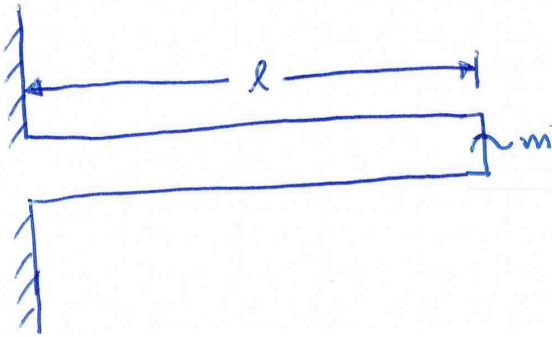
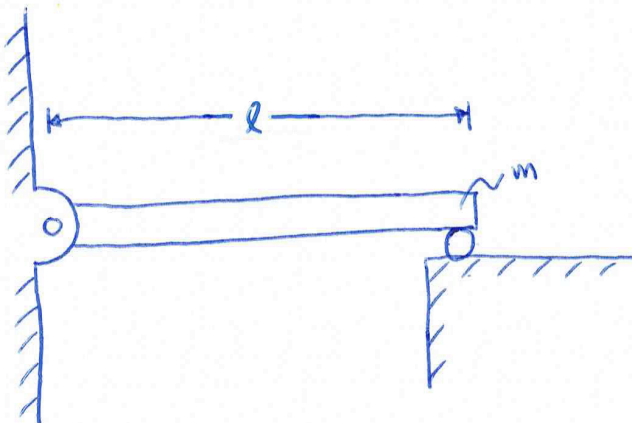


Determine the shear, axial and bending moment equations for



$$l = 10 \text{ m}$$
$$m = 100 \text{ kg}$$

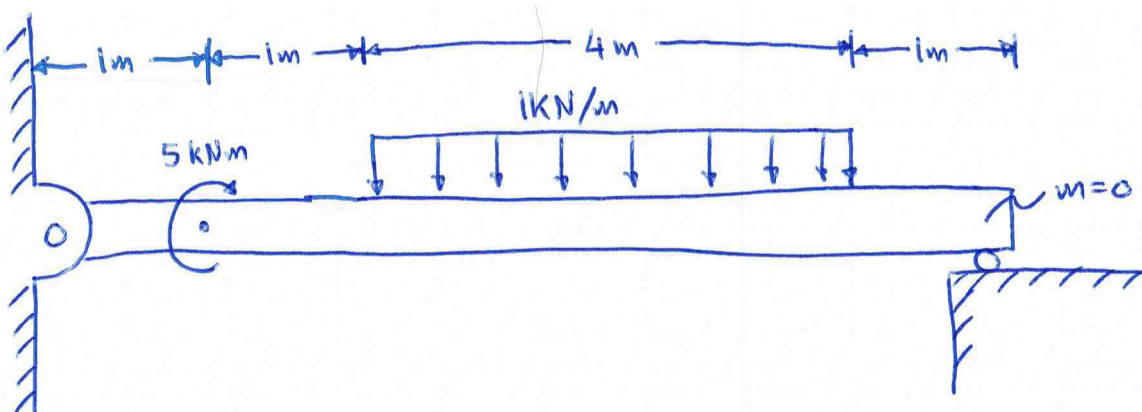
Determine the shear, axial and bending moment equations for



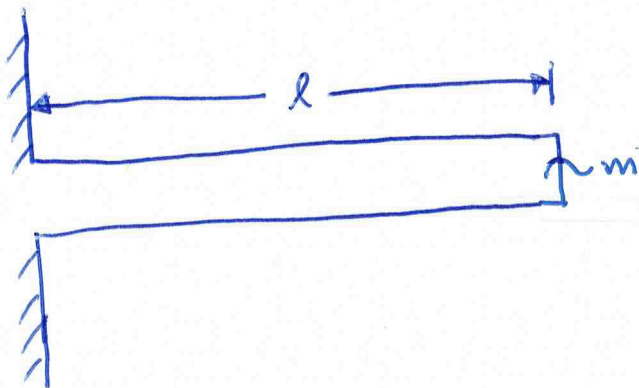
$$l = 10 \text{ m}$$

$$m = 100 \text{ kg}$$

Determine the shear, axial and bending moment equations for

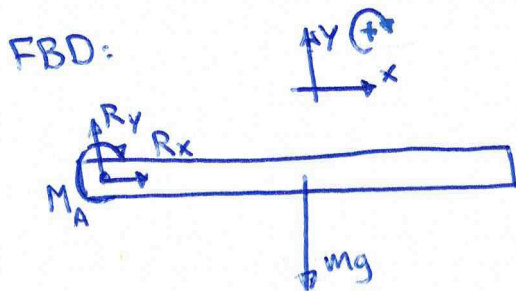


Determine the shear, axial and bending moment equations for



$$l = 10 \text{ m}$$

$$m = 100 \text{ kg}$$



Newton's Laws

$$\sum F_x = m a_x = R_x \quad (1)$$

$$\sum F_y = m a_y = R_y - mg \quad (2)$$

$$\sum M = I_A \alpha = M_A + \frac{l}{2} mg \quad (3)$$

Solve (1) for R_x :

