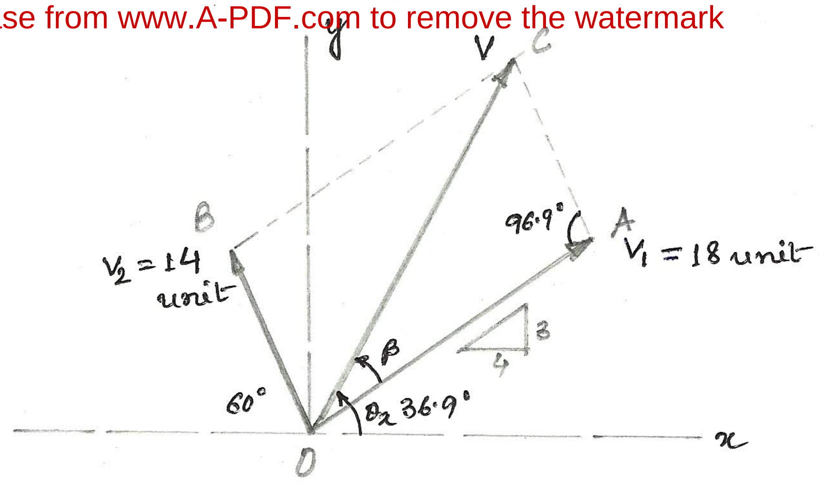
1)

i)



Graphically :-

A parallelogram drawn to scale with sides equals to V_1 and V_2

Measuring the diagonal length OC, the resultant is obtained as

$$V = 24 \text{ units}$$

and $\theta_x = 72°$

Algebrically :- Applying cosine law

$$V^2 = V_1^2 + V_2^2 - 2V_1V_2 \cos\alpha$$

$$= 18^2 + 14^2 - 2(18)(14)\cos 96.9°$$

$$V = 24.1 \text{ units}$$

$$\alpha = \frac{4\times 90° - 2(180° - 60° - 36.9°)}{2}$$

$$= 96.9°$$

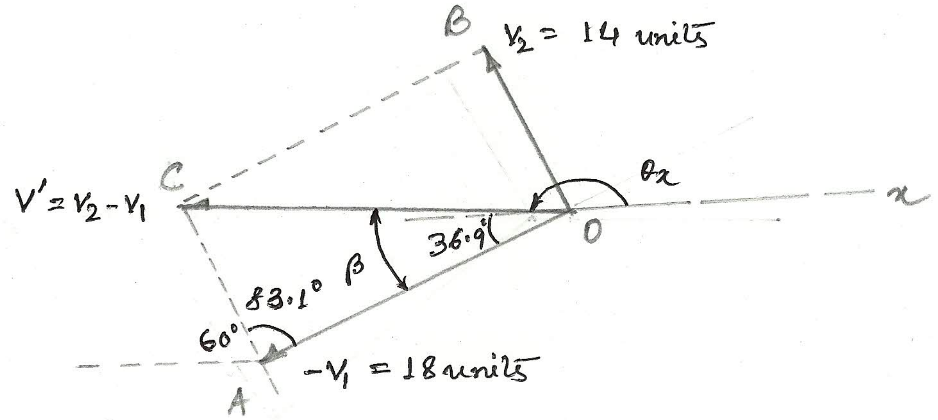
Applying sine law

$$\frac{\sin\beta}{14} = \frac{\sin 96.9°}{24.1}$$

$$\Rightarrow \beta = 35.2°$$

$$\therefore \theta_x = \beta + 36.9° = 72.1°$$

1) ii)



Graphically :-

A parallelogram drawn to scale with side V_1 and V_2 and the angles makes to x-axis. Measureing the length of OC resulltant can be obtained

