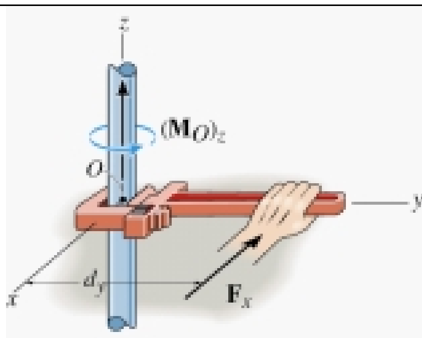
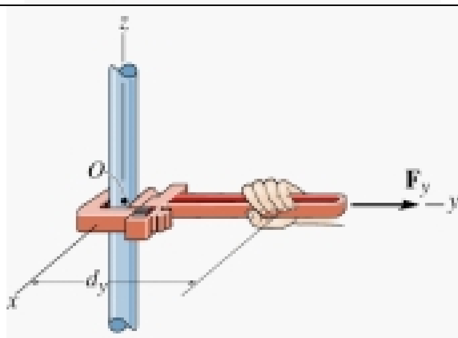
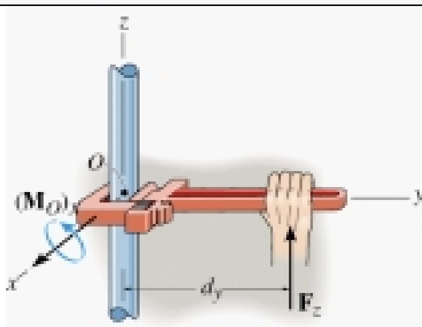
Forces and Moments: Part 1

Moment of Force F around point O: $\mathbf{M}_O$

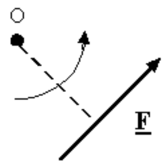
The moment of a force about a point or an axis provides a measure of the tendency of the force to cause a body to rotate about the point or axis.

oz ⊥ plane xoy in which F_x lies F_x causes the pipe to turn about the z-axis F_x causes a moment about the z-axis = $(Mo)_z$	
F_y passes through O F_y does not cause the pipe to turn because the line of action of the force passes through O.	
ox ⊥ plane zoy in which F_z lies F_z causes the pipe to turn about the x-axis F_z causes a moment about the x-axis $(Mo)_x$	

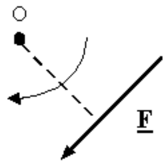
Direction of the moment:

The direction of M_o would be specified by using the right hand rule.

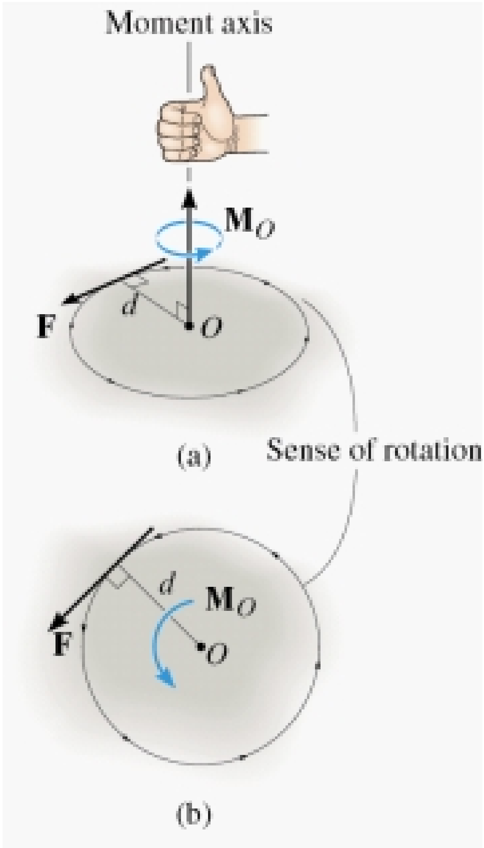
Counter Clockwise (CCW) is out of the page, Clockwise (CW) is into the page.