$$R_x = 0 \quad (1a)$$

Solve (2) for R_y :

$$R_y = mg \quad (2a)$$

Solve (3) for M :

$$M_A = -\frac{lmg}{2} \quad (3a)$$

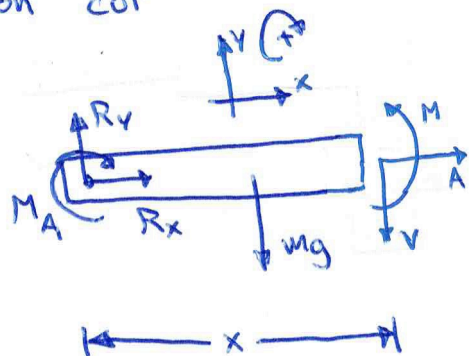
with numbers:

$$R_x = 0$$

$$R_y = (100)(9.81) = 981 \text{ N}$$

$$M_A = -\frac{(10)(100)(9.81)}{2} = -4905 \text{ Nm}$$

Section cut



$$\sum F_x = \cancel{m a_x} = R_x + A \quad (4)$$

$$\sum F_y = \cancel{m a_y} = R_y - V - \frac{x}{l} mg \quad (5)$$

$$\sum M = \cancel{I_A \ddot{\theta}} = M_A + xV - M + \frac{x}{2} \left(\frac{x}{l} mg \right) \quad (6)$$

solve (4) for A with sub (1a):

$$\boxed{A = -R_x = 0} \quad (4a)$$

with numbers:

$$\boxed{A = 0}$$

solve (5) for V:

$$V = R_y - \frac{x}{l} mg$$

sub (2a) for R_y :

$$V = [mg] - \frac{x}{l} mg$$

$$\boxed{V = mg \left(1 - \frac{x}{l} \right)} \quad (5a)$$

$$V = (100)(9.81) \left(1 - \frac{x}{10} \right) \\ = 981 (1 - 0.1x)$$

$$\boxed{V = -98.1x + 981}$$

solve (6) for M:

$$M = M_A + xV + \frac{x}{2} \left(\frac{x}{l} mg \right)$$

sub. (3a) for M_A & (5a) for V:

$$M = \left[-\frac{l mg}{2} \right] + x \left[mg \left(1 - \frac{x}{l} \right) \right] + \frac{x}{2} \left(\frac{x}{l} mg \right)$$

$$= -\frac{mg}{l} x^2 + \frac{mg}{2l} x^2 + mgx - \frac{mg l}{2}$$

$$\boxed{M = -\frac{mg}{2l} x^2 + mgx - \frac{mg l}{2}}$$

$$\boxed{M = 49.05x^2 + 981x - 4905}$$

differential relationships check

$$M = -\frac{mg}{2l}x^2 + mgx - \frac{mg l}{2}$$

$$\frac{d}{dx} \left(\right) \rightarrow \frac{dM}{dx} = -\frac{mg}{l}x + mg$$

$$\frac{dM}{dx} = mg \left(1 - \frac{x}{l} \right)$$

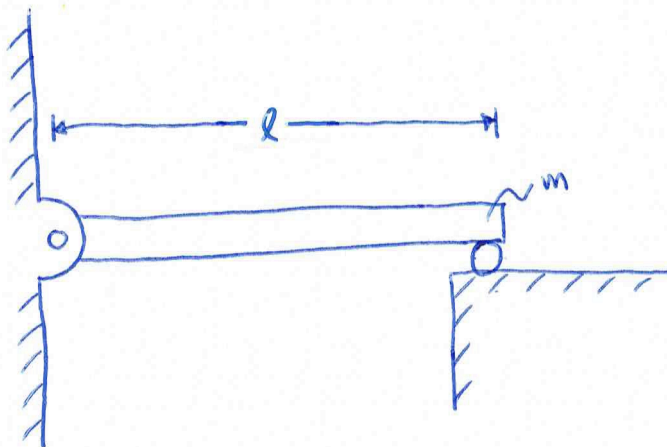
$$\boxed{\frac{dM}{dx} = V(x)} \quad \checkmark$$

