Date.....

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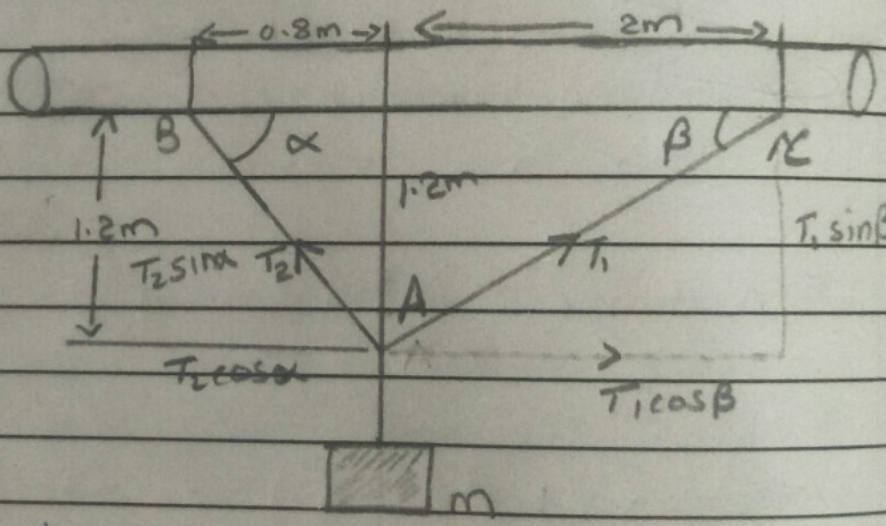
Subject :- Engineering Mechanics

Q1
Parta




Sol Part-a

m = mass of tank + mass of water

mass of tank = 400 pounds

1 kg = 2.21 Pounds

mass of tank = $400/2.21 \Rightarrow 181$ kg

mass of water = ?

Volume = 3000 liters

$1 m^3$ = 1000 liters

Volume of water = $\frac{3000}{1000} = 3 m^3$

Total mass (m) = 181 + 3000

= 3181 kg

density of water $= 1000\ kgm^{-3}$

mass $= 3 \times 1000 = 3000\ kg$

weight $= 3181 \times 9.81$

$F = 31205\ N$

$\Sigma F_x = 0$

$\Sigma F_x = T_1 \cos\beta = T_2 \cos\alpha$ ——(i)

$\Sigma F_y = 0$

$\Sigma F_y = T_1 \sin\beta + T_2 \sin\alpha = mg$ ——(ii)

from eq (i)

$T_1 \cos\beta = T_2 \cos\alpha$

$$T_2 = \frac{T_1 \cos\beta}{\cos\alpha}$$

Put values in eq (2)

$$T_1 \sin\beta + \frac{T_1 \cos\beta (\sin\alpha)}{\cos\alpha} = mg$$

$$T_1 \left[\sin\beta + \frac{\cos\beta \sin\alpha}{\cos\alpha}\right] = mg$$

$$T_1 = \frac{mg}{\sin\beta + \frac{\cos\beta \sin\alpha}{\cos\alpha}}$$

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$$\alpha = \tan^{-1}\left[\frac{1.2}{1.8}\right]$$

$$\alpha = 56.30^\circ$$

$$\beta = \tan^{-1}\left[\frac{1.2}{2}\right]$$

$$\beta = 31^\circ$$

$$T_1 = \frac{31205}{\sin(31) + \frac{\sin(56.3)\cos(31)}{\cos(56.3)}}$$

$$T_1 = 17333.16\ N$$

$$T_2 = \frac{17.333.16 \times \cos(31)}{\cos(56.3)}$$

$$T_2 = 26777.63\ N$$

$$AB\ \% = \frac{26777.63 \times 100}{31205}$$

$$AB = 85.81\ \%$$

S M T W T F S

Part-b

tank mass increases 15%.

new mass = 181 × 1.15

= 208.15 kg

Volume of water increases 35%.