$V' = 21$ units

$\theta_x = 176°$

Algebraically :-

$$V'^2 = V_1^2 + V_2^2 - 2V_1V_2\cos\alpha'$$

$$= 18^2 + 14^2 - 2(18)(14)\cos 83.1°$$

$$V' = 21.4 \text{ units}$$

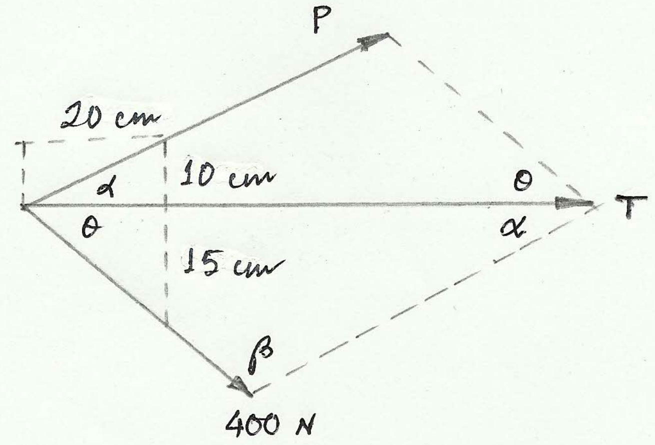
$$\frac{\sin\beta}{14} = \frac{\sin 83.1}{21.4} \Rightarrow \beta = 40.4°$$

$$\theta_x + \beta = 180° + 36.9°$$

$$\Rightarrow \theta_x = 216.9° - 40.4°$$

$$= 176.5°$$

2)



$$\alpha = \tan^{-1}\left(\frac{10}{20}\right) = 26.57^\circ$$

$$\theta = \tan^{-1}\left(\frac{15}{20}\right) = 36.87^\circ$$

$$\beta = 180^\circ - (\alpha + \theta) = 116.57^\circ$$

$$\frac{P}{\sin 36.89^\circ} = \frac{400}{\sin 26.57^\circ}$$

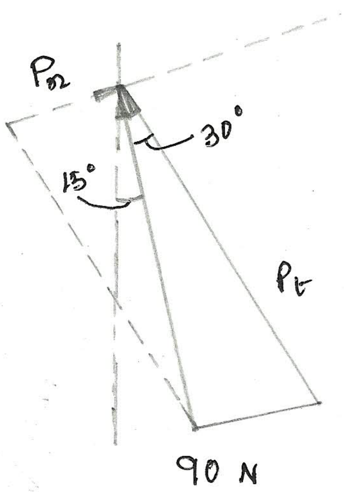
$$\Rightarrow \quad P = 537 \text{ N}$$

$$\frac{T}{\sin 116.56^\circ} = \frac{400}{\sin 26.57^\circ}$$

$$\Rightarrow \quad T = 800 \text{ N}$$

3.)

~~b)~~ b)



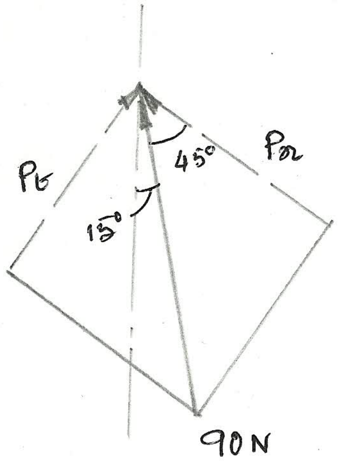
Perpendicular to arm BC

$P_n = 90 . \sin 30° = 45.0 N$

Parallel to arm BC

$P_t = 90 . \cos 30° = 77.9 N$

a)



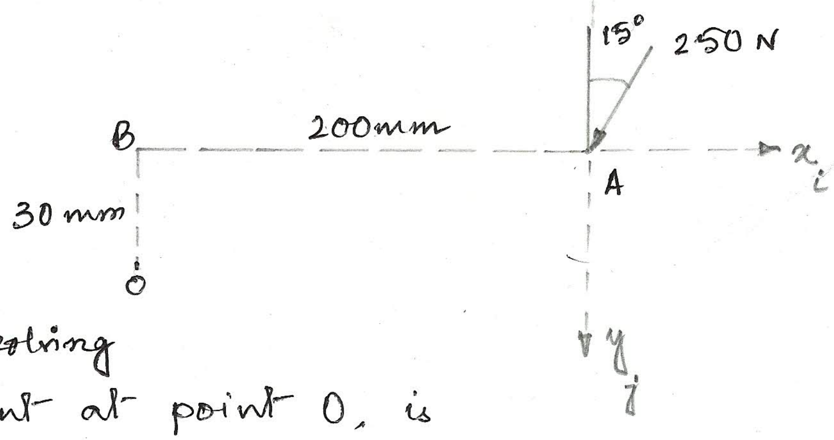
Perpendicular to arm AB

$P_n = 90 . \cos 45° = 45 N.$

Parallel to arm AB

$P_t = 90 . \sin 45° = 45 N$

4)



