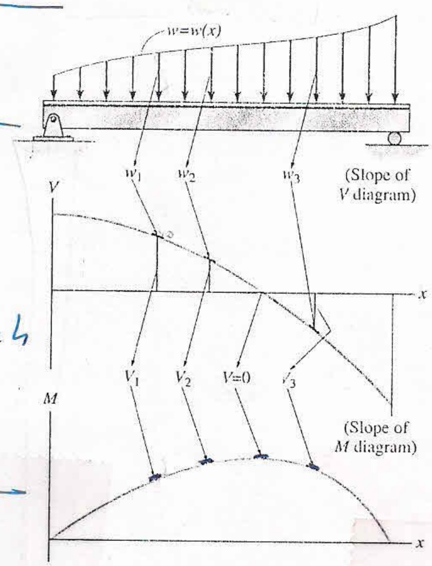
Dividing by Δx and taking the limit as $\Delta x \to 0$, equation 1 and 2 became :-

$$\frac{dV}{dx} = -w(x) \quad \text{——} \ (3)$$

slope of shear diagram at each point = − distributed Load intensity at each point



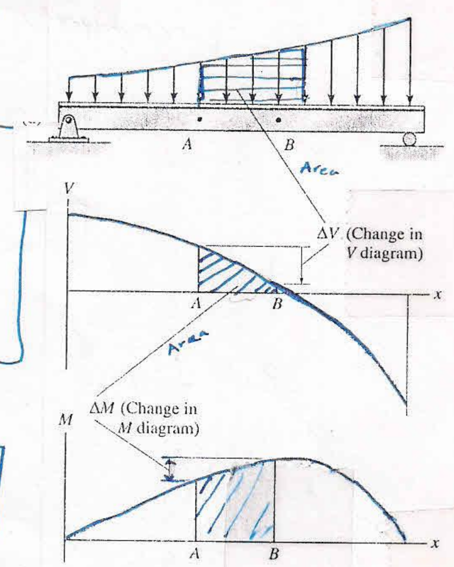
$$\frac{dM}{dx} = V \quad \text{——} \ (4)$$

slope of moment diagram at each point = Shear at each Point

Now take integration for both equations 3 and 4

$$\Delta V = -\int w(x)\, dx$$

change in shear = − area under distributed Loading

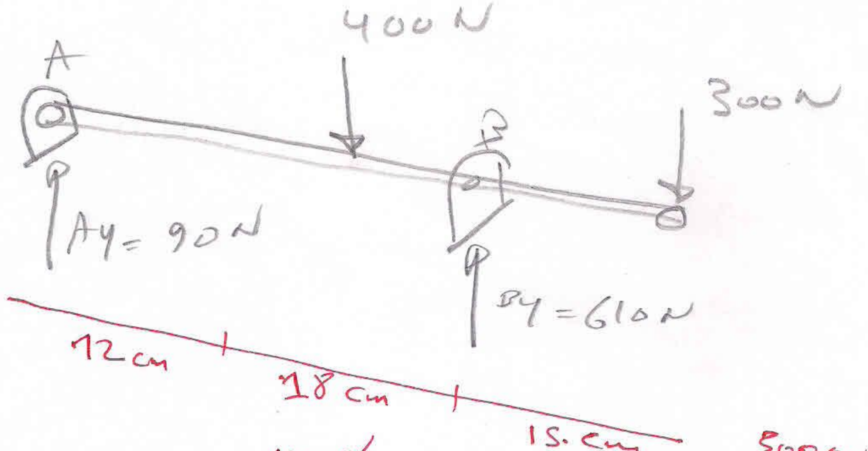


$$\Delta M = \int V(x)\, dx$$

change in moment = area under Shear diagram

G-15

Determine the smallest allowable diameter of the shaft, $\sigma_{allow} = 154$ MPa



