Cross Products

$$\bar{A} \times \bar{B} = |\bar{A}||\bar{B}| \sin\theta$$

$$|\bar{A}| = \sqrt{A_x^2 + A_y^2 + A_z^2}$$

$$\bar{A} \times \bar{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ A_x & A_y & A_z \\ B_x & B_y & B_z \end{vmatrix}$$

$\bar{A} = A_x\hat{i} + A_y\hat{j} + A_z\hat{k}$

$\bar{B} = B_x\hat{i} + B_y\hat{j} + B_z\hat{k}$

$$= \hat{i}(A_yB_z - A_zB_y) - \hat{j}(A_xB_z - A_zB_x) + \hat{k}(A_xB_y - A_yB_x)$$

$$\bar{A} \times \bar{B} \neq \bar{B} \times \bar{A}$$

$$\bar{A} \times \bar{B} = -\bar{B} \times \bar{A}$$

$$\bar{A} \times (\bar{B} + \bar{C}) = \bar{A} \times \bar{B} + \bar{A} \times \bar{C}$$

- Solution to a cross product is a vector perpendicular to the other two vectors.

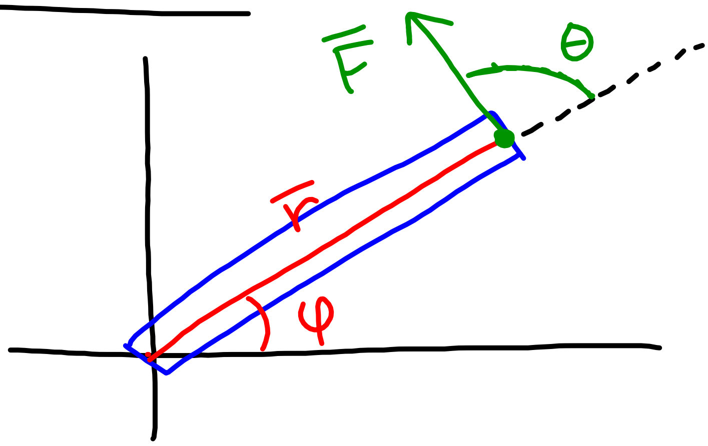
PRACTICE - CROSS PRODUCTS AND ROTATIONAL STATICS

1) $\hat{i} - 3\hat{j} + 2\hat{k}$ and $5\hat{i} - \hat{j} - 4\hat{k}$

$$\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & -3 & 2 \\ 5 & -1 & -4 \end{vmatrix} = \hat{i}\left[(-3)(-4) - (2)(-1)\right] - \hat{j}\left[(1)(-4) - (2)(5)\right] + \hat{k}\left[(1)(-1) - (-3)(5)\right]$$

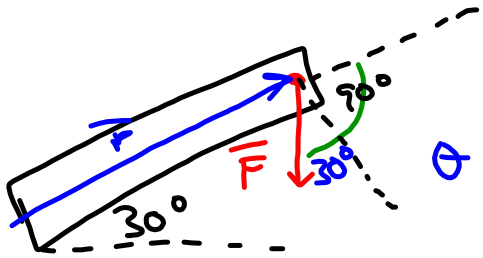
$$= 14\hat{i} + 14\hat{j} + 14\hat{k}$$

TORQUE

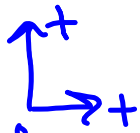


θ is measured ccw from dashed line that extends radially from $\bar{r}$

4)



$\theta = -120°$



ccw +

$$\tau = |\bar{r}||\bar{F}| \sin\theta$$

$$= (0.2\,m)(100\,N)\sin(-120°)$$

$$= -17\,N \cdot m$$

- Net Torque:

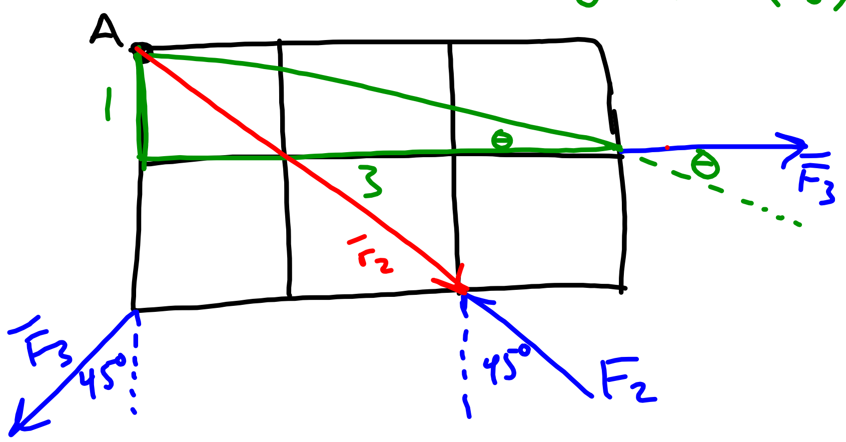
$$\sum \bar{\tau} = \bar{\tau}_1 + \bar{\tau}_2 + \bar{\tau}_3 + \dots$$

TIPERs

- B6-QRTØ7

A)

$\theta = \tan^{-1}\left(\frac{1}{3}\right)$



$$\sum \bar{\tau} = \bar{\tau}_1 + \bar{\tau}_2 + \bar{\tau}_3$$

$$= |\bar{r}_1||\bar{F}_1|\sin\theta_1 + |\bar{r}_2||\bar{F}_2|\sin\theta_2 + |\bar{r}_3||\bar{F}_3|\sin\theta_3$$

$$= (2)(F)\sin(-45°) + \cancel{(2\sqrt{2})(F)\sin(180°)} \rightarrow \emptyset$$

$$+ (\sqrt{10})(F)\sin(18.44)$$

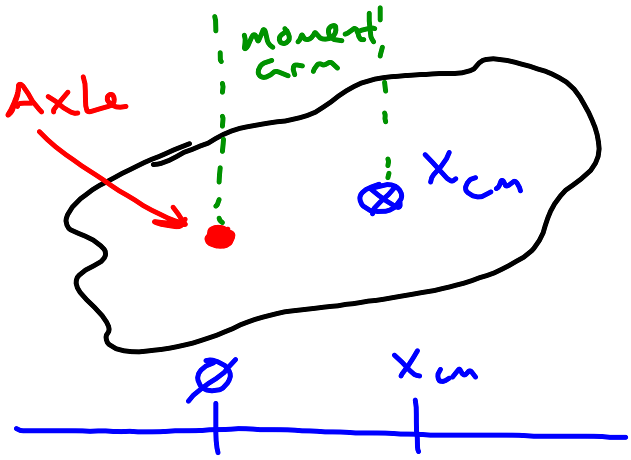
$$= (-0.414)F$$

negative means clockwise!

B. Zero

C. Zero

GRAVITATIONAL TORQUE



$$\tau = -M a_g x_{cm}$$