new volume = 3 × 1.35

= 4.05 $m^3$

mass of water = 4050

Total mass = 4258.15 kg

F = 41772.45 N

$T_1$ will be = 23203 N

$T_2$ = 35846 N

AB% will be same

AB% = 85.81%

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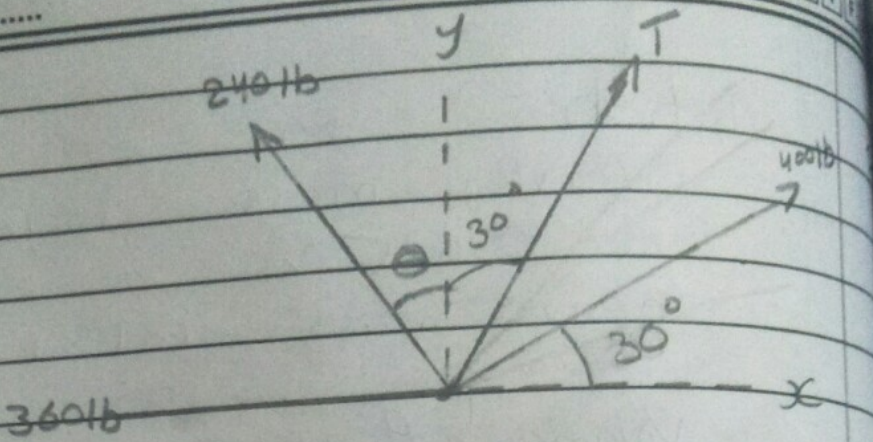
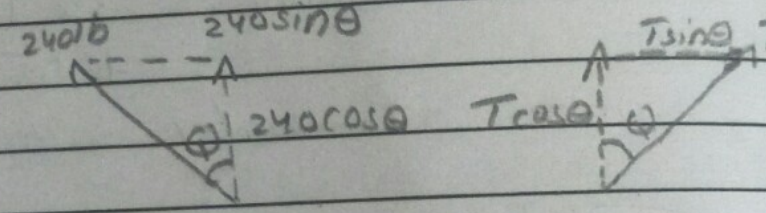
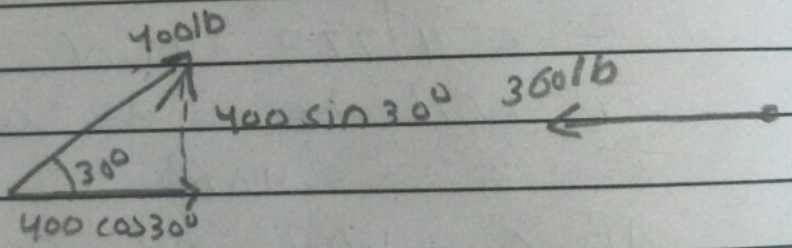
Q2




Sol




$\Sigma F_x = 0 \qquad \overset{+}{\rightarrow} \overset{-}{\leftarrow}$

$-240\sin\theta - 360 + T\sin 30^\circ + 400\cos 30^\circ = 0$

$-240\sin\theta + 0.5T - 360 + 346.4T = 0$

$0.5T - 240\sin\theta - 13.59 = 0 \quad -(i)$

$\Sigma F_y = 0 \qquad \uparrow + \downarrow -$

$240\cos\theta + T\cos 30^\circ + 400\sin 30^\circ = 600$

$0.866T + 240\cos\theta + 200 = 600$

$0.866T + 240\cos\theta = 600 - 200$

$0.866T + 240\cos\theta = 400 \quad -(ii)$

$\therefore \sin^2\theta + \cos^2\theta = 1 \quad -(iii)$

Now find value for $\sin\theta$ & $\cos\theta$

Take eq (i)

$$0.5T - 240\sin\theta - 13.59 = 0$$

$$240\sin\theta = 0.5T - 13.59$$

$$\sin\theta = \frac{0.5T - 13.59}{240} \quad \text{— (iv)}$$

Take eq (ii)

$$0.866T + 240\cos\theta = 400$$

$$240\cos\theta = 400 - 0.866T$$

$$\cos\theta = 400 - 0.866T$$

$$\cos\theta - \frac{400 - 0.866T}{240} \quad \text{— (v)}$$

Put eq (iv) & eq (v) in eq (iii) we get

$$\left(\frac{0.5T - 13.59}{240}\right)^2 + \left(\frac{400 - 0.866T}{240}\right)^2 = 1$$

$$(0.5T - 13.59)^2 + (400 - 0.866T)^2 = 240^2$$

$$0.25T^2 - 13.59T + 184.688 + 0.75T^2 - 692.8T + 160000 = 57600$$

$$0.25T^2 + 0.75T^2 - 13.59T - 692.8T + 184.688 + 160000 - 57600 = 0$$

$$T^2 - 706.36T + 102584.688 = 0$$

using quadratic formula (we get)

