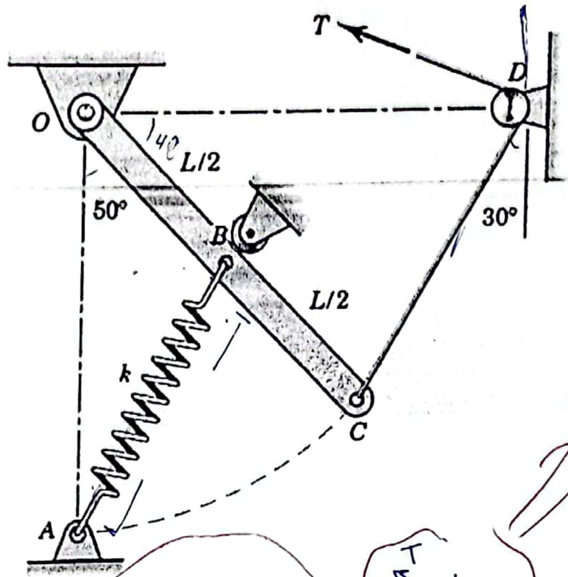
Problem 3. (8 points) 2.5

Bar OC has a length L =1 m. The spring has a stiffness k =400 N/m and is unstretched when C is coincident with A. Considering smooth contact at B and neglecting the mass of the bar, determine the reactions at O and B in the position shown for which T=100 N.



