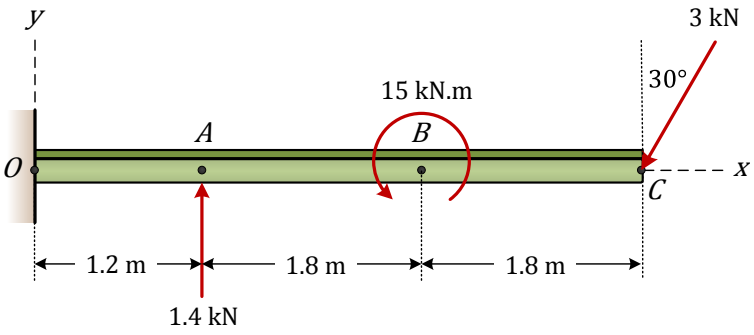
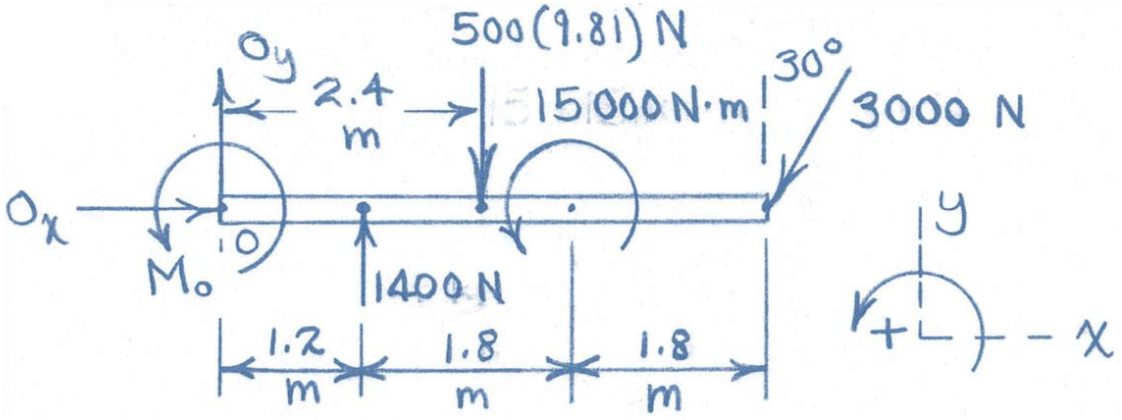
Question 2.8.

The 500 kg uniform beam is subjected to the three external loads shown. Compute the reactions at the support point O.



Solution



$+\rightarrow [\sum F_x = 0]$

$O_x - 3000 \sin 30° = 0$

$O_x = 1500$ N (Answer)

$+\uparrow [\sum F_y = 0]$

$O_y + 1400 - 500(9.81) - 3000 \cos 30° = 0$

$O_y = 6100$ N (Answer)

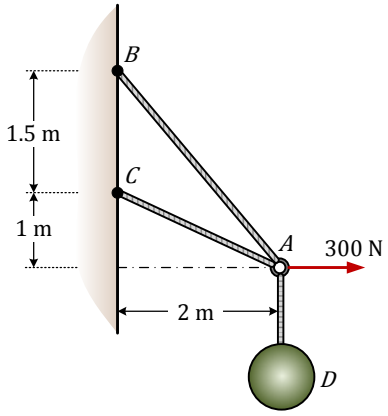
$+\circlearrowleft [\sum M_O = 0]$

$M_O + 1400(1.2) - 500(9.81)(2.4) + 15000 - 3000 \cos 30° (4.8) = 0$

$M_O = 7560$ N. m (Answer)

Question 2.9.

Determine the forces in cables AC and AB needed to hold the 20 kg ball D in equilibrium.



Solution

Referring to FBD of joint A in Fig. (a)

$+\rightarrow [\sum F_x = 0]$

$$300 - F_{AB}\left(\frac{4}{\sqrt{41}}\right) - F_{AC}\left(\frac{2}{\sqrt{5}}\right) = 0$$

$$0.6247\, F_{AB} + 0.8944\, F_{AC} = 300 \quad \text{---------- (1)}$$

$+\uparrow [\sum F_y = 0]$

$$-196.2 + F_{AB}\left(\frac{5}{\sqrt{41}}\right) + F_{AC}\left(\frac{1}{\sqrt{5}}\right) = 0$$

