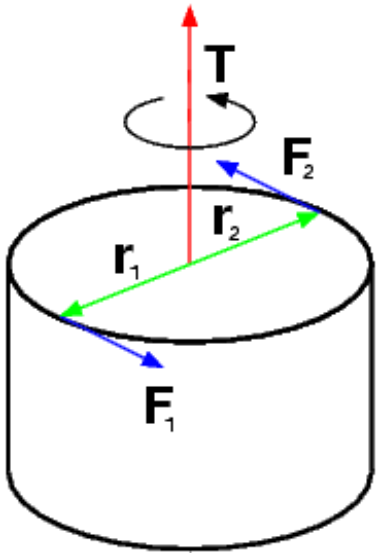
Statics - TAM 211

Lecture 9

October 8, 2018

Announcements

- Upcoming deadlines:
  - Tuesday (10/9)
    - Prairie Learn HW3
  - Friday (10/12)
    - Written Assignment 3



https://fr.wikipedia.org/wiki/Couple_(physique)

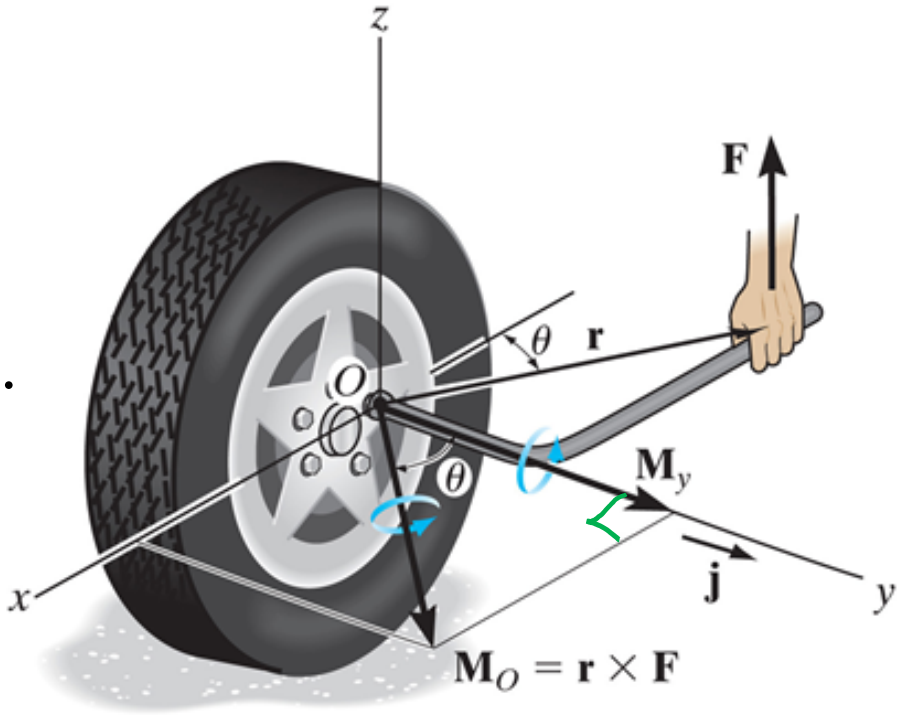
Chapter 4: Force System Resultants

Goals and Objectives

- Discuss the concept of the moment of a force and show how to calculate it in two and three dimensions
- How to find the moment about a specified axis
- Define the moment of a couple
- Finding equivalence force and moment systems
- Reduction of distributed loading

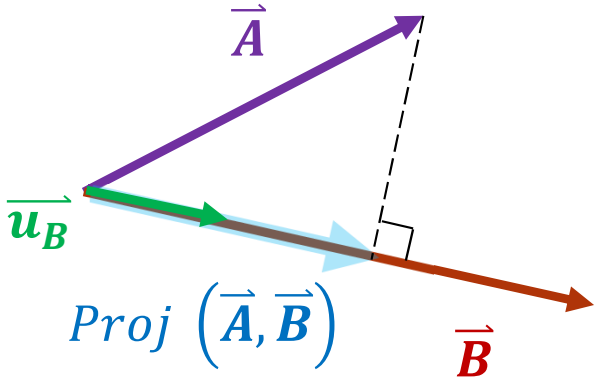
Recap: Moment of a force about a specified axis

A force is applied to the tool as shown. Find the magnitude of the moment of this force about the *y*-axis.