$\Sigma F_x = 0$

$F_x - T \sin 30 = 0$

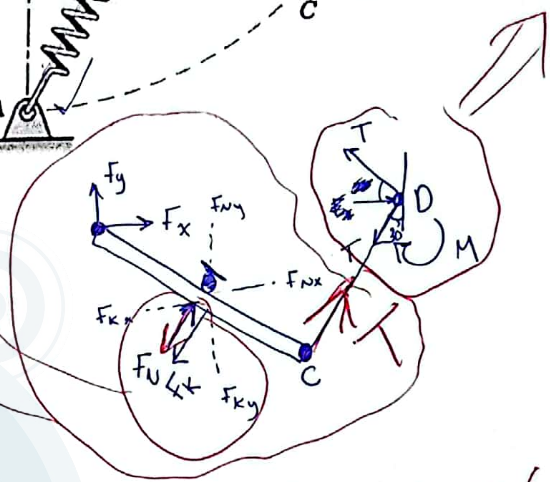
$F_x - (100)\sin 30 =$

$\boxed{F_x = 50\ N}$

$\Sigma F_y = 0$

$-T\cos 30 + F_y = 0$

$\boxed{F_y = 86.6\ N}$



$\Sigma M_O = 0$

$= F_N(0.5) - F_K(0.5)$

$+ T(1) - T(1)$

$0 = F_N(0.5) - 400(s)(0.5)$

$F_K = ks$

$= 400\ (1 \sin 50)$

$=$

$\Sigma M_O = 0$

$= F_N\left(\frac{1}{2}\right) - F_K\left(\frac{1}{2}\right)$

$+ T(1)$

$\Sigma M_O = F_N(0.5) -$

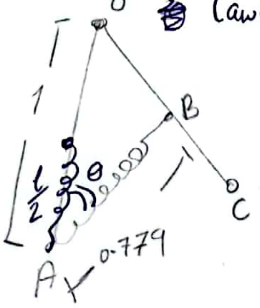
$L = 0.779$ (m) when it is stretched

$L_0 = 0.5$ m

$F_{spring} = 400(0.779 - 0.5)$

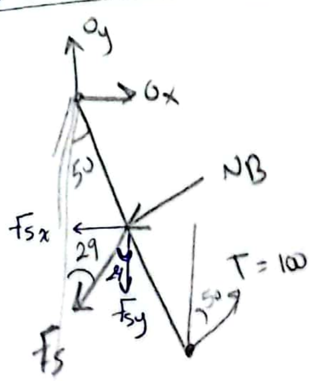
$= 111.6\ N$

Law of Cosins



$\Sigma M_O = 0$ +↺

$N_B(0.5) -$

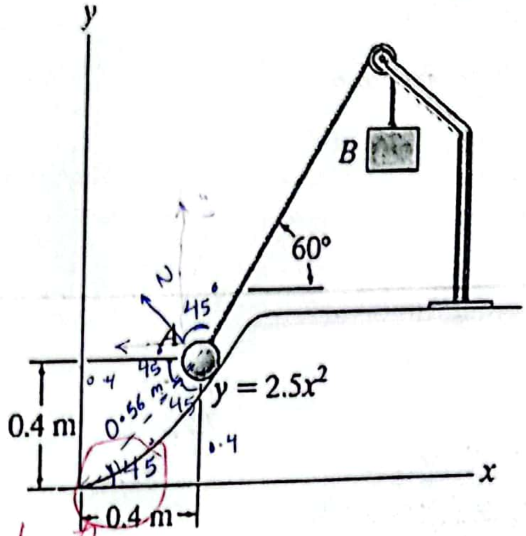


Law of Sins (θ)

$\frac{0.5}{\sin\theta} = \frac{0.779}{\sin 50}$

4.5 $w = 4 \times 9.81 = 39.24\ N$

Problem 2. (6 points)
A 4-kg sphere rests on the smooth parabolic surface and is held in equilibrium by block B connected to the sphere by a cord, as shown. Determine:
a) The normal force from the surface on the sphere
b) The mass block *B*.



a)

$\Sigma F_y = 0$

$-39.24 + N_y + T_y = 0$

$N\,0.7 + T\,0.86 = +39$

$\Sigma F_x = 0$

$T_x - N_x = 0$

$T_x = N_x$

$T\,0.5 = N\,0.7$

$\frac{T}{N} = \frac{0.7}{0.5}$

~~$T = 0.8\ N$~~

$\boxed{T = 0.7\ N}$

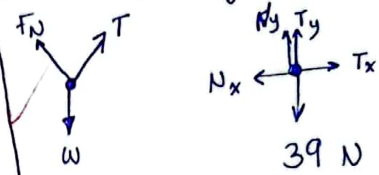
$\theta = \tan^{-1}\left(\frac{dy}{dx}\Big|_{x=0.4}\right) = 63.43^\circ$

$\Sigma F_x = 0$

$T\cos 60 - N\sin\theta = 0$

$T = 1.789\ N$!!?

Free Body Diagram of Sphere:-



$T_y = T\sin 60$

$T_x = T\cos 60$

$N_y = N\cos 45$

$N_x = N\sin 45$

~~$y = 2.5x^2$~~

~~$y' = 5x$~~

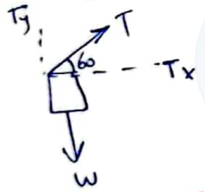
~~$y' = 5(0.4)$~~

~~$= 2$~~ ليش

~~$1/2$ الجواب من~~ 0.?

~~$F_N = 1/2\ N$~~

Free body diagram for B:



$= 9.81\ m_b$

$m_b = 3.585\ kg$

$\Sigma F_y = 0$

$T\sin 60 = W$??

$\Sigma F_x = 0$

$T\cos 60 = N_x$

$T\cos 60 = N\cos 45$

$T\,0.5 = N$

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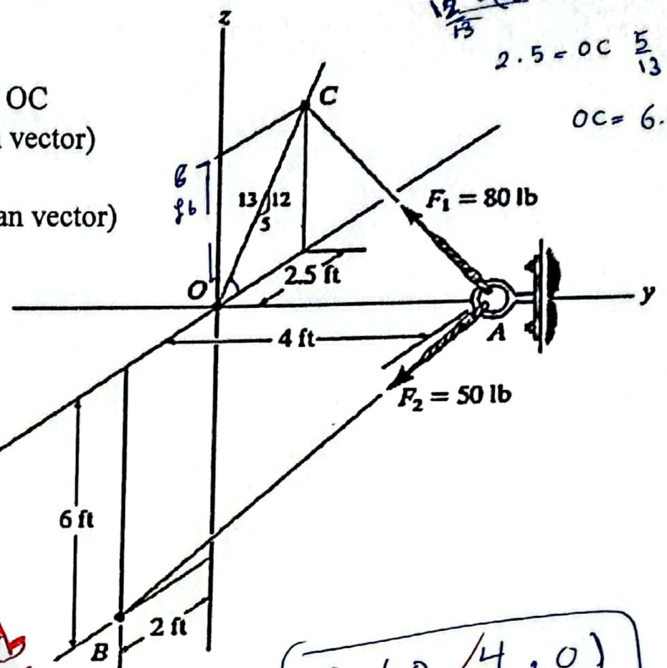
Problem 1. (11 points)

a) Express F_1 and F_2 in Cartesian vectors
b) Find the magnitude of the component of F_1 acting along OC
c) Find the resultant force (F_R) at A (express as a Cartesian vector)
d) Find the coordinate angles of F_R
e) Find the resultant moment about O (express as a Cartesian vector)