By force resolving

Moment at point O, is

$$\circlearrowleft + \; M_O = 250 . \cos 15° (0.20) - 250 \sin 15° (0.030)$$
$$= 48.30 - 1.941$$
$$= 46.4 \; KN\text{-}m$$

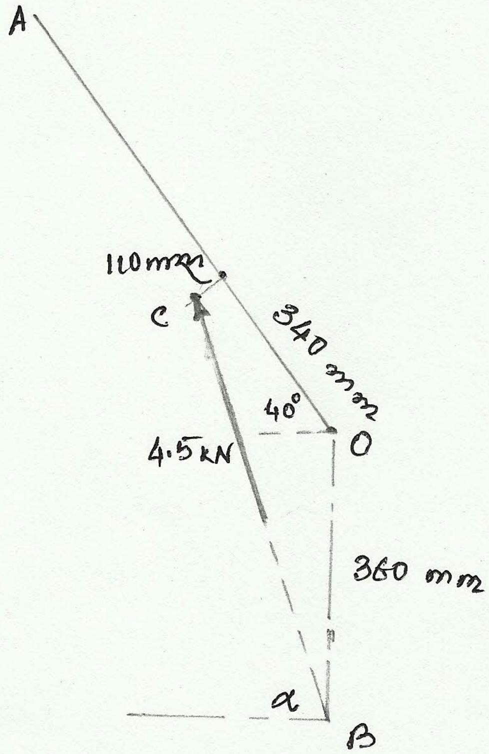
By vector notation

$$r_{AO} = -0.2i + 0.03j$$
$$F = -250 \sin 15° i - 250 \cos 15° j$$
$$= -64.7 i - 241.48 j$$

$\therefore$ So, Moment is

$$M_O = r_{AO} \times F$$
$$= [-0.2i + 0.03j] \times [-64.7i - 241.48j]$$
$$= 48.296 - 1.941$$
$$= 46.36 \; N\text{-}m$$

560)



$$\alpha = \tan^{-1}\left[\frac{360 + 340 \sin 40^\circ - 110 \sin 50^\circ}{340 \cos 40^\circ + 110 \cos 50^\circ}\right]$$

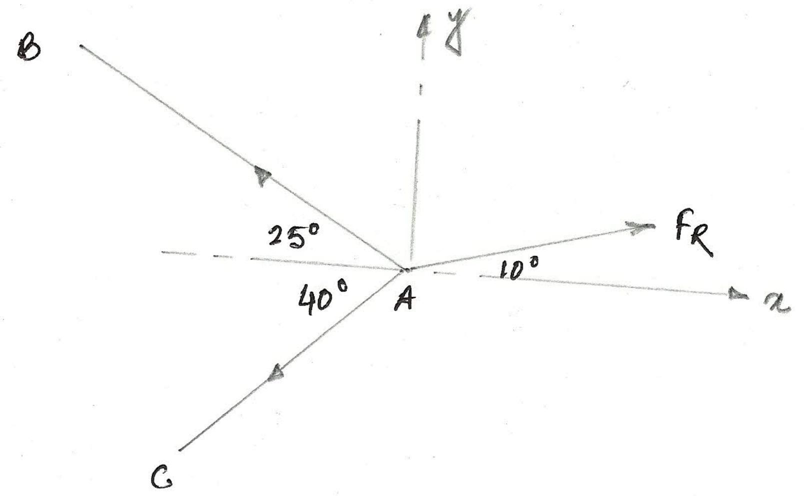
$$= 56.2^\circ$$

So, moment is

$$+\circlearrowleft M_O = 4.5\ (0.360 \cos 56.2^\circ)$$

$$= 0.902 \text{ kN-m}$$

6).