$$V = mg \left(1 - \frac{x}{l} \right)$$

$$\frac{d}{dx} \left(\right) \rightarrow \frac{dV}{dx} = -\frac{mg}{l}$$

$$\boxed{\frac{dV}{dx} = w(x)} \quad \checkmark$$

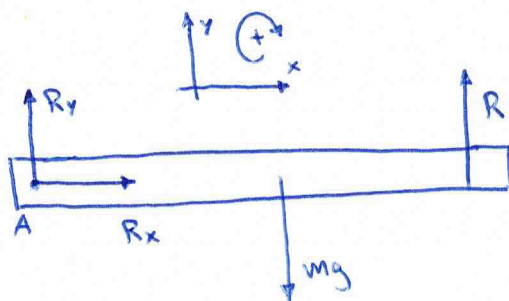
Determine the shear, axial and bending moment equations for



$$l = 10 \text{ m}$$

$$m = 100 \text{ Kg}$$

FBD:



Newton's Law:

$$\sum F_x = m a_x = R_x \quad (1)$$

$$\sum F_y = m a_y = R_y + R - mg \quad (2)$$

$$\sum M = I_A \alpha_A = \left(\frac{l}{2}\right) mg - l R \quad (3)$$

solve (1) for R_x :

$$R_x = 0 \quad (1a)$$

solve (3) for R :

$$R = \frac{mg}{2} \quad (3a)$$

solve (2) for R_y :

$$R_y = mg - R$$

sub. (3a) into above eq.

$$R_y = mg - \frac{mg}{2}$$

$$R_y = \frac{mg}{2} \quad (2a)$$

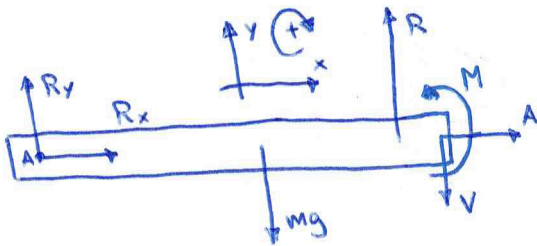
with numbers:

$$R_x = 0$$

$$R = \frac{(100)(9.81)}{2} = 490.5 \text{ N}$$

$$R_y = \frac{(100)(9.81)}{2} = 490.5 \text{ N}$$

section cut at $x = l$:



$$\sum F_x = \cancel{m a_x} = R_x + A \quad (4)$$

$$\sum F_y = \cancel{m a_y} = R_y + R - V - mg \quad (5)$$

$$\sum M = \cancel{I \alpha_A} = \left(\frac{l}{2}\right)mg - lR + lV - M \quad (6)$$

solve (4) for A:

$$\boxed{A = -R_x = 0} \quad (4a)$$

solve (5) for V:

$$V = R_y + R - mg$$

sub (3a) & (2a) into above eqn.

$$V = \left[\frac{mg}{2}\right] + \left[\frac{mg}{2}\right] - mg$$

$$\boxed{V = 0} \quad (5a)$$

solve (6) for M:

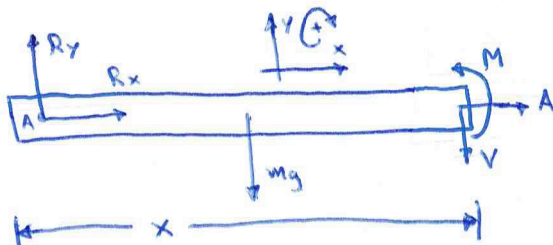
$$M = \frac{l}{2}mg - lR + lV$$

sub (3a) & (5a) into above eqn.

$$M = \frac{lmg}{2} - l\left[\frac{mg}{2}\right] + l[0]$$

$$\boxed{M = 0}$$

section cut at $x < l$:



$$\sum F_x = \cancel{m a_x} = R_x + A \quad (7)$$

$$\sum F_y = \cancel{m a_y} = R_y - V - \frac{x}{2}mg \quad (8)$$

$$\sum M = \cancel{I \alpha_A} = \left(\frac{x}{2}\right)\left(\frac{x}{2}mg\right) + xV - M \quad (9)$$

solve (7) for A:

$$\boxed{A = -R_x = 0} \quad (7a)$$

solve (8) for V:

$$V = R_y - \frac{x}{2}mg$$

sub (2a) into above eqn.

