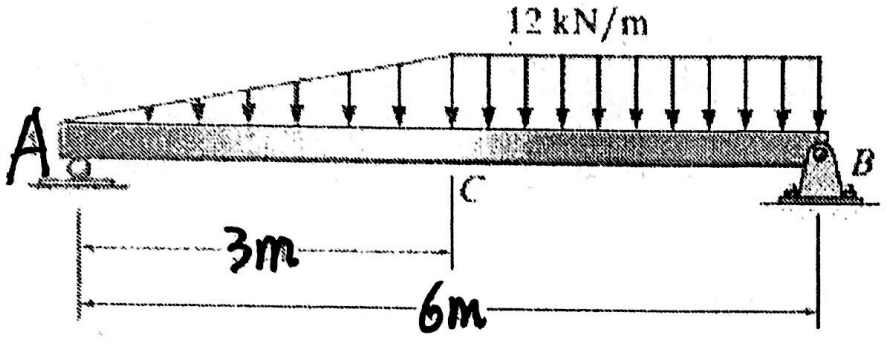
Chinese Name: Kay English Name: _____

ID#: _____

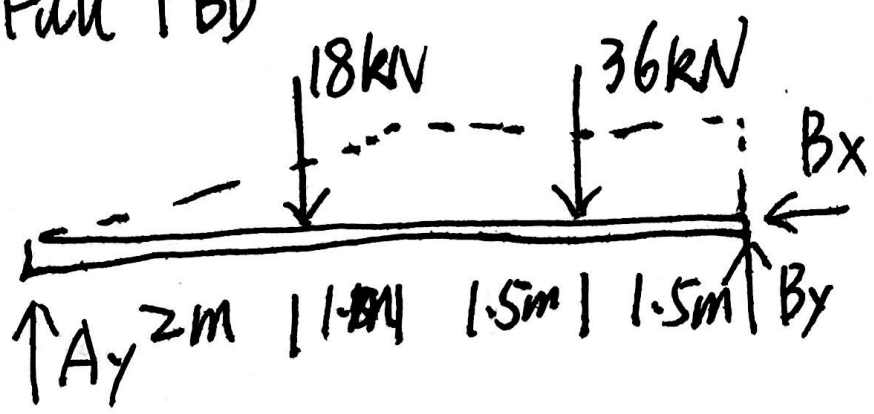
ENSC 2113 – Fall 2023 – EXAM #3

EACH PROBLEM IS WORTH THE POINTS INDICATED. BOX YOUR ANSWERS AND PROVIDE PROPER UNITS, WHERE APPLICABLE. CALCULATIONS AND FREE BODY DIAGRAMS MUST BE SHOWN THAT SUPPORT THE ANSWER TO RECEIVE CREDIT.

1. Determine the internal shear, moment, and axial force at point C. Point A is a roller and point B is a pin. Draw all pertinent free-body diagrams. 20 POINTS



