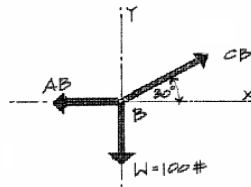


rigid body equilibrium



Free Body Diagram

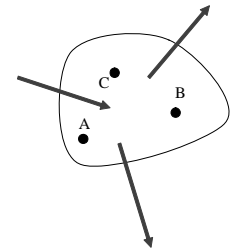
- FBD (sketch)
- tool to see all forces on a body or a point including
 - external forces
 - weights
 - force reactions
 - external moments
 - moment reactions
 - internal forces



(Example 1)

Equilibrium

- rigid body
 - doesn't deform
 - coplanar force systems



- static:

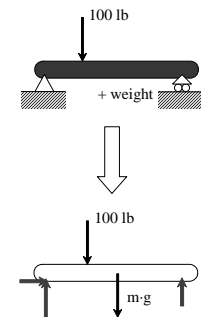
$$R_x = \sum F_x = 0$$

$$R_y = \sum F_y = 0$$

$$M = \sum M = 0$$

Free Body Diagram

- determine body
- FREE it from:
 - ground
 - supports & connections
- draw all external forces acting ON the body
 - reactions
 - applied forces
 - gravity

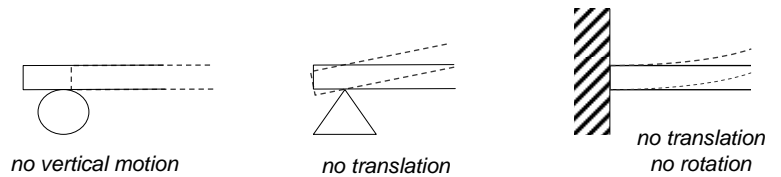


Free Body Diagram

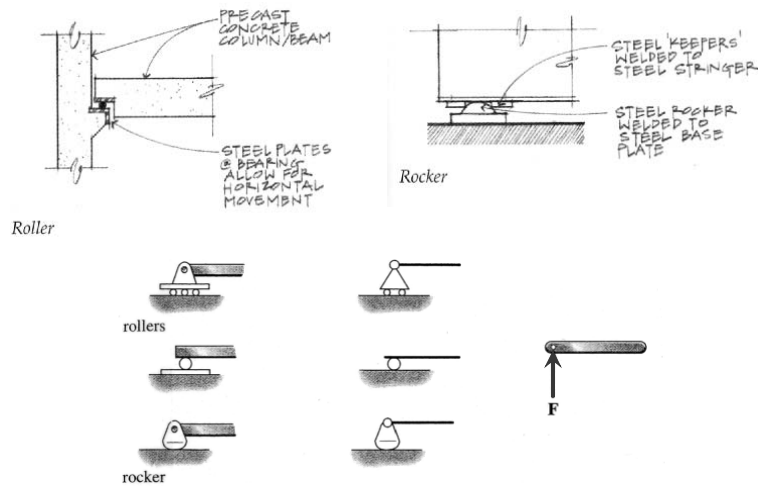
- include relevant geometry
 - guidelines helpful to see moment arms
- name and/or color the unknown
 - forces
 - moments
 - angles
- solve up to 3 equations