$$V = \left[\frac{mg}{2}\right] - \frac{x}{2}mg$$

$$\boxed{V = mg\left(\frac{1}{2} - \frac{x}{2}\right)} \quad (8a)$$

$$\boxed{V = -98.1x + 490.5}$$

solve (9) for M:

$$M = \left(\frac{x}{2}\right)\left(\frac{x}{2}mg\right) + xV$$

sub (8a) into above equation

$$M = \frac{mg}{2l}x^2 + x\left[mg\left(\frac{1}{2} - \frac{x}{2}\right)\right]$$

$$\boxed{M = -\frac{mg}{2l}x^2 + \frac{mg}{2}x}$$

$$\boxed{M = -49.05x^2 + 490.5x}$$

differential relationships check

$$M = -\frac{mg}{2l}x^2 + \frac{mg}{2}x$$

$\frac{d}{dx}$

$$\frac{dM}{dx} = -\frac{mg}{l}x + \frac{mg}{2}$$

$$\frac{dM}{dx} = mg\left(\frac{1}{2} - \frac{x}{l}\right)$$

$$\boxed{\frac{dM}{dx} = V(x)} \quad \checkmark$$

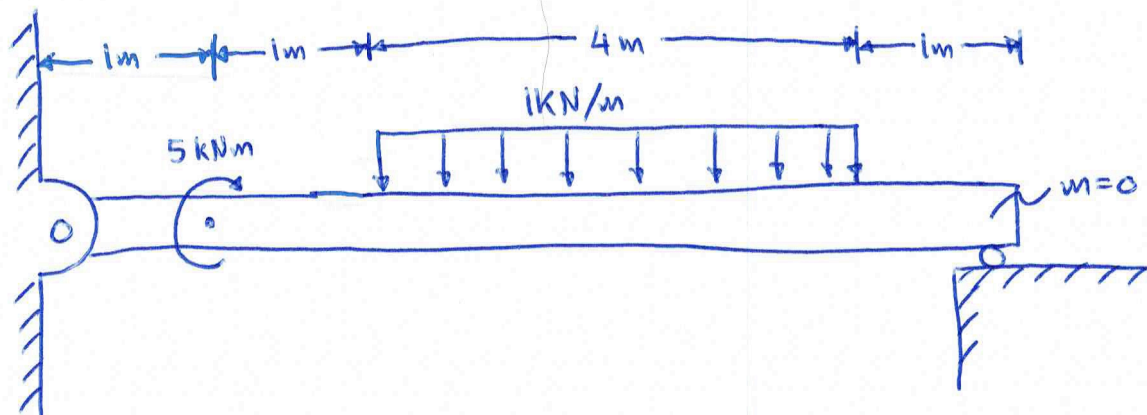
$$V = mg\left(\frac{1}{2} - \frac{x}{l}\right)$$

$\frac{d}{dx}$

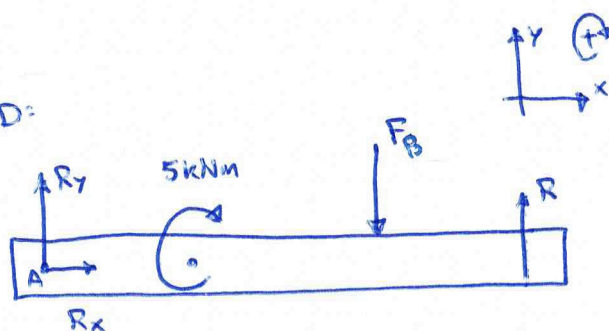
$$\frac{dV}{dx} = -\frac{mg}{l}$$

$$\boxed{\frac{dV}{dx} = w(x)} \quad \checkmark$$

Determine the shear, axial and bending moment equations for



FBD:



$$F_B = (4)(1) = 4 \text{ kN}$$

$$x_B = \left(\frac{1}{2}\right)(4) = 2 \text{ m}$$

Newton's laws

$$\sum F_x = m a_x = R_x$$

(1)

$$\sum F_y = m a_y = R_y - F_B + R$$

(2)

$$\sum M = I_{xx} \ddot{\theta} = 5000 + (2)(4)(F_B) - 7R$$

(3)

