TUTORIAL SESSION 3

PROBLEMS ON:

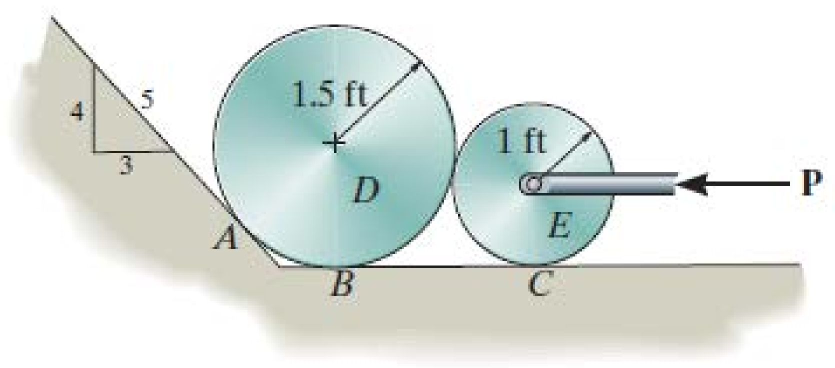
- REMAINING PROBLEMS: EQUILIBRIUM
- USING FREE BODY DIAGRAMS AND PRINCIPLES OF STATICS AND MECHANICS
- INTERNAL FORCES

The following problems have been taken from Engineering Mechanics: Statics – R. C. Hibbeler 13th edition

Q-1 – USING FBD IN EQUILIBRIUM PROBLEMS

5–22.

The smooth disks D and E have a weight of 200 lb and 100 lb, respectively. If a horizontal force of $P = 200$ lb is applied to the center of disk E, determine the normal reactions at the points of contact with the ground at A, B, and C.



SOLUTION

For disk E:

$$\xrightarrow{+} \Sigma F_x = 0; \qquad -P + N'\left(\frac{\sqrt{24}}{5}\right) = 0$$

$$+\uparrow \Sigma F_y = 0; \qquad N_C - 100 - N'\left(\frac{1}{5}\right) = 0$$

For disk D:

$$\xrightarrow{+} \Sigma F_x = 0; \qquad N_A\left(\frac{4}{5}\right) - N'\left(\frac{\sqrt{24}}{5}\right) = 0$$

$$+\uparrow \Sigma F_y = 0; \qquad N_A\left(\frac{3}{5}\right) + N_B - 200 + N'\left(\frac{1}{5}\right) = 0$$

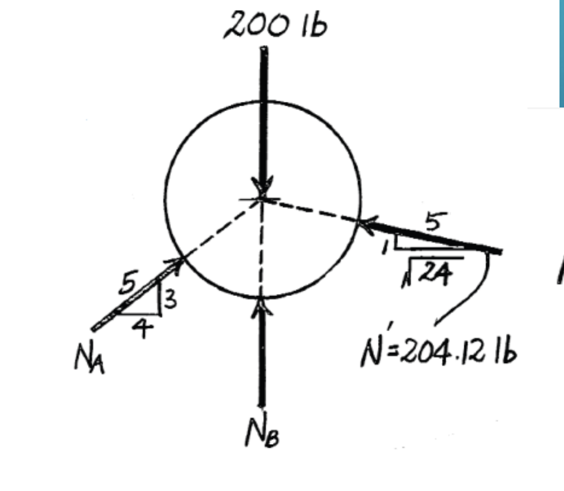
Set $P = 200$ lb and solve:

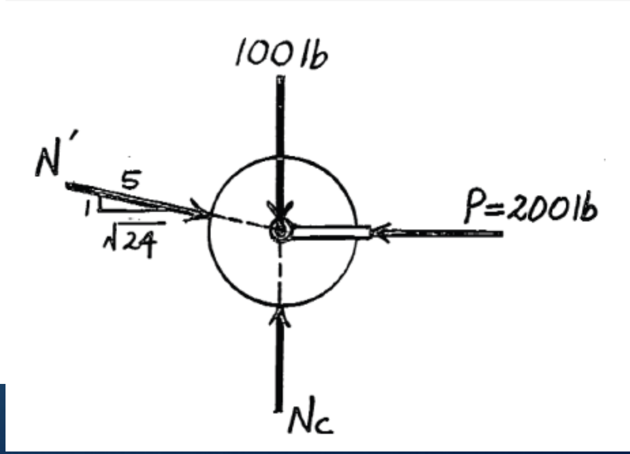
$$N' = 204.12 \text{ lb}$$

$$N_A = 250 \text{ lb}$$

$$N_B = 9.18 \text{ lb}$$

$$N_C = 141 \text{ lb}$$

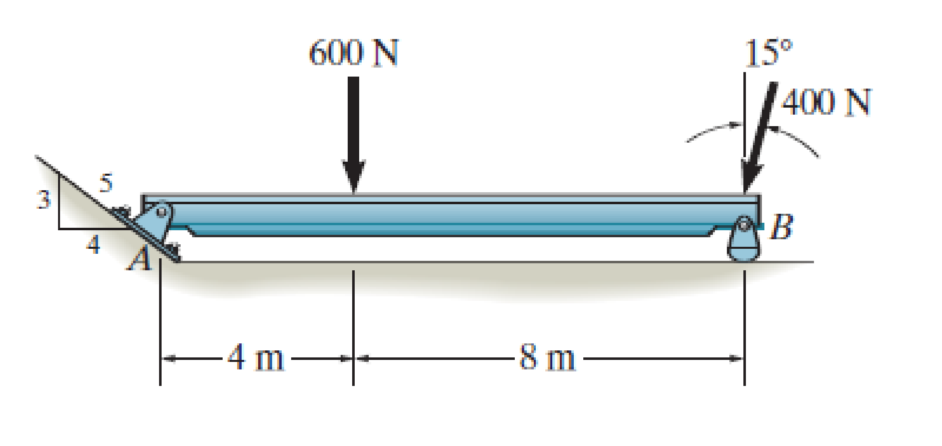




Q-2

5–11.

Determine the magnitude of the reactions on the beam at A and B. Neglect the thickness of the beam.



SOLUTION

$\circlearrowleft + \Sigma M_A = 0;$ $\quad B_y(12) - (400\cos 15°)(12) - 600(4) = 0$

$B_y = 586.37 = 586\text{ N}$

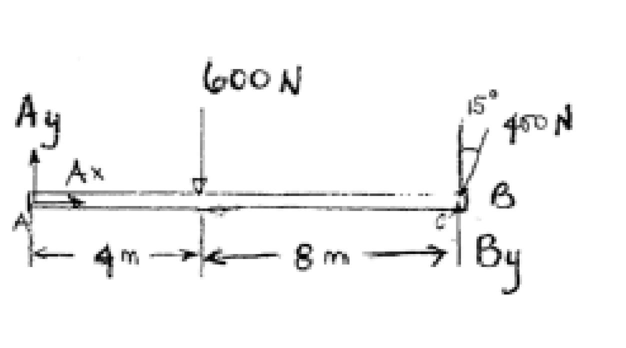
$\xrightarrow{+} \Sigma F_x = 0;$ $\quad A_x - 400\sin 15° = 0$

$A_x = 103.528\text{ N}$

$+\uparrow \Sigma F_y = 0;$ $\quad A_y - 600 - 400\cos 15° + 586.37 = 0$

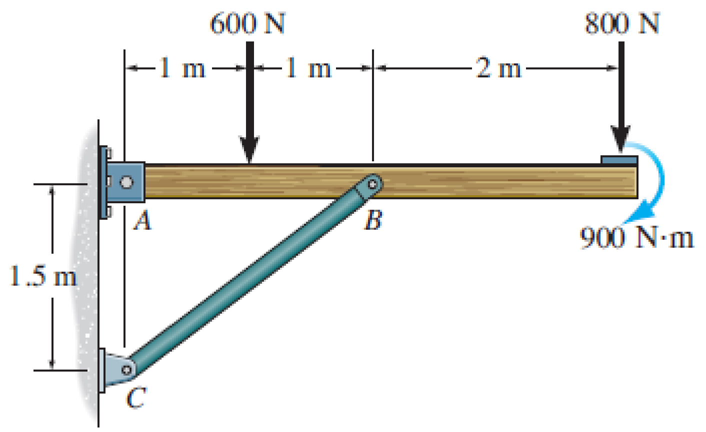
$A_y = 400\text{ N}$

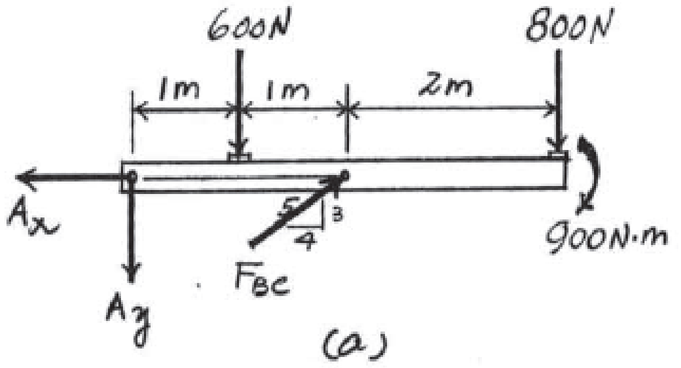
$F_A = \sqrt{(103.528)^2 + (400)^2} = 413\text{ N}$



Q-3 Assignment Problem

The overhanging beam is supported by a pin at *A* and the two-force strut *BC*. Determine the horizontal and vertical components of reaction at *A* and the reaction at *B* on the beam.

