LECTURE # 6

In this lecture you will learn about:

Numerical:

- Equilibrium of Rigid Bodies.

Course Name:

“Applied Mechanics”

Course Code: CT-144

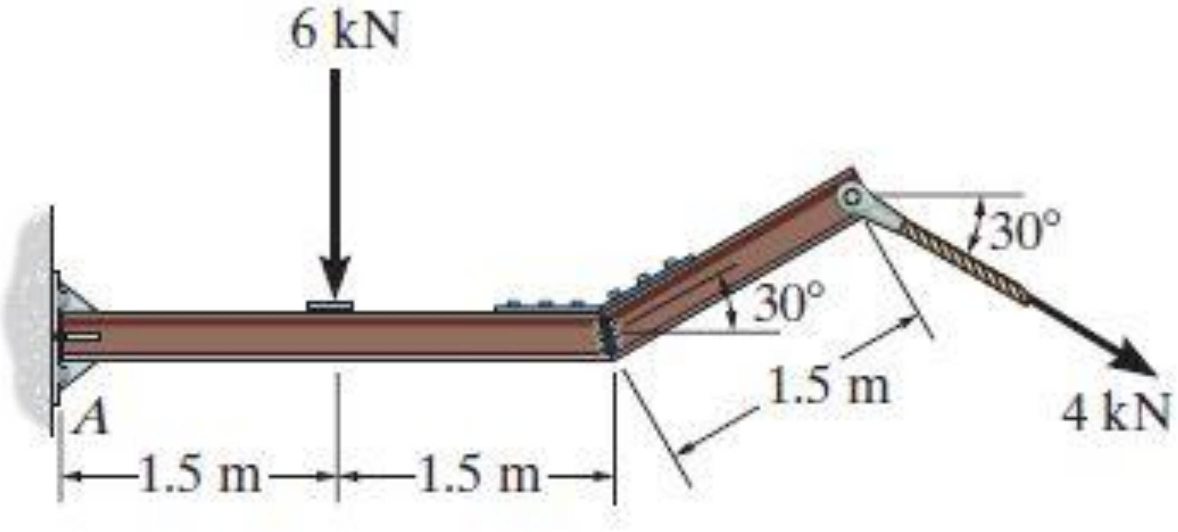
Credit Hours: 3

Semester: Summer 2020

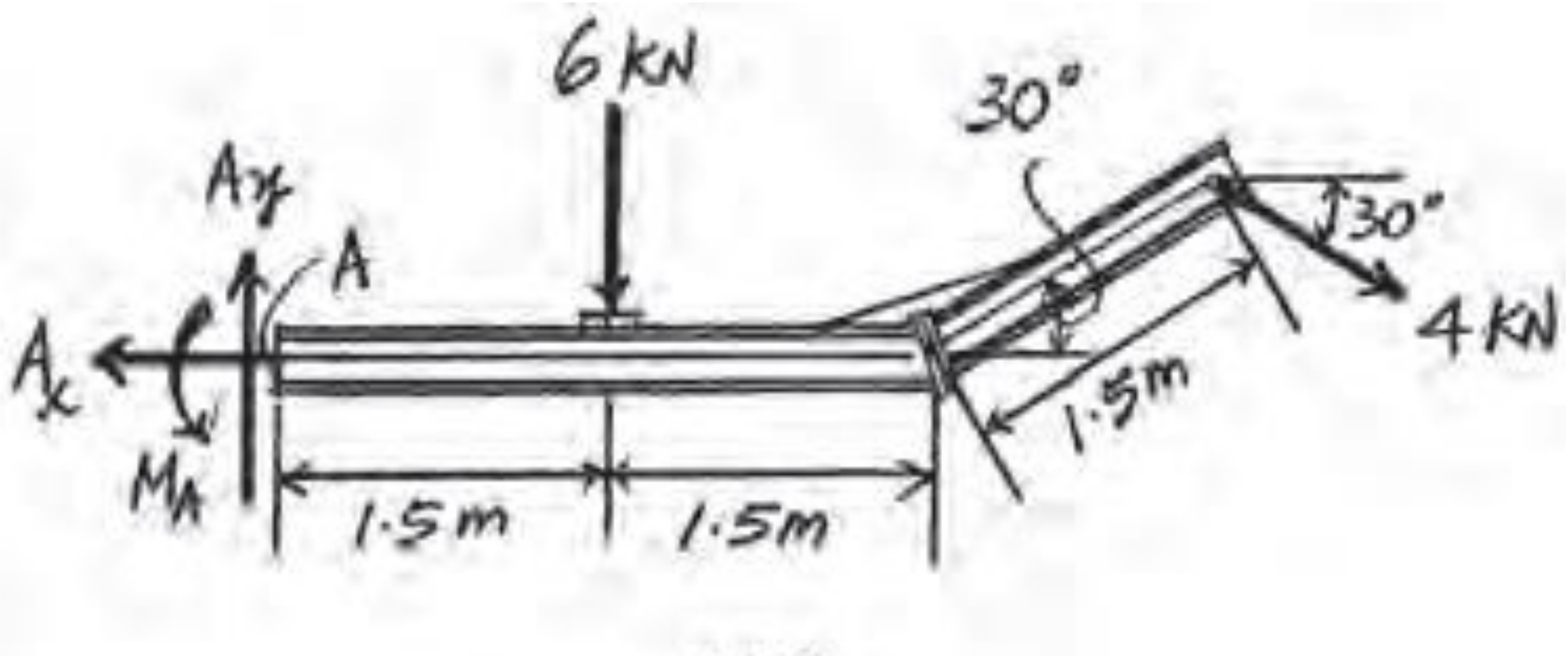
Prepared By: Engr. Khurshid Alam

PROBLEM # 1

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



SOLUTION



(a)

