of gravity and centroids in different places as Steel is more dense than wood.

2) Find the centroid of the diagram



$$\begin{aligned} \textcircled{1} \quad I_{xx1} &= (\pi \times r^4) / 8 & I_{yy1} &= (\pi \times r^4) / 8 \\ I_{xx1} &= (3.142 \times 15^4) / 8 & I_{yy1} &= (3.142 \times 15^4) / 8 \\ I_{xx1} &= 19,882.97 \text{ mm}^4 & I_{yy1} &= 19,882.97 \text{ mm}^4 \end{aligned}$$

$$\begin{aligned} \textcircled{2} \quad I_{xx2} &= (b \times d^3) / 12 & I_{yy2} &= (d \times b^3) / 12 \\ I_{xx2} &= (60 \times 30^3) / 12 & I_{yy2} &= (30 \times 60^3) / 12 \\ I_{xx2} &= 135,000 \text{ mm}^4 & I_{yy2} &= 540,000 \text{ mm}^4 \end{aligned}$$

$$\begin{aligned} \textcircled{3} \quad I_{xx3} &= (b \times h^3) / 36 & I_{yy3} &= (h \times b^3) / 36 \\ I_{xx3} &= (30 \times 30^3) / 36 & I_{yy3} &= (30 \times 30^3) / 36 \\ I_{xx3} &= 22,500 \text{ mm}^4 & I_{yy3} &= 22,500 \text{ mm}^4 \end{aligned}$$

$$I_{xx} = I_{xx1} + I_{xx2} + I_{xx3}$$

$$I_{xx} = 177,382.97$$

$$I_{yy} = I_{yy1} + I_{yy2} + I_{yy3}$$

$$I_{yy} = 582,382.97$$

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