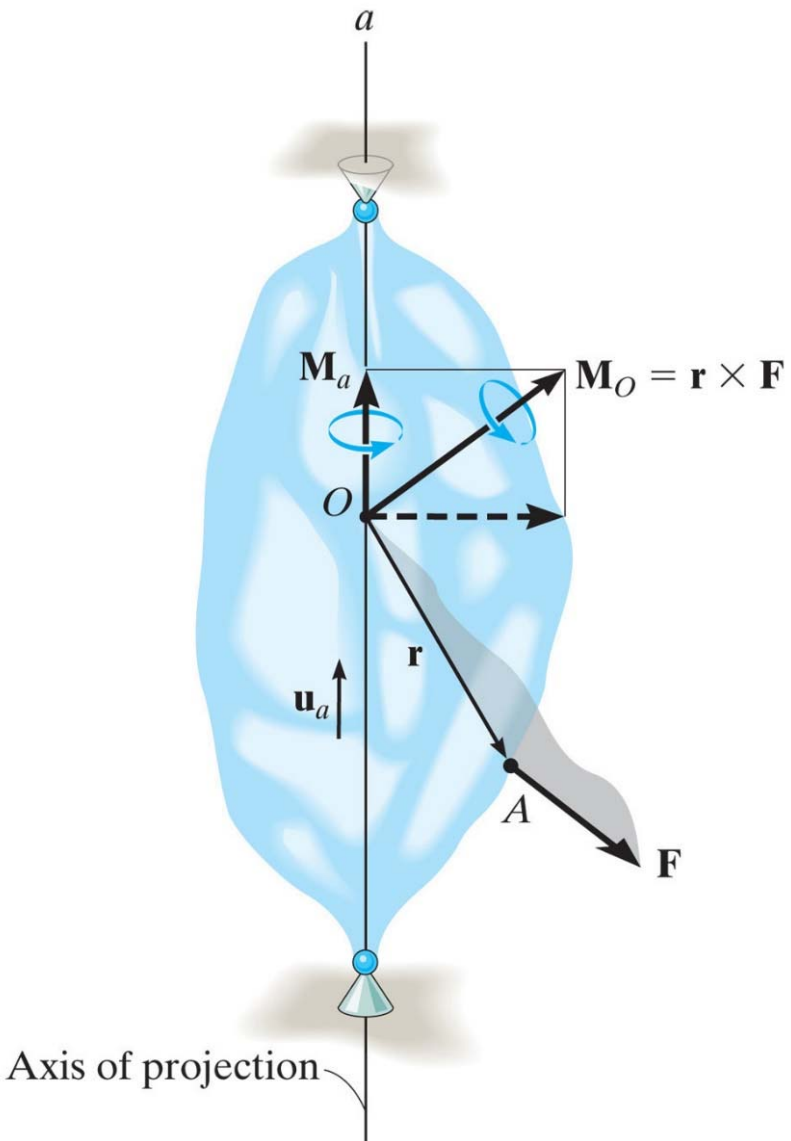
Recall: the projected component of a vector, $\vec{A}$, along the direction of another, $\vec{B}$, can be determined using the dot product.

$$Proj\ \left(\vec{A}, \vec{B}\right) = \left(\vec{A} \cdot \overrightarrow{u_B}\right) \overrightarrow{u_B}$$



Recap: Moment of a force about a specified axis (Scalar Triple Product)

The magnitude of the projected moment about any generic axis a can be computed using the scalar triple product:



$$\left|\overrightarrow{\boldsymbol{M_a}}\right| = \overrightarrow{\boldsymbol{M_o}} \cdot \overrightarrow{\boldsymbol{u_a}}$$

$$= \overrightarrow{\boldsymbol{u_a}} \cdot \left(\vec{\boldsymbol{r}} \times \vec{\boldsymbol{F}}\right)$$