For equllibrium of point A

$\overset{+}{\rightarrow}\sum F_x = 0$ $\qquad\qquad$ $+\uparrow \sum F_y = 0$

$F_R \cos 10^\circ - T_{AC} \cos 40^\circ - T_{AB} \cos 25^\circ = 0$ $\qquad$ $F_R \sin 10^\circ - T_{AC} \sin 40^\circ - T_{AB} \sin 25^\circ = 0$

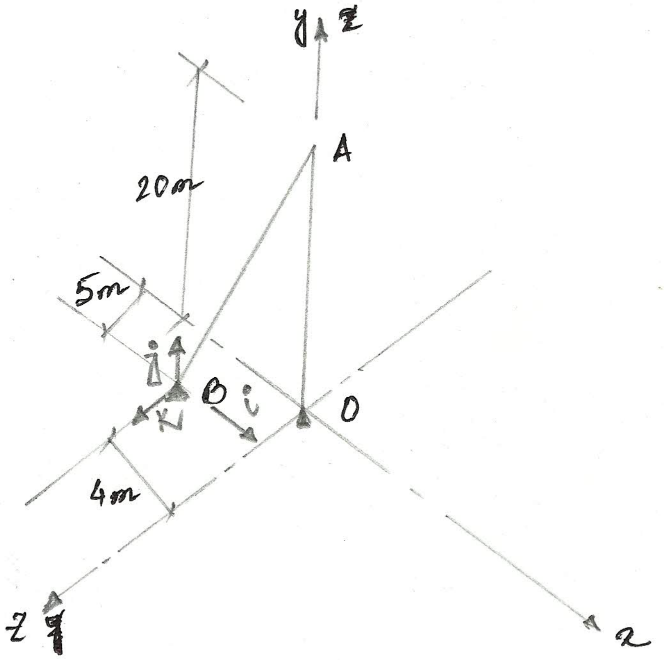
$\Rightarrow 0.77\, T_{AC} + 0.91\, T_{AB} = 68.94$ $\qquad$ $\Rightarrow 0.643\, T_{AC} + 0.423\, T_{AB} = 12.16$

Solving this two equation

$T_{AC} = -69.76\,N$ $\qquad$ $T_{AB} = 134.78\,N$

78) i)

(a)



The force act along ~~BA~~ BA. The components

For, point B, of the vector $\vec{BA}$, are

$d_x = -4m$ $\quad d_y = 20\ m$ $\quad d_z = 5m$

Then, length of AB wire is

$$BA = d = \sqrt{d_x^2 + d_y^2 + d_z^2}$$

$$= \sqrt{(-4)^2 + (20)^2 + (5)^2}$$

$$= 21\ m.$$

Denoting i, j and k the unit vectors along the co-ordinate axes, we have

$$\vec{BA} = -4i + 20j + 5k$$

For unit vector λ,

$$\lambda = \frac{\vec{BA}}{BA}$$

Then,

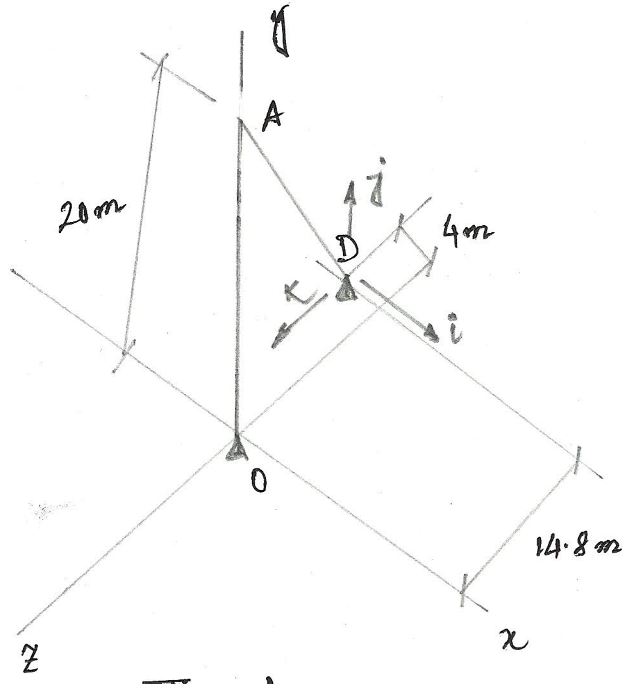
$$F = f \cdot \lambda = \frac{2100}{21}(-4i + 20j + 5k)$$

$$= -400i + 2000j + 500k$$

$\therefore$ The force components are

$F_x = -4000$ kN, $\quad F_y = 2000$ kN, $\quad F_z = 500$ kN.