SOLUTION

Equations of Equilibrium: From the free-body diagram of the cantilever beam, A_x, A_y, and M_A can be obtained by writing the moment equation of equilibrium about point A.

$$\overset{+}{\rightarrow} \Sigma F_x = 0; \qquad 4\cos 30^\circ - A_x = 0$$

$$A_x = 3.46 \text{ kN} \qquad \textbf{Ans.}$$

$$+\uparrow \Sigma F_y = 0; \qquad A_y - 6 - 4\sin 30^\circ = 0$$

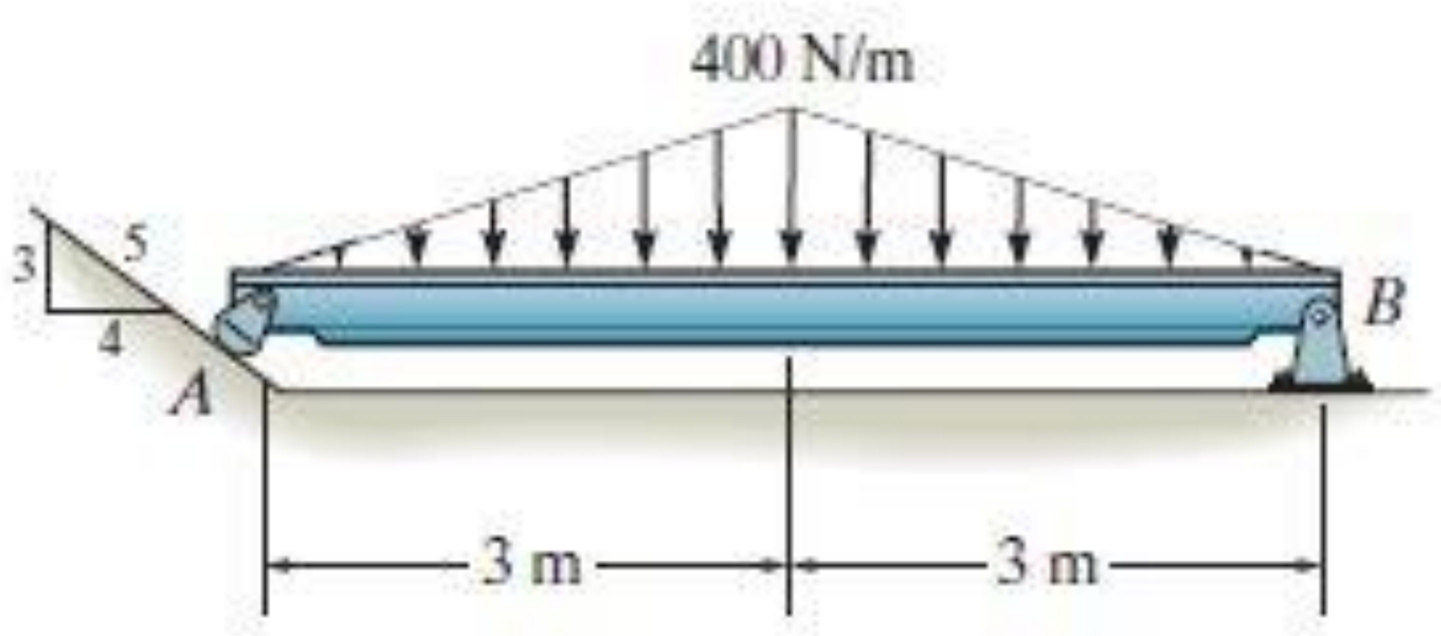
$$A_y = 8 \text{ kN} \qquad \textbf{Ans.}$$

$$\circlearrowleft + \Sigma M_A = 0; M_A - 6(1.5) - 4\cos 30^\circ\,(1.5\sin 30^\circ) - 4\sin 30^\circ(3 + 1.5\cos 30^\circ) = 0$$