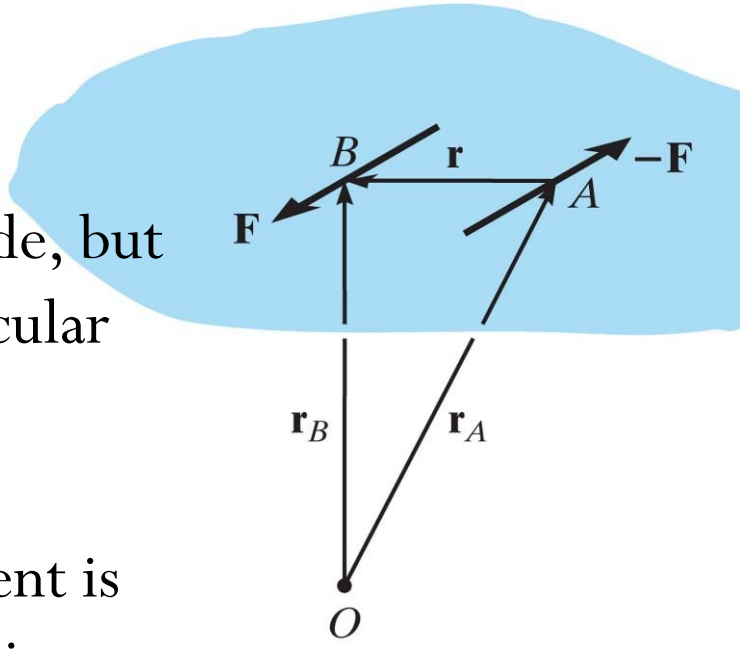
$$= \begin{vmatrix} u_{a_x} & u_{a_y} & u_{a_z} \\ r_x & r_y & r_z \\ F_x & F_y & F_z \end{vmatrix}$$

The direction of the projected moment about any generic axis a can be defined using :

$$\overrightarrow{\boldsymbol{M_a}} = \left|\overrightarrow{\boldsymbol{M_a}}\right| \overrightarrow{\boldsymbol{u_a}}$$

where $\overrightarrow{\boldsymbol{u_a}}$ is the unit vector along axis a

Moment of a couple

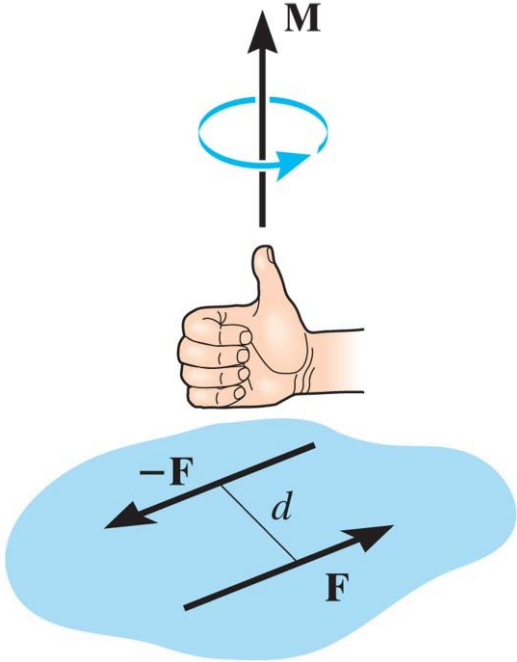


Couple: two parallel forces that have same magnitude, but opposite directions, and are separated by a perpendicular distance *d*.

- Resultant force is zero.
- Couple produces actual rotation, or if no movement is possible, tendency of rotation in a specified direction.

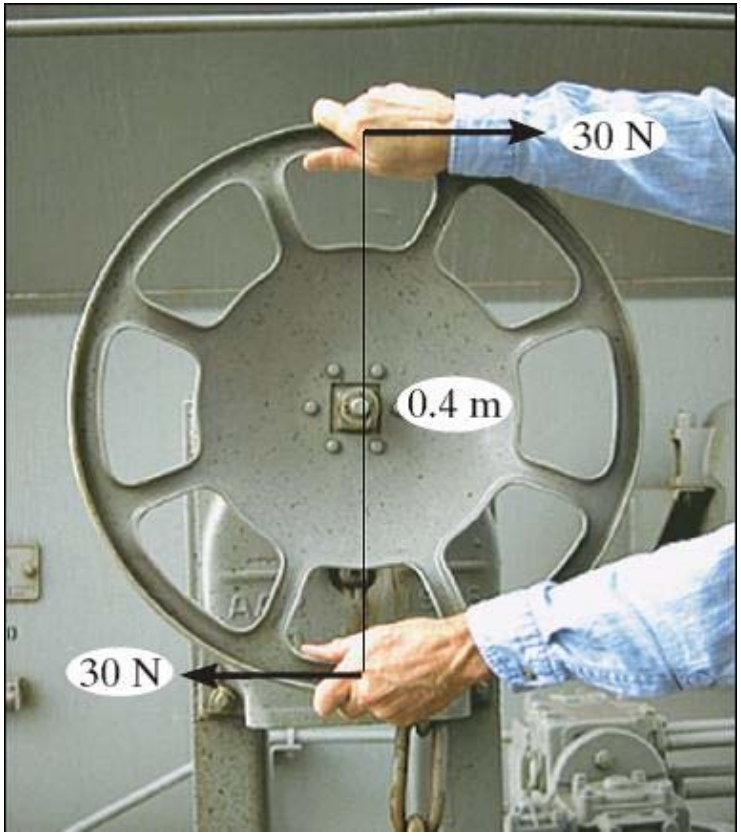
Moment produced by a couple is called **couple moment**.