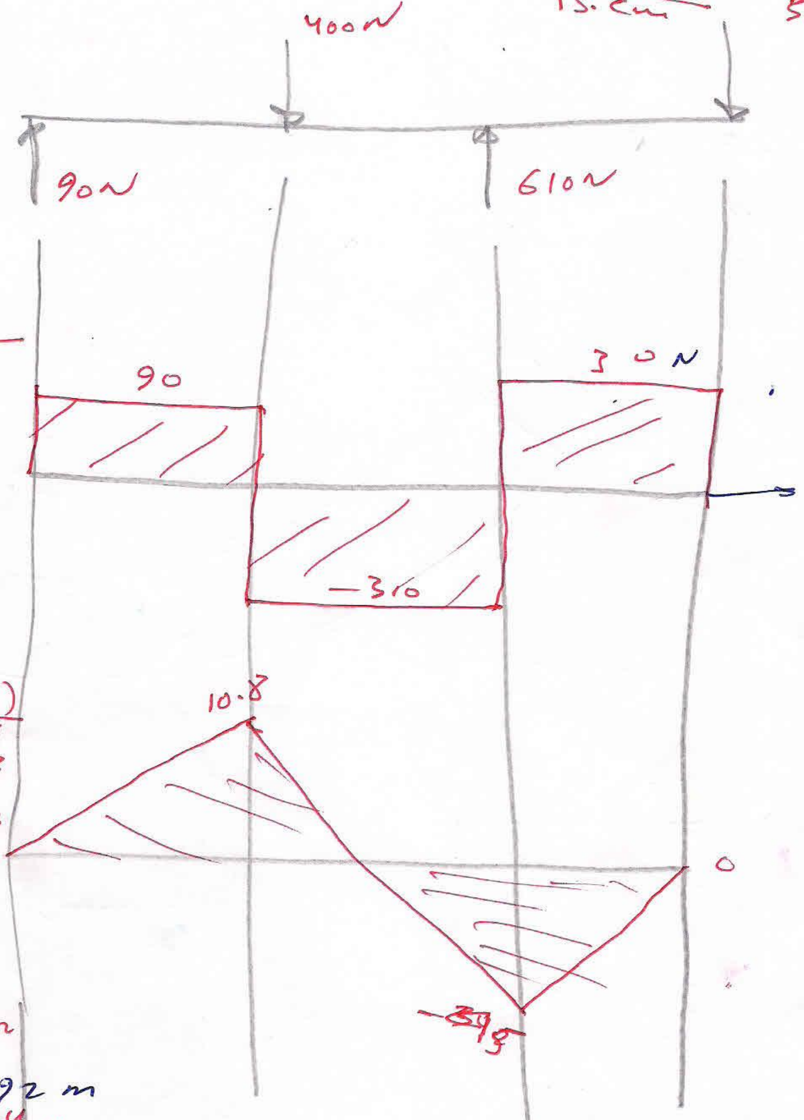
$\circlearrowright \Sigma M_A = 0$

$-400(.12) + B_y(.3) - 300(.45) = 0$

$B_y = 610$ N

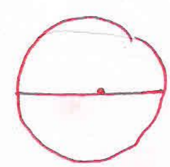
$+\uparrow \Sigma F_y = 0$,

$A_y = 90$ N



$\sigma = \frac{Mc}{I}$

$I = \frac{1}{4}\pi r^4$



$154 \times 10^6 = \frac{(45)(r)}{\frac{1}{4}\pi r^3}$

$120,951,317.2\, r^3 = 45$

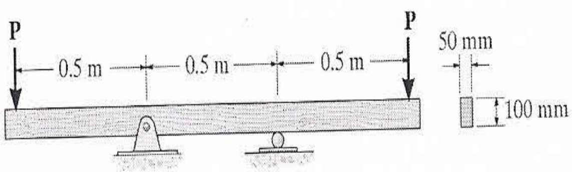
$r^3 = \frac{45}{120,951,317.2}$

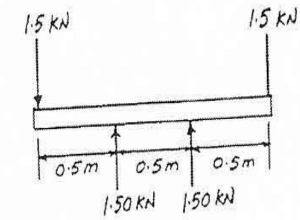
$r = 0.\cancel{015514}$ m $.001792$ m

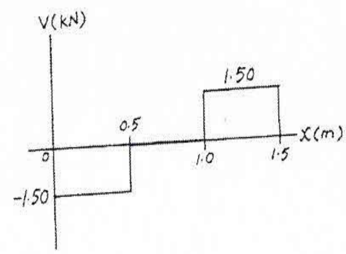
$r = 7.19$ mm, diameter = 14.38 mm.

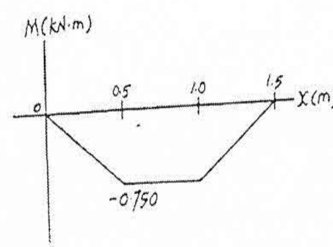
14.38

6–91. The beam has the rectangular cross section shown. If $P = 1.5$ kN, determine the maximum bending stress in the beam. Sketch the stress distribution acting over the cross section.





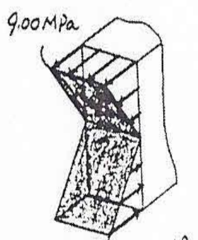




$$\sigma_{max} = \frac{M_{max}\, c}{I}$$

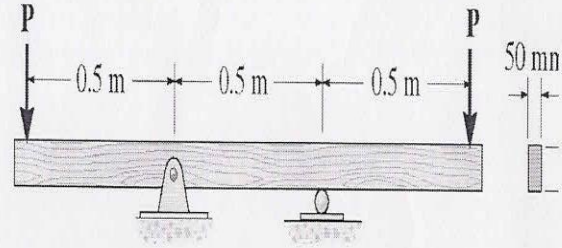
$$= \frac{.75\,(10^3)\,(.05)}{\frac{1}{12}\,(.05)(.1)^3}$$

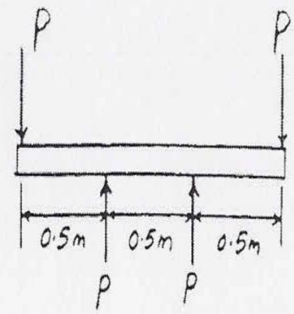
$$= 9 \text{ MPa}$$



Absolute Maximum Bending Stress *:* The maximum moment is $M_{max} = 0.750$ kN · m as indicated on moment diagram. Applying the flexure formula

6–90. The beam has a rectangular cross section as shown. Determine the largest load P that can be supported on its overhanging ends so that the bending stress in the beam does not exceed $\sigma_{max} = 10$ MPa.



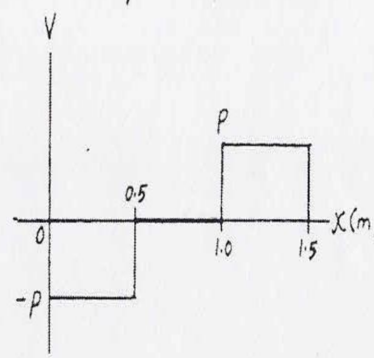


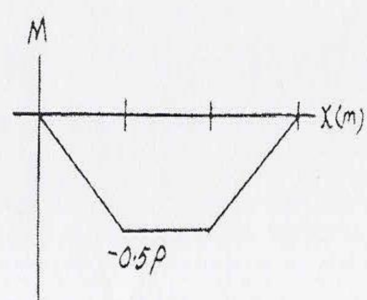
Absolute Maximum Bending Stress: The maximum moment is $M_{max} = 0.5P$ as indicated on the moment diagram. Applying the flexure formula

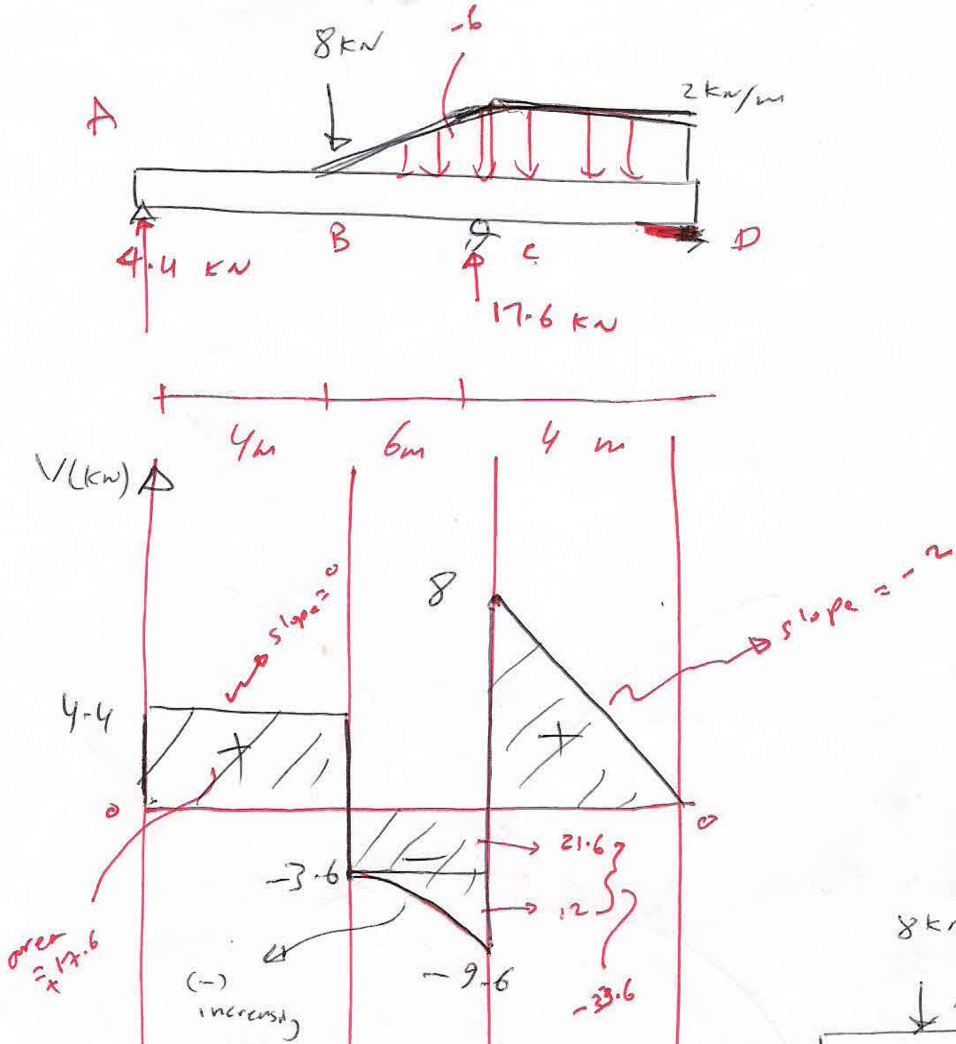
$$\sigma_{max} = \frac{M_{max}\,c}{I}$$

$$10\left(10^6\right) = \frac{0.5P(0.05)}{\frac{1}{12}(0.05)(0.1^3)}$$

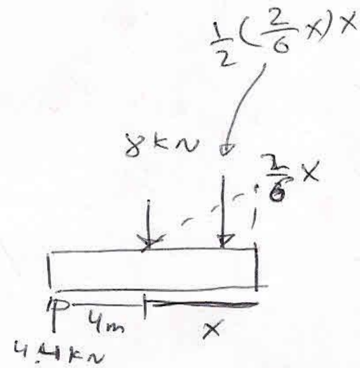
$$P = 1666.7\text{ N} = 1.67\text{ kN} \qquad \textbf{Ans}$$