7) i) (10)



The force act along DA. The components ~~For point D,~~ of the vector $\overrightarrow{DA}$ are

$$d_x = -4m \quad d_y = 20m \quad d_z = -14.8m.$$

Then length of AD wire is

$$DA = d = \sqrt{d_x^2 + d_y^2 + d_z^2}$$

$$= \sqrt{(-4)^2 + (20)^2 + (-14.8)^2}$$

$$= 25.2\ m.$$

Denoting i, j and k the unit vectors along the co-ordinate axes, we have

$$\overrightarrow{DA} = -4i + 20j - 14.8k$$

For the unit vector λ

$$\lambda = \frac{\overrightarrow{DA}}{DA}$$

Then,

$$F = f.\lambda = \frac{1260}{25.2}(-4i + 20j - 14.8k)$$

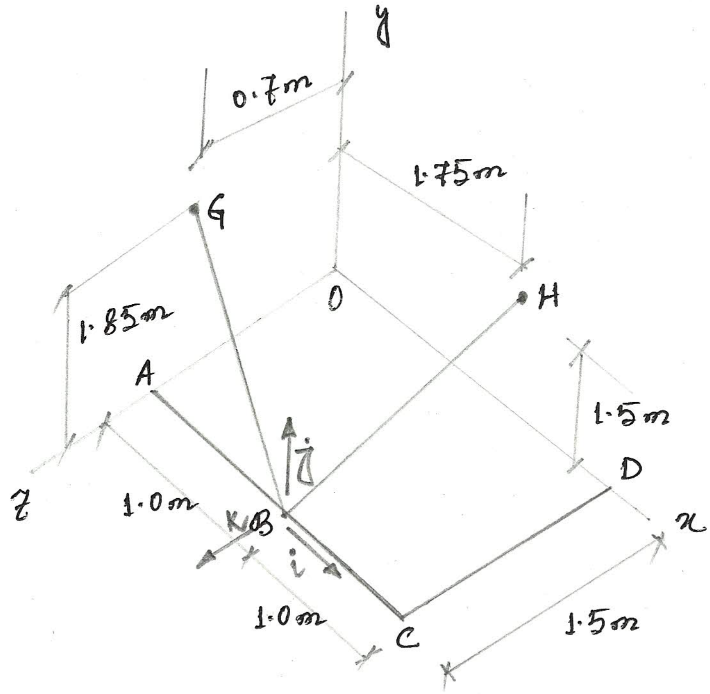
$$= -200i + 1000j - 740k$$

$\therefore$ The force components at D, are

$$F_x = -200\ N, \quad F_y = 1000\ N, \quad F_z = -740\ N$$

78) ii)

a).



In the above diagram, co-ordinate B is (1,0,1.5) and co-ordinate G is (0, 1.85, 0.7). While force act along the BG, the components of vector $\vec{BG}$ are

$d_x = 1$ $\quad d_y = -1.85$ $\quad d_z = 1.5 - 0.7 = 0.8$

Distance B to G is

$$BG = \sqrt{d_x^2 + d_y^2 + d_z^2}$$

$$= \sqrt{(1.0)^2 + (1.85)^2 + (0.8)^2}$$

$$= 2.25 \text{ m.}$$

Denoting i, j and k the unit vectors along the co-ordinate axes, we have

$$\vec{BG} = i \pm 1.85 j + 0.8 k$$

For unit vector λ

$$\lambda = \frac{\vec{BG}}{BG}$$

Then,

$$F = f \cdot \frac{\vec{BG}}{BG} = \frac{450}{2.25}(i \pm 1.85 j + 0.8K)$$

$$= 200 i \pm 370 j + 160 K$$

∴ The force components are

$F_x = 200$ N $\quad F_y = -370$ N $\quad F_z = 160$ N.