Reactions

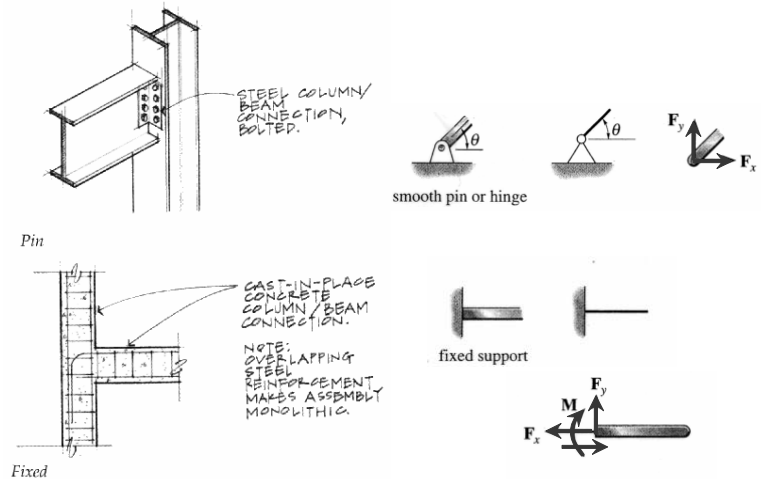
- result of applying force
- unknown size
- connection or support type
 - known direction
 - related to motion prevented



Supports and Connections

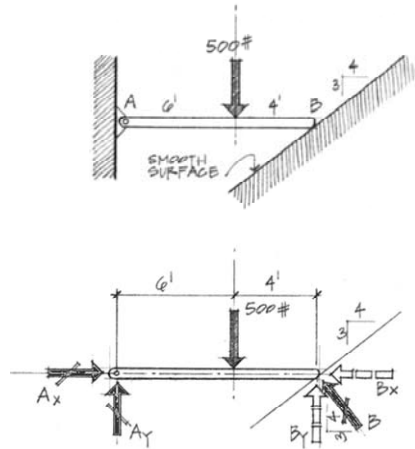


Supports and Connections



FBD Example

- 500 lb known
- pin – A_x, A_y
- smooth surface – B at 4:3
- 3 equations
- sum moments at
 - A?
 - B? (B_x)

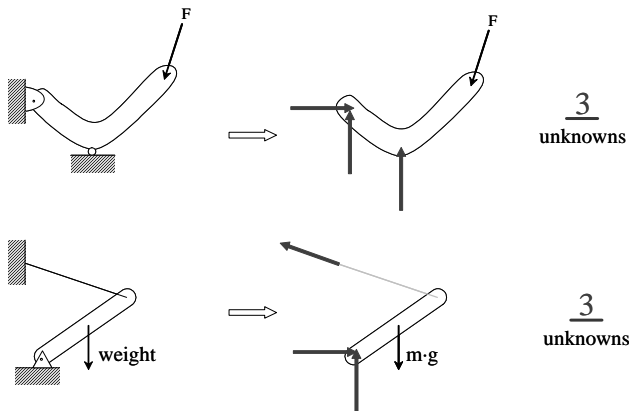


Moment Equations

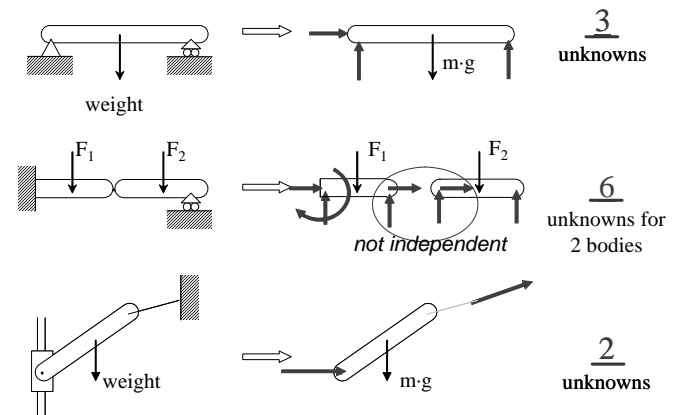
- sum moments at intersection where the most forces intersect
- multiple moment equations may not be useful
- combos:

$$\begin{array}{lll} \sum F_x = 0 & \sum F = 0 & \sum M_1 = 0 \\ \sum F_y = 0 & \sum M_1 = 0 & \sum M_2 = 0 \\ \sum M_1 = 0 & \sum M_2 = 0 & \sum M_3 = 0 \end{array}$$