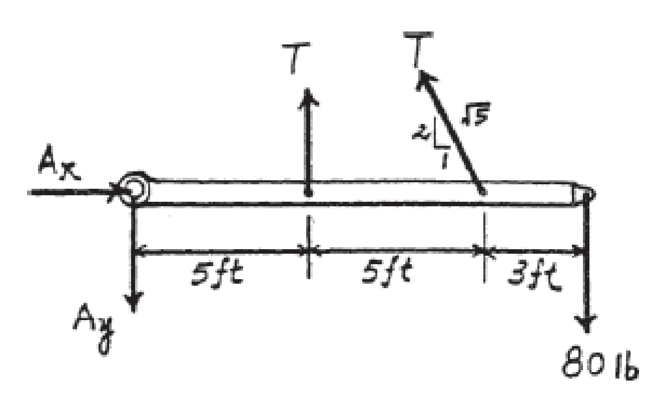


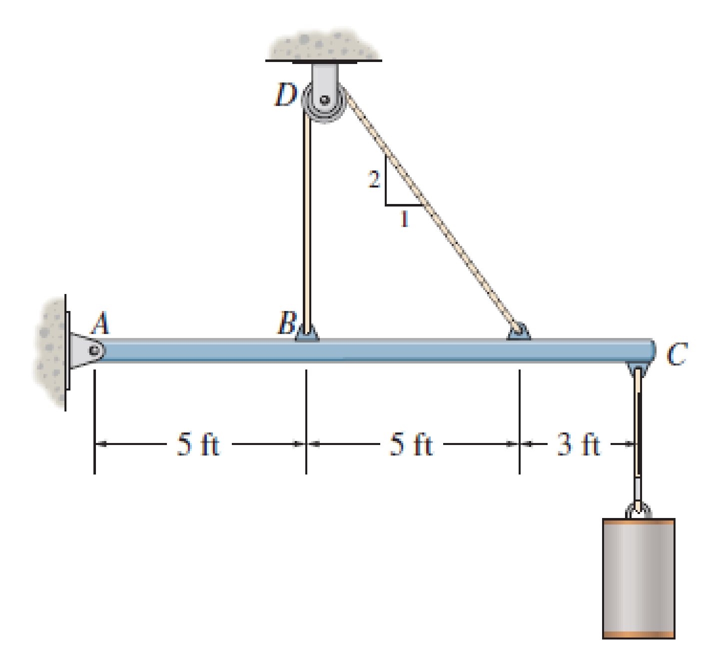


Q-4 Assignment Problem

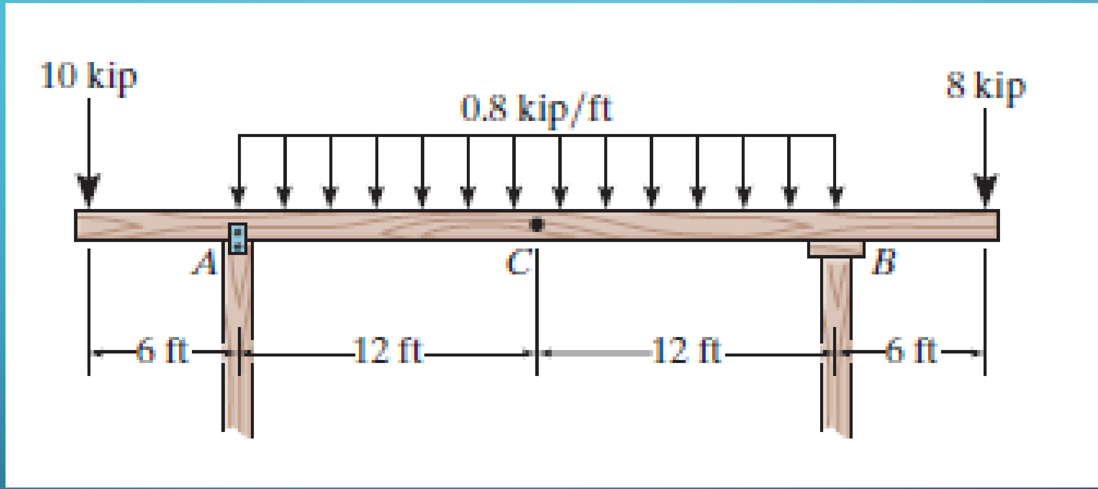
Determine the tension in the cable and the horizontal and vertical components of reaction of the pin A. The pulley at D is frictionless and the cylinder weighs 80 lb.