78) ii)

b) As per diagram given in sol. 8. i) b), the co-ordinate of H is (1.75, 1.5, 0). Here component vector of $\overrightarrow{BH}$ are

$d_x = (1-1.75) = -0.75 \quad d_y = -1.5 \quad d_z = 1.5$

Distance of B to H is

$$BH = \sqrt{d_x^2 + d_y^2 + d_z^2}$$

$$= \sqrt{(-0.75)^2 + (-1.5)^2 + (1.5)^2}$$

$$= 2.25 \text{ m.}$$

Denoting i, j and k the unit vectors along the co-ordinate axes, we have

$$\overrightarrow{BH} = -0.75i - 1.5j + 1.5k$$

For unit vector λ

$$\lambda = \frac{\overrightarrow{BH}}{BH}$$

Then,

$$F = f.\lambda = 600. \frac{\overrightarrow{BH}}{BH}$$

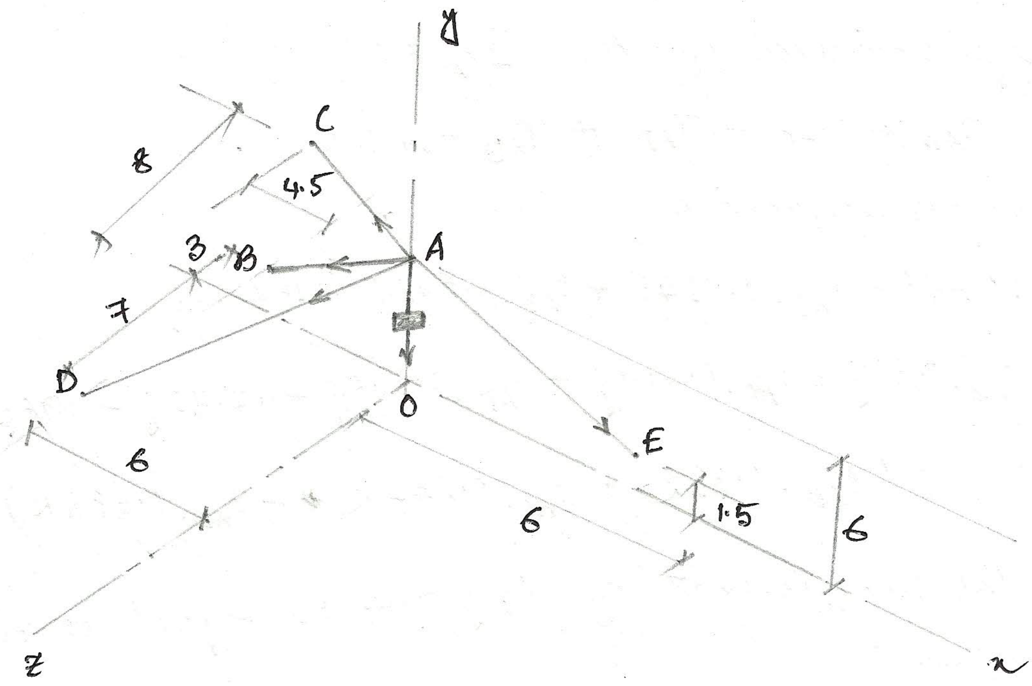
$$= \frac{600.}{2.25}(-0.75i - 1.5j + 1.5k)$$

$$= -200i - 400j + 400k$$

$\therefore$ The force components are

$F_x = -200$ N $\quad F_y = -400$ N $\quad F_z = 400$ N.

8)



The co-ordinate of the points

$A(0,6,0)$, $B(-6,0,-3)$, $C(-10.5,0,-8)$

$D(-6,0,7)$ $E(6,1.5,0)$.

