Lec13

Wednesday, October 21, 2020 7:59 AM

Lecture Objectives

- Support Reactions 2D & 3D
- Proper Constraints and Determinancy

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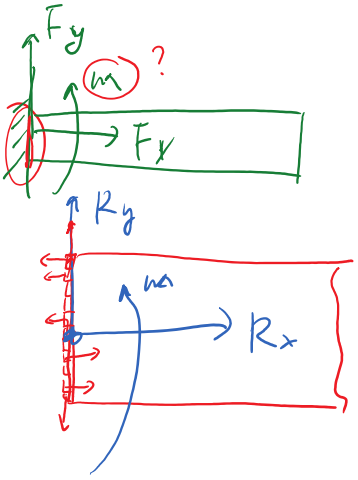
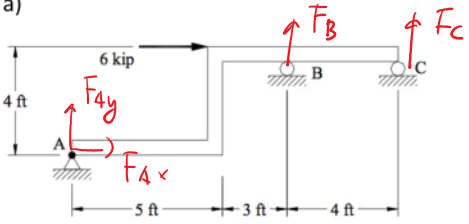


Constraints

Proper, redundant, or improper constraints

a)



Constraints

Proper, redundant, or improper constraints

$\Sigma F_x = 0$

$\Sigma F_y = 0 \Rightarrow A + B + C - 4 = 0$ — ①

$\Sigma M_A = 0 \Rightarrow -20 + 8B + 12C = 0$ — ②

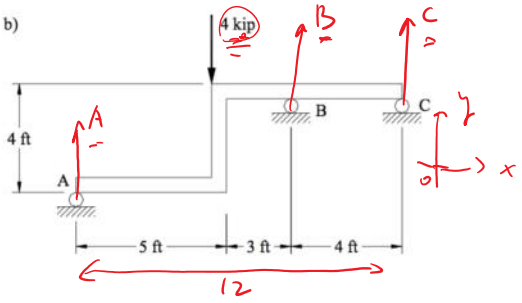
~~$\Sigma M_C = 0 \Rightarrow -4B + 28 - 12A = 0$ — ③~~

$\Sigma M_B = 0 \Rightarrow 3 \times 4 - 8A + 4C = 0$ — ③

② − ③ :

$8A + 8B + 8C - 32 = 0$

b)



Constraints

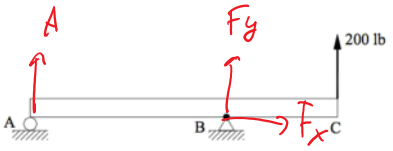
Proper, redundant, or improper constraints

$\Sigma F_x = 0$

$\Sigma F_y = 0$

$\Sigma M_B = 0$

c)



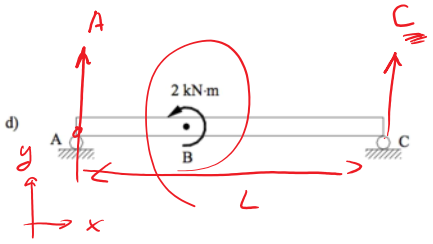
Constraints

Proper, redundant, or improper constraints

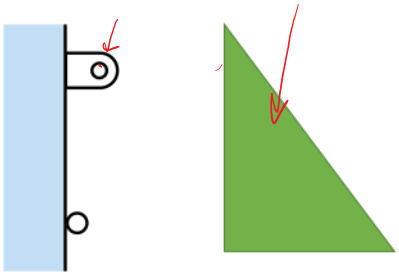
$\begin{cases} \Sigma F_x = 0 \\ \Sigma F_y = 0 \\ \Sigma M_A = 0 \end{cases} \Rightarrow \begin{cases} 0 = 0 \\ A + C = 0 \\ C \cdot L + 2 = 0 \end{cases}$

$C = -\frac{2}{L}$

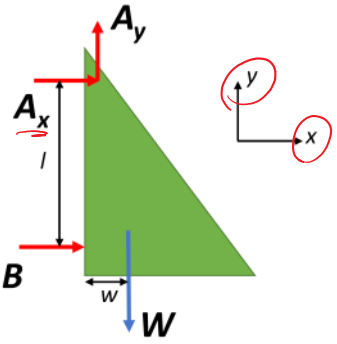
$A = \frac{2}{L}$



Rigid Body at Equilibrium



FBD



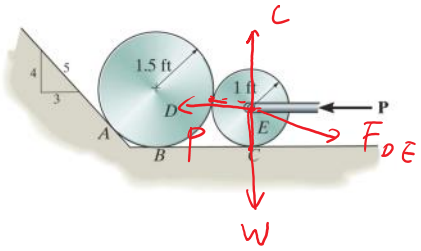
Support reactions provide just enough force and/or moment to keep another body at equilibrium.