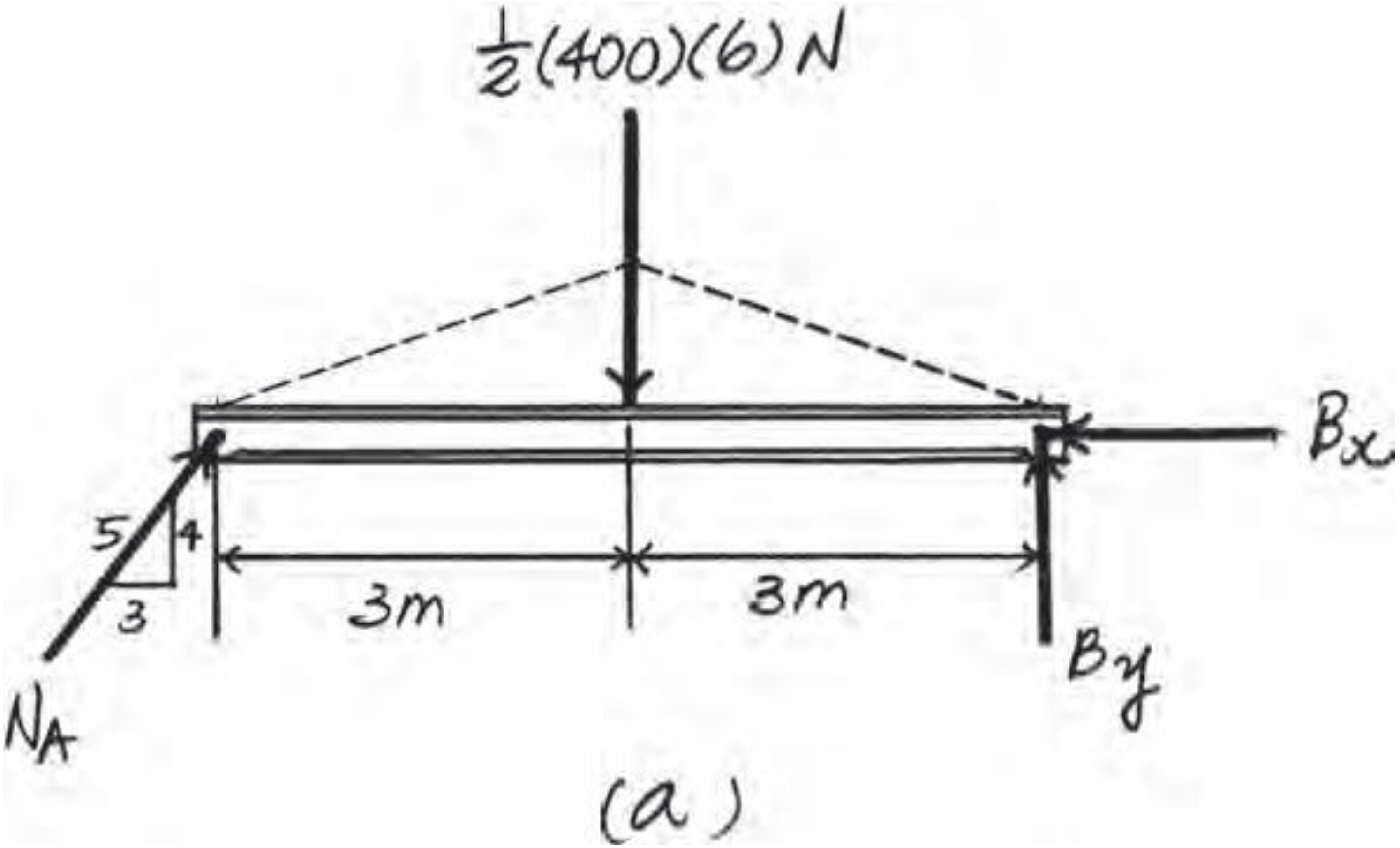
$$M_A = 20.2 \text{ kN}\cdot\text{m} \qquad \textbf{Ans.}$$

PROBLEM # 2

- Determine the reactions at the supports.



SOLUTION



SOLUTION

Equations of Equilibrium. $\mathbf{N}_A$ and $\mathbf{B}_y$ can be determined directly by writing the moment equations of equilibrium about points B and A, respectively, by referring to the beam's FBD shown in Fig. a.

$$\zeta + \Sigma M_B = 0; \qquad \frac{1}{2}(400)(6)(3) - N_A\left(\frac{4}{5}\right)(6) = 0$$