The point A is subjected ~~4~~ fowre forces. Being a single cable, tension in AE will be same as weight of that block. Introducing i, j and k unit vector and resolving the force component

$$W = -mgj = -20\times 9.81 j = -196.2 j$$

$\overrightarrow{AB} = 6i + 6j + 3k$ $\quad AB = 9$

$\overrightarrow{AC} = 10.5i + 6j + 8k$ $\quad AC = 14.5$

$\overrightarrow{AD} = 6i + 6j - 7k$ $\quad AD = 11$

$\overrightarrow{AE} = -6i + 4.5j + 0$ $\quad AE = 7.5$

$$T_{AB} = t_{AB}\cdot\frac{\overrightarrow{AB}}{AB} = t_{AB}.0.67i + t_{AB}.0.67j + t_{AB}.0.33k$$

$$T_{AC} = t_{AC}\cdot\frac{\overrightarrow{AC}}{AC} = t_{AC}.0.724i + t_{AC}.0.414j + t_{AC}.0.552k$$

$$T_{AD} = t_{AD}\frac{\overrightarrow{AD}}{AD} = t_{AD}.0.545i + t_{AD}.0.545j - t_{AD}.0.636k$$

$$T_{AE} = 196.2.\frac{\overrightarrow{AE}}{AD} = -156.96i + 117.72j$$

For equillibrium of A, $\Sigma F_A = 0$

$$T_{AB} + T_{AC} + T_{AD} + T_{AE} + W = 0$$

Putting all the expression

$$(t_{AB} \cdot 0.67i + t_{AC} \cdot 0.724i + t_{AD} \cdot 0.545i - 156.96i)$$

$$+ (t_{AB} \cdot 0.67j + t_{AC} \cdot 0.414j + t_{AD} \cdot 0.545j + 117.72j - 196.2j)$$

$$+ (t_{AB} \cdot 0.33k + t_{AC} \cdot 0.552k - t_{AD} \cdot 0.636k) = 0$$

setting the co-efficient of i, j and k equal to zero, we can write

$$0.67\, t_{AB} + 0.724\, t_{AC} + 0.545\, t_{AD} = 156.96$$

$$0.67\, t_{AB} + 0.414\, t_{AC} + 0.545\, t_{AD} = 78.48$$

$$0.33\, t_{AB} + 0.552\, t_{AC} - 0.636\, t_{AD} = 0$$

Solving this eqn

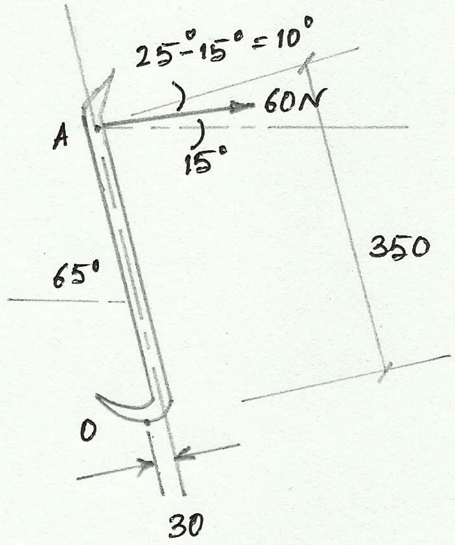
$$t_{AB} = -153.3181$$

$$t_{AC} = 253.1613$$

$$t_{AD} = 140.1731$$

$\therefore$ So, force in the boom is 153.32 N with opposite to the direction assume and cable AC & AD is exerted force 253.1613 N & 140.1731 N as direction assumed.