Solve (1) for R_x :

$$R_x = 0$$

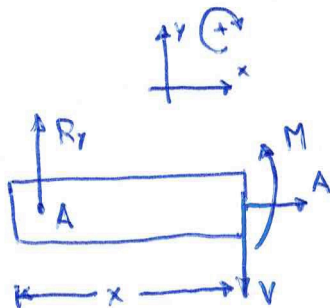
Solve (3) for R :

$$R = \frac{1}{7} (5000 + 4[4000]) = 3000 \text{ N}$$

Solve (2) for R_y :

$$R_y = F_B - R = [4000] - [3000] = 1000 \text{ N}$$

section cut ($0 < x < 1$)



$$\sum F_x = w/a_x = A \quad (4)$$

$$\sum F_y = w/a_y = R_y - V \quad (5)$$

$$\sum M = I_A/a_A = Vx - M \quad (6)$$

solve (4) for A:

$$A = 0$$

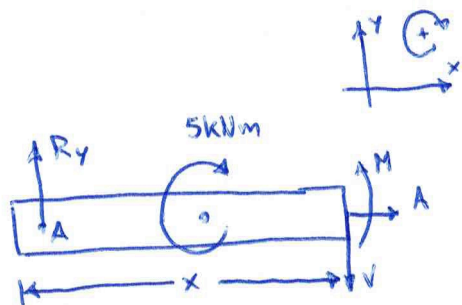
solve (5) for V:

$$V = R_y = 1000 \text{ N}$$

solve (6) for M:

$$M = Vx = 1000x$$

section cut ($1 < x < 2$)



$$\sum F_x = w/a_x = A \quad (7)$$

$$\sum F_y = w/a_y = R_y - V \quad (8)$$

$$\sum M = I_A/a_A = 5000 + Vx - M \quad (9)$$

solve (7) for A:

$$A = 0$$

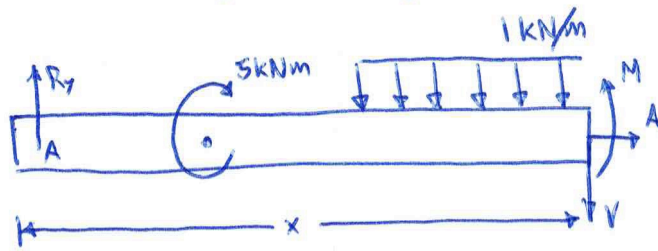
solve (8) for V:

$$V = R_y = 1000 \text{ N}$$

solve (9) for M:

$$M = 5000 + Vx = 1000x + 5000$$

Section cut $(2 < x < 6)$



$$\sum F_x = w/\alpha_x = A \quad (10)$$

$$\sum F_y = w/\alpha_y = R_y - (x-2)(1000) - V \quad (11)$$

$$\sum M = I/\alpha_M = 5000 + \left(2 + \frac{x-2}{2}\right)(x-2)(1000) + Vx - M \quad (12)$$

solve (10) for A:

$$A = 0$$

solve (11) for V:

$$V = R_y - (x-2)(1000)$$

$$= [1000] - 1000x + 2000$$

$$V = -1000x + 3000$$

solve (12) for M:

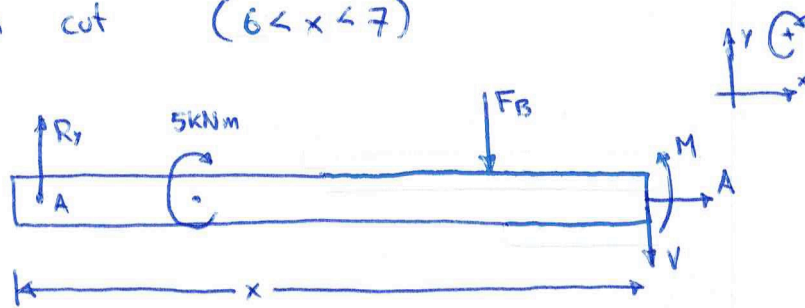
$$M = 5000 + \left(2(x-2) + \frac{1}{2}(x-2)^2\right)(1000) + Vx$$

$$= 5000 + (2x - 4 + \frac{1}{2}x^2 - 2x + 2)(1000) + [-1000x + 3000]x$$

$$= 5000 + (\frac{1}{2}x^2 - 2)(1000) - 1000x^2 + 3000x$$

$$M = -500x^2 + 3000x + 3000$$

Section cut $(6 < x < 7)$



$$\sum F_x = \text{max} = A \quad (13)$$

$$\sum F_y = \text{may} = R_y - F_B - V \quad (14)$$

$$\sum M = \sum I_A \alpha_A = 5000 + (4)F_B + Vx - M \quad (15)$$

Solve (13) for A :

$$\boxed{A = 0}$$

Solve (14) for V :

$$V = R_y - F_B$$

$$= 1000 - 4000$$

$$\boxed{V = -3000}$$

Solve (15) for M :

$$M = 5000 + (4)[4000] + [-3000]x$$

$$\boxed{M = -3000x + 21000}$$