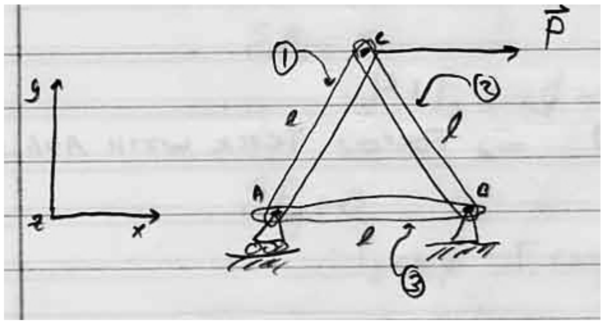
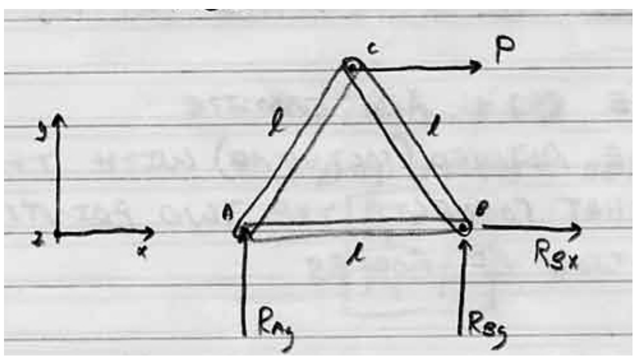
2.001 - MECHANICS AND MATERIALS I
Lecture #3
9/13/2006
Prof. Carol Livermore

Recall from last time:



FBD:



Solve equations of motion.

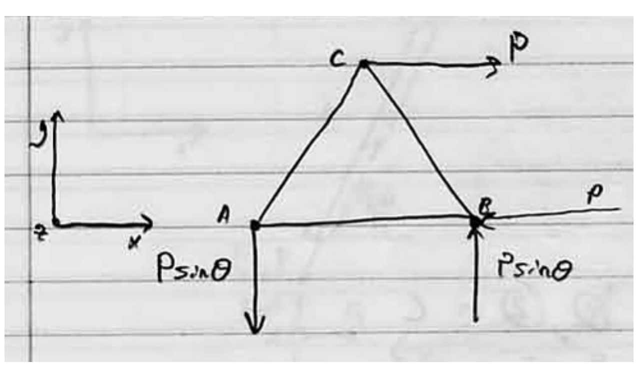
$$\sum F_x = 0$$

$$\sum F_y = 0$$

$$\sum M_A = 0$$

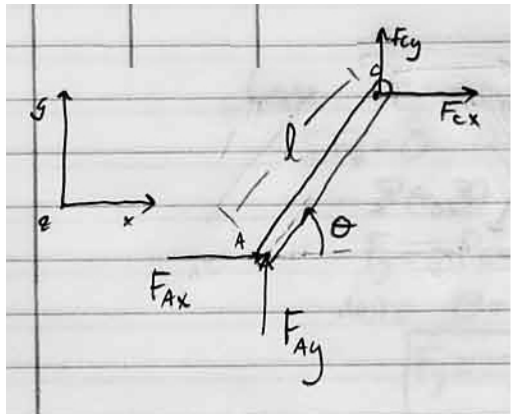
See 9/11/06 Notes.

Solution:



Draw each component separately.

FBD of Bar 1



$$\sum F_x = 0$$
$$F_{A_x} + F_{C_x} = 0$$

$$\sum F_y = 0$$
$$F_{A_y} + F_{C_y} = 0$$

$$\sum M_A = 0$$
$$l \cos\theta F_{C_y} - l \sin\theta F_{C_x} = 0$$

Solve.

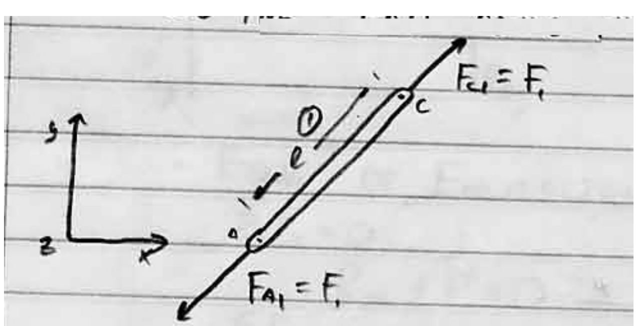
$$F_{A_x} = F_{C_x}$$
$$F_{A_y} = -F_{C_y}$$
$$\frac{F_{C_y}}{F_{C_x}} = \frac{\sin\theta}{\cos\theta} = \tan\theta \text{ Forces track with angle.}$$

Two Force Member:

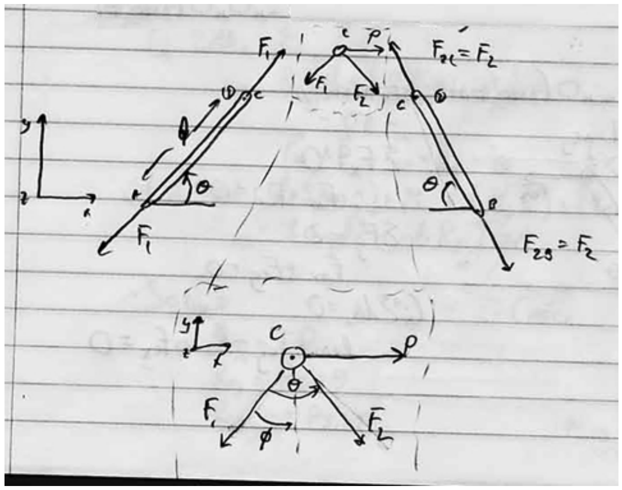
If forces are only applied at 2 points, then:

1. Forces are equal and opposite.
2. Forces are aligned (colinear) with the vector tha connects the two points of application of forces.

So the FBD could be rewritten as:



Now look at the FBDs of 1, 2, and C:



Solve equations of equilibrium for Pin C.

$$\sum F_x = 0$$
$$P + F_2 \sin\phi - F_1 \sin\phi = 0$$

$$\sum F_y = 0$$
$$-F_2 \cos\phi - F_1 \cos\phi = 0 \Rightarrow F_1 = -F_2$$

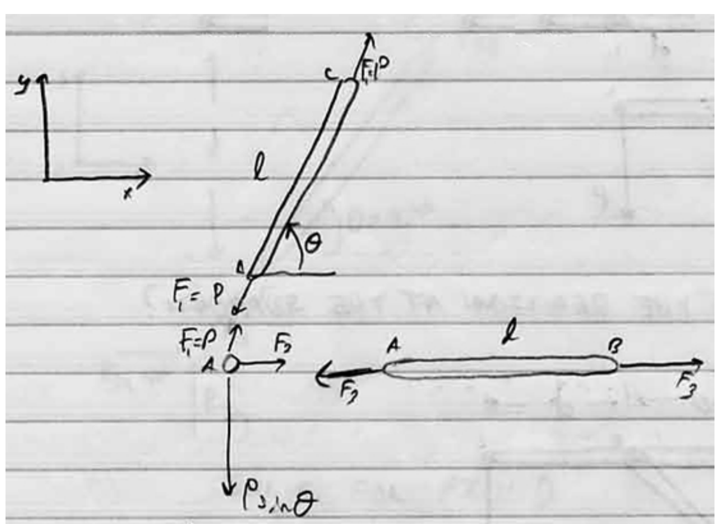
$$\sum M = 0 \Rightarrow \text{ No additional info.} (\vec{\Gamma} = 0)$$

$$P + 2F_2 \sin\phi = 0$$

Note $\phi = 30°$, so:

$$F_2 = -P$$
$$F_1 = P$$

Now look at FBD of 1, 2, and A:

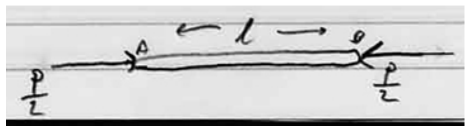


Look at equilibrium of Pin A:

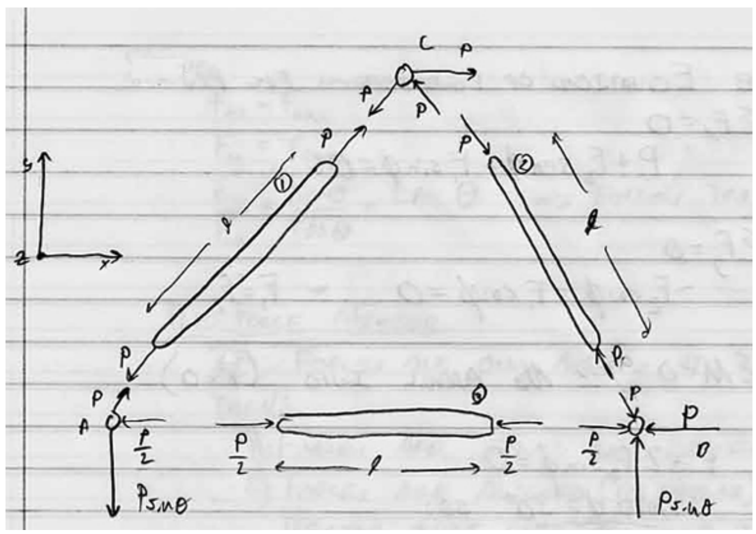
$$\sum F_X = 0$$
$$P\cos\theta + F_3 = 0$$
$$F_3 = -P\cos\theta$$

Note $\theta = 60°$, so:

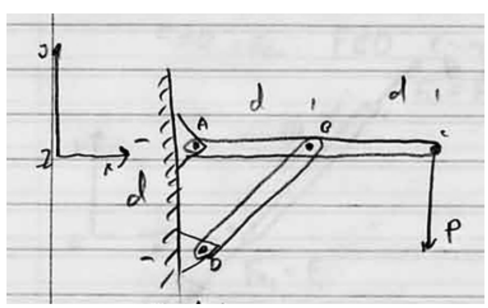
$$F_3 = -\frac{P}{2}$$



So:

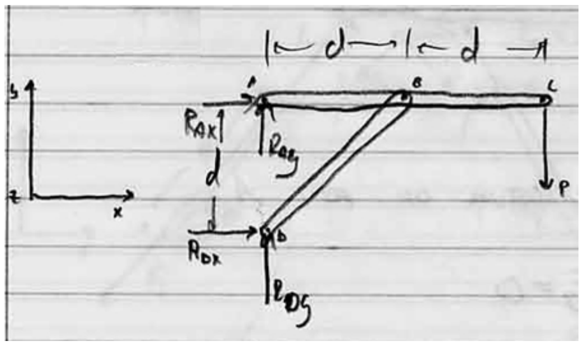


EXAMPLE:



Q: What are the reactions at the supports?

