wc13lect

Announcements

- In-class Quiz 3 next Monday (10/2)
  - DRES accommodations for in class quiz/final – make your appointment for Testing Accommodations Center (TAC) with DRES
  - DRES accommodations for CBTF –Talk to CBTF proctors directly prior to the exam

❑ Upcoming deadlines:

- Thursday (9/28)
  - ME HW9
- Tuesday (10/3)
  - PL HW10

WA#1. check feedback please!!!

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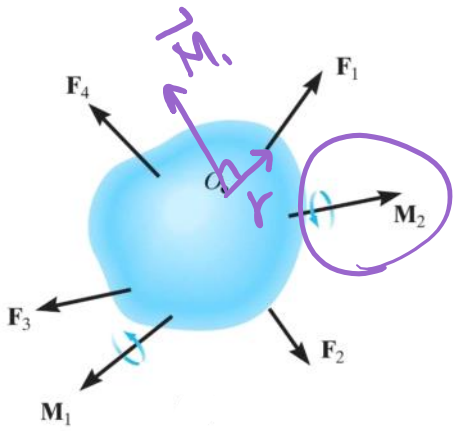
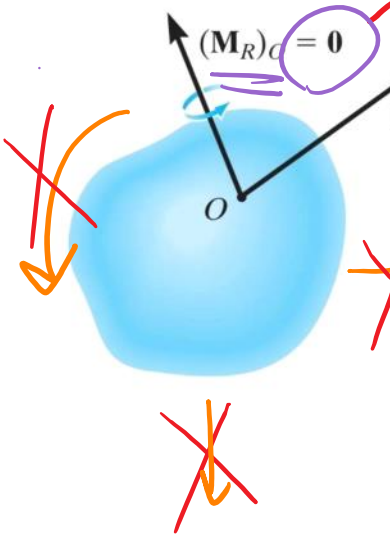
Wednesday, September 27, 2017 10:00 AM

Recap: Equilibrium of a Rigid Body





No Rotation

No Translation

3

Equilibrium in two-dimensional bodies

Active Forces vs. Support reactions

massless

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(1)

$\Sigma F_x = F + A_x = 0$

$A_x = -F$

$\Sigma M_A = -Fr \neq 0$?

- Unable to prevent rotational motion

⇒ No moment support, cannot maintain equi-

Support "reacts" to forces

(3)

$\Sigma F_x = C_x - F = 0$

$C_x = F$

$\Sigma M_A = rF + M_C = 0$

$M_C = -rF$

- Provides moment support (M_C) to prevent rotational motion

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Equilibrium in two-dimensional bodies

Why different support?

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lateral motions are non-issues, so use the simplest, lightest option: cable

Truck must move to be useful, so only surface support is available

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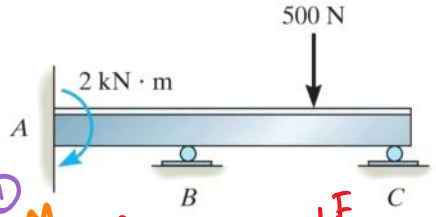
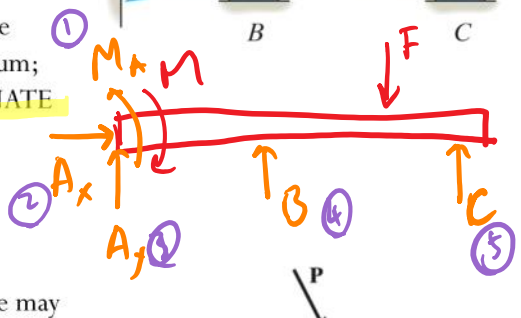
Constraints

To ensure equilibrium of a rigid body, it is not only necessary to satisfy equations of equilibrium, but the body must also be properly constrained by its supports

- **Redundant constraints**: the body has more supports than necessary to hold it in equilibrium; the problem is STATICALLY INDERTERMINATE and cannot be solved with statics alone





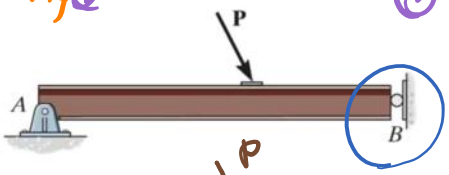
$\Sigma F_x = 0$

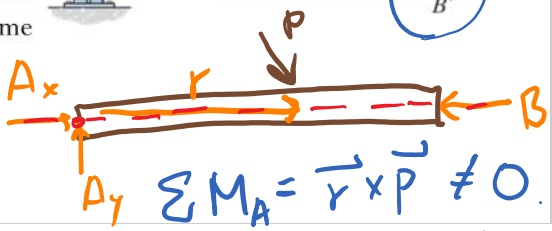
$\Sigma F_y = 0$

$\Sigma M_0 = 0$ } 3

5 > 3

- **Improper constraints:** In some cases, there may be as many unknown reactions as there are equations of equilibrium. However, if the supports are not properly constrained, the body may become unstable for some loading cases.