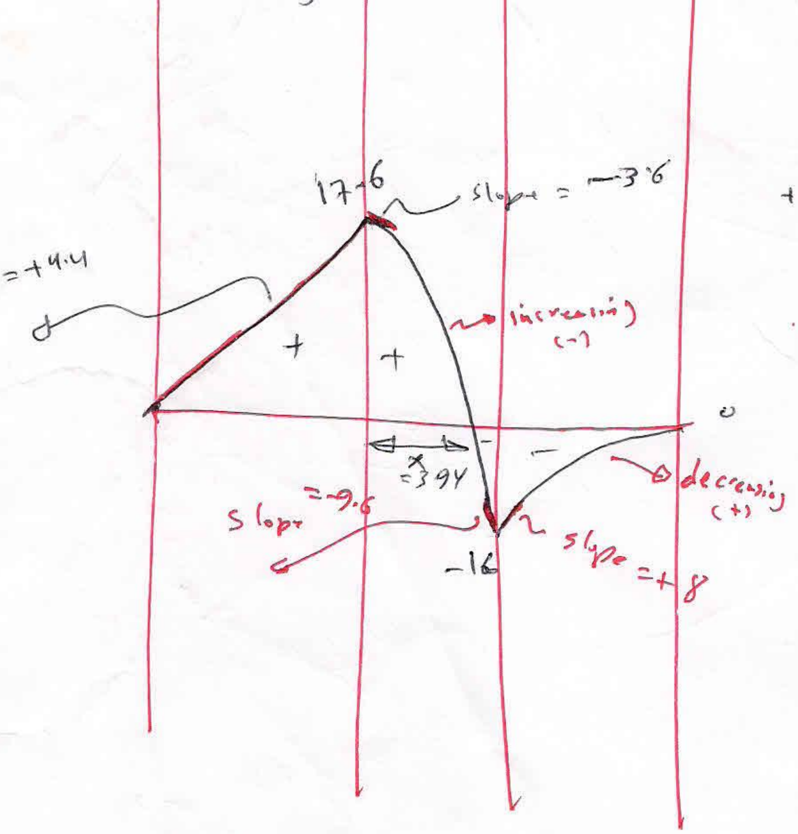






21.6
12





$+\circlearrowleft \Sigma M = 0$

$-4.4(4+x) + 8x + \frac{1}{2}\left(\frac{2}{6}\right)x^2\frac{x}{3} + M = 0$

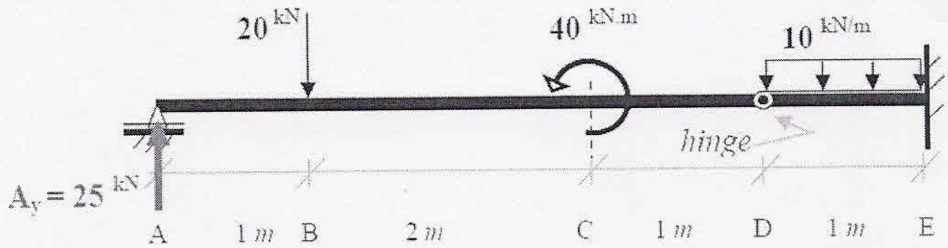
$M = -\frac{1}{18}x^3 - 3.6x + 17.6 = 0$