$$N_A = 750 \text{ N} \qquad \textbf{Ans.}$$

$$\zeta + \Sigma M_A = 0; \qquad B_y(6) - \frac{1}{2}(400)(6)(3) = 0$$

$$B_y = 600 \text{ N} \qquad \textbf{Ans.}$$

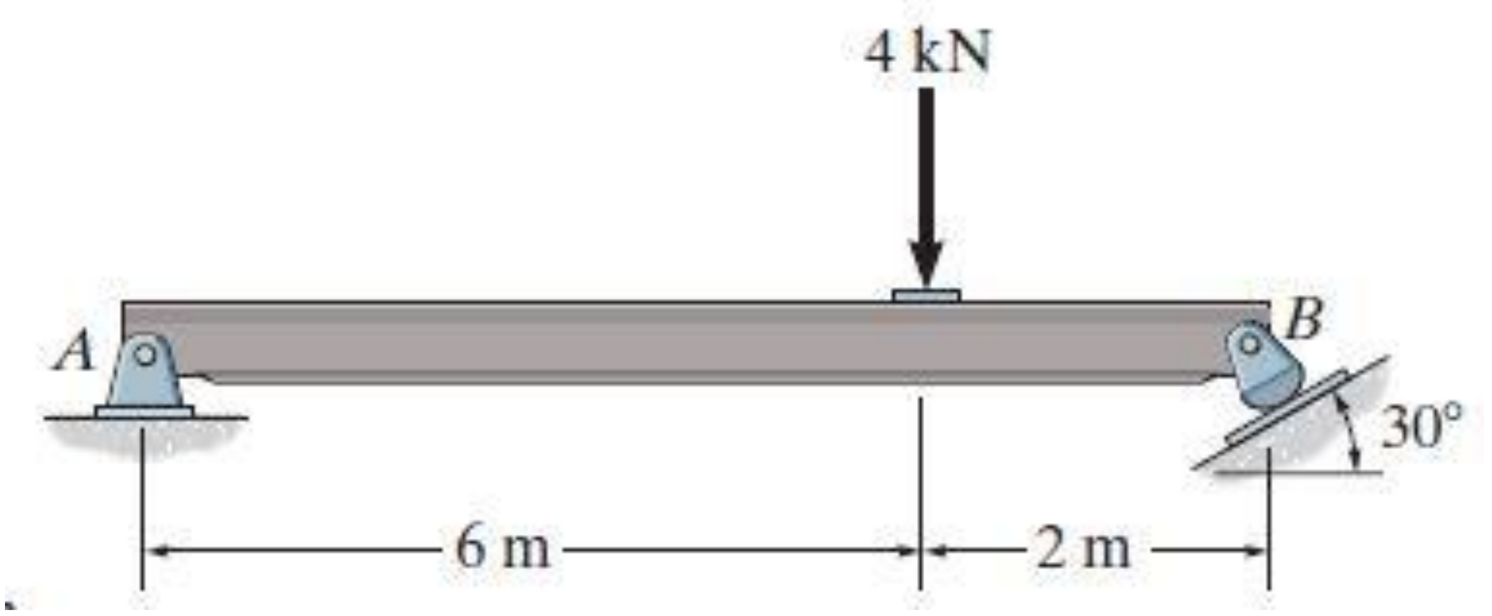
Using the result of $\mathbf{N}_A$ to write the force equation of equilibrium along the x axis,

$$\xrightarrow{+} \Sigma F_x = 0; \qquad 750\left(\frac{3}{5}\right) - B_x = 0$$

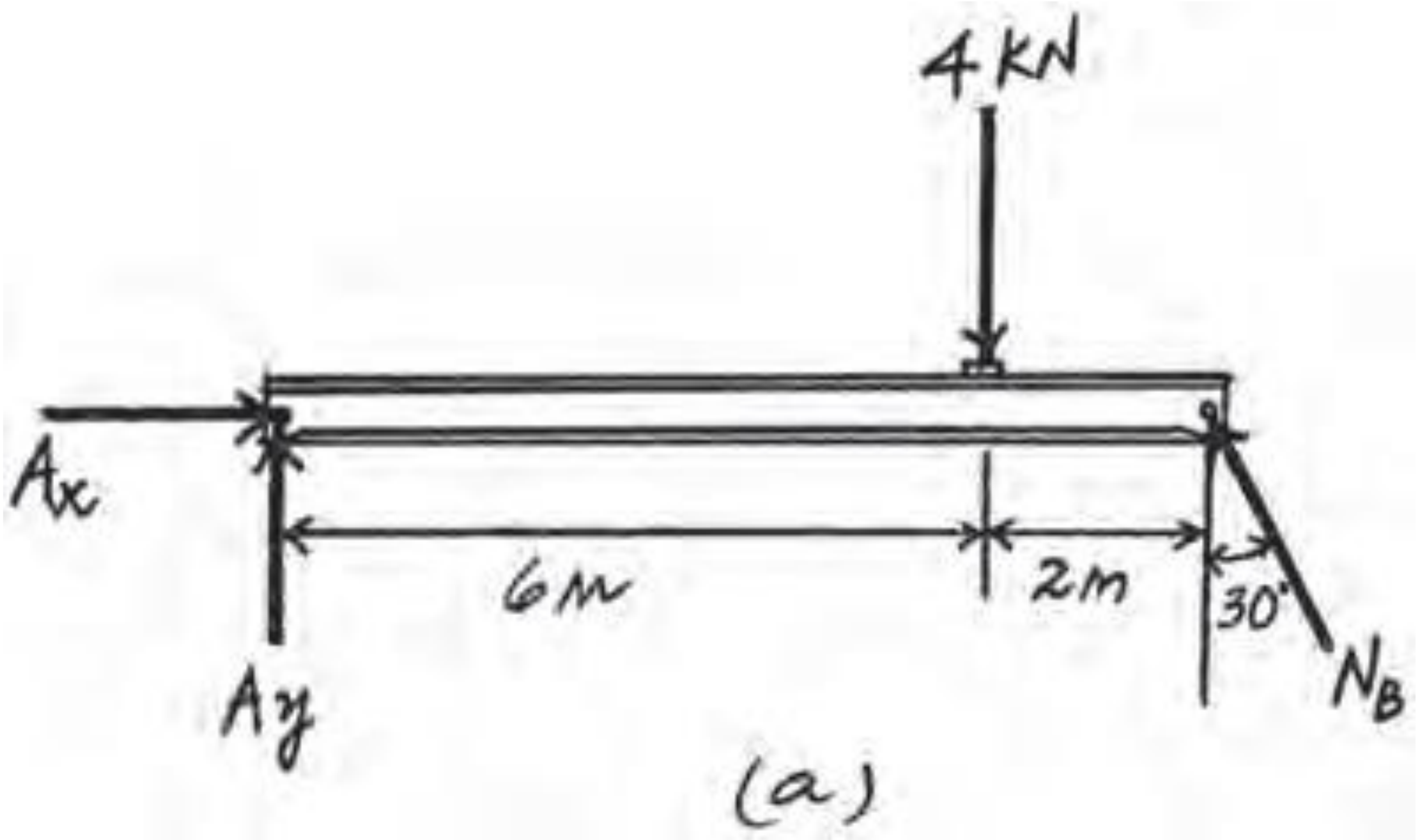
$$B_x = 450 \text{ N} \qquad \textbf{Ans.}$$

