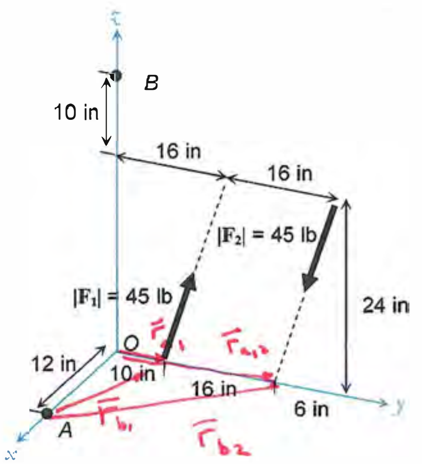
Example

Two forces, each of magnitude 45 lb, are directed as shown in the figure.

a) Find the resultant moment due to both forces about the origin, O.
b) Find the resultant moment due to both forces about the point A.
c) Find the resultant moment due to both forces about the point B.



a) $\vec{F}_1 = F_1 \hat{e}_{F_1}$

$= 45 \frac{(6\hat{j} + 24\hat{k})}{\sqrt{6^2 + 24^2}}$

$= 45(0.2425\,\hat{j} + 0.9701\,\hat{k})$

$= 10.91\,\hat{j} + 43.65\,\hat{k}$ lb

$\vec{F}_2 = F_2 \hat{e}_{F_2}$

$= \ldots\ 45(-0.2425\,\hat{j} - 0.9701\,\hat{k})$

$= -10.91\,\hat{j} - 43.65\,\hat{k}$ lb

$\vec{M}_o = \vec{r}_{a1} \times \vec{F}_1 + \vec{r}_{a2} \times \vec{F}_2 = (10\hat{j}) \times (10.91\,\hat{j} + 43.65\,\hat{k})$ in-lb

$+ (26\hat{j}) \times (-10.91\,\hat{j} - 43.65\,\hat{k})$ in-lb

$= (10)(43.65)\,\hat{j}\times\hat{k} - (26)(43.65)\,\hat{j}\times\hat{k}$

$= \boxed{-698\,\hat{i}\ \text{in-lb}}$

b) $\vec{M}_A = \vec{r}_{b1} \times \vec{F}_1 + \vec{r}_{b2} \times \vec{F}_2 = (-12\hat{i} + 10\hat{j})\text{in} \times (10.91\hat{j} + 43.65\hat{k})$

$+ (-12\hat{i} + 26\hat{j}) \times (-10.91\hat{j} - 43.65\hat{k})$

$$= \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ -12 & 10 & 0 \\ 0 & 10.91 & 43.65 \end{vmatrix} + \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ -12 & 26 & 0 \\ 0 & -10.91 & -43.65 \end{vmatrix}$$

$$= (10)(43.65)\,\hat{i} - [(-12)(43.65) - 0]\,\hat{j} + [(-12)(10.91) - 0]\,\hat{k}$$

$$+ (26)(-43.65)\,\hat{i} - [(-12)(-43.65) - 0]\,\hat{j} + [(-12)(-10.91) - 0]\,\hat{k}$$

$$= \boxed{-698\,\hat{i} \text{ in-lb}}$$

c) NOT GONNA' DO IT AGAIN! I AM CONVINCED I WILL GET SAME ANSWER.

d) FIND SHORTEST DISTANCE BETWEEN LINES.

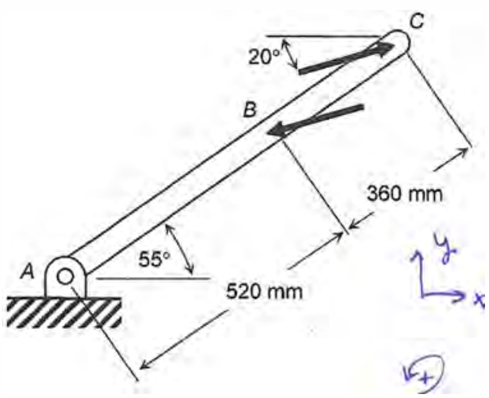
$$M_{COUPLE} = (d_{\perp})\,F$$

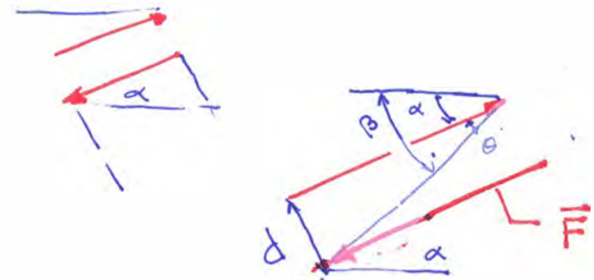
$$= 698 \text{ in-lb} = d_{\perp}\,(45 \text{ lb})$$

$$\boxed{d_{\perp} = 15.5 \text{ in}}$$

Example

Two parallel and oppositely directed forces, each of magnitude 60 N, (and therefore a COUPLE!) are applied to the lever as shown in the figure. Find the moment due to the forces about point A.





$M_A = -dF$

$d = \sin\theta\,(BC)$ $\qquad \theta = \beta - \alpha = 55° - 20° = 35°$

$= \sin(35°)(360\text{ mm})$

$= 206.5\text{ mm}$

$M_A = -(0.2065\text{ m})(60\text{ N})$

$= -12.4\text{ N m}$

$\boxed{\vec{M}_A = 12.4\text{ N}\cdot\text{m}}$ (clockwise)

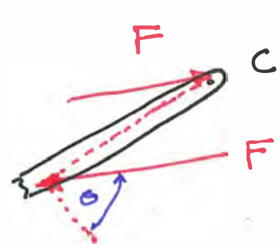
OR TAKE MOMENT ABOUT C.

$M_C = M_A$ ('CUZ IT'S A COUPLE)

$= -(BC)[F\sin\theta]$

$= -(360\text{ mm})[60\text{ N}\cdot\sin(35°)]$

$= -12.4\text{ N}\cdot\text{m}$



SAME! (AS IT SHOULD BE)