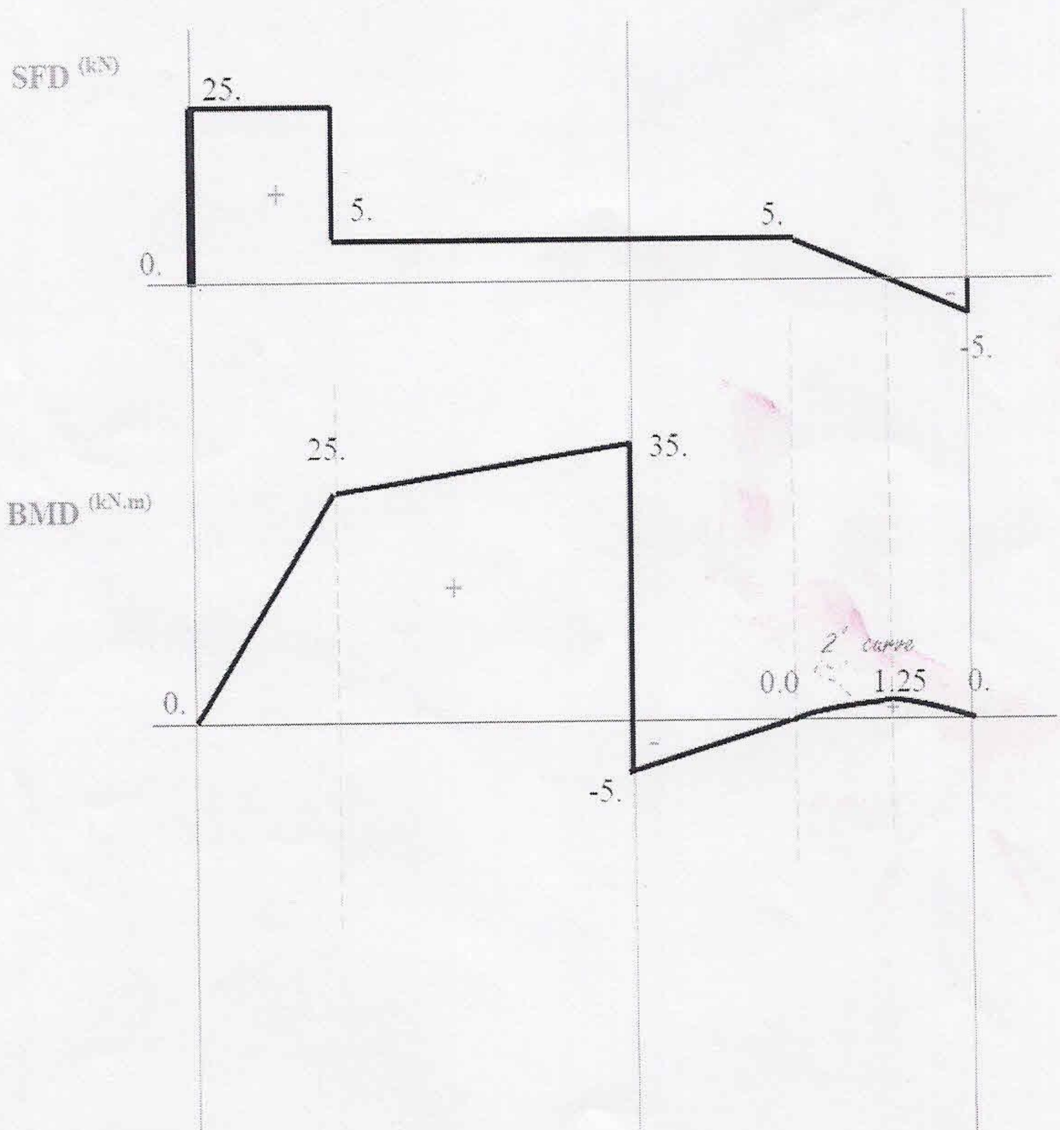
$x = 3.94 \text{ m}$

Problem # 3

Use the graphical method (*i.e.* areas summation) to draw shear force diagram (SFD) and bending moment diagram (BMD) for beam ABCDE having a *hinge* at D.

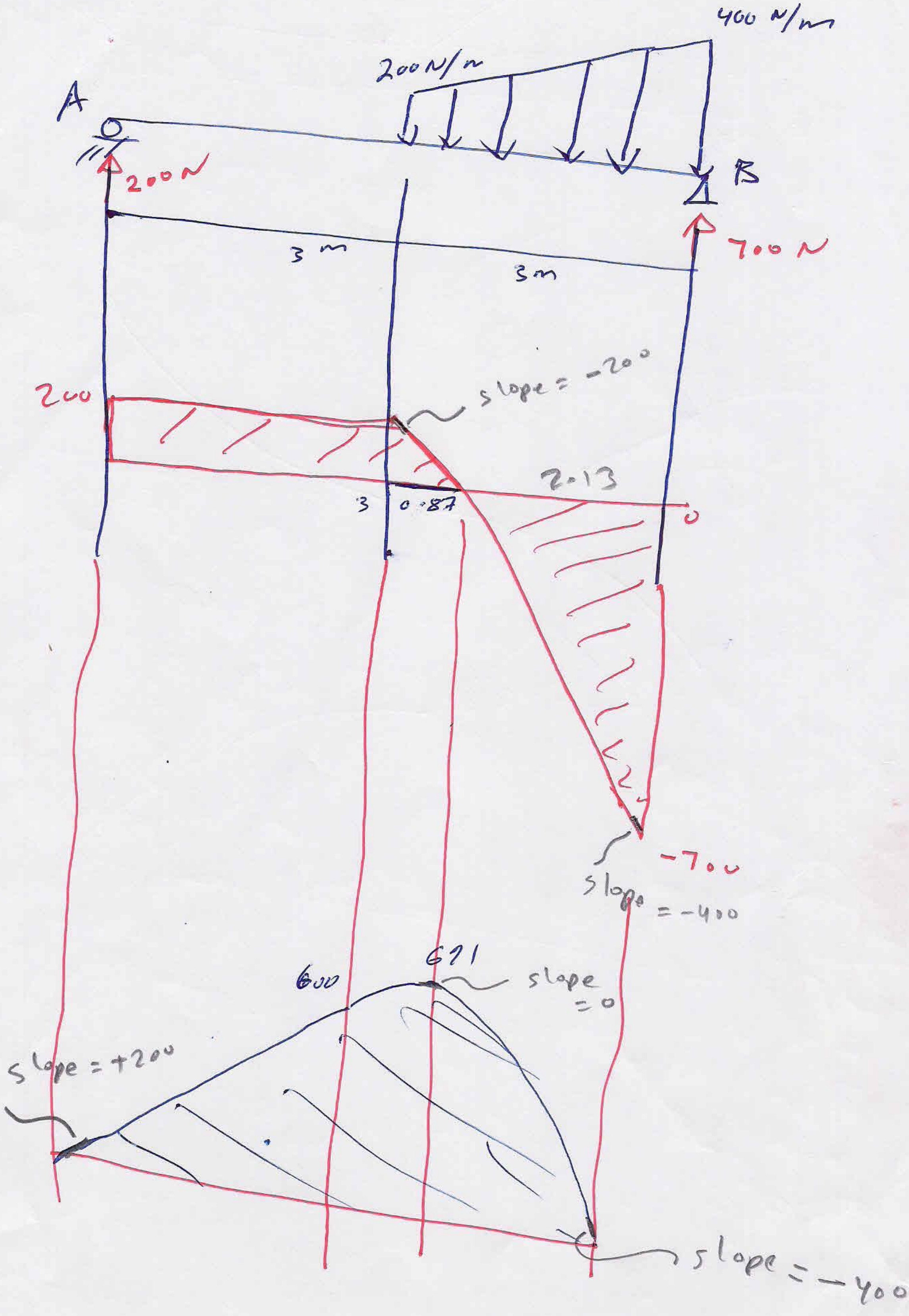
Note: Reaction $A_y = 25$ kN (↑).