PROBLEM # 3

- Determine the horizontal and vertical components of reaction at the pin *A* and the reaction of the rocker *B* on the beam.



SOLUTION



SOLUTION

Equations of Equilibrium: From the free-body diagram of the beam, Fig. a, N_B can be obtained by writing the moment equation of equilibrium about point A.

$\circlearrowleft + \Sigma M_A = 0;$ $\quad N_B \cos 30°(8) - 4(6) = 0$

$N_B = 3.464 \text{ kN} = 3.46 \text{ kN}$ **Ans.**

Using this result and writing the force equations of equilibrium along the x and y axes, we have

$\overset{+}{\rightarrow} \Sigma F_x = 0;$ $\quad A_x - 3.464 \sin 30° = 0$

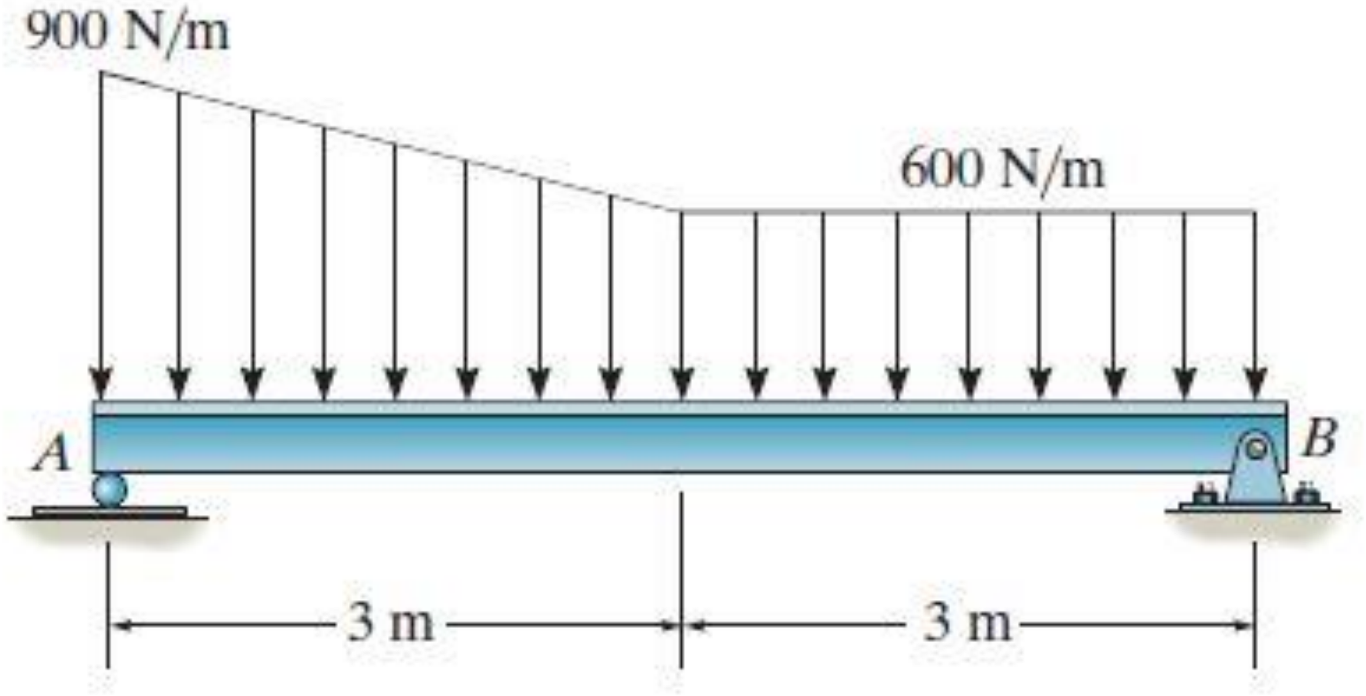
$A_x = 1.73 \text{ kN}$ **Ans.**

