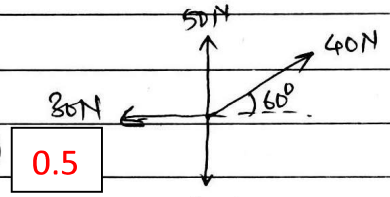
Q1 a]



$\Sigma F_x = 40\cos 60° - 80$

$= -10 \quad = 10\ N\ (\leftarrow)$ 0.5

$\Sigma F_y = 50 + 40\sin 60° - 20$

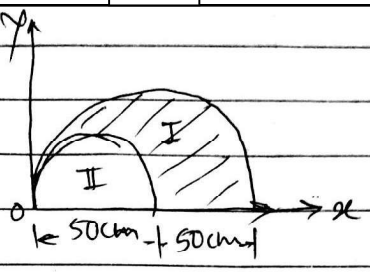
$= 64.64\ N.\ (\uparrow)$ 0.5

$R = \sqrt{\Sigma F_x^2 + \Sigma F_y^2} = 65.60\ N.$ 0.5

$\theta = \tan^{-1}\left(\frac{\Sigma F_y}{\Sigma F_x}\right) = 81.20°$ 0.5

$\therefore P = 81\ N$

b]



Part	Area A_i	x-coord. x_i	y-coord y_i	$A_i x_i$	$A_i y_i$
I	$\pi r^2/2 = \pi \times 50^2/2 = 3926.99\ cm^2$	50	21.22	196349.5	83350.72
II	$\pi r^2/2 = \pi \times 25^2/2 = 981.74\ cm^2$	25	10.61	24543.5	10416.26

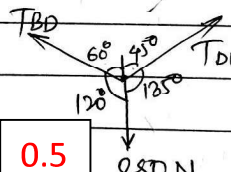
0.5 0.5

$\bar{x} = \frac{A_i x_i}{A_i} = \frac{A_1 x_1 - A_2 x_2}{A_1 - A_2} =$ ~~58.27 cm~~ (58.33 cm) 0.5

$\bar{y} = \frac{A_i y_i}{A_i} = \frac{A_1 y_1 - A_2 y_2}{A_1 - A_2} = 24.075\ cm.$ 0.5

c] For FBD of point 'D'.

By Lami's Theorem,



1.0

$\frac{250}{\sin 105} = \frac{T_{BD}}{\sin 135} = \frac{T_{DE}}{\sin 120°}$ 0.5

$\therefore T_{BD} = 183.01\ N$ 0.5

$T_{DE} = 224.14\ N.$ Extra.

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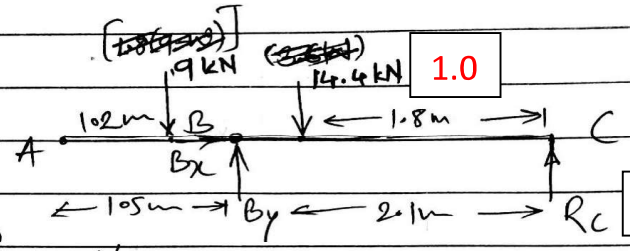
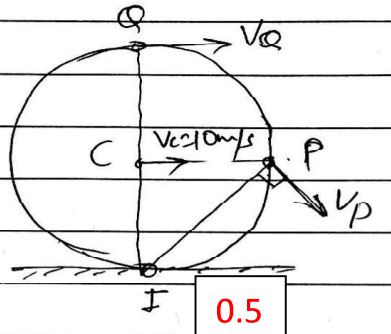
D] FBD of AC.



1.0

1.0

E]



0.5

$\omega = \frac{V_C}{IC} = \frac{10}{0.75} = 13.33$ r/s

$V_Q = \omega \times IQ = 13.33 \times 1.05$

$= 19.99$ m/s.

0.5

$IP = \sqrt{CP^2 + IC^2} = 1.06$ m

$V_P = \omega \times IP = 13.33 \times 1.06$

$= 14.13$ m/s

Extra.

F]

$\Sigma F_x = -10 + 20 + 25\cos 53.13°$

$= 25$ kN

0.5

$\Sigma F_y = 20 - 25\sin 53.13°$

$= -0.01 \times 10^{-5}$ kN.

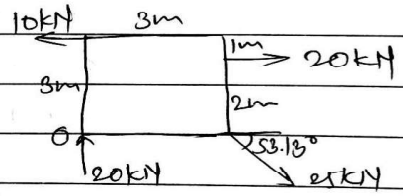
0.5

$R = \sqrt{\Sigma F_x^2 + \Sigma F_y^2} = 25.02$ kN.