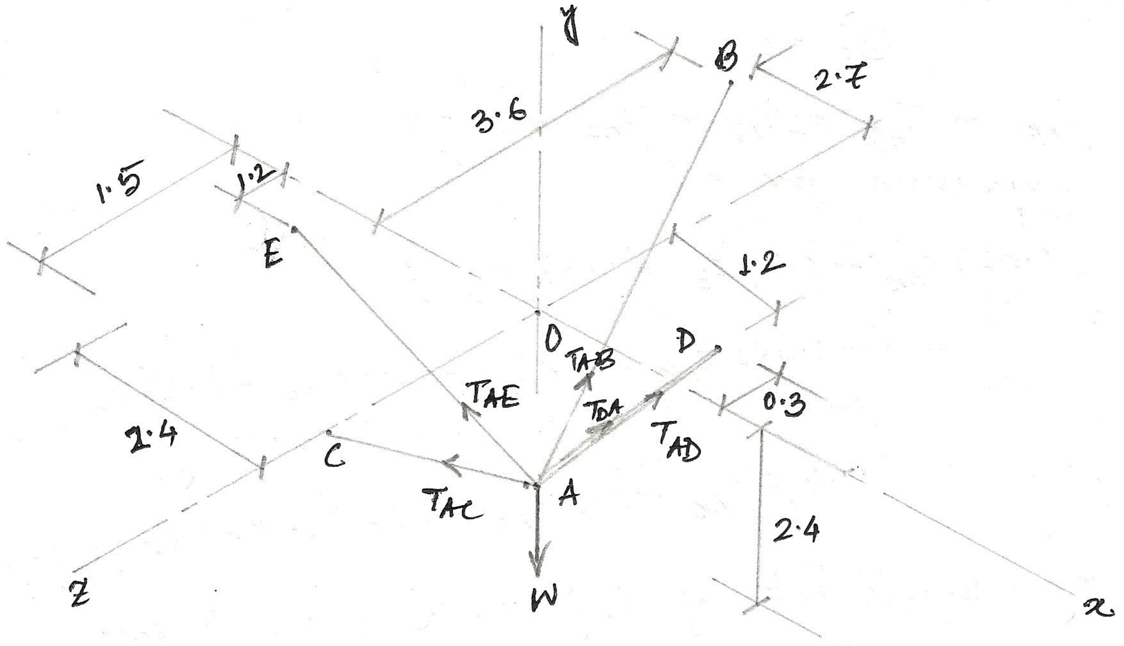
9)



Moment about the point O is

$$\overset{+}{\curvearrowright} M_O = (60\cos 10^\circ)(0.350) + (60\sin 10^\circ)(0.030)$$
$$= 21 \text{ N-m.}$$

10)



co-ordinates are

$A(0,-2.4,0)$, $B(-2.7,0,-3.6)$, $C(0,0,1.8)$, $D(1.2,0,-0.3)$

$E(-2.4,0,1.2)$

i, j and k are unit vectors

$$W = -mg\,j = -1400\,N\,j$$

$\vec{AB} = 2.7i - 2.4j + 3.6k$ $\quad AB = 5.1$

$\vec{AC} = -2.4j - 1.8k$ $\quad AC = 3$

$\vec{AD} = -1.2i - 2.4j + 0.3k$ $\quad AD = 2.7$

$\vec{AE} = 2.4i - 2.4j - 1.2k$ $\quad AE = 3.6$

Being single cable ADE

$$t_{AD} = t_{DA} = t_{AE} = t_E$$

$$\therefore\; T_{AB} = t_{AB} \cdot \frac{\vec{AB}}{AB} = 0.529i\,t_{AB} - 0.471j\,t_{AB} + 0.706k\,t_{AB}$$

$$T_{AC} = t_{AC} \cdot \frac{\vec{AC}}{AC} = -0.8j\,t_{AC} - 0.6k\,t_{AC}$$

$$T_{AD} = t_E \cdot \frac{\vec{AD}}{AD} = -0.44i\,t_E - 0.89j\,t_E + 0.11k\,t_E$$

$$T_{AE} = t_E\,\frac{\vec{AE}}{AE} = 0.67i\,t_E + -0.67j\,t_E - 0.33k\,t_E$$

For equillibrium of A

$$\Sigma F = 0$$

$$\therefore T_{AB} + T_{AC} + 2T_{AD} + T_{AE} + W = 0$$

putting expression for all

$$(0.529\, t_{AB} - 0.88\, t_E + 0.67\, t_B)\, i$$

$$+ (-0.471\, t_{AB} - 0.8\, t_{AC} - 1.78\, t_E - 0.67\, t_E - 1400)\, j$$

$$+ (0.706\, t_{AB} - 0.6\, t_{AC} + 0.22\, t_E + -0.33\, t_E) = 0$$

equating co-efficient of i, j and k equal to zero

$$0.529\, t_{AB} - 0.21\, t_E = 0$$

$$-0.471\, t_{AB} - 0.8\, t_{AC} - 2.45\, t_E - 1400 = 0$$

$$0.706\, t_{AB} - 0.6\, t_{AC} - 0.11\, t_E = 0$$

$\therefore$ So,

$$t_{AB} = -194.053\ N$$

$$t_{AC} = -138.72\ N$$

$$t_E = -488.828\ N.$$