$+\uparrow \Sigma F_y = 0;$ $\quad A_y + 3.464 \cos 30° - 4 = 0$

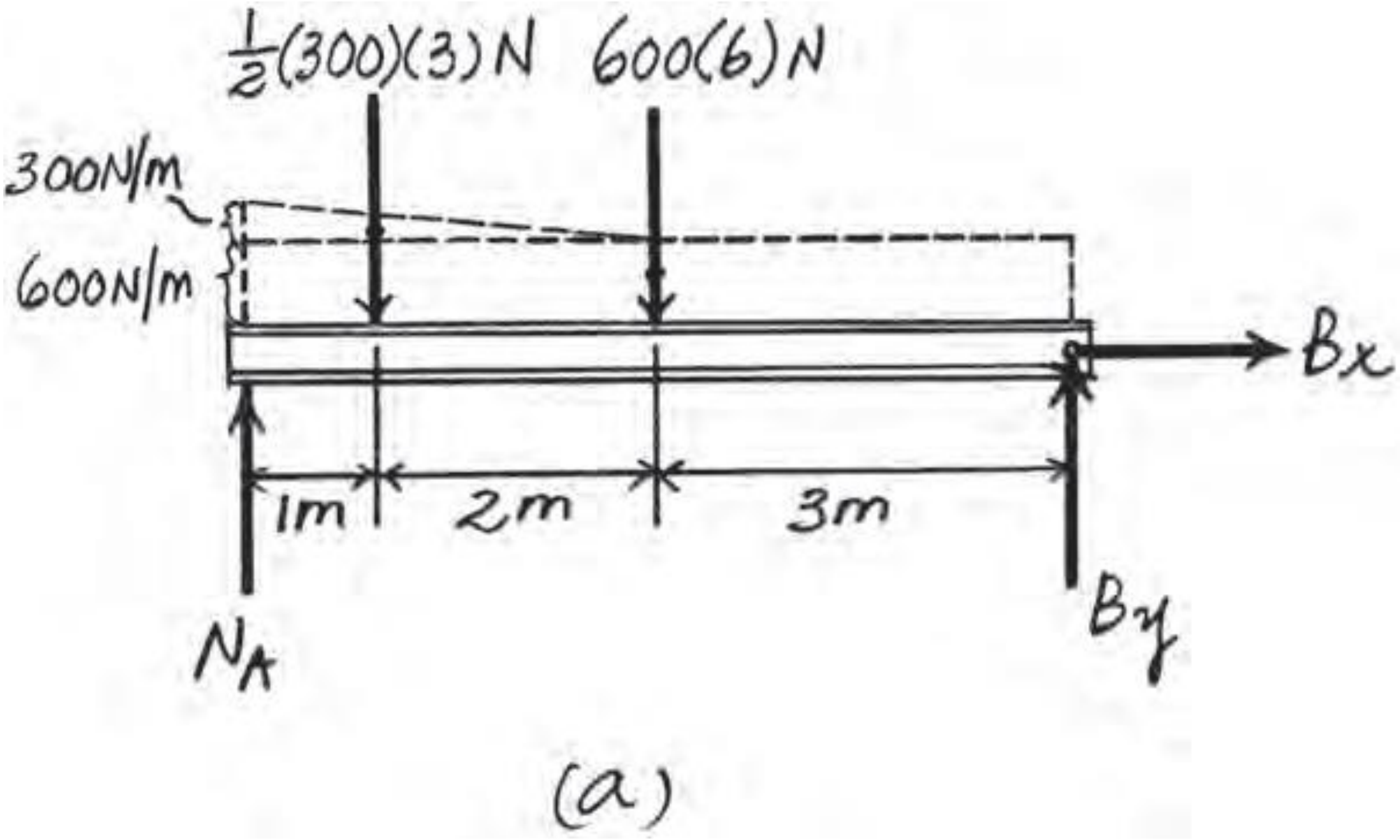
$A_y = 1.00 \text{ kN}$ **Ans.**

PROBLEM # 4

- Determine the reactions at the supports.



SOLUTION



SOLUTION

Equations of Equilibrium. $\mathbf{N}_A$ and $\mathbf{B}_y$ can be determined directly by writing the moment equations of equilibrium about points B and A, respectively, by referring to the FBD of the beam shown in Fig. a.

$$\circlearrowleft + \Sigma M_B = 0; \qquad 600(6)(3) + \frac{1}{2}(300)(3)(5) - N_A(6) = 0$$

$$N_A = 2175 \text{ N} = 2.175 \text{ kN} \qquad \textbf{Ans.}$$

$$\circlearrowleft + \Sigma M_A = 0; \qquad B_y(6) - \frac{1}{2}(300)(3)(1) - 600(6)(3) = 0$$

