

Statics - TAM 211

Lecture 16

October 31, 2018

Announcements

□ Upcoming deadlines:

- **Friday (11/2) all in Teaching Building A418-420**
 - 8:00 am: Quiz 3, Chapter 5. On paper.
 - 9:00 am: Lecture 17
 - 10:00 am: Discussion section for ALL students
- Friday (11/2)
 - Written Assignment 6
- Tuesday (11/6)
 - Prairie Learn HW7

Happy Halloween



Chapter 5: Equilibrium of Rigid Bodies

Goals and Objectives

- Introduce the free-body diagram for a rigid body
- Develop the equations of equilibrium for a 2D and 3D rigid body
- Solve rigid body equilibrium problems using the equations of equilibrium in 2D and 3D

- Introduce concepts of
 - Support reactions for 2D and 3D bodies
 - Two- and three-force members
 - Constraints and statical determinacy

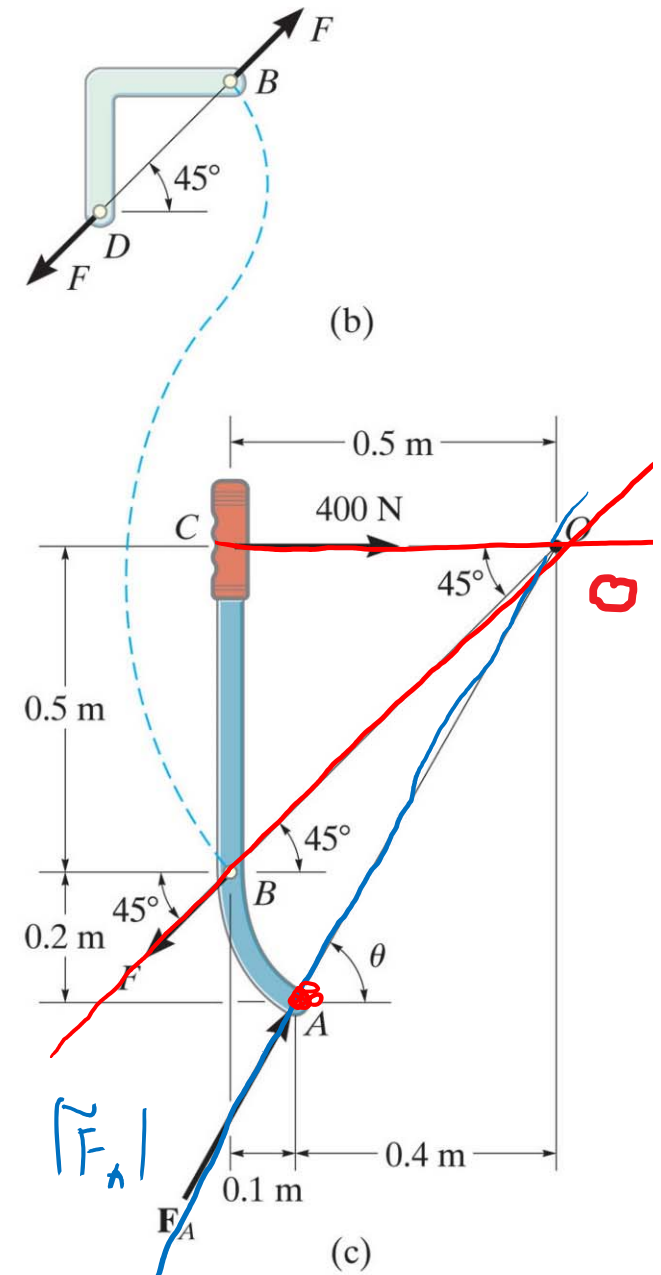
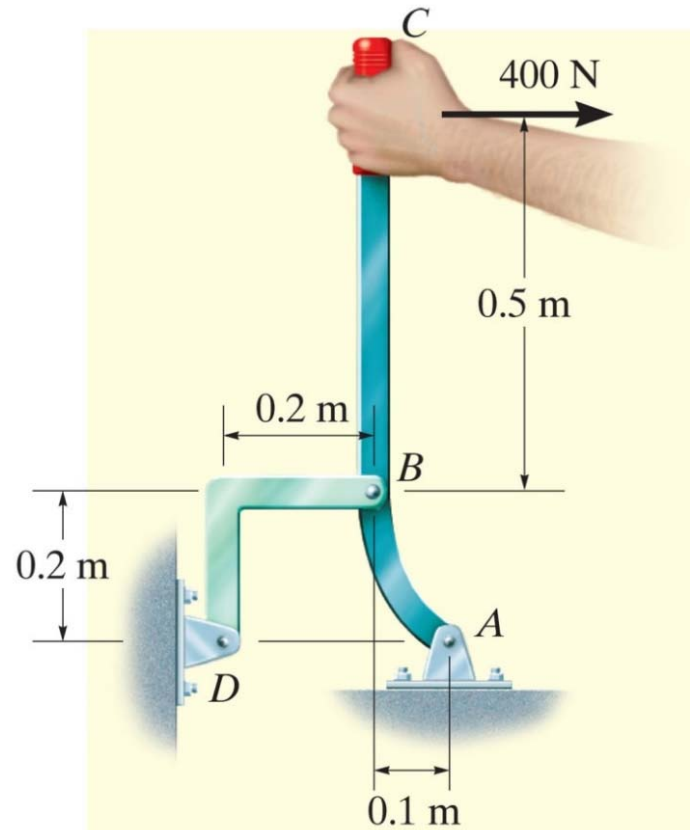
Two-force and three-force members