Full FBD

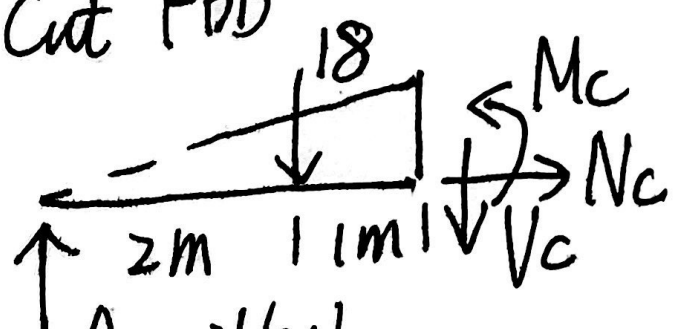


$\sum M_B(\bar{F}) = 0$

$36 \times 1.5 + 18 \times 4 - Ay \times 6 = 0$

$Ay = 21\ kN$

Cut FBD



$\sum F_x = 0$ $\boxed{Nc = 0}$

$\sum F_y = 0$ $Ay - 18 - Vc = 0$

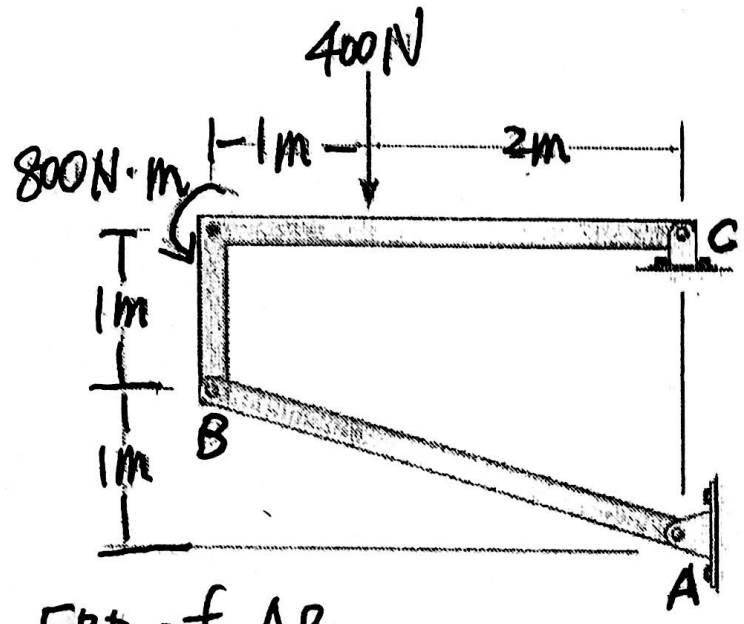
$\boxed{Vc = 3kN}$

$\sum M_c(\bar{F}) = 0 = Mc + 18 \times 1 - Ay \times 3$

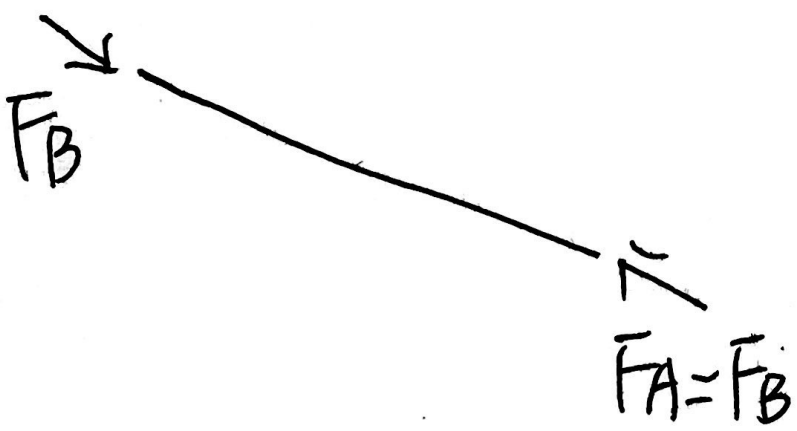
$Mc = 21 \times 3 - 18 = 45\ kN \cdot m$

$\boxed{Mc = 45\ kN \cdot m}$

2. The frame below consists of two members, AB and CB. Determine the external support reactions at the pins A and C. Indicate direction in your answer with directional arrows and draw any pertinent free-body diagrams. 30 POINTS