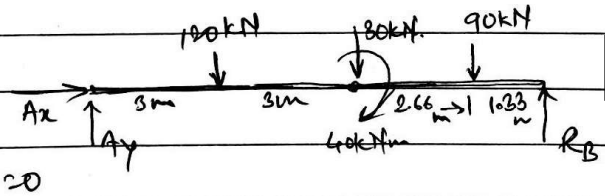
0.5

$\theta = \tan^{-1}\frac{\Sigma F_y}{\Sigma F_x} = -0.0000611°$

0.5



Q2a]



2.0

$\Sigma M_A = 0$

$-(120 \times 3) - (80 \times 6) - 40 - (90 \times 8.66) + (R_B \times 10) = 0$

$\therefore R_B = 135.94$ kN.

2.0

$\Sigma F_x = 0$, $A_x = 0$.

$\Sigma F_y = 0$

$A_y - 120 - 80 - 90 + R_B = 0$

$A_y = 104.06$ kN

1.0

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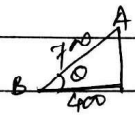
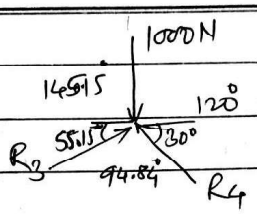
Q2 b] for FBD of 'A'.



0.5



1.0

$\theta = 55.15^\circ$

∴ By Lami's thm

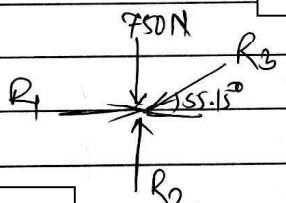
$$\frac{1000}{\sin 94.84^\circ} = \frac{R_3}{\sin 120^\circ} = \frac{R_4}{\sin 145.15^\circ}$$

0.5

∴ $R_3 = 869.12$ N $R_4 = \cancel{496.64\ N}$ 573.47 N

for FBD of 'B',

0.5



1.0

$\Sigma F_x = 0$,

$R_1 - R_3 \cos 55.15^\circ = 0$

$R_1 = 496.64$ N.

0.5

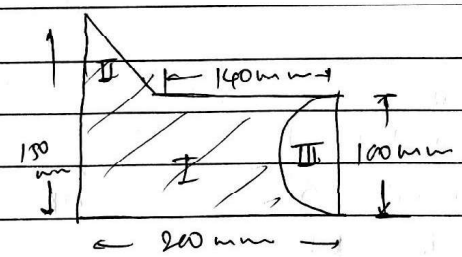
$\Sigma F_y = 0$,

$R_2 - 750 - R_3 \sin 55.15 = 0$

$R_2 = 1463.24$ N.

0.5

Q3 a]



Part	Area	x_i	y_i	$A_i x_i$	$A_i y_i$	
I	$200 \times 100 = 20000\ mm^2$	100	50	2000000	1000000	1.0
II	$\frac{1}{2} \times 50 \times 60 = 1500\ mm^2$	20	116.66	80000	174990	1.0
III	$\pi \times 50^2/2 = 3926.99\ mm^2$	178.78	50	702067.27	196349.5	1.0

$\bar{x} = 75.58$ mm

$\bar{y} = 55.689$ mm

$$\bar{x} = \frac{A_1x_1 + A_2x_2 - A_3x_3}{A_1 + A_2 - A_3} = 74.03\ mm. \qquad \bar{y} = \frac{A_1y_1 + A_2y_2 - A_3y_3}{A_1 + A_2 - A_3} = 55.69\ mm.$$

1.0 1.0

1.0

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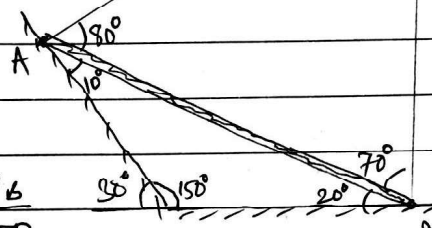
Q3 b]



In Δ IAB, by sine rule,

$$\frac{IA}{\sin 70^\circ} = \frac{IB}{\sin 80^\circ} = \frac{AB}{\sin 30^\circ}$$

$$\omega_{AB} = \frac{V_A}{IA} = \frac{V_B}{IB}$$

$\therefore IA = 5.63$ m 1.0

$IB = 5.94$ m 1.0

$\therefore \omega_{AB} = \frac{V_A}{IA} = \frac{5}{5.63} = 0.89$ r/s. 1.0

$V_B = \omega_{AB} \times IB = 5.27$ m/s. 1.0