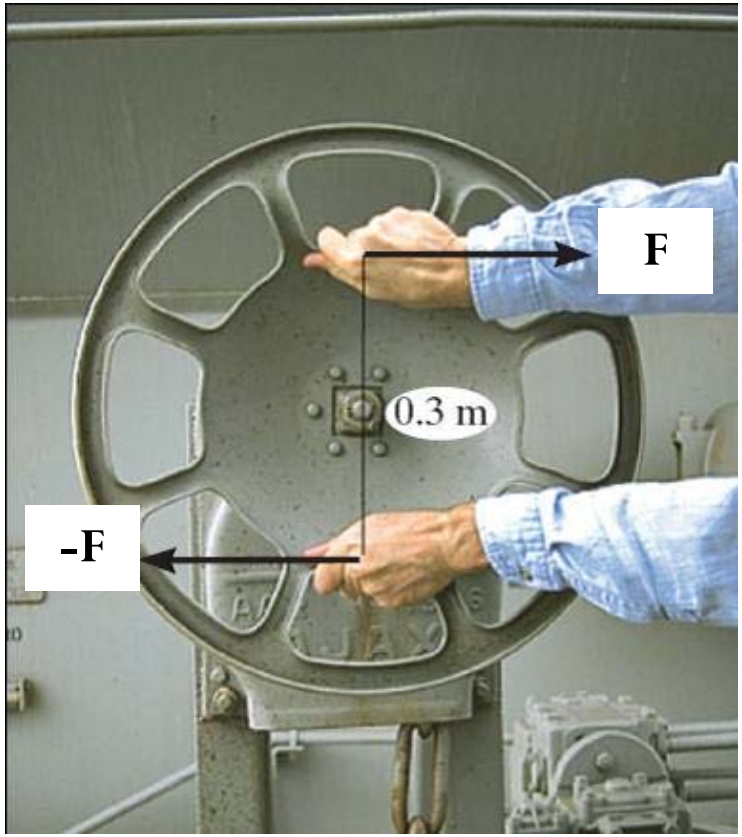
Sum of moments of both couple forces about **any** arbitrary point:



Couple moment is a **free vector**, i.e. is **independent** of the choice of O!