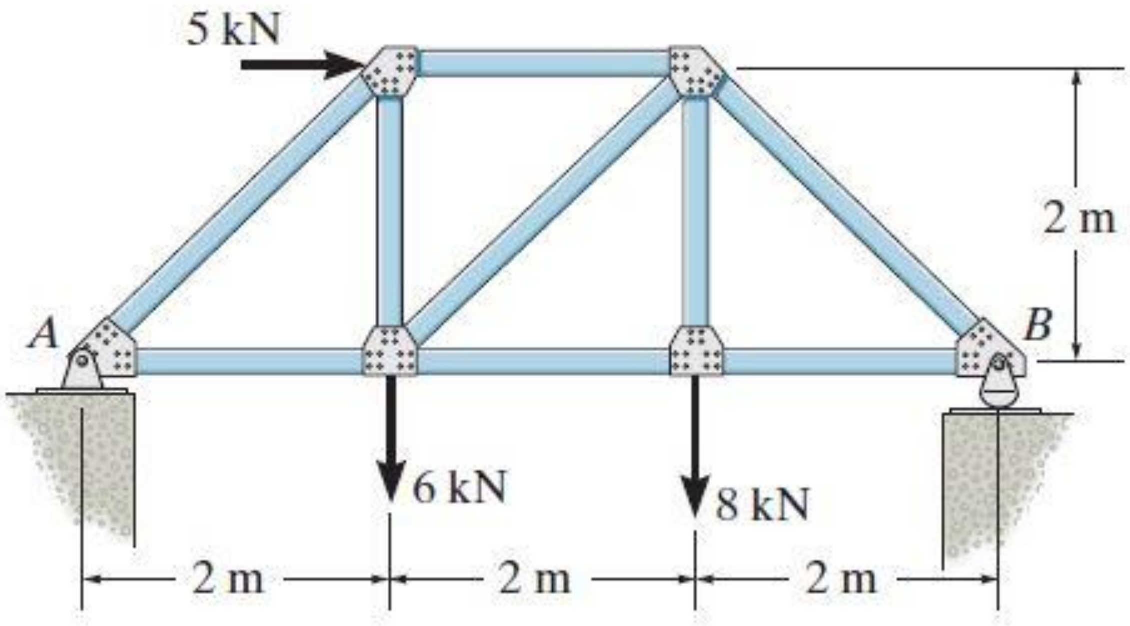
$$B_y = 1875 \text{ N} = 1.875 \text{ kN} \qquad \textbf{Ans.}$$

Also, $\mathbf{B}_x$ can be determined directly by writing the force equation of equilibrium along the x axis.

$$\xrightarrow{+} \Sigma F_x = 0; \qquad B_x = 0 \qquad \textbf{Ans.}$$

PROBLEM # 5

- Determine the reactions at the supports.



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SOLUTION

Equations of Equilibrium. $\mathbf{A}_y$ and $\mathbf{N}_B$ can be determined by writing the moment equations of equilibrium about points B and A, respectively, by referring to the FBD of the truss shown in Fig. a.

$$\zeta+\Sigma M_B = 0; \qquad 8(2) + 6(4) - 5(2) - A_y(6) = 0$$

$$A_y = 5.00 \text{ kN} \qquad \textbf{Ans.}$$

$$\zeta+\Sigma M_A = 0; \qquad N_B(6) - 8(4) - 6(2) - 5(2) = 0$$

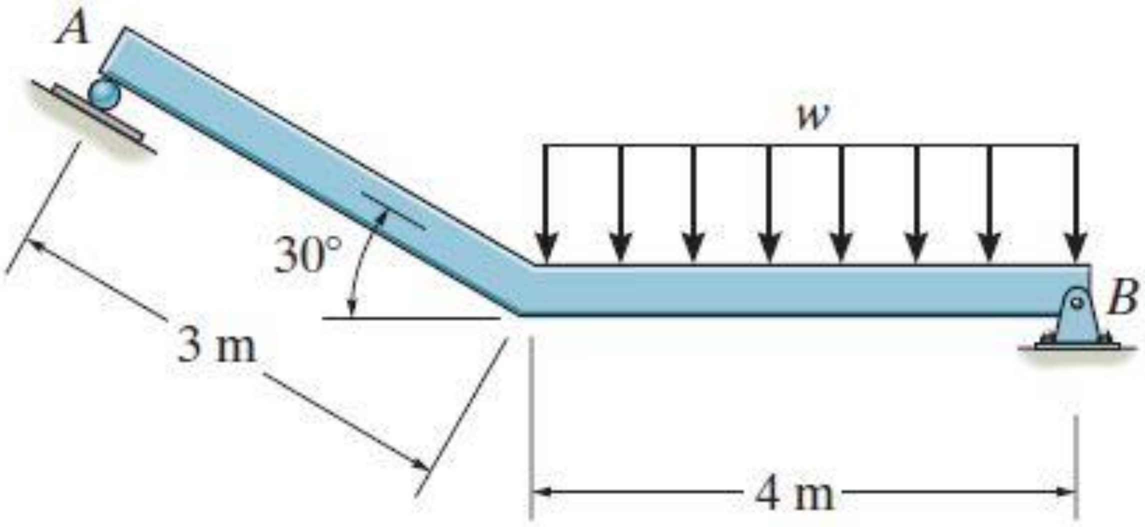
$$N_B = 9.00 \text{ kN} \qquad \textbf{Ans.}$$

Also, $\mathbf{A}_x$ can be determined directly by writing the force equation of equilibrium along x axis.

$$\overset{+}{\rightarrow}\Sigma F_x = 0; \qquad 5 - A_x = 0 \qquad A_x = 5.00 \text{ kN} \qquad \textbf{Ans.}$$

PROBLEM # 6

- If the intensity of the distributed load acting on the beam is *w* = 3 kN/m, determine the reactions at the roller *A* and pin *B*.