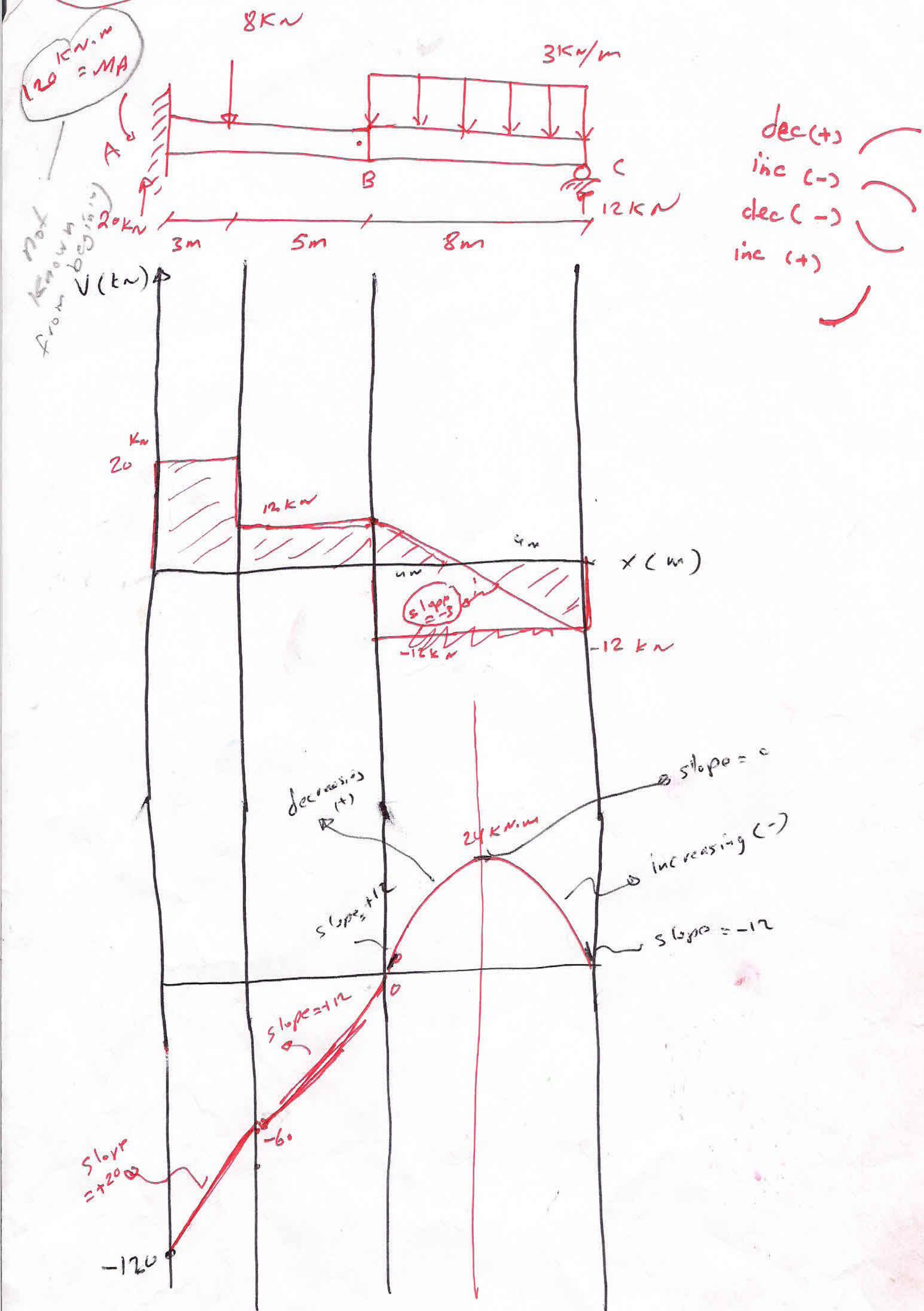


Note: $E_y = 5.0$ kN and $M_E = 0.0$ kN.m.

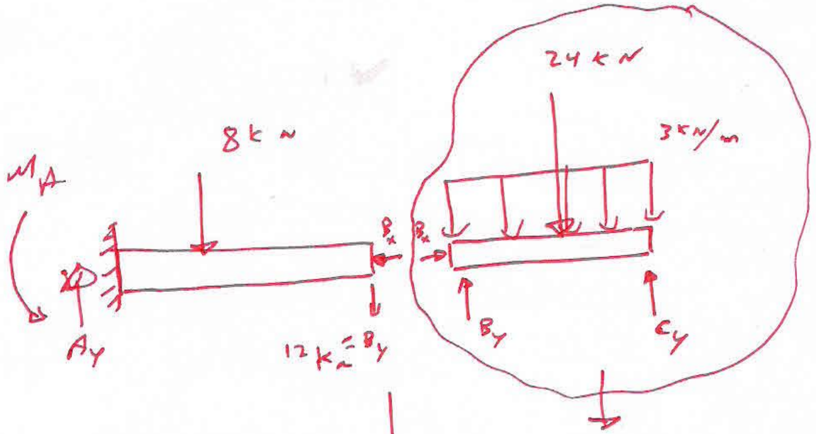
$\boxed{6-39}$


400 N/m
200 N/m
A
B
200 N
700 N
3 m
3 m
200
slope = -200
2.13
3
0.87
0
-700
slope = -400
600
671
slope = 0
slope = +200
slope = -400

6-25



120 KN.m = MA
not known from beginning
8KN
3KN/m
A
B
C
20KN
12KN
3m
5m
8m
dec (+)
inc (-)
dec (-)
inc (+)
V (kN)
20 KN
12 KN
4m
4m
slope = -3
x (m)
-12 KN
-12 KN
slope = 0
decreasing (+)
24 KN.m
increasing (-)
slope = +12
slope = -12
0
slope = +12
-60
slope = +20
-120



$+\uparrow \sum F_y = 0,$

$A_y - 8 - 12 = 0$

$A_y = 20\ kN$

$+\circlearrowleft \sum M_A = 0$

$M_A - 8(3) - 12(8) = 0$

$M_A = 120\ kN.m$

$+\uparrow \sum F_y = 0,$

$B_y + C_y = 24\ kN$

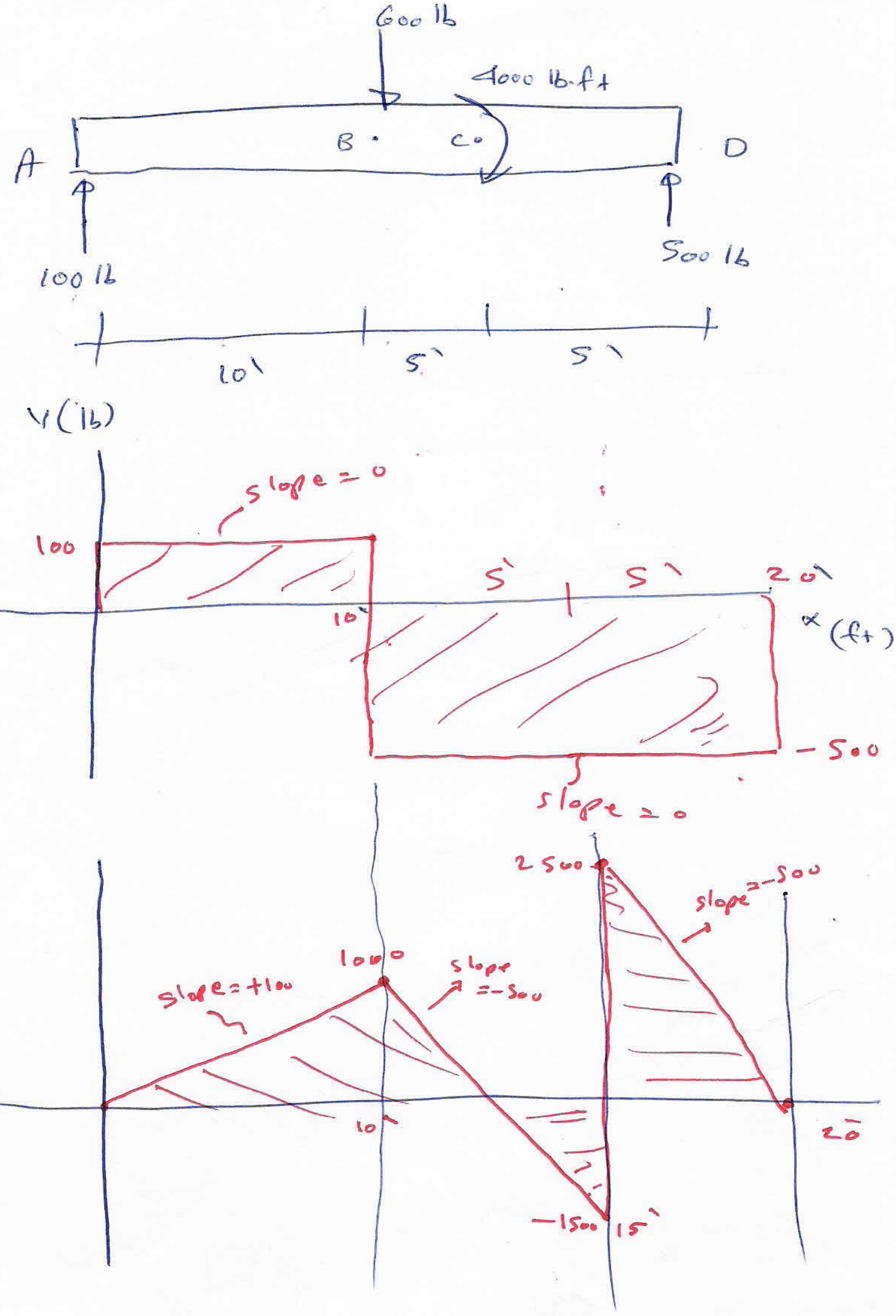
$+\circlearrowleft \sum M_C = 0, \quad 24(4) - B_y(8) = 0$

