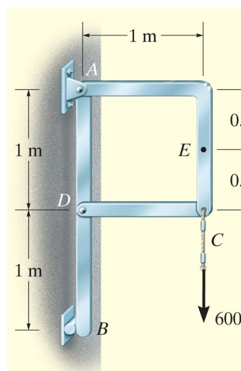
Name: ________________
Group members: ______________________ ______________________ ______________________

TAM 210/211 - Worksheet 7

Objectives:

- Investigate 2D and 3D rigid bodies in equilibrium.

1) The frame in equilibrium shown below is loaded with a force of 600 N in the negative y-direction on pin C. The frame is also supported by a roller at B. Assume the weight of the frame and its components are negligible.



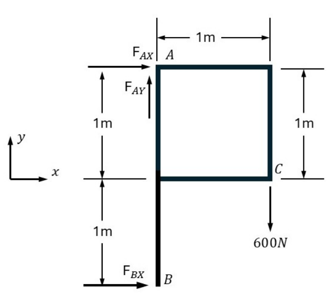
(A) What support reactions (force component(s) and/or couple moment) for the frame are possible at
(i) Pin support A?

F_{Ax}, F_{Ay}

(ii) Roller support B?

F_{Bx}

(B) Draw a free-body diagram for the whole frame.

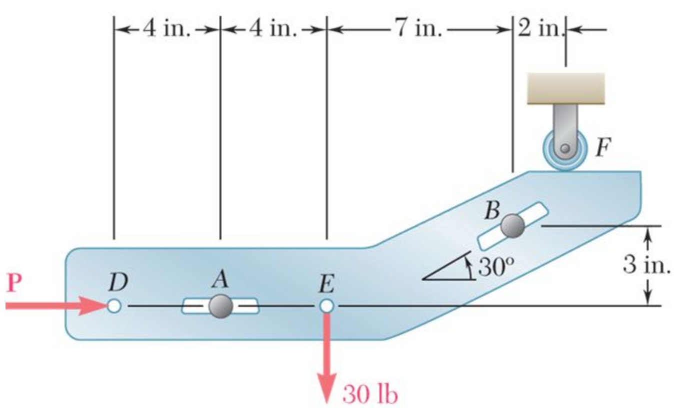


(C) Write the equations of equilibrium for the frame and solve for the support reactions at A and B.

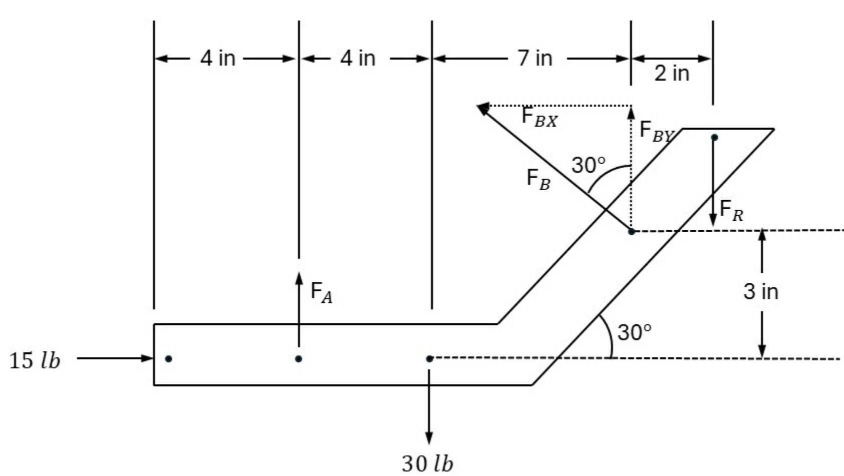
$$\sum F_x = 0 \implies F_{A_x} + F_{B_x} = 0 \implies F_{A_x} = -F_{B_x}$$
$$\sum F_y = 0 \implies -600 + F_{A_y} = 0 \implies F_{A_y} = 600\,\text{N}$$
$$\sum M_A = 0 \implies F_{B_x} * (2) - 600 * (1) = 0 \implies F_{B_x} = 300\,\text{N}$$

$$\boxed{F_{A_x} = -300\,\text{N}}$$

2) Two slots have been cut in plate DEF, and the plate has been placed so that the slots fit two fixed, frictionless pins A and B. Knowing that $P = 15$ lb.



(A) Draw a free-body diagram for the plate.



(B) Write the equations of equilibrium for the plate and determine the support reaction from the roller at F.

$$\sum F_x = 0 \implies 15 - F_B\ sin(30°) = 0 \implies F_B = \frac{15}{\sin(30°)} = 30\,\text{lb}$$
$$\sum M_A = 0 \implies -30 * (4) + F_B\ cos(30°) * (11) + F_B \sin(30°) * (3) - F_r * (13) = 0$$

$$\boxed{F_r = 16.21\,\text{lb}}$$

3) The bent rod AB has 2 force loadings supported at A and B as shown below.

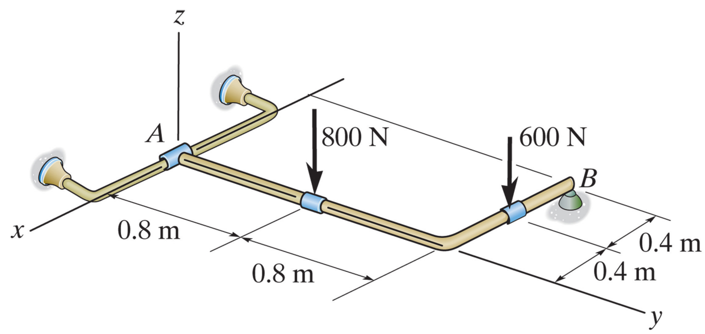


Figure: 05_P071

(A) What support reactions (force component(s) and/or couple moment) for the rod are possible at

(i) Fixed connect collar A?

F$_{Ay}, F_{Az}, M_{Ay}, M_{Az}$

(ii) Roller B?

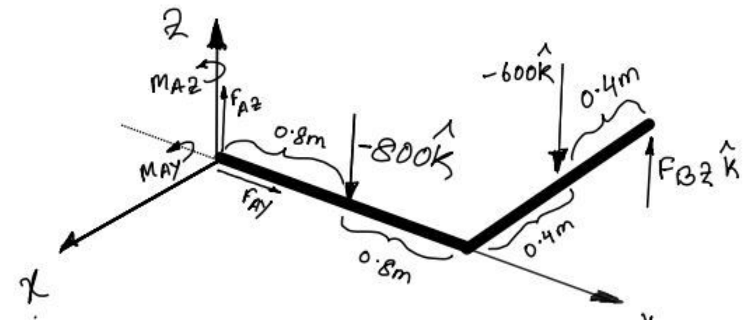
F$_{Bz}$

(B) Does AB have redundant constraints? Why or why not?

No.**Redundant constraints** are defined as supports/unnecessary supports that make the body statically indeterminate, i.e., more unknowns than equations.

In this case, we have 5 unknowns and 6 equations of equilibrium (EoE), where all the unknowns can be solved for.

(C) Draw a free-body diagram for rod AB.



(D) Determine the support reaction at B.

$$\sum M_{A_x} \implies -800 * (0.8) - 600 * (0.8 + 0.8) + F_{B_z}(1.6) = 0$$

$$\boxed{F_{B_z} = 1000\,\mathrm{N}}$$