MOMENTS

1. A force with a magnitude of 100 N is directed from the origin to (3,2,2). Find the scalar moments of this force about the x, y, and z axes.

(0,0,0) to (3,2,2)

$r = \sqrt{(3-0)^2+(2-0)^2+(2-0)^2}$

$r = \sqrt{17}$

$F_x = \frac{x}{r}F = \frac{3}{\sqrt{17}}(100N) = 72.8N$

$F_y = \frac{y}{r}F = \frac{2}{\sqrt{17}}(100N) = 48.5N$

$F_z = \frac{z}{r}F = \frac{2}{\sqrt{17}}(100N) = 48.5N$

$r \times F$

$$\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} & \hat{i} \\ 3 & 2 & 2 & 3 \\ 72.8 & 48.5 & 48.5 & 72.8 \end{vmatrix}$$

$M = [2(48.5) - 2(48.5)]\hat{i} + [2(72.8) - 3(48.5)]\hat{j} + [3(48.5) - 2(72.8)]\hat{k}$

$\boxed{M = 0\hat{i} + 0.1\hat{j} - 0.1\hat{k}}$ Nm

2. A force with a magnitude of 75 N is directed from (1,2,1) to (7,3,5). Find the moment of t his force acting through the point (2,3,4) with respect to the line passing from (1,-1,-1) to (4,2,3).

(1,2,1) to (7,3,5)

$r = \sqrt{(7-1)^2+(3-2)^2+(5-1)^2}$

$r = \sqrt{41}$

$F_x = \frac{x}{r}F = \frac{6}{\sqrt{41}}(75N) = 70.3N$

$F_y = \frac{y}{r}F = \frac{1}{\sqrt{41}}(75N) = 11.7N$

$F_z = \frac{z}{r}F = \frac{4}{\sqrt{41}}(75N) = 46.9N$

(1,2,1) to (1,-1,-1)

$r = (1-1)\hat{i} + (2-(-1))\hat{j} + (1-(-1))\hat{k}$

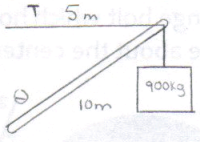
$r = 3\hat{j} + 2\hat{k}$

$$\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} & \hat{i} \\ 0 & 3 & 2 & 0 \\ 70.3 & 11.7 & 46.9 & 70.3 \end{vmatrix}$$

$M = [3(46.9) - 11.7(2)]\hat{i} + [2(70.3) - 0]\hat{j} + [0 - 70.3(3)]\hat{k}$

$\boxed{M = 117.3\hat{i} + 140.6\hat{j} - 210.9\hat{k}}$ Nm

3. A boom which is 10 m in length supports a mass ***M*** = 900 kg. The mass is connected to a chord which is in turn fastened on a wall 5 m away. Find the tension in the chord and the force on the boom.



$\theta = \sin^{-1}\left(\frac{5}{10}\right)$

$\theta = 30°$

$w = \sqrt{10^2 - 5^2}$

$w = 8.7m$

$\Sigma M_p = T_w - F_g L = 0$

T: tension
w: width
Fg: weight of mass
L: length

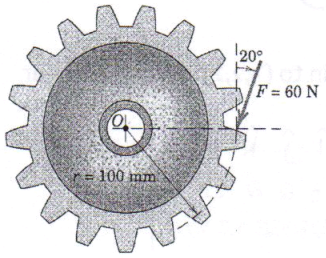
$F_g L = T_w$

$\frac{F_g L}{w} = T$

$\frac{900kg(9.81 m/s^2)(5m)}{8.7m} = T$

$5074N = T$

4. A force **F** of magnitude 60 N is applied to the gear. Determine the moment of **F** about point O.



$\Sigma M_o = F_y r$

$M_{NET} = -60\cos 20°\,(0.1m)$

$M_{NET} = -5.64\,Nm$

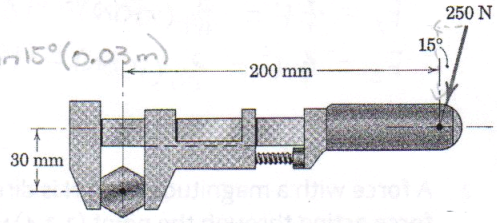
5.64 Nm Clockwise

5. Calculate the moment of the 250 N force on the handle of the monkey wrench about the center of the bolt.

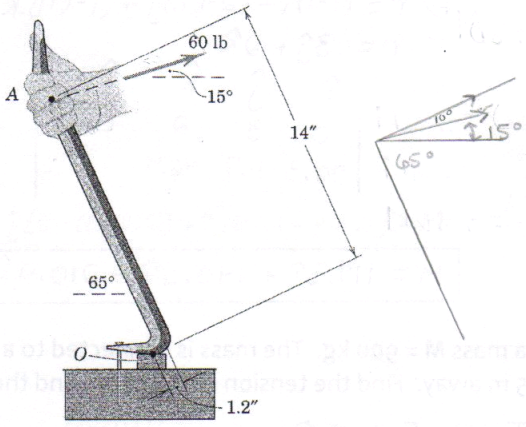
$\Sigma M_C = F_y r$

$\Sigma M_C = 250\cos 15°\,(0.2m) + 250\sin 15°\,(0.03m)$

$M_{NET} = 50.2\,Nm$



6. A prybar is used to remove a nail as shown. Determine the moment of the 60-lb force about the point O of contact between the prybar and the small support block.



$M_o = F_y d_x + F_x d_y$

$M_o = -(60lb\sin 10°)1.2in - (60lb\cos 10°)14in$

$M_o = -839.7\,lbin$

$M_o = -70\,lbft$

$X = 450\cos 20 - 68.5 = 360.4$

7. A force of 200 N is applied to the end of the wrench to tighten a flange bolt which holds the wheel to the axle. Determine the moment ***M*** produced by this force about the center O of the wheel for the position of the wrench shown.

$M_o = Fd$ $\quad 23 - 20 = 3$

$M_o = 200N\,(391.85\cos 3°)$

$M_o = 78.25Nm$

$\tan^{-1}\left(\frac{153}{360}\right) = \theta$

$23° = \theta$

$y = 450\sin 20$