One can use these concepts to quickly identify the direction of an unknown force.


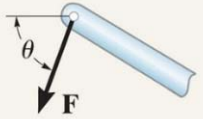
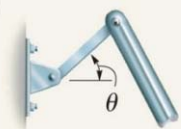
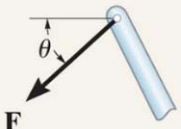
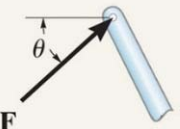

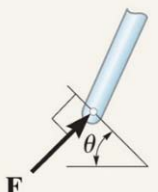

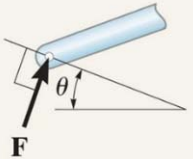
Two-force member: (2FM)
 the two forces at ends are equal, opposite, collinear

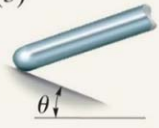
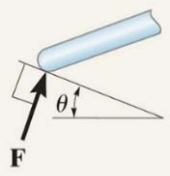
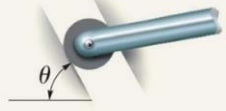
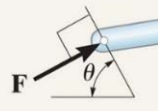
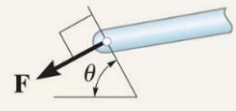

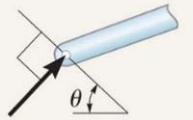
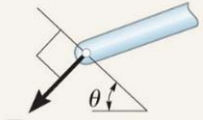
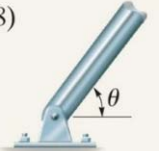
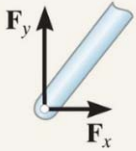
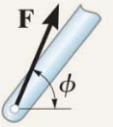

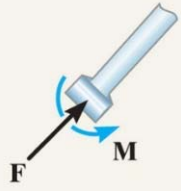

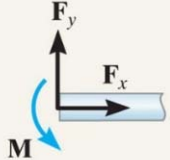
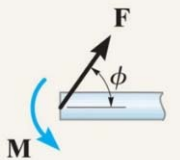
Three-force member: (3FM)
 a force system where the three forces

1. meet at the same point (point O), or
2. are parallel



Types of 2D connectors

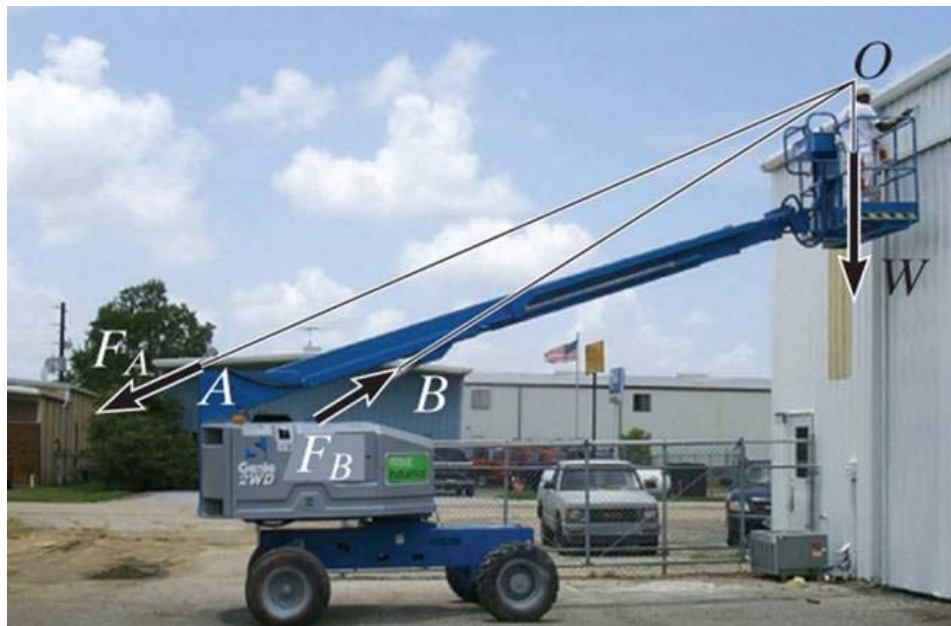
Types of Connection	Reaction
(1)  cable	
(2)  weightless link	 or 
(3)  roller	
(4)  rocker	

Types of Connection	Reaction
(5)  smooth contacting surface	
(6)  roller or pin in confined smooth slot	 or 
(7)  member pin connected to collar on smooth rod	 or 
(8)  smooth pin or hinge	 or 
(9)  member fixed connected to collar on smooth rod	
(10)  fixed support	 or 

Equilibrium of a rigid body



Now we add the z-axis to the coordinate system!







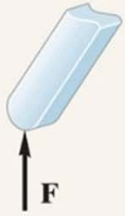


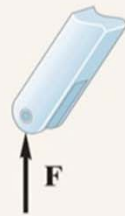
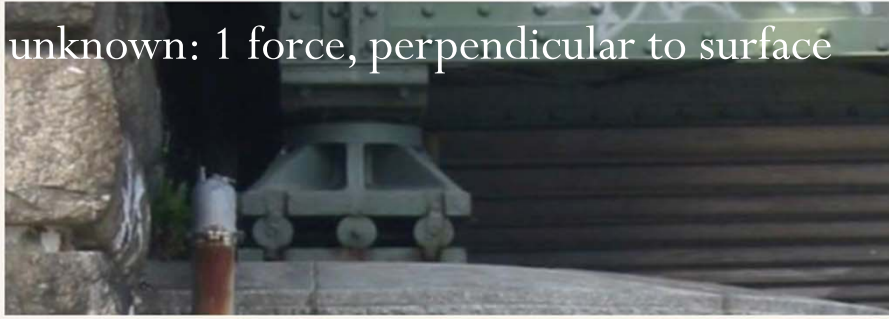

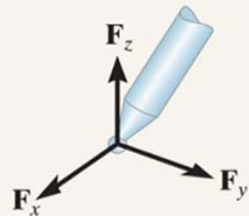

Equilibrium of a rigid body



Now we add the z-axis to the coordinate system!

How many Equations of Equilibriums?

TABLE 5-2 Supports for Rigid Bodies Subjected to Three-Dimensional Force Systems

Types of Connection	Reaction	Number of Unknowns
<p>(1)</p>  <p>cable</p>		<p>1 unknown: 1 force, along cable</p> 
<p>(2)</p>  <p>smooth surface support</p>		<p>1 unknown: 1 force, perpendicular to surface</p> 
<p>(3)</p>  <p>roller</p>		<p>1 unknown: 1 force, perpendicular to surface</p> 
<p>(4)</p>  <p>ball and socket</p>		<p>3 unknowns: 3 forces, prevent translation</p> 

The 50-lb mulching has a center of gravity at G . Determine the vertical reactions at the smooth contact point A .

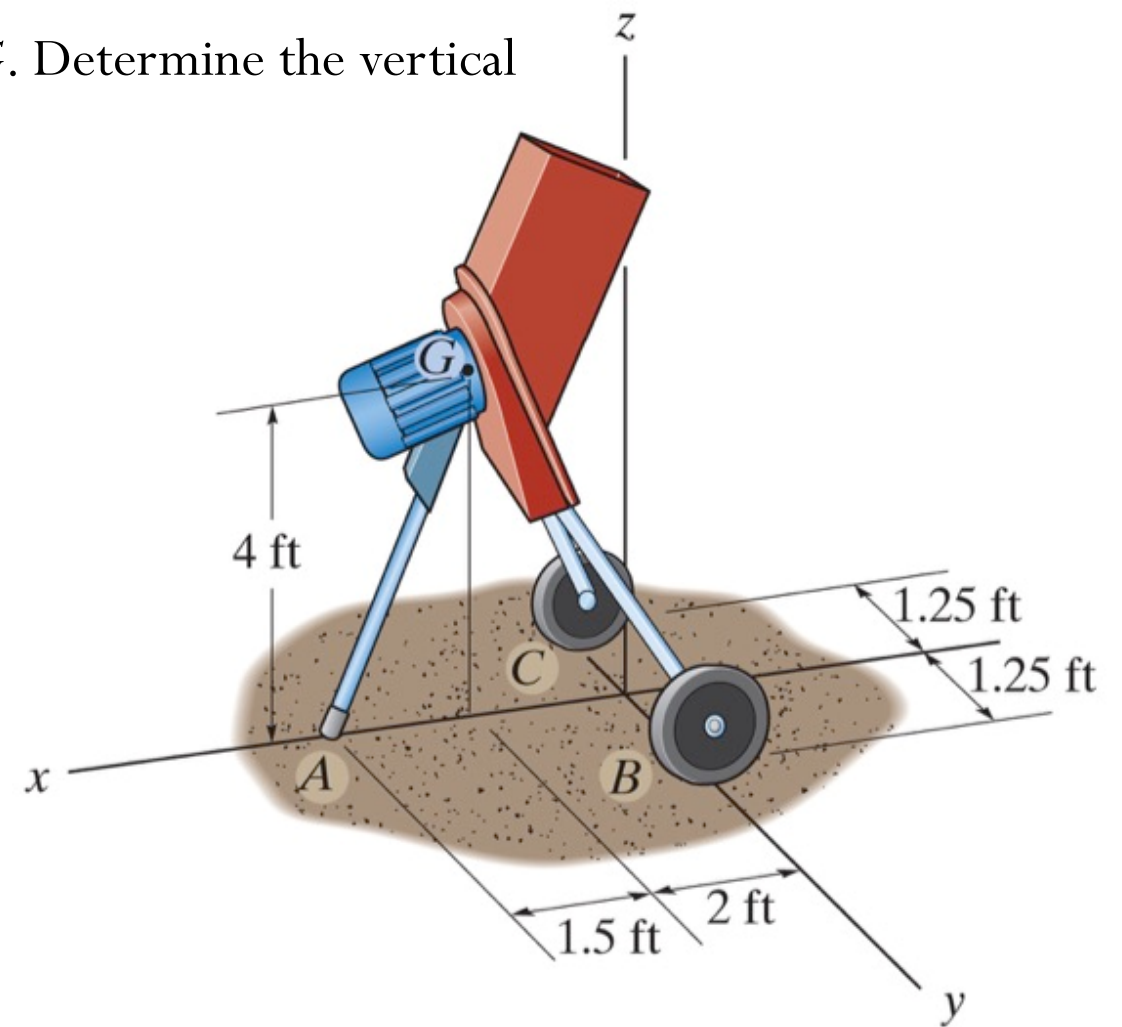

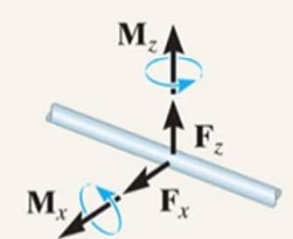


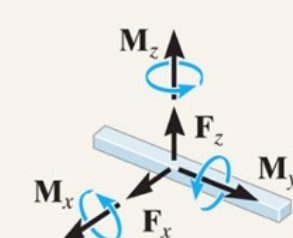


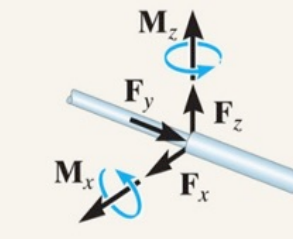



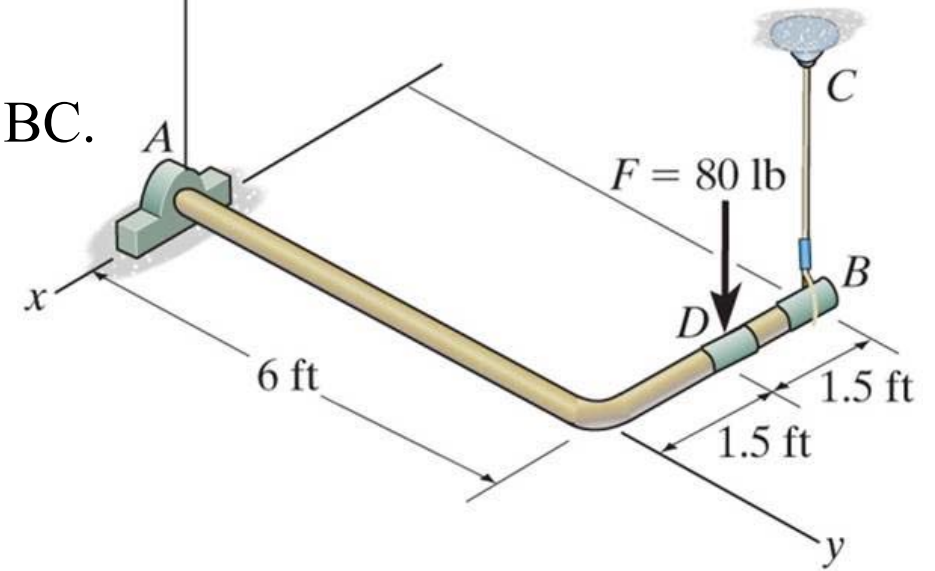
TABLE 5-2 Continued

Types of Connection	Reaction	Number of Unknowns
<p>(5)</p>  <p>single journal bearing Shaft rotates and slides along axis</p>		 <p>4 unknowns: 2 forces, 2 couple-moments*</p>
<p>(6)</p>  <p>single journal bearing with square shaft Shaft rotates and slides along axis</p>		<p>5 unknowns: 2 forces, 3 couple-moments*</p> 
<p>(7)</p>  <p>single thrust bearing Shaft rotates and slides along axis</p>		<p>5 unknowns: 3 forces, 2 couple-moments*</p> 

* Couple-moments are not applied to FBD if the body is supported elsewhere by additional bearings, pins or hinges that are **properly aligned** to prevent rotation in one or more axes).

Given: The rod, supported by thrust bearing at A and cable BC, is subjected to an 80 lb force.

Find: Reactions at the thrust bearing A and cable BC.



A bent rod is supported by smooth journal bearings at A , B , and C . $F = 800$ N. The supports are properly aligned such that no moment support is present. Determine the reactions at support C .

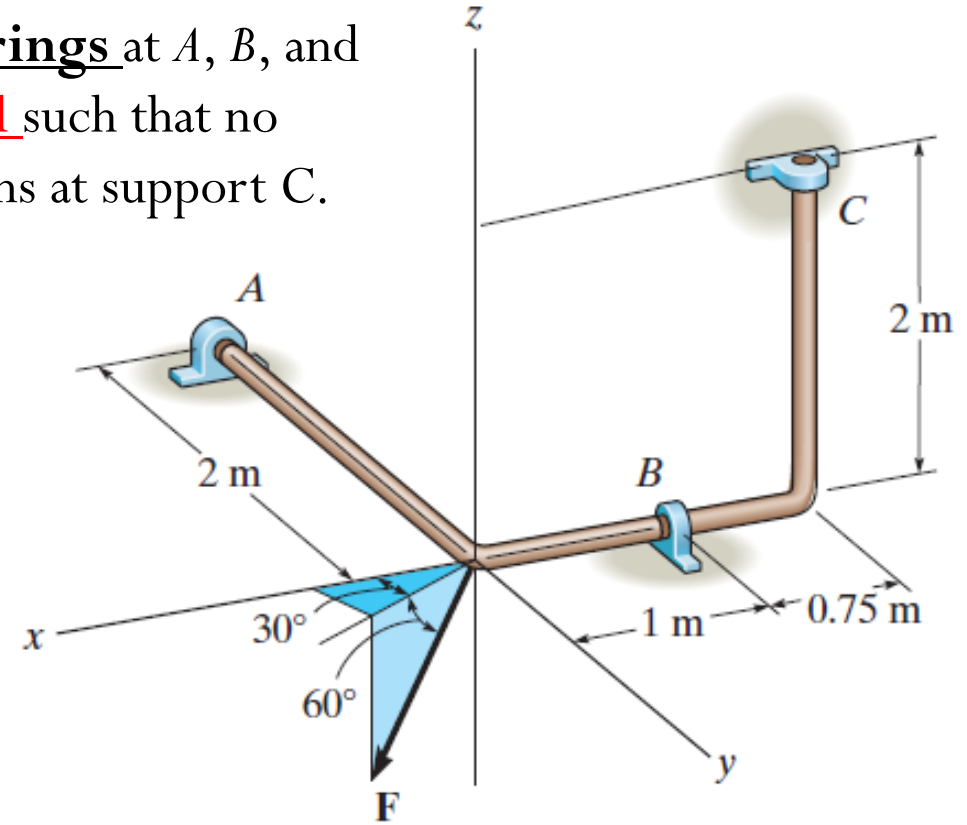





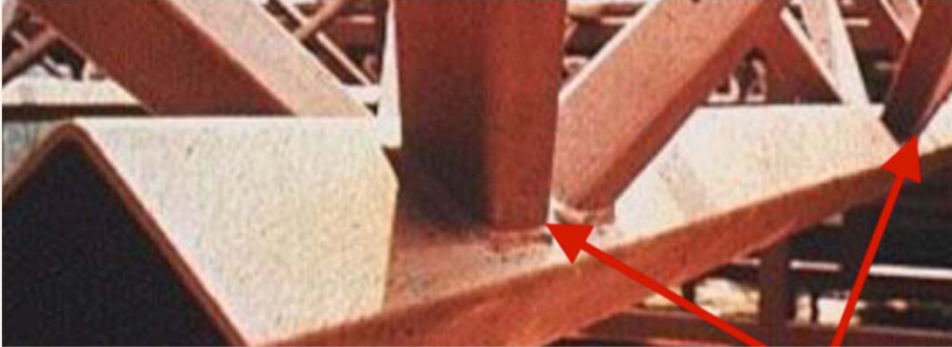
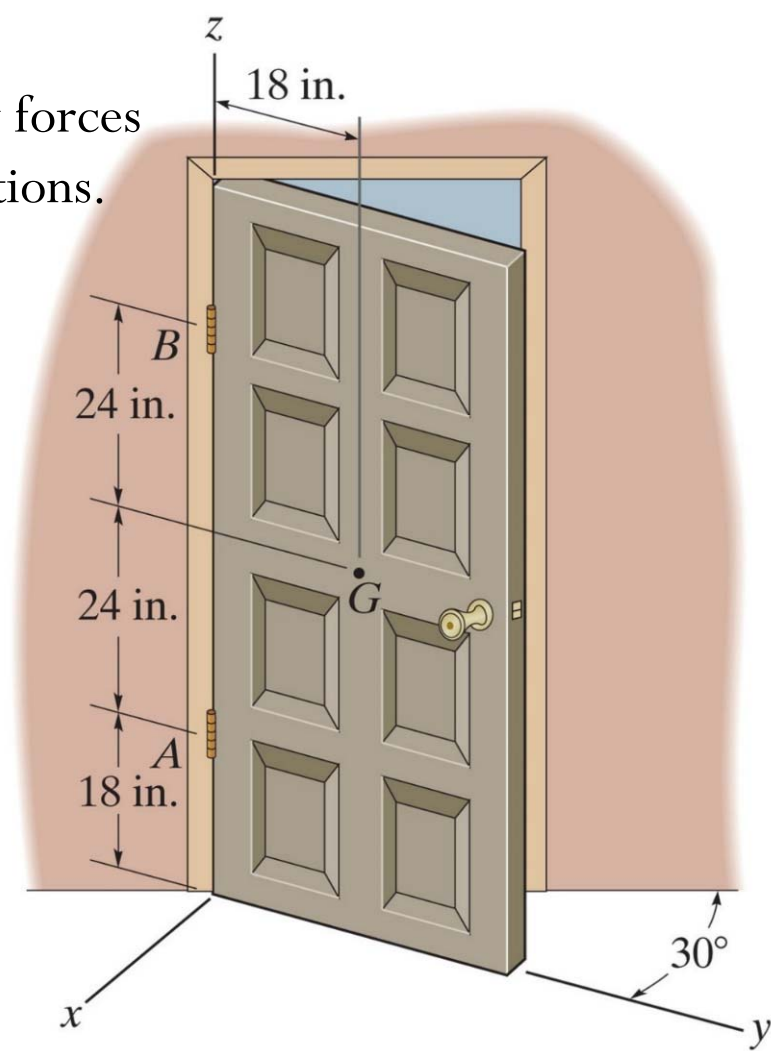


TABLE 5-2 Continued

Types of Connection	Reaction	Number of Unknowns
(8)  single smooth pin		 5 unknowns: 3 forces, 2 couple-moments*
(9)  single hinge		 5 unknowns: 3 forces, 2 couple-moments*
(10)  fixed support		 6 unknowns: 3 forces, 3 couple-moments

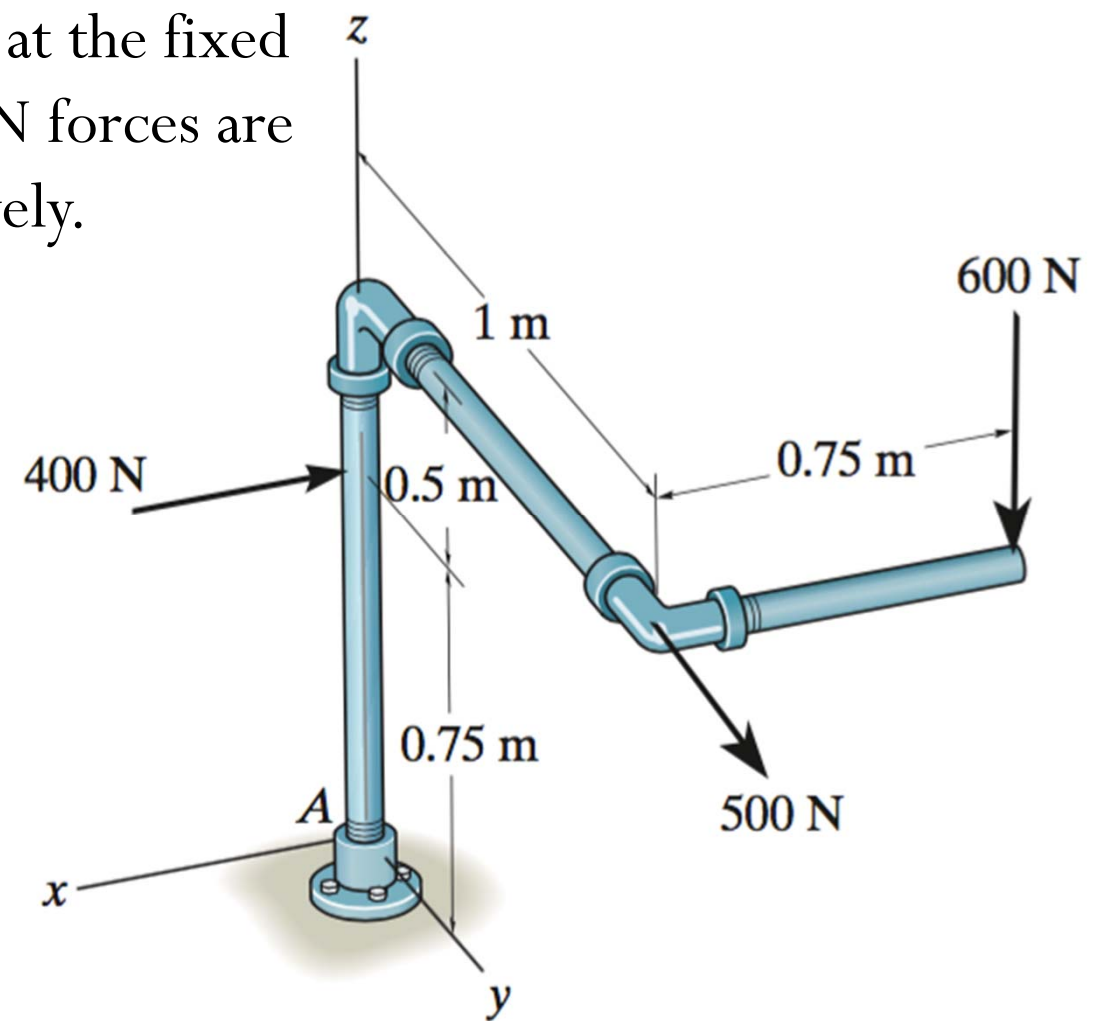
Note: for fixed supports, must always apply couple-moments to FBD

The 100 lb door has its center of gravity at G . Determine the components of reaction at hinges A and B if hinge B resists only forces in the x and y directions and A resists forces in the x, y, z directions.



Determine the components of reaction at the fixed support A . The 400 N, 500 N, and 600 N forces are parallel to the x , y , and z axes, respectively.

Draw FBD for blue structure.
How many unknowns?



Calculate the reaction forces and moments at the support D at the base of the structure.

Draw FBD for blue structure.
How many unknowns?