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$T_1 = 502.065$ lb

$T_2 = 204.325$ lb

since $\sin^2\theta = \sin^2(-\theta)$ & $\cos^2\theta = \cos^2(-\theta)$

For $T = 502.065$ lb

Using eq (iv)

$$\sin\theta = \left[\frac{(0.5 \times 502.065) - 13.59}{240}\right]$$

$$\theta = \sin^{-1}\left[\frac{(0.5 \times 502.065) - 13.59}{240}\right]$$

$$\theta = 81.63^\circ$$

using eq (v)

$$\cos\theta = \frac{400 - (0.866 \times 502.065)}{240}$$

$$\theta = \cos^{-1}\left[\frac{400 - (0.866 \times 502.065)}{240}\right]$$

$$\theta = 98.33^\circ$$

$81.63^\circ \neq 98.33^\circ$

Solution is Not Valid.

For $T = 204.325$ lb

S M T W T F S

using eq (iv)

$$\sin\Theta = \frac{(0.5 \times 204.325) - 13.59}{240}$$

$$\Theta = \sin^{-1}\left[\frac{(0.5 \times 204.325) - 13.59}{240}\right]$$

$$\Theta = 21.66^\circ$$

using eq (v)

$$\cos\Theta = \frac{400 - 0.866(204.325)}{240}$$

$$\Theta = \cos^{-1}\left[\frac{400 - (0.866 \times 204.325)}{240}\right]$$

$$\Theta = 21.66^\circ$$

since $21.66^\circ = 21.66$

solution is valid

There fore

$$T = 204.325 \text{ lb}$$

$$\Theta = 21.66^\circ$$

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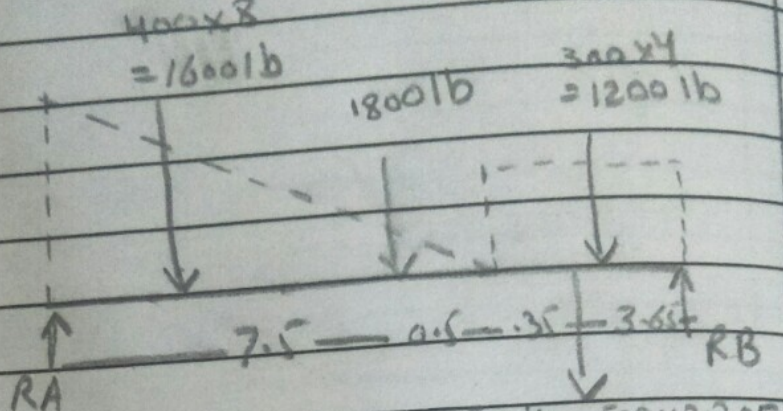
Q3




Sol $\Sigma M_A = 0 \ (+,-)$

$= -(1600 \times 2.66) - (1800 \times 7.5) - (1102.5 \times 8.35)$

$- (1200 \times 10) + RB \times 12 = 0$

$RB \times 12 = 4267.2 + 13500 + 9205.875 + 1200$

$\frac{RB \times 12}{12} = \frac{28173.075}{12}$

$RB = 2347.75625$

$\Sigma F_y = 0 \quad \uparrow + \downarrow -$

$RA - 1600 - 1800 - 1102.5 - 1200 + RB = 0$

$RA = 1600 + 1800 + 1102.5 + 1200 - RB$

$= 5702.5 - RB$

$= 5702.5 - 2347.75625$

$RA = 3354.74375 lb$

Reaction

$A = RA = 3354.75625$

$B = RB = 2347.75625$