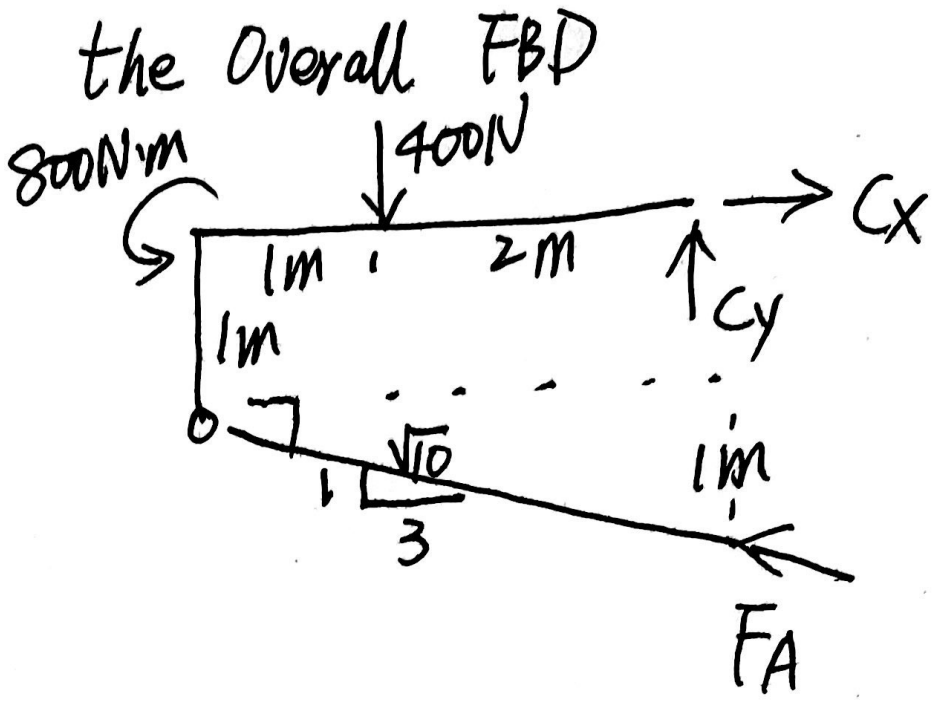


FBD of AB



AB is a 2-F-M.

the Overall FBD



$\Sigma M_A(\bar{F}) = 0$

$-C_x \cdot 2 + 400 \cdot 2 + 800 = 0$

$\boxed{C_x = 800N \rightarrow}$

$\Sigma F_x = 0$

$C_x - F_A \cdot \frac{3}{\sqrt{10}} = 0$

$\boxed{F_A = \frac{800\sqrt{10}}{3} = 843.3N (\swarrow)}$

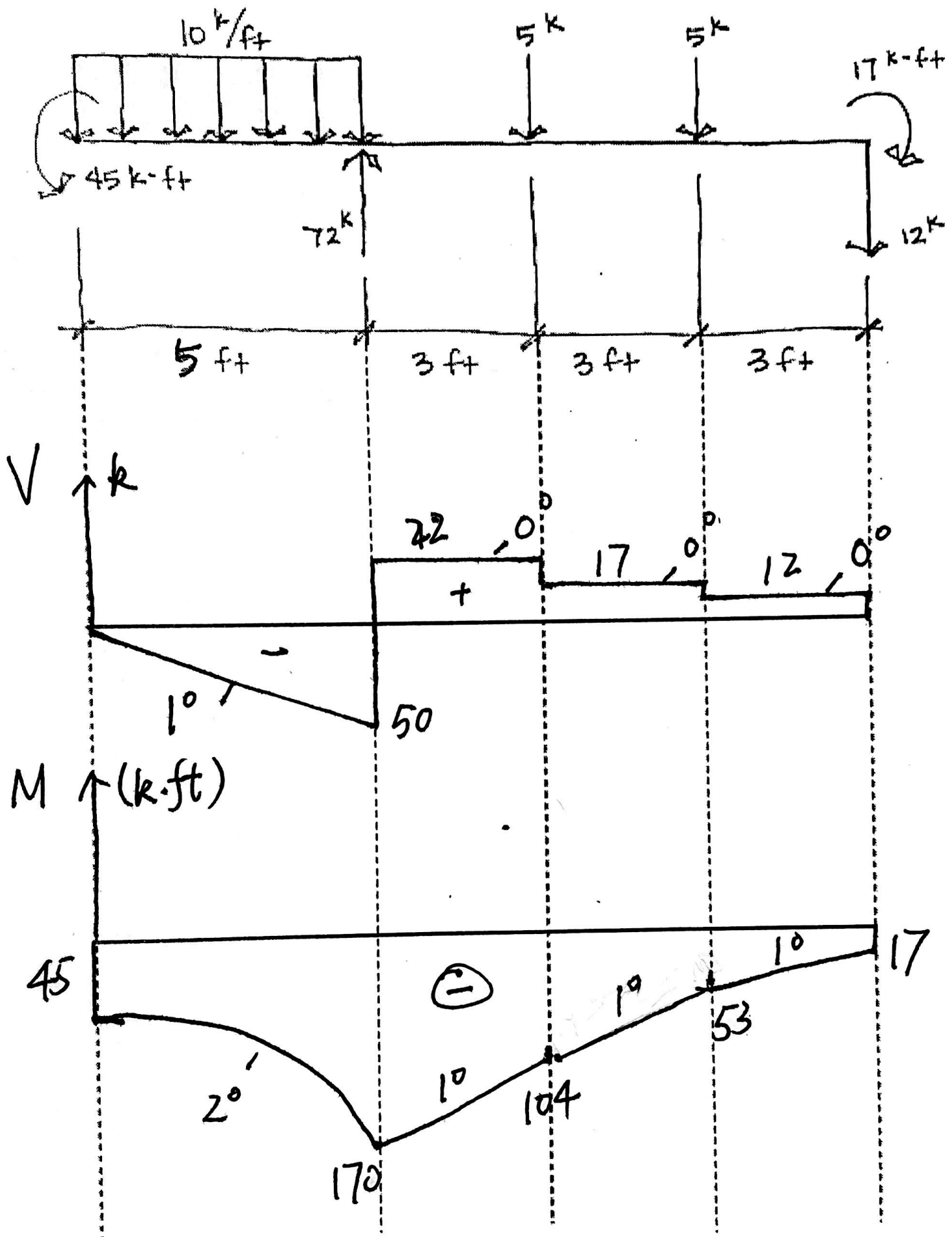
or $\boxed{A_x = 800N (\leftrightarrow)}$ $\boxed{A_y = 266.7 (\uparrow)}$