$\frac{12}{13}$ ~~(2.5)~~

$2.5 = OC \frac{5}{13}$

$OC = 6.5$

a)

$F_1 = 80$ lb

$\vec{AC} = -2.5i - 4\hat{j} + 6\hat{k}$

$|AC| = \sqrt{16 + 36 + (2.5)^2} = 7.6$

$\vec{F_1} = 80\left(-\frac{2.5}{7.6}i - \frac{4}{7.6}\hat{j} + \frac{6}{7.6}\hat{k}\right)$

$\boxed{\vec{F_1} = -26.3i - 42\hat{j} + 63\hat{k}}$ N lb

$F_2 = 50$ lb

$\vec{AB} = 2\hat{i} - 4\hat{j} - 6\hat{k}$

$|AB| = \sqrt{36+16+4} = \sqrt{56} = 7.4$

$\vec{F_2} = 50\left(\frac{2}{7.4}\hat{i} - \frac{4}{7.4}\hat{j} - \frac{6}{7.4}\hat{k}\right)$

$\boxed{\vec{F_2} = 13.5\hat{i} - 27\hat{j} - 40.5\hat{k}}$ N

A (0, 4, 0)
B (2, 0, -6)
C (-2.5, 0, 6)
ft

$\Sigma M = \vec{r_{OA}} \times (\vec{F_1} + \vec{F_2})$
$= \vec{r_{OA}} \times \vec{F_R}$

e)

$\vec{M_1} = \vec{r_{OC}} \times \vec{F_1} =$ r_A

$$\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ -2.5 & 0 & 6 \\ -26.3 & -42 & 63 \end{vmatrix}$$

$\vec{M_1} = (0 - 252)i - (-157.5 - 157.8)\hat{j} + (105 - 0)k$

$\boxed{\vec{M_1} = -252i + 315.3\hat{j} + 105\hat{k}}$

$\vec{M_2} = r_{AB} \times F_2$

$\vec{r_A} = (0, 4, 0)$

$$\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & +4 & 0 \\ 13.5 & -27 & -40.5 \end{vmatrix}$$

~~$M_2 = (-162 - 162)i - (-81 - 81)j + (-54 - 54)$~~

~~$M_2 = -0i - 0j + 0k$~~

$\vec{M_2} = -162i - 0\hat{j} - 54\hat{k}$

$\boxed{M_{total} = -414\hat{i} + 315.3\hat{j} + 51\hat{k}}$

b)

$\boxed{\vec{OC} = -2.5\hat{i} + 6\hat{k}}$

magnitude of F_1 along OC:

$\vec{F_1} \cdot \vec{OC} = (F_{1x} \cdot OC_x)\hat{i} + (F_{1y} \cdot OC_y) + (F_{1z} \cdot OC_z)$

$= (-26.3 \times -2.5) + (-42 \times 0) + (63 \times 6)$

$= 65.75 + 0 + 378$

$U_{OC} = \boxed{443.75 \text{ N}} \Big/ \sqrt{2.5^2 + 6^2}$

c) $\vec{F_{RA}} = \vec{F_1} + \vec{F_2}$

$= -12.8\hat{i} - 69\hat{j} + 22.5\hat{k}$ N

d)

$\alpha = \cos^{-1}\frac{\vec{F_{Rx}}}{|F_R|}$

$\beta = \cos^{-1}\frac{F_{Ry}}{|F_R|}$

$\gamma = \cos^{-1}\frac{F_{Rz}}{|F_R|}$

$|F_R| = \sqrt{(12.8)^2 + (69)^2 + (22.5)^2}$

$= \sqrt{163.84 + 4761 + 506.25}$

$= 73.7$

$\alpha = \cos^{-1}\left(\frac{-12.8}{73.7}\right) = 100°$

$\beta = \cos^{-1}\left(\frac{-69}{73.7}\right) = 159.$

$\gamma = \cos^{-1}\left(\frac{22.5}{73.7}\right) = 72.2°$

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