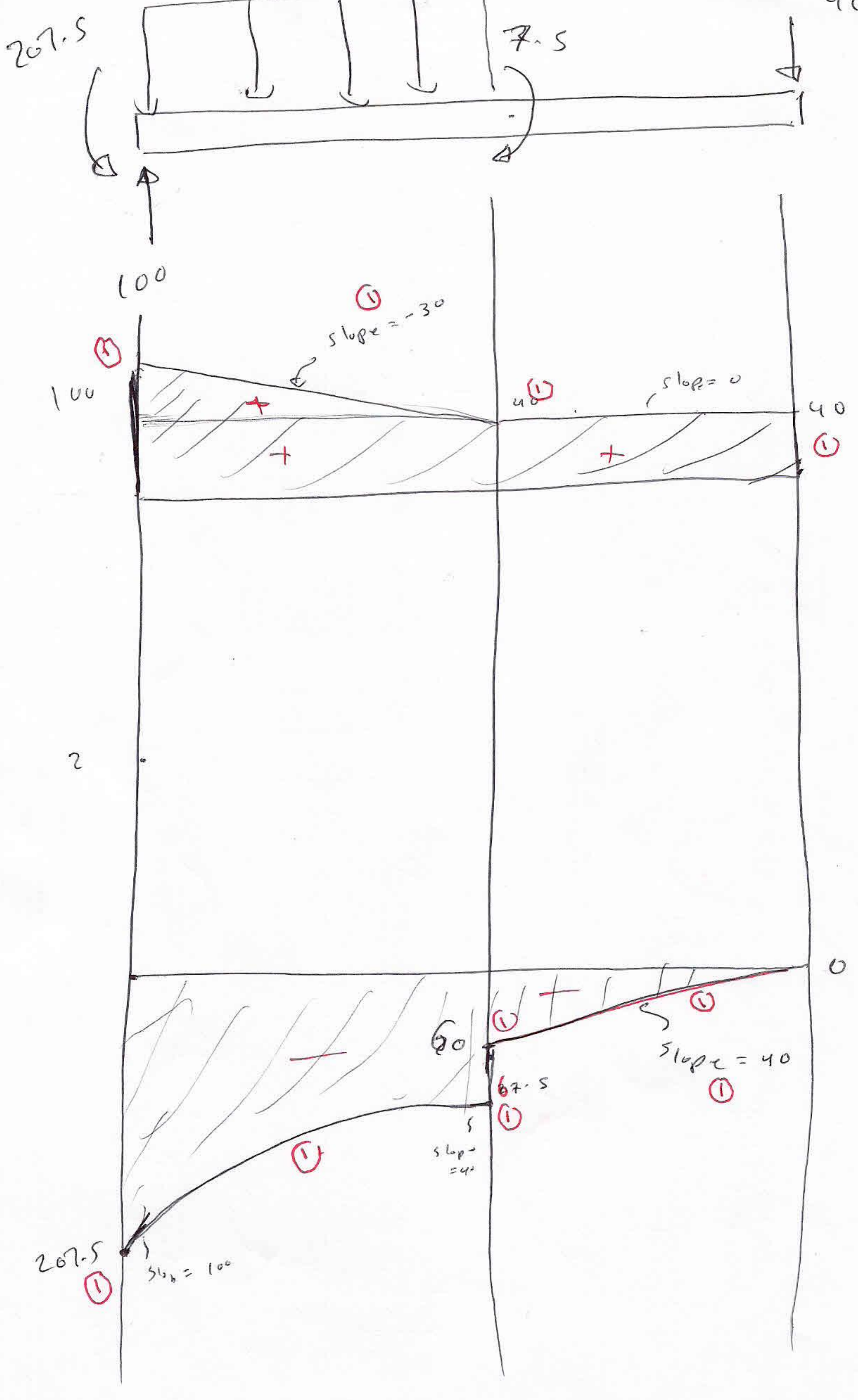
$B_y = 12\ kN$

$C_y = 12\ kN$

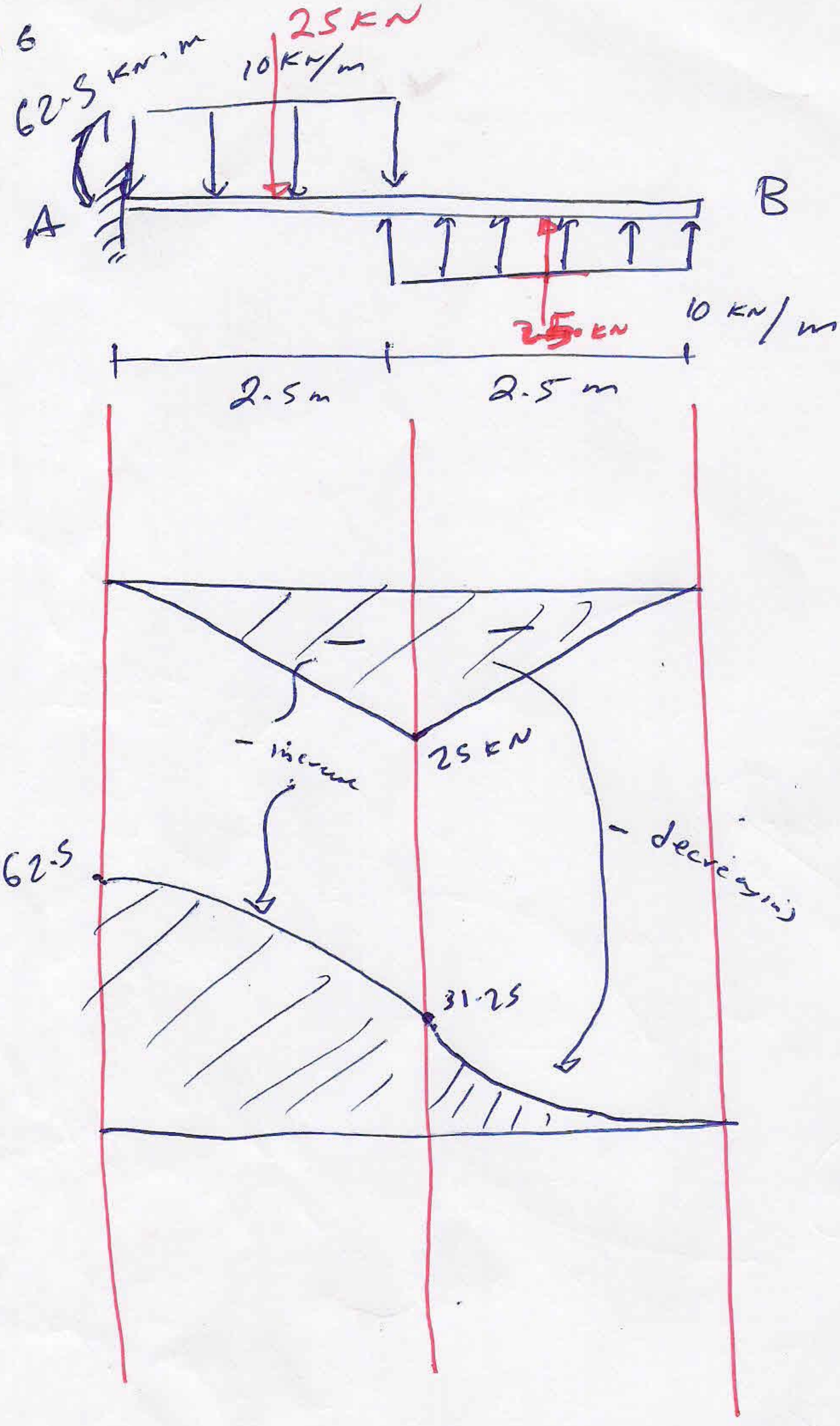
$B_x = 0$

Clockwise couple moment cause the jump upward in the moment diagram.




207.5
7.5
100
slope = -30
100
40
slope = 0
40
0
60
67.5
slope = 40
slope = 40
207.5
slope = 100

6-16

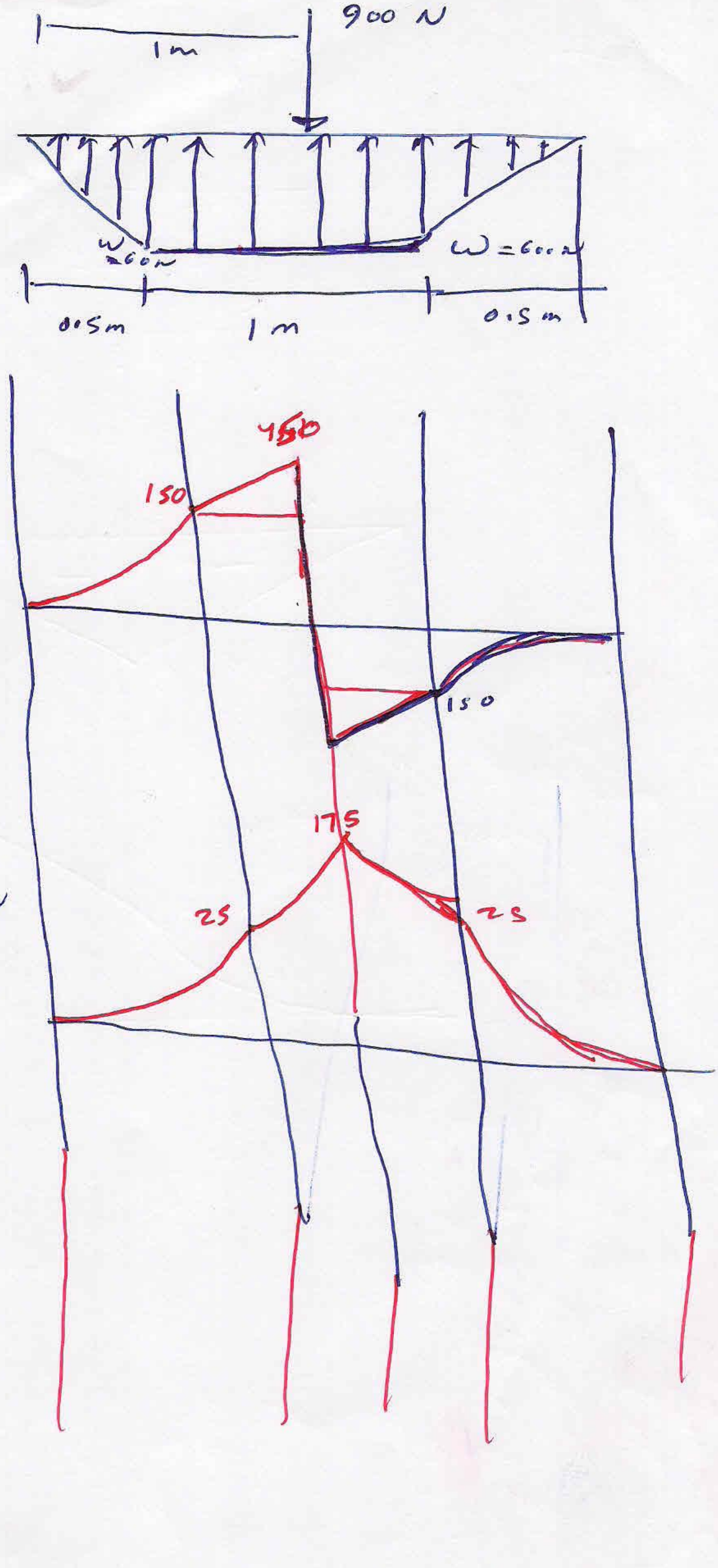