Recognizing Reactions

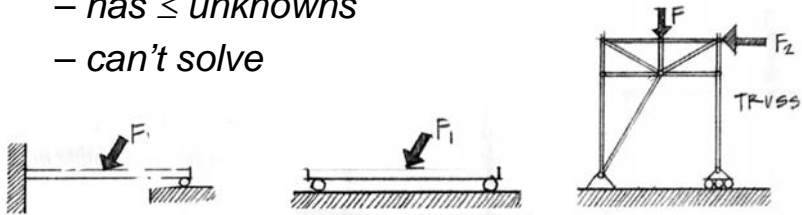


Recognizing Reactions



Constraints

- *completely constrained*
 - doesn't move
 - may not be statically determinate
- *improperly or partially constrained*
 - has \leq unknowns
 - can't solve



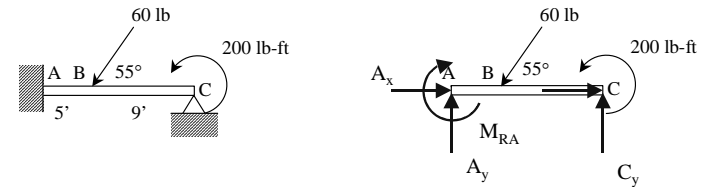
Rigid Bodies and Supports 14

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ENDS 231

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Constraints

- *overconstrained*
 - won't move
 - can't be solved with statics
 - statically indeterminate to n^{th} degree

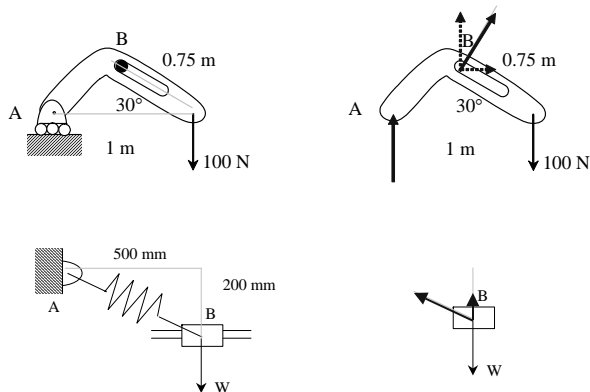


Rigid Bodies and Supports 15

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Partial Constraints



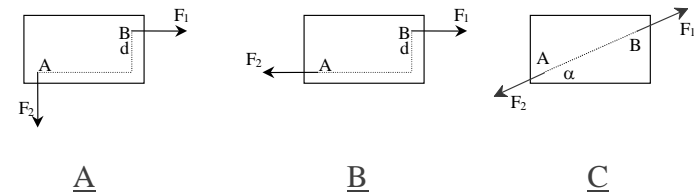
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Two Force Rigid Bodies

- *equilibrium:*
 - forces in line, equal and opposite



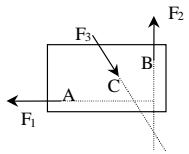
Rigid Bodies and Supports 22

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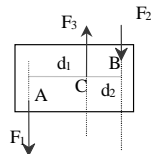
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Three Force Rigid Bodies

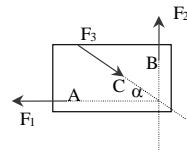
- *equilibrium:*
 - *concurrent or parallel forces*



A



B



C

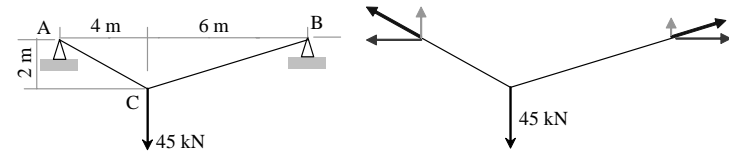
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Cable Reactions

- *equilibrium:*
 - *more reactions (4) than equations*
 - *but, we have slope relationships*
 - *x component the same everywhere*



Rigid Bodies and Supports 24

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