Lec08

Monday, September 28, 2020 7:57 AM

Lecture Objectives

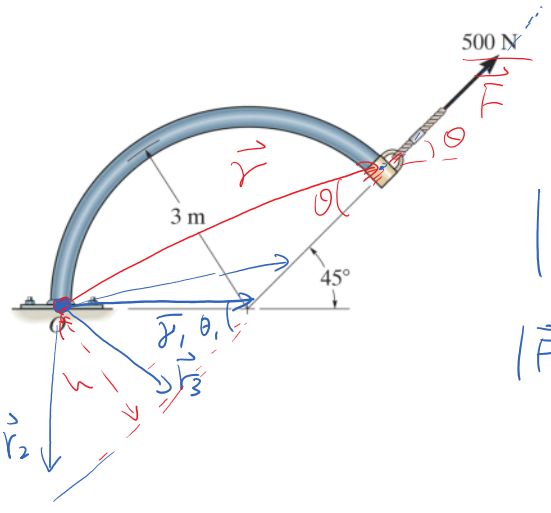
- Moment about a point
- Couple moments

- Equivalent systems

1

Moment about a Point from a Force

To find the moment about point O by the 500 N force shown below, what is the position vector that represents the moment arm?



$\vec{M}_o = \vec{r} \times \vec{F}$

$|\vec{M}_o| = |\vec{r}| \cdot |\vec{F}| \cdot \sin\theta$

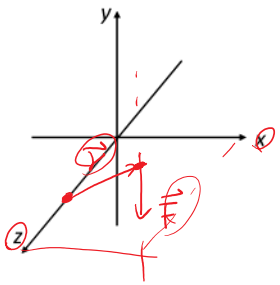
$= |\vec{F}| \cdot h$

$|\vec{r}_1 \times \vec{F}| = |\vec{M}_o|$

$|\vec{F}| \cdot h = |\vec{M}_o|$

Determine the direction of a moment

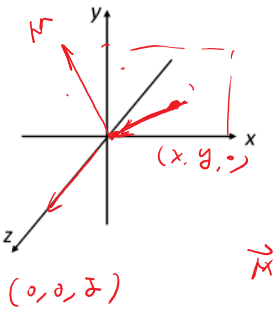
If force vector **F** is on the *xz*-plane, what is the direction of the moment vector about a point on the *z*-axis?



$\hat{j}$

i-Clicker

If force vector **F** goes along the *z*-axis, what is(are) the direction component(s) of the moment vector about a point on the *xy*-plane?



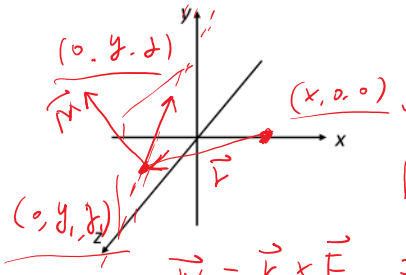
(A) **i**
(B) **j**
(C) **k**
(D) **i** and **j**
(E) **j** and **k**

$\vec{M} = \vec{r} \times \vec{F}$

$\vec{M} = \begin{vmatrix} i & j & k \\ -x & -y & 0 \\ 0 & 0 & z \end{vmatrix} = -yz\,\hat{i} + xz\,\hat{j} + 0\,\hat{k}$

i-Clicker

If force vector **F** is on the *yz*-plane, what is the direction of the moment vector about a point on the *x*-axis?



(A) **i**
(B) **i** and **j**
(C) **j** and **k**
(D) **i** and **k**
(E) **i, j** and **k**

$\vec{M} = \vec{r} \times \vec{F} = \begin{vmatrix} i & j & k \\ -x & y_1 & z_1 \\ 0 & y & z \end{vmatrix}$ $\vec{r} = (-x, y_1, z_1)$

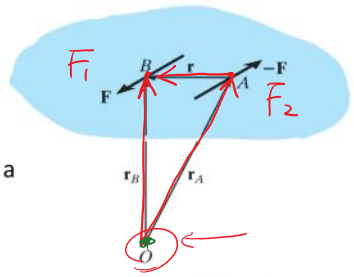
Moment of a couple

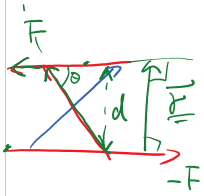
A **couple** is defined as two parallel forces that have the same magnitude, but opposite directions, and are separated by a perpendicular distance d.

Since the resultant force is zero, the only effect of a couple is to produce an actual rotation, or if no movement is possible, there is a tendency of rotation in a specified direction.