$\Sigma M_A = \vec{r} \times \vec{P} \neq 0$

- Body goes out of equilibrium and becomes unstable.

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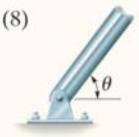
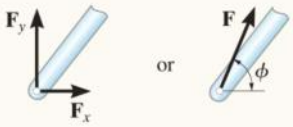
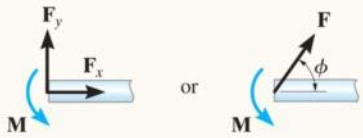
Types of connectors

TABLE 5–1 Continued

Types of Connection	Reaction	Number of Unknowns
(8)  smooth pin or hinge		Two unknowns. The reactions are two components of force, or the magnitude and direction ϕ of the resultant force. Note that ϕ and θ are not necessarily equal [usually not, unless the rod shown is a link as in (2)].
(9)  member fixed connected to collar on smooth rod		Two unknowns. The reactions are the couple moment and the force which acts perpendicular to the rod.
(10)  fixed support		Three unknowns. The reactions are the couple moment and the two force components, or the couple moment and the magnitude and direction ϕ of the resultant force.

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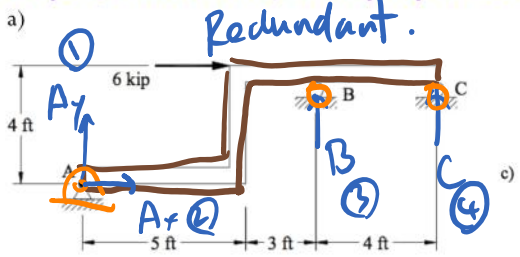
Constraints

Proper, redundant, or improper constraints

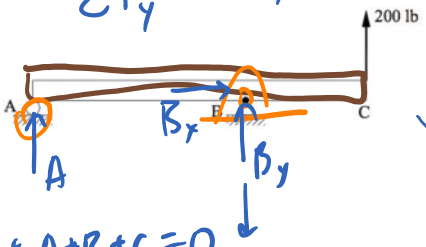
a)



$\Sigma M_B = +r_C(200\,lb) - r_A A = 0 \Rightarrow A = \frac{200 r_C}{r_A}$

$\Sigma F_y = A + B_y + 200\,lb = 0 \Rightarrow B_y = -200\,lb - \frac{200 r_C}{r_A}$

c)



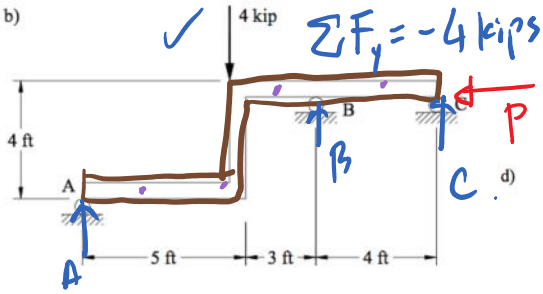
A) Proper

B) Redundant

C) Improper

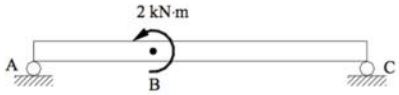
D) None of the above

b)



$\Sigma F_y = -4\,kips + A + B + C = 0$

d)



A) Proper ✓

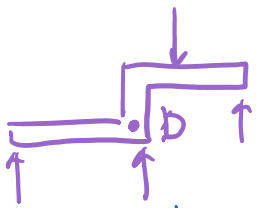
B) Redundant

C) Improper

D) None of the above.

$\Sigma F_x, \Sigma F_y, \Sigma M_A$

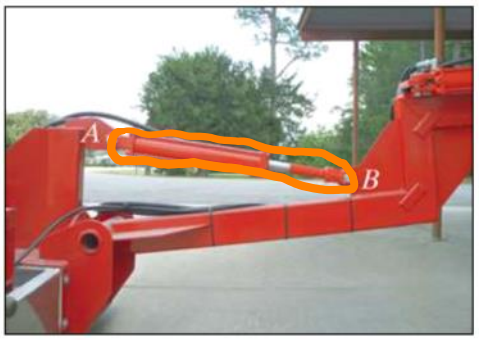
$\Sigma F_x, \Sigma M_A, \Sigma M_B$ No.