Equivalent couples



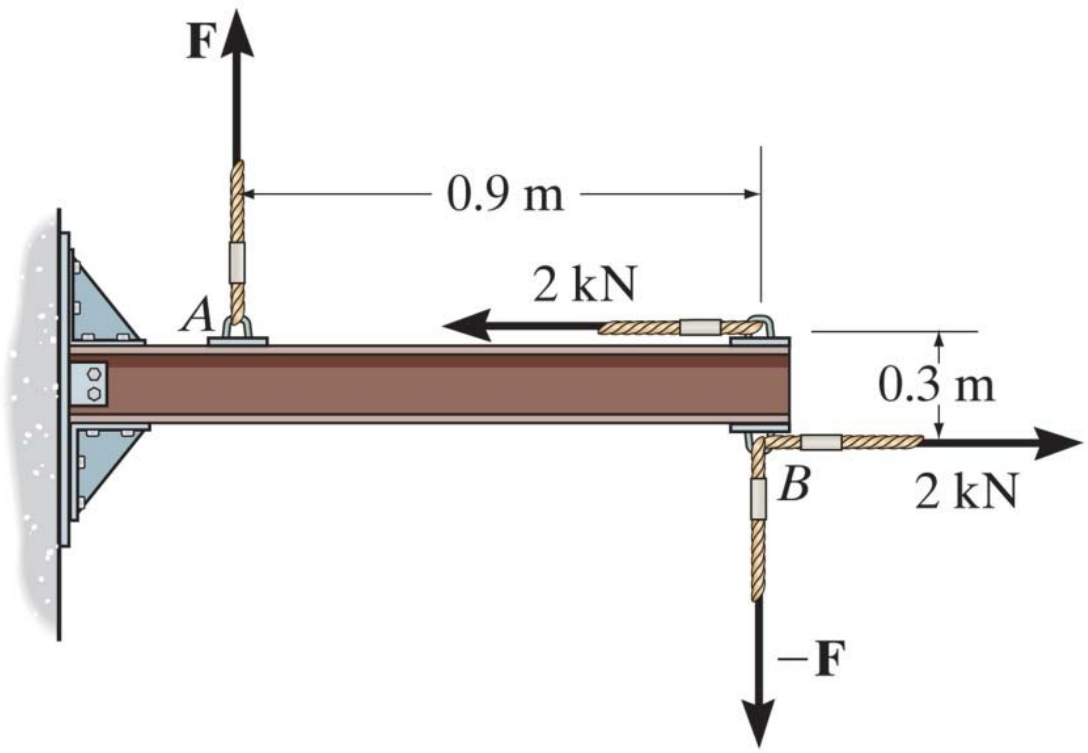


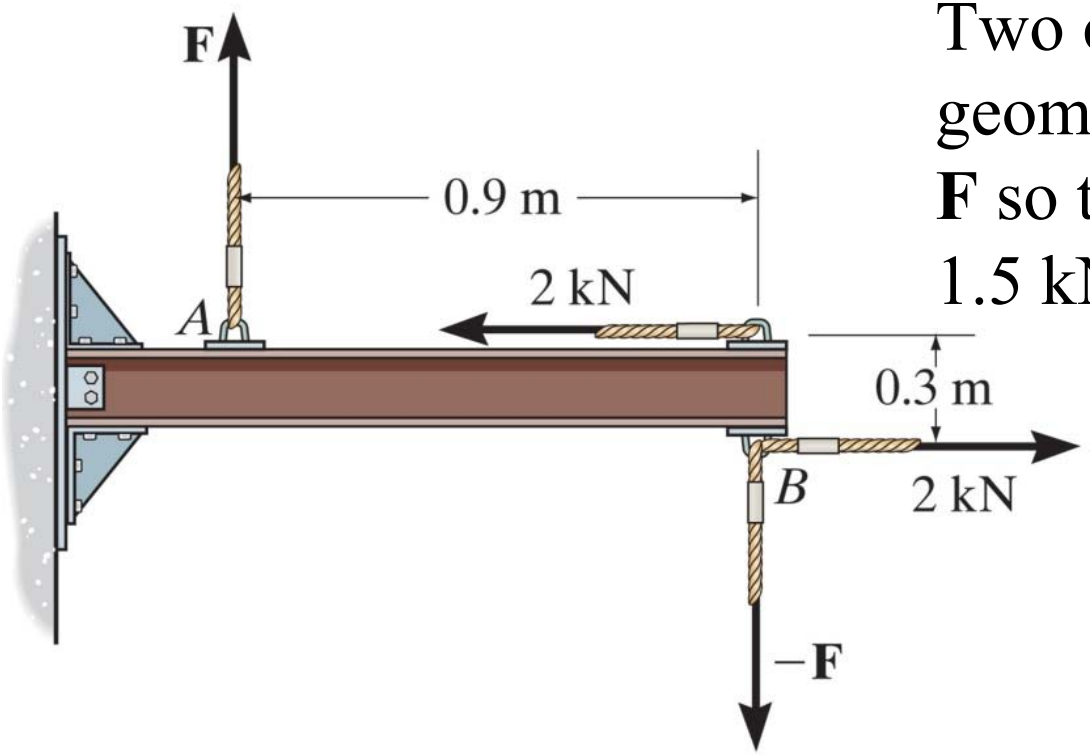
A torque or moment of 12 N·m is required to rotate the wheel.