$$0.7809\, F_{AB} + 0.4472\, F_{AC} = 196.2 \quad \text{---------- (2)}$$

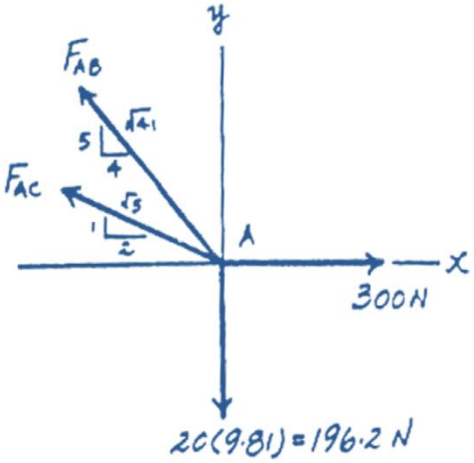


Fig. (a): FBD of joint A

Solving equation 1 and 2, simultaneously

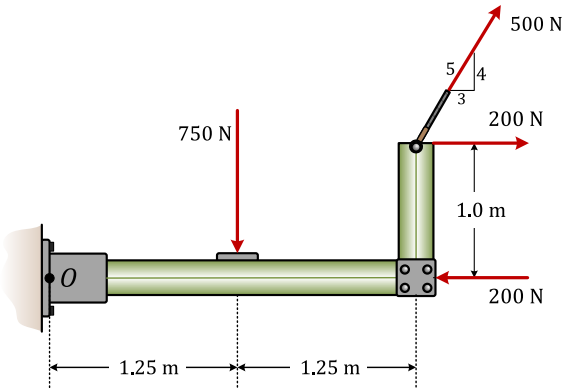
$F_{AB} = 98.6$ N (Answer)

and

$F_{AC} = 267$ N (Answer)

Question 2.10.

Replace the force system by a resultant force and couple moment at point O. (a) Determine the magnitude of the resultant force and specify its direction and (b) Determine the magnitude of the couple moment and specify its direction.



Solution

$$+\rightarrow \sum F_x = 200 - 200 + 500\left(\frac{3}{5}\right)$$

$$+\rightarrow \sum F_x = 300 \text{ N}$$

$$+\uparrow \sum F_y = -750 + 500\left(\frac{4}{5}\right)$$

$$+\uparrow \sum F_y = -350 \text{ N}$$

$$|F_R| = \sqrt{(300)^2 + (-350)^2} = 461 \text{ N}$$ (Answer)

$$\theta = \tan^{-1}\left(\frac{350}{300}\right) = 49.4°$$

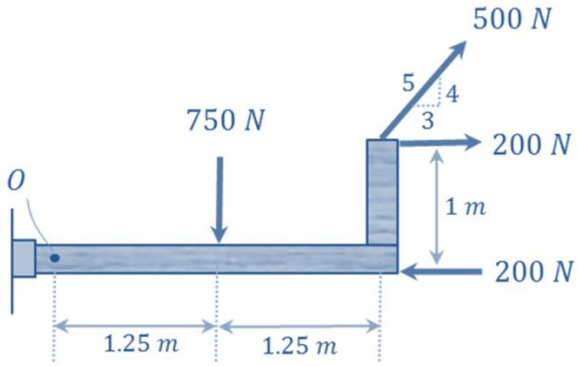
(Answer)

$$+\circlearrowleft \sum M_o = -700(1.25) - 200(1) + 500\left(\frac{4}{5}\right)(2.5) - 500\left(\frac{3}{5}\right)(1)$$

$$+\circlearrowleft \sum M_o = -438 \text{ N.m}$$

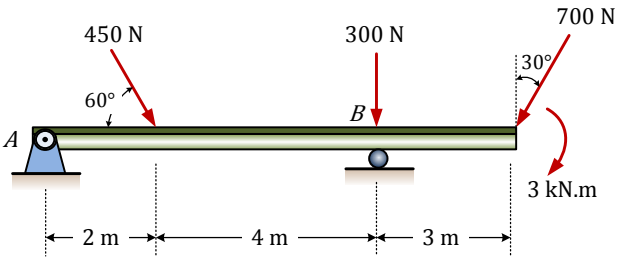
or

$M_o = 438 \text{ N.m}$ (CW) (Answer)



Question 2.11.

For the loaded beam shown, replace the loading by a single resultant force. Specify the location of the resultant force, measured from end A.



Solution

$+\rightarrow \sum F_{Rx} = \sum F_x$

$F_{Rx} = 450\cos 60° - 700\sin 30°$

$F_{Rx} = -125\ \text{N} = 120\ \text{N}\ (\leftarrow)$

$+\uparrow \sum F_{Ry} = \sum F_y$

$F_{Ry} = -300 - 450\sin 60° - 700\cos 30°$

$F_{Ry} = -1296\ \text{N} = 1296\ \text{N}\ (\downarrow)$

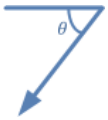
Magnitude of the resultant force

$F = \sqrt{(F_{Rx})^2 + \left(F_{Ry}\right)^2}$

$F = \sqrt{(-125)^2 + (-1296)^2} = 1302\ \text{N}$ (Answer)

Direction of the resultant force

$\theta = \tan^{-1}\left(\frac{1296}{125}\right) = 84.5°$



(Answer)

The location of the resultant force

$+\circlearrowleft \sum M_{RA} = \sum M_A$

$1296\ (x) = 450\sin 60°\ (2) + 300\ (6) + 700\cos 30°\ (9) + 3000$

$x = 8.51\ \text{m}$ (Answer)