Solution





Q-5. Determine the normal force, shear force, and moment at a section passing through point C. Assume the support at A can be approximated by a pin and B as a roller.



SOLUTION

$\circlearrowleft + \Sigma M_A = 0;$ $\quad -19.2(12) - 8(30) + B_y(24) + 10(6) = 0$

$B_y = 17.1 \text{ kip}$

$\overset{+}{\rightarrow} \Sigma F_x = 0;$ $\quad A_x = 0$

$+\uparrow \Sigma F_y = 0;$ $\quad A_y - 10 - 19.2 + 17.1 - 8 = 0$

$A_y = 20.1 \text{ kip}$

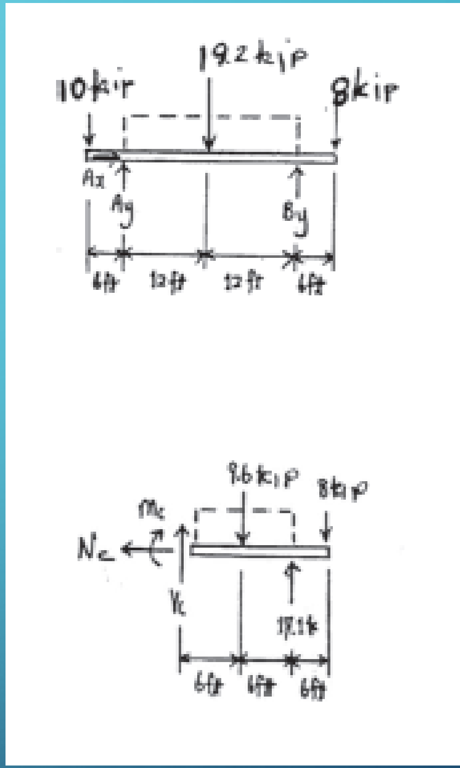
$\overset{+}{\rightarrow} \Sigma F_x = 0;$ $\quad N_C = 0$

$+\uparrow \Sigma F_y = 0;$ $\quad V_C - 9.6 + 17.1 - 8 = 0$

$V_C = 0.5 \text{ kip}$

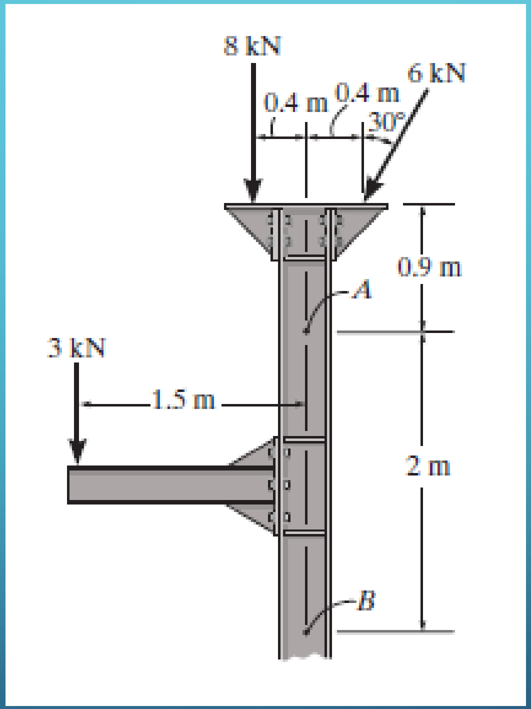
$\circlearrowleft + \Sigma M_C = 0;$ $\quad -M_C - 9.6(6) + 17.1(12) - 8(18) = 0$

$M_C = 3.6 \text{ kip} \cdot \text{ft}$



Q-6.

Determine the internal normal force, shear force, and moment at points *A* and *B* in the column.