CCW-out of the page



CW-into the page



Magnitude of the moment:

$|M_o|=Fd$

Calculating the moment in 2-D using components:

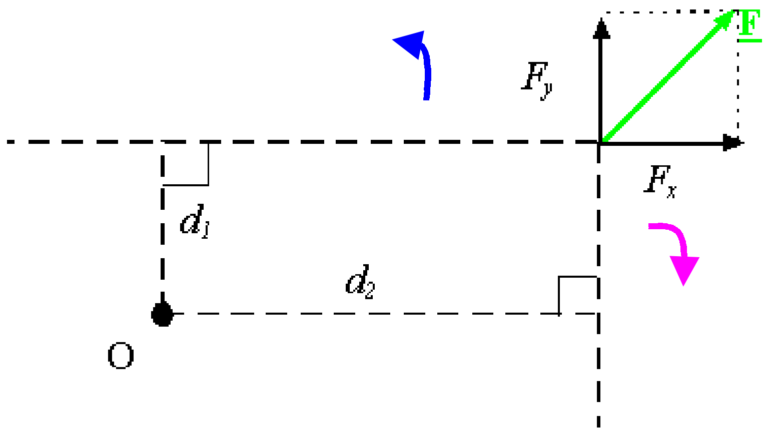
1) Select a positive direction (CCW or CW),
2) Calculate each moment and add them, using the proper sign for each term,
3) Always remember to write the unit of moment which is Nm.

Example:

In the following figure, calculate the moment about the point O:

1) We choose the CCW as positive direction for moment,
2) Moment of component of ***F*** along *x* about O is Fx times the perpendicular distance from O (or $d1$), which is clockwise, so it is $-F_x d_1$
3) Moment of component of ***F*** along *y* about O is Fy times the perpendicular distance from O (or $d2$), which is counter clockwise, so it is $F_y d_2$
4) Moments add together as vectors, so the total moment is:

$$M_o = -F_x d_1 + F_y d_2$$



Example:

In the following figure, if θ is 60 degrees and ***r*** is 30 mm and ***F*** is 6 N, what is the magnitude of the moment about O.

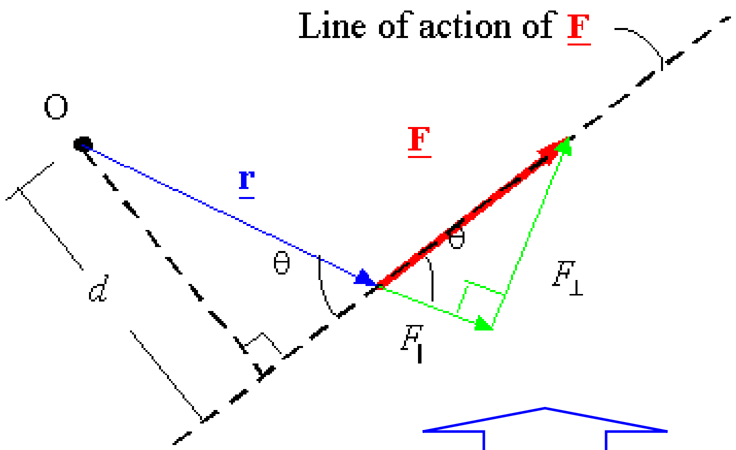
1) We choose the CCW as positive direction for moment,
2) Component of ***F*** along ***r*** (or $F_{||}$) produces no moment, since it passes from point O.
3) Component of ***F*** perpendicular to ***r*** (or $F_{\perp} = F\sin\theta$)

   produces the moment $Fr\sin\theta$.

If a force passes through a point, it produces no moment about that point!

So the total moment of F about O is:

$$M_O = F_{\perp}r = (F\sin\theta)r = 6\times\sin 60\times.03 = .156 \text{ Nm}.$$



Note: moving a force along its line of action does not change its moment

Remember:
The moment about O is also calculated using the magnitude of force ***F*** times perpendicular distance from O to the line of action of ***F*** which is d:

$d = r\sin\theta$

$M_O = Fd = F(r\sin\theta) = 6\times.03\times\sin 60 = .156 \text{ Nm}.$