FBD:



$$\sum F_x = 0$$
$$R_{A_x} + R_{D_x} = 0$$

$$\sum F_y = 0$$
$$R_{A_y} + R_{D_y} - P = 0$$

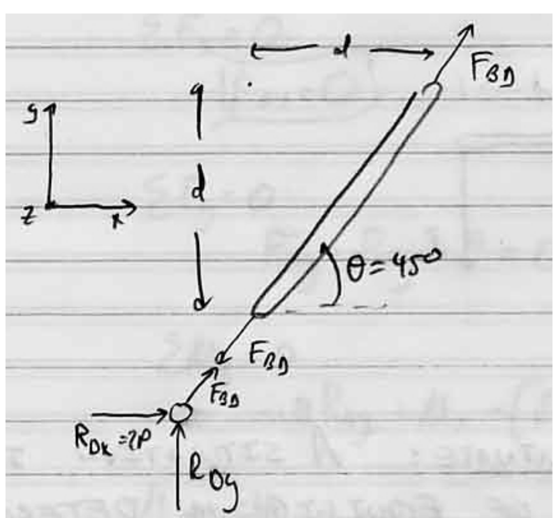
$$\sum M_A = 0$$
$$-2dP + dR_{D_x} = 0$$

Solve.

$$R_{D_x} = 2P$$
$$R_{A_x} = -2P$$
$$R_{A_y} + R_{D_y} = P$$

Note: BD is a 2-Force member.

Draw FBD of BD and Pin D.



Solve for Pin D.

$$\sum F_x = 0$$
$$2P + F_{BD}\cos\theta = 0$$

$$\sum F_y = 0$$
$$R_{D_y} + F_{BD}\sin\theta = 0$$

Solve.

$$F_{BD} = -\frac{2P}{\cos\theta}$$
$$R_{D_y} - \frac{2P}{\cos\theta}\sin\theta = 0$$
$$R_{D_y} = 2P\tan\theta$$

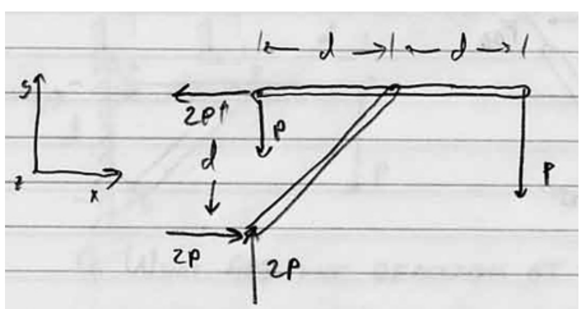
Note: $\theta = 45°$, so:

$$R_{D_y} = 2P$$

Substituting:

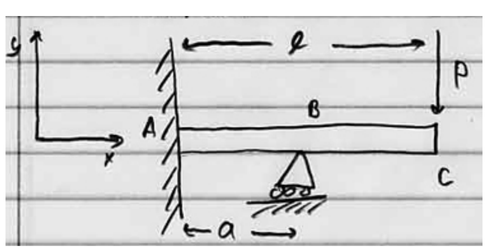
$$R_{A_y} + 2P - P = 0$$
$$R_{A_y} = -P$$

Check:

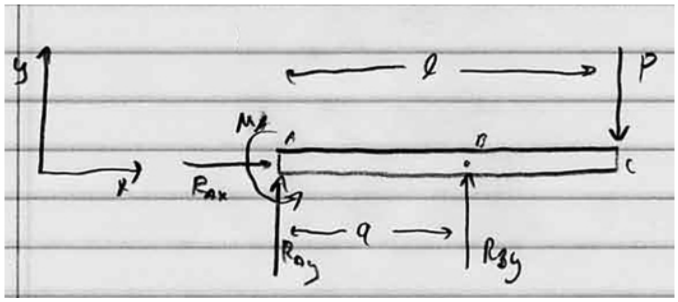


Statically Determinate: A situation in which the equations of equilibrium determine the forces and moments that support the structure.

EXAMPLE:



FBD



$$\sum F_x = 0$$
$$R_{A_x} = 0$$

$$\sum F_y = 0$$
$$R_{A_y} + R_{B_y} - P = 0$$

$$\sum M_B = 0$$
$$-aR_{A_y} + M_A - (l - a)P = 0$$

Note: 4 unknowns and 3 equations.

This is *statically indeterminate*.