SOLUTION

Applying the equation of equilibrium to Fig. *a* gives

$\xrightarrow{+} \Sigma F_x = 0; \quad V_A - 6 \sin 30^\circ = 0 \quad V_A = 3 \text{ kN}$ **Ans.**

$+\uparrow \Sigma F_y = 0; \quad N_A - 6 \cos 30^\circ - 8 = 0 \quad N_A = 13.2 \text{ kN}$ **Ans.**

$\circlearrowleft + \Sigma M_A = 0; \quad 8(0.4) + 6 \sin 30^\circ(0.9) - 6 \cos 30^\circ(0.4) - M_A = 0$

$M_A = 3.82 \text{ kN} \cdot \text{m}$ **Ans.**

and to Fig. *b*,

$\xrightarrow{+} \Sigma F_x = 0; \quad V_B - 6 \sin 30^\circ = 0 \quad V_B = 3 \text{ kN}$ **Ans.**

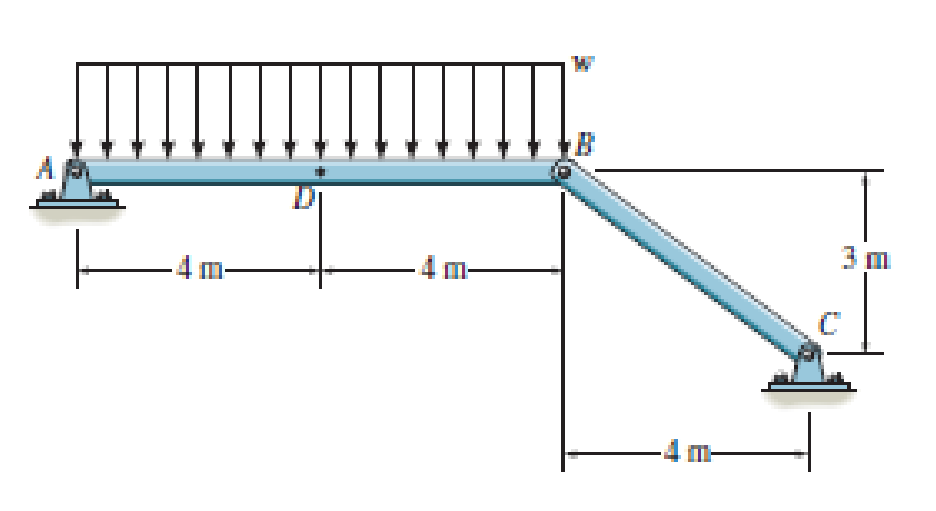
$+\uparrow \Sigma F_y = 0; \quad N_B - 3 - 8 - 6 \cos 30^\circ = 0 \quad N_B = 16.2 \text{ kN}$ **Ans.**

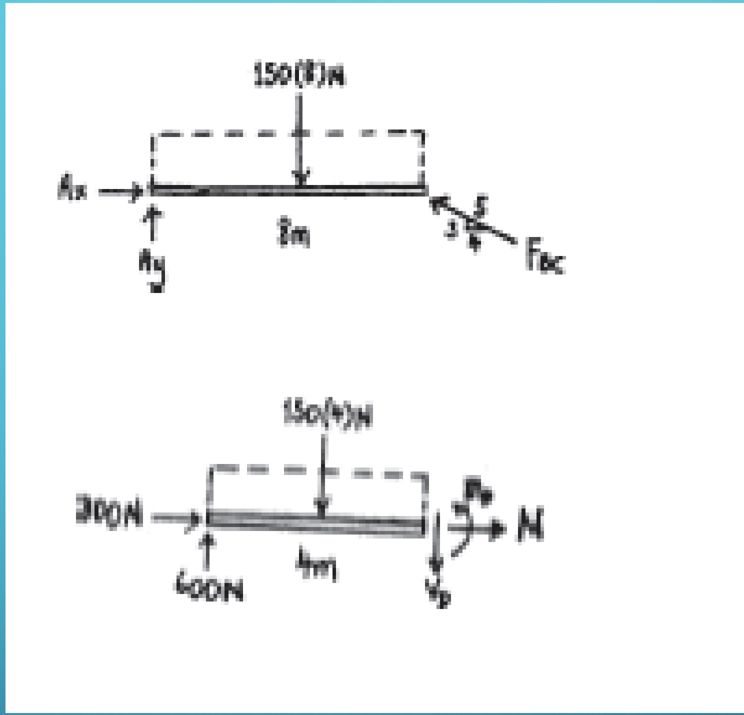
$\circlearrowleft + \Sigma M_B = 0; \quad 3(1.5) + 8(0.4) + 6 \sin 30^\circ(2.9) - 6 \cos 30^\circ(0.4) - M_B = 0$

$M_B = 14.3 \text{ kN} \cdot \text{m}$ **Ans.**

Q-7. Assignment Problem

Determine the normal force, shear force, and moment at a section passing through point D. Take $w = 150$ N/m.




150(8)N
Ax
Ay
8m
5
3
4
FBC
150(4)N
300N
600N
4m
MD
N
VD