$\circlearrowleft \Sigma M_A = 0, \quad -25(1.25) + 25(3.75) + M_A = 0$

$M_A = 62.5$ kN·m

6-32

Determine the intensity w, Draw V & M



$\Sigma F_y = 0,$

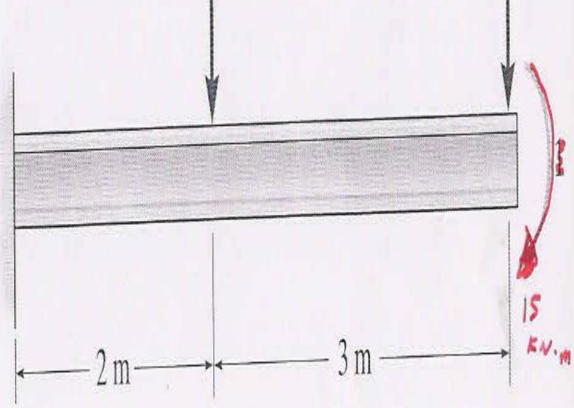
$\frac{1}{2} w(.5) + w + \frac{1}{2} w(.5)$

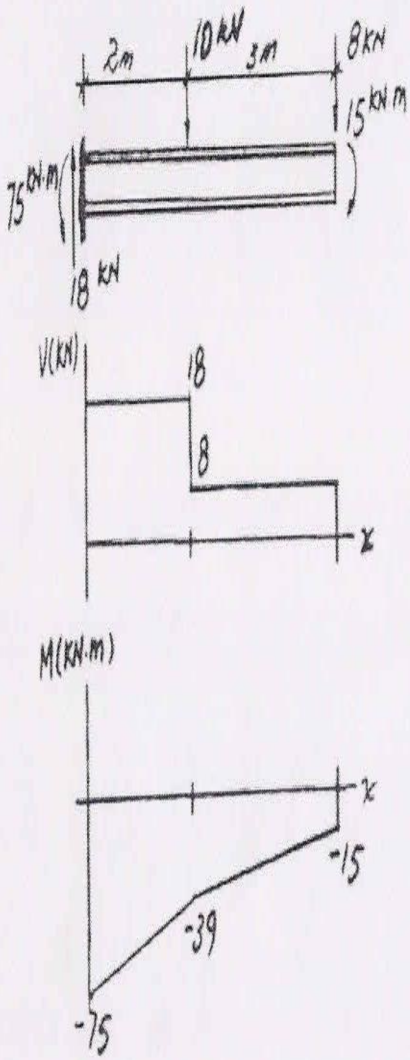
$-900 = 0$

$1.5w = 900$

$w = \frac{900}{1.5} = 600\ N$

6–5. Draw the shear and moment diagrams for the beam.

