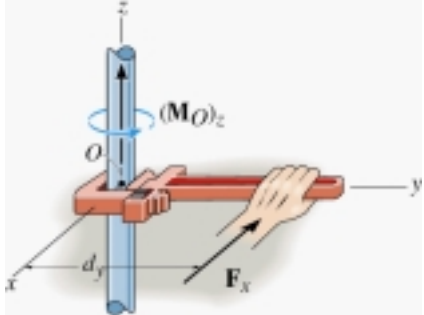
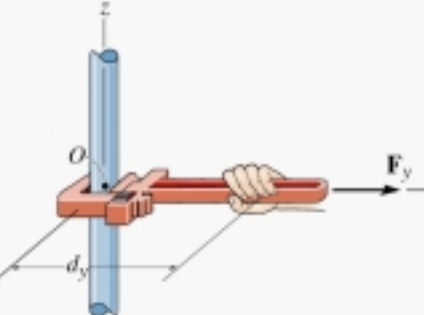
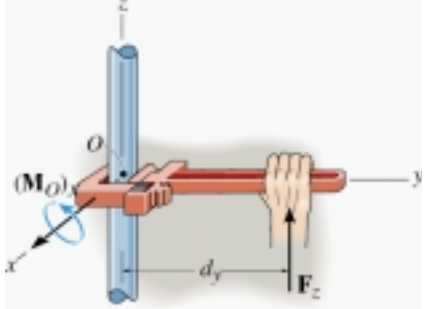


Forces and Moments: Part 1

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

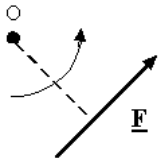
The moment of a force about a point or an axis provides a measure of the tendency of the force to cause a body to rotate about the point or axis.

<p>$oz \perp$ plane xoy in which F_x lies</p> <p>F_x causes the pipe to turn about the z-axis</p> <p>F_x causes a moment about the z-axis = $(M_o)_z$</p>	 <p>The diagram shows a vertical blue pipe along the z-axis. A red horizontal bar is attached to the pipe at point O. A force F_x is applied to the bar, pointing in the positive x-direction. The perpendicular distance from the z-axis to the line of action of F_x is labeled d_y. A blue curved arrow around the z-axis indicates the resulting moment $(M_o)_z$.</p>
<p>F_y passes through O</p> <p>F_y does not cause the pipe to turn because the line of action of the force passes through O.</p>	 <p>The diagram shows the same setup as the first diagram. A force F_y is applied to the red bar, pointing in the positive y-direction. The line of action of F_y passes through point O on the z-axis. The distance d_y is shown, but no moment is indicated.</p>
<p>$ox \perp$ plane zoy in which F_z lies</p> <p>F_z causes the pipe to turn about the x-axis</p> <p>F_z causes a moment about the x-axis $(M_o)_x$</p>	 <p>The diagram shows the same setup. A force F_z is applied to the red bar, pointing in the positive z-direction. The perpendicular distance from the x-axis to the line of action of F_z is labeled d_y. A blue curved arrow around the x-axis indicates the resulting moment $(M_o)_x$.</p>

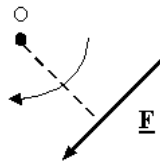
Direction of the moment:

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.



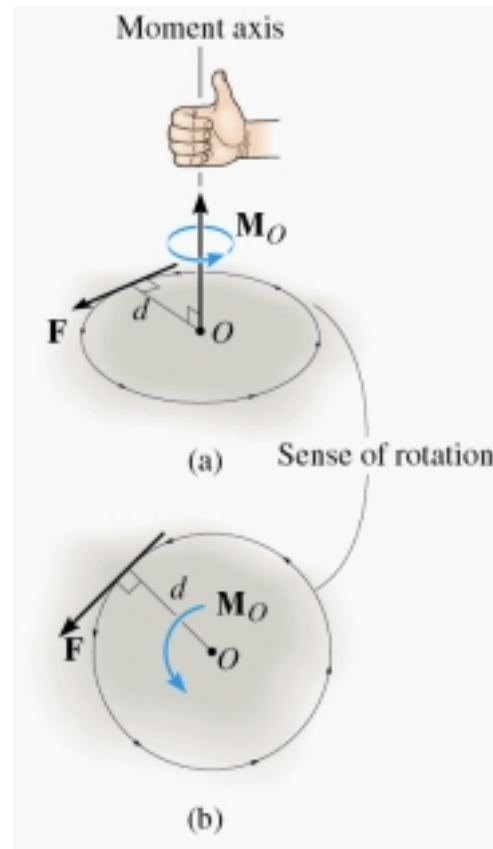
CCW-out of the page



CW-into the page

Magnitude of the moment:

$$|M_o| = Fd$$



Calculating the moment in 2-D using components:

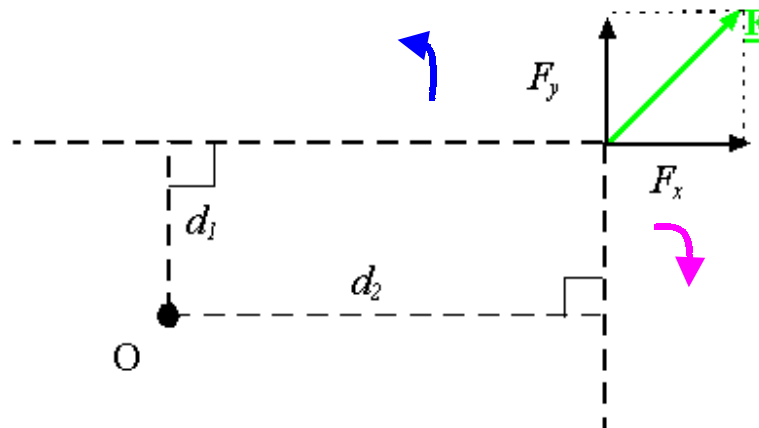
- 1) Select a positive direction (CCW or CW),
- 2) Calculate each moment and add them, using the proper sign for each term,
- 3) Always remember to write the unit of moment which is Nm.

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 F_x times the perpendicular distance from O (or d_1), which is clockwise, so it is $-F_x d_1$
- 3) Moment of component of F along y about O is F_y times the perpendicular distance from O (or d_2), 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.

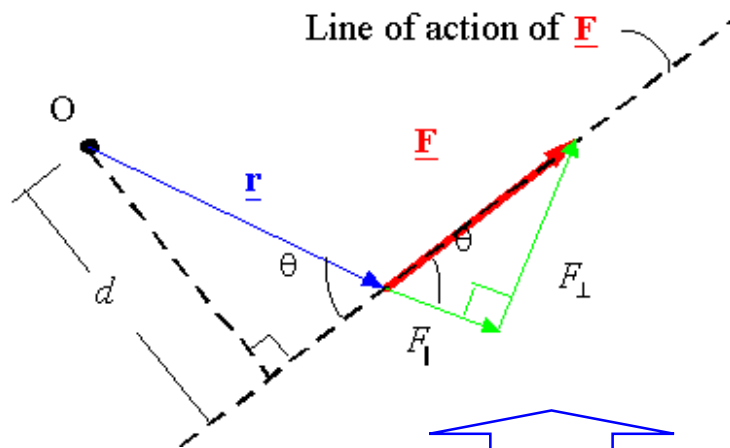
- 1) We choose the CCW as positive direction for moment,
- 2) Component of F along r (or F_{\parallel}) produces no moment, since it passes from point O.
- 3) Component of F perpendicular to r (or $F_{\perp} = F \sin \theta$)

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 :

$$d = r \sin \theta$$

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