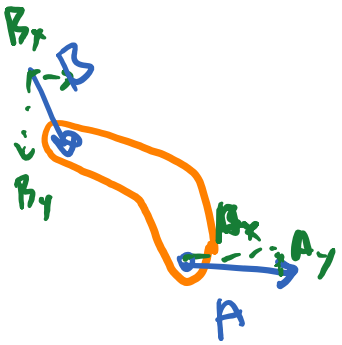
M_D = moment about D

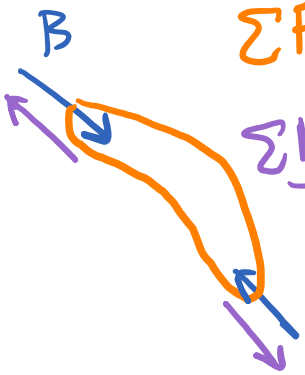
$= \Sigma \vec{r} \times \vec{F} + \Sigma \vec{M} \rightarrow 0$: No external moments in the problem.

Two-force members



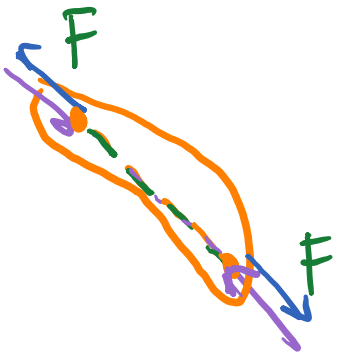
Members AB can be considered as two-force members, provided that their weight is neglected.





$\Sigma F_x = \Sigma F_y = 0$

$\Sigma M = 0$



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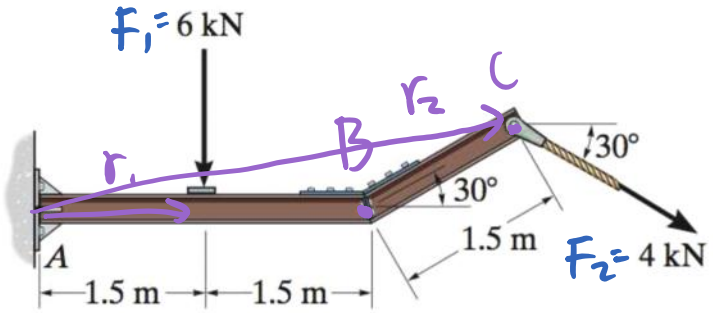
Magnitudes of the two forces on the two force member are the same, in opposite directions, pointing along the line that connects the locations wher the two forces are applied.

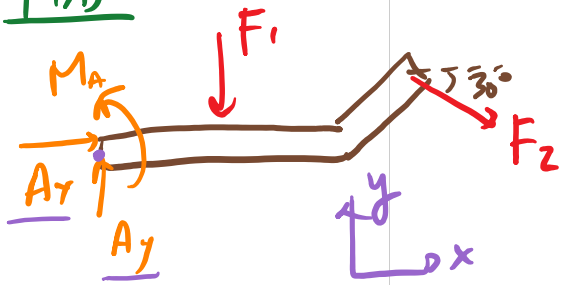
Determine the components of the support reactions at the fixed support A on the cantilevered beam.



Given: F_1, F_2

Find: A_x, A_y, M_A

FBD



EoE.

$\sum F_x = A_x + F_2 \cos 30° = 0$

$\sum F_y = A_y - F_1 - F_2 \sin 30° = 0.$

$\sum \vec{M}_A = -F_1 r_1 \hat{k} + \vec{r}_2 \times \vec{F}_2 + M_A = 0 \Rightarrow \boxed{\vec{M}_A = +F_1 r_1 \hat{k} - \vec{r}_2 \times \vec{F}_2}$

$\Rightarrow A_x = -F_2 \cos 30° = -2\sqrt{3}\ \text{kN}$ or $2\sqrt{3}\ \text{kN} \leftarrow$

Negative sign tells the direction of the unknown force

$A_y = F_1 + F_2 \sin 30° = 8\ \text{kN}$ or $8\ \text{kN} \uparrow$

$M_A = r_1 F_1 + r_{2x} F_{2y} + r_{2y} F_{2x}$

$= (9\ \text{kN}\cdot\text{m}) + (3 + 0.75\sqrt{3}\ \text{m})(2\ \text{kN}) + (0.75\text{m})(2\sqrt{3}\ \text{kN})$

$M_A \approx 20.1\ \text{kN}\cdot\text{m}$ ↺ (ccw)