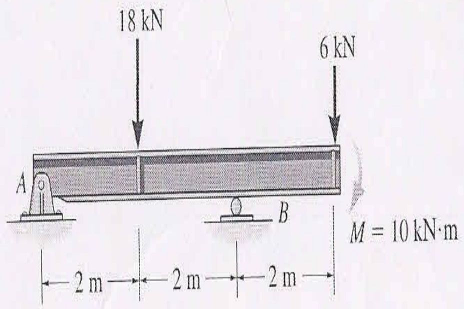


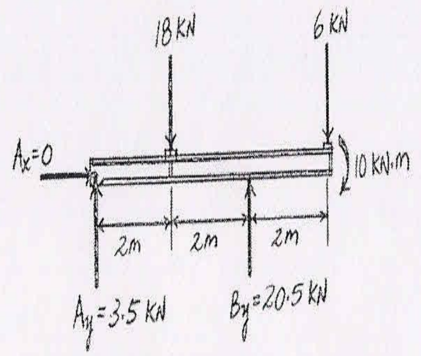


8 kN/m

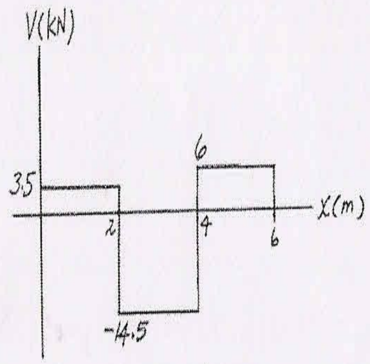
6-6. Draw the shear and moment diagrams for the

*6–36. Draw the shear and moment diagrams for the overhang beam.



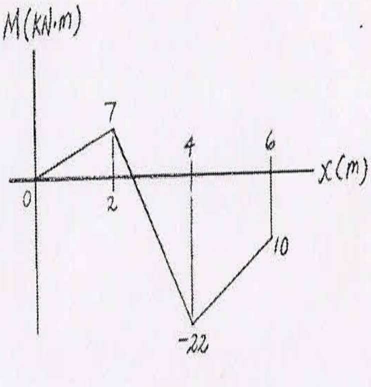


(a)



shear diagram

(b)



moment diagram

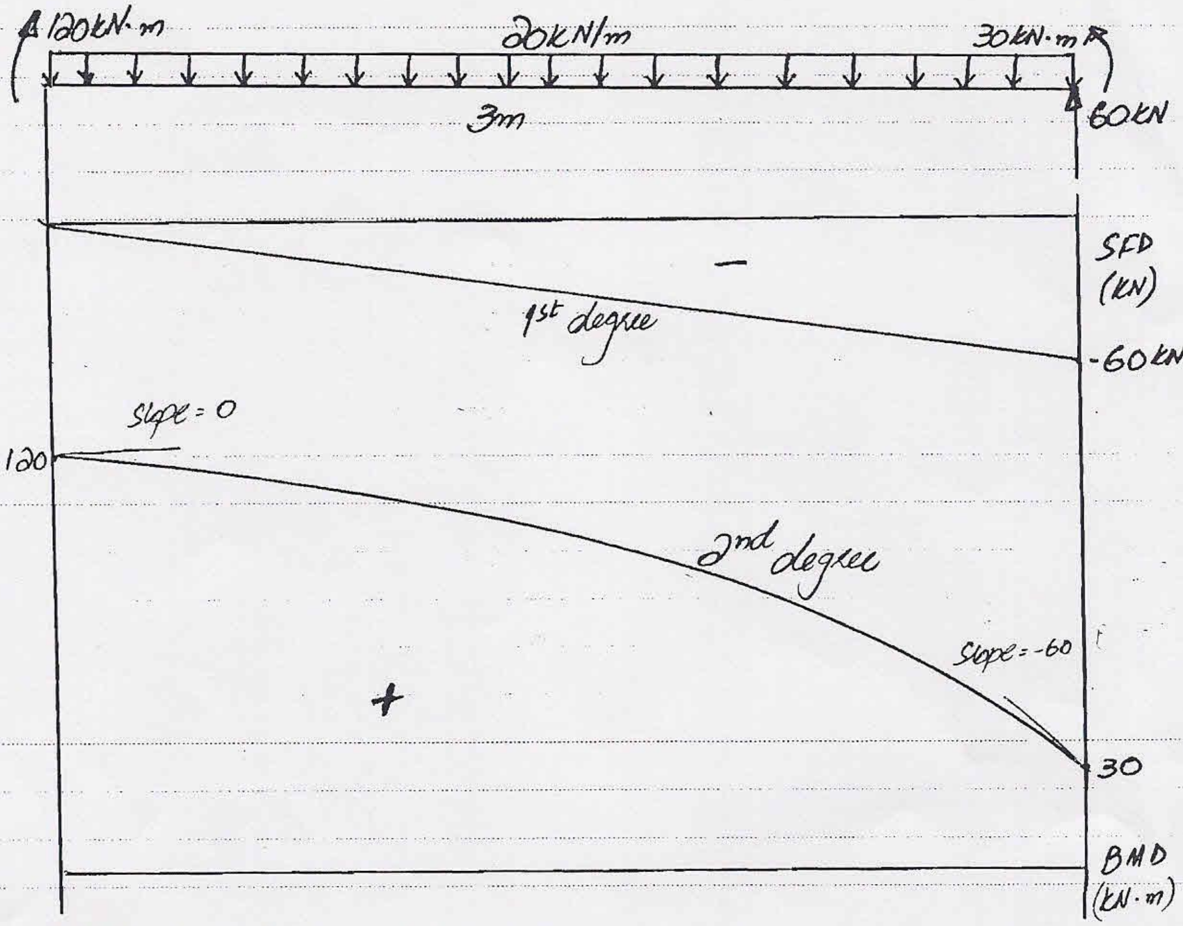
(c)

6–37. Draw the shear and moment diagrams for the beam.

50 kN/m

50 kN/m

Solution of HW #9

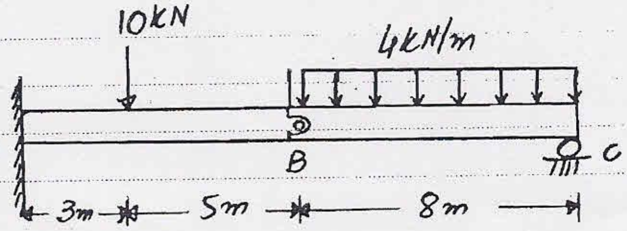


Between A & B

Area of Load = $\Delta V = -20(3) = -60\,kN$

Area of $V = \Delta M = \frac{1}{2}(3)(-60) = -90\,kN\cdot m$

Problem#03:



Given:
The beam Shown

Required:
SFD & BMD by the Semi-graphical Method.