Would F be greater or less than 30 N?

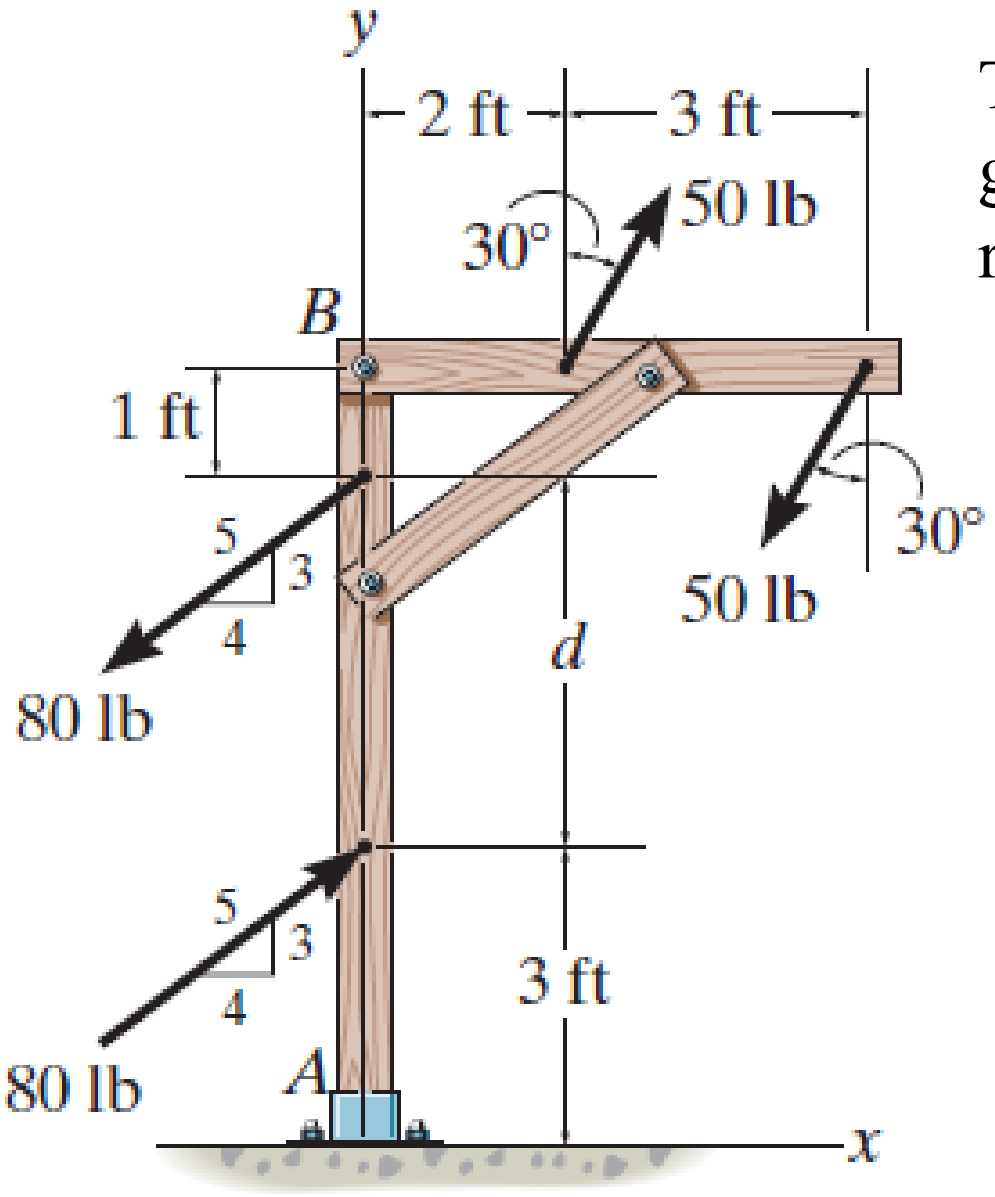
Resultant Couple Moment

Since couple moments are vectors, their resultant is due to vector addition:





Two couples act on the beam with the geometry shown. Find the magnitude of **F** so that the resultant couple moment is 1.5 kN·m clockwise.



Two couples act on the beam with the geometry shown and d = 4 ft. Find the resultant couple