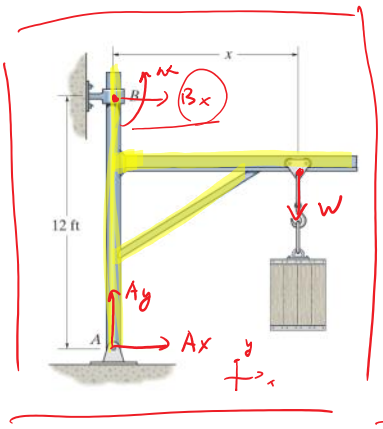
Equations of Equilibrium

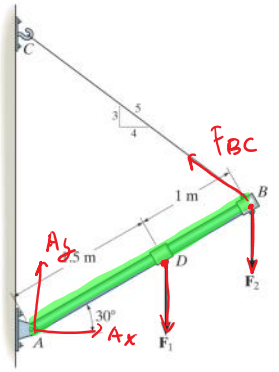
$$\begin{cases} \Sigma F_x = A_x + B = 0 \\ \Sigma F_y = A_y - W = 0 \\ \Sigma M_A = lB - wW = 0 \end{cases}$$

Note: The "signs" of forces should correspond to your FBD and the chosen coordinate system.

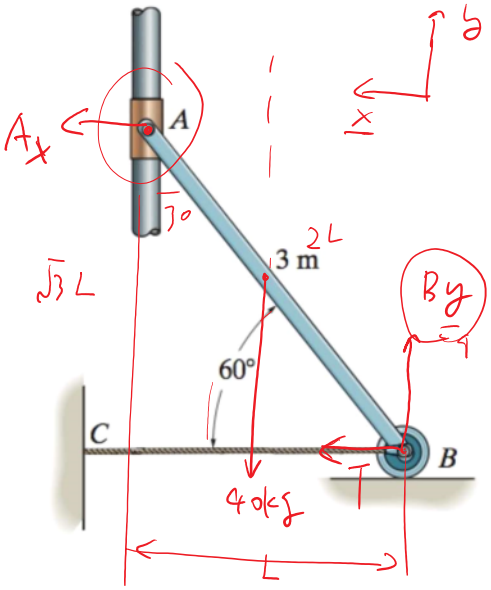
Free Body Diagrams







The uniform rod *AB* has a mass of 40 kg. Determine the force in the cable when the rod is in the position shown. ~~There is a~~

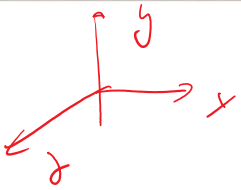


$$\begin{cases} \Sigma F_x = 0 \\ \Sigma F_y = 0 \\ \Sigma M_A = 0 \end{cases} \quad \begin{cases} T + A_x = 0 \\ B_y - 40 \times 9.8 = 0 \\ 40 \times 9.8 \cdot \frac{L}{2} - L B_y + T\sqrt{3}L = 0 \end{cases}$$

Equilibrium of a 3D rigid body

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

What are the possible movements for a 3-D body?



Equilibrium of a 3D rigid body

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

6 Equations of Equilibriums:

$\Sigma F_x = 0$ $\quad \Sigma M_x = 0$

$\Sigma F_y = 0$ $\quad \Sigma M_y = 0$

$\Sigma F_z = 0$ $\quad \Sigma M_z = 0$

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

Types of Connection	Reaction	Number of Unknowns
(1) cable	F	
(2) smooth surface support	F	
(3) roller	F	

i-Clicker Time

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

Types of Connection	Reaction	Number of Unknowns
(4) ball and socket		

A) 3 forces

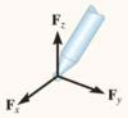
B) 3 forces and 1 moment

C) 3 forces and 2 moments

D) 3 forces and 3 moments

E) None of the above

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

Types of Connection	Reaction	Number of Unknowns
(4)  ball and socket		
(5)  single journal bearing