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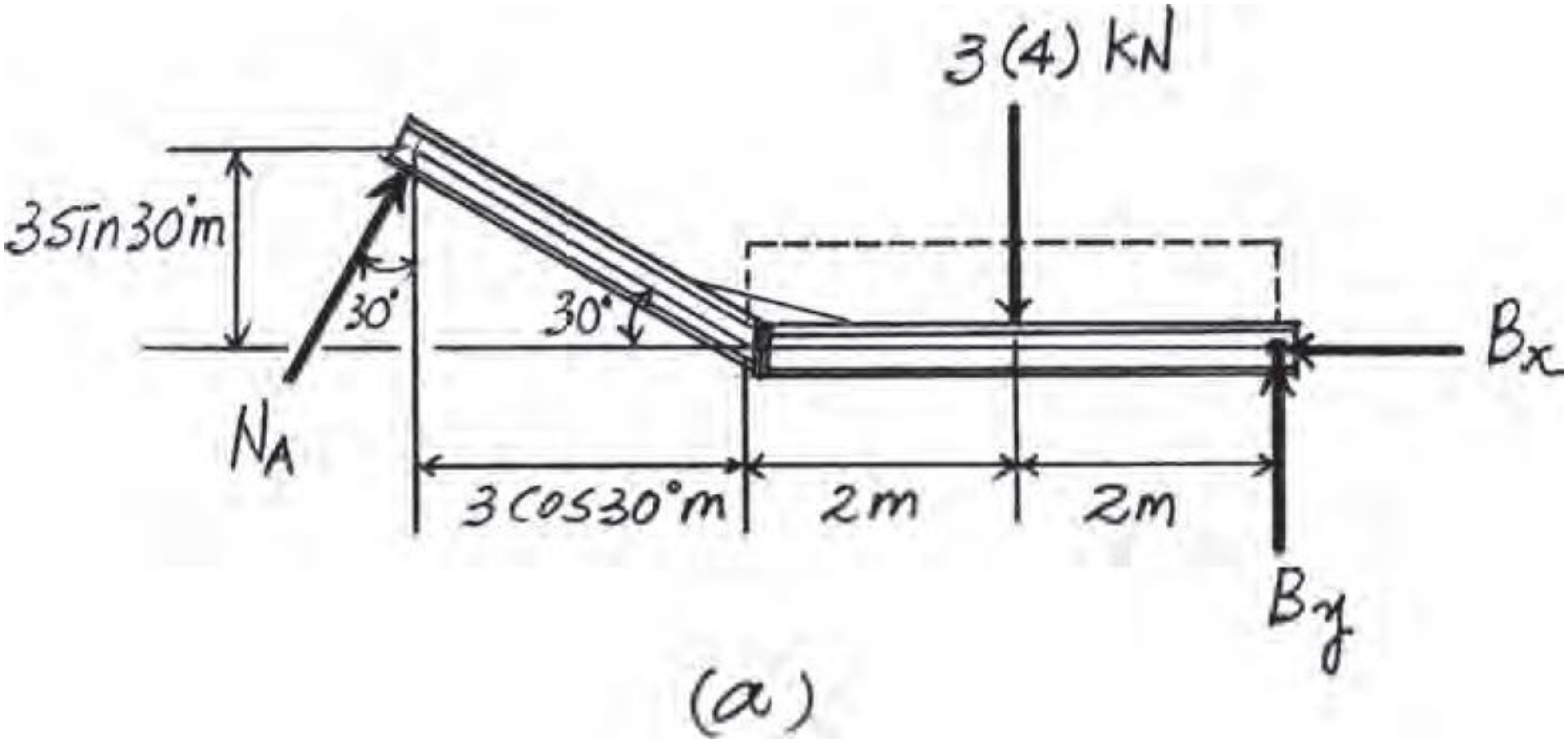
SOLUTION



SOLUTION

Equations of Equilibrium. $\mathbf{N}_A$ can be determined directly by writing the moment equation of equilibrium about point B by referring to the *FBD* of the beam shown in Fig. *a*.

$$\circlearrowleft + \Sigma M_B = 0; \qquad 3(4)(2) - N_A \sin 30° \, (3 \sin 30°) - N_A \cos 30° \, (3 \cos 30° + 4) = 0$$

$$N_A = 3.713 \text{ kN} = 3.71 \text{ kN} \qquad \textbf{Ans.}$$

Using this result to write the force equation of equilibrium along the x and y axes,

$$\overset{+}{\rightarrow} \Sigma F_x = 0; \qquad 3.713 \sin 30° - B_x = 0$$

$$B_x = 1.856 \text{ kN} = 1.86 \text{ kN} \qquad \textbf{Ans.}$$

$$+\uparrow \Sigma F_y = 0; \qquad B_y + 3.713 \cos 30° - 3(4) = 0$$

$$B_y = 8.7846 \text{ kN} = 8.78 \text{ kN} \qquad \textbf{Ans.}$$

Thank You