$\Sigma F_y = 0$

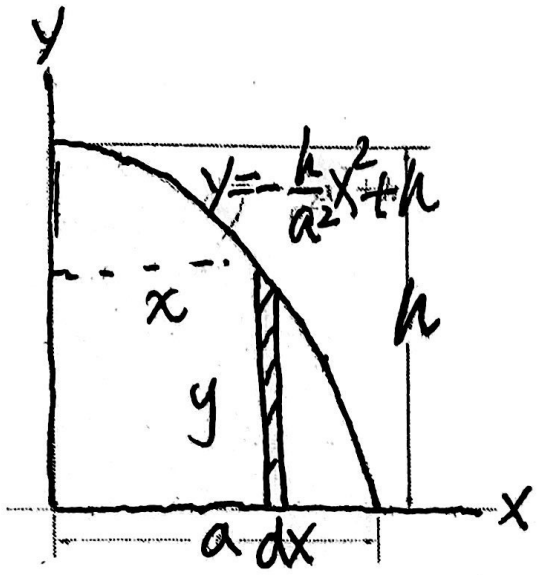
$C_y + F_A \frac{1}{\sqrt{10}} - 400 = 0$

$\boxed{C_y = F_A \frac{1}{\sqrt{10}} + 400 = 133.3N (\uparrow)}$

3. Draw the shear and bending moment diagrams for the loading condition below. Label all diagrams appropriately. 30 POINTS



4. Determine the moment of inertia of the shaded area about the y-axis by integration. State which method of integration is used and label the diagram accordingly. 20 POINTS



$$dA = y\,dx = \left(-\frac{h}{a^2}x^2+h\right)dx$$

$$I_y = \int_A x^2\,dA$$

$$= \int_0^a x^2\left(-\frac{h}{a^2}x^2+h\right)dx$$

$$= \int_0^a \left(-\frac{h}{a^2}x^4 + x^2h\right)dx$$

$$= \left(-\frac{h}{5a^2}x^5 + \frac{x^3}{3}h\right)\Big|_0^a$$

$$= \frac{2}{15}ah^3$$

$$\boxed{I_y = \frac{2}{15}ah^3}$$