The moment produced by a couple is called **couple moment**.

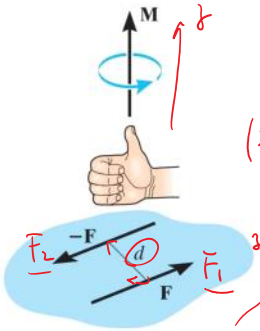
Let's determine the sum of the moments of both couple forces about **any** arbitrary point:





$\vec{M} = \vec{r} \times \vec{F}$

$|\vec{M}| = |\vec{r}| \cdot |\vec{F}| \sin\theta = |\vec{F}| \cdot d$



$|F_1| = |F_2|$

$\vec{F}_1 = -\vec{F}_2$

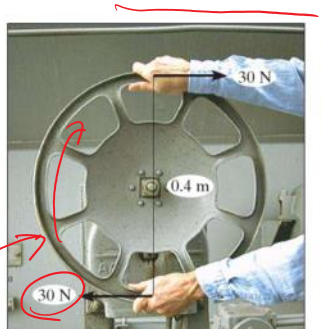
$\sum F_x = 0$

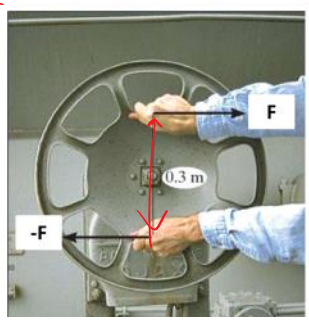
$\sum F_y = 0$

$\vec{M} = \vec{r}_B \times \vec{F}_1 + \vec{r}_A \times \vec{F}_2$

$\vec{r}_B \times \vec{F} - \vec{r}_A \times \vec{F}$

$(\vec{r}_B - \vec{r}_A) \times \vec{F} = \vec{r} \times \vec{F}$

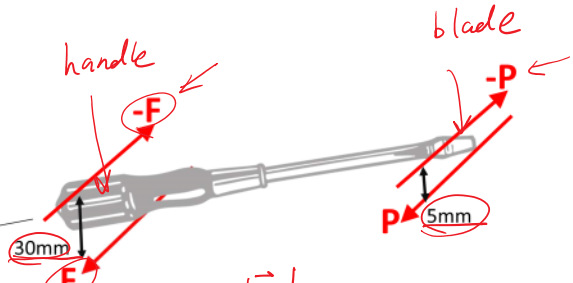




A torque or moment of 12 N·m is required to rotate the wheel. Would F be greater or less than 30 N?

$|\vec{M}| = |\vec{F}| d = 30 \times 0.4 = 12\ N.m$

A twist of 4 N-m is applied to the handle of the screwdriver. Resolve this couple moment into a pair of couple forces **F** exerted on the handle and **P** exerted on the blade.



$|\vec{M}| = |\vec{F}| d = 4\ N.m$

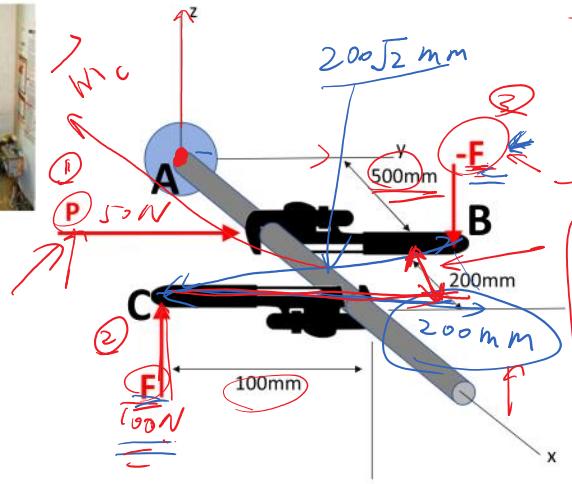
$d_h = 0.03\ m$

$d_b = 0.005\ m$

$|\vec{F}|$

$|\vec{P}| >> |\vec{F}|$

Find the moment about the support at *A*? F = 100 N, P = 50 N.



$\vec{M} = \vec{M}_1 + \vec{M}_2 + \vec{M}_3$

$\vec{M}_1 = \vec{r}_1 \times \vec{P}$

$\vec{M} = M_x \hat{i} + M_y \hat{j} + M_z \hat{k}$

$= -|\vec{F}| d \hat{i} - |\vec{F}| d \hat{j} + |\vec{P}||\vec{r}| \hat{k}$

200mm 200mm 500mm