To do ...

- HW 10 PL due Tues
- Quiz 3 starts Tues
- HW 11ME due Thurs
- WA 6 due Sun

* Piazza posts
* Matlab code posted
The beam is supported by the roller at A and the pin at B. Find the reactions at points A and B on the beam.

\[ \sum \text{forces and moments:} \]

\[ \sum F_x: \quad B_x + A \cos 60 = 0 \]

\[ \sum F_y: \quad B_y - F_R + A \sin 60 = 0 \]

\[ \sum M_A: \quad (2)F_R - (4 + 3 \cos 30) A \sin 60 - (3 \sin 30) A \cos 60 = 0 \]

\[ A = \frac{2 (4 \cdot 3)}{ (4 + 3 \cos 30) \sin 60 + (3 \sin 30) A \cos 60} = 3.71 \text{ kN} \]

\[ B_x = -A \cos 60 = -1.86 \text{ kN} \]
\[ B_y = F_r - A \sin 60^\circ = 8.78 \text{ kN} \]
Equilibrium of a rigid body

\[ \Sigma F_x = \Sigma F_y = \Sigma F_z = 0 \]
\[ \Sigma M_x = \Sigma M_y = \Sigma M_z = 0 \]

6 equations, can solve for 6 unknowns!

with 2D, only worried about
\[ \vec{M} = [0, 0, 1] \]
### TABLE 5–2  Supports for Rigid Bodies Subjected to Three-Dimensional Force Systems

<table>
<thead>
<tr>
<th>Types of Connection</th>
<th>Reaction</th>
<th>Number of Unknowns</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) cable</td>
<td><img src="image1.png" alt="Diagram" /></td>
<td>One unknown. The reaction is a force which acts away from the member in the known direction of the cable.</td>
</tr>
<tr>
<td>(2) smooth surface support</td>
<td><img src="image2.png" alt="Diagram" /></td>
<td>One unknown. The reaction is a force which acts perpendicular to the surface at the point of contact.</td>
</tr>
<tr>
<td>(3) roller</td>
<td><img src="image3.png" alt="Diagram" /></td>
<td>One unknown. The reaction is a force which acts perpendicular to the surface at the point of contact.</td>
</tr>
</tbody>
</table>

Q: What about friction?
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</tr>
</thead>
<tbody>
<tr>
<td>(4) ball and socket</td>
<td><img src="image" alt="Diagram" /></td>
<td>Three unknowns. The reactions are three rectangular force components.</td>
</tr>
<tr>
<td>(5) single journal bearing</td>
<td><img src="image" alt="Diagram" /></td>
<td>Four unknowns. The reactions are two force and two couple-moment components which act perpendicular to the shaft. Note: The couple moments are generally not applied if the body is supported elsewhere. See the examples.</td>
</tr>
</tbody>
</table>
TABLE 5–2  Continued

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<tr>
<th>Types of Connection</th>
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</tr>
</thead>
<tbody>
<tr>
<td>(6) single journal bearing with square shaft</td>
<td><img src="image1" alt="Diagram" /></td>
<td>Five unknowns. The reactions are two force and three couple-moment components. <em>Note:</em> The couple moments are generally not applied if the body is supported elsewhere. See the examples.</td>
</tr>
<tr>
<td>(7) single thrust bearing</td>
<td><img src="image2" alt="Diagram" /></td>
<td>Five unknowns. The reactions are three force and two couple-moment components. <em>Note:</em> The couple moments are generally not applied if the body is supported elsewhere. See the examples.</td>
</tr>
<tr>
<td>(8) single smooth pin</td>
<td><img src="image3" alt="Diagram" /></td>
<td>Five unknowns. The reactions are three force and two couple-moment components. <em>Note:</em> The couple moments are generally not applied if the body is supported elsewhere. See the examples.</td>
</tr>
</tbody>
</table>
### TABLE 5-2  Continued

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<th>Types of Connection</th>
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<tbody>
<tr>
<td>(9) single hinge</td>
<td><img src="image" alt="Diagram" /></td>
<td>Five unknowns. The reactions are three force and two couple-moment components. <em>Note:</em> The couple moments are generally not applied if the body is supported elsewhere. See the examples.</td>
</tr>
<tr>
<td>(10) fixed support</td>
<td><img src="image" alt="Diagram" /></td>
<td>Six unknowns. The reactions are three force and three couple-moment components.</td>
</tr>
</tbody>
</table>

Cannot rotate about $z$ or $y$, :: reactions

Able to rotate about $x$, :: no reaction $M_x$
Joint Connec


Welded connection

Gusset plate

Does not allow ANY translation or rotation. :: 6 reaction!
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.

\[ \vec{F} = F \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} \]

**Force at handle, F**

- Identify support reactions
- Draw FBD, coordinates

**Q: unknowns?**

5!

\[ B_x \ \ \ B_y \ \ \ A_x \ \ A_y \ \ A_z \]

**Sum the forces and moments.**

\[ \Sigma F_x: \quad A_x + B_x + F = 0 \]

\[ \Sigma F_y: \quad A_y + B_y = 0 \]
\[ \Sigma F_y: \quad A_y + B_y = 0 \]
\[ \Sigma F_x: \quad A_x - G = 0 \quad \Rightarrow \quad A_x = G \]

\[ \Sigma M_x: \quad -B_y (48) - (100 \times 18) = 0 \]
\[ B_y = -\frac{100 \times 18}{48} = -37.5 \text{ lb} \]

\[ \Sigma M_y: \quad B_x (48) + F (24) = 0 \]
\[ B_x = -\frac{F (24)}{48} = -\frac{F}{2} \]

Now using:
\[ \Sigma F_y: \quad A_y = -B_y = 37.5 \text{ lb} \]
\[ \Sigma F_x: \quad A_x = -B_x - F = \frac{F}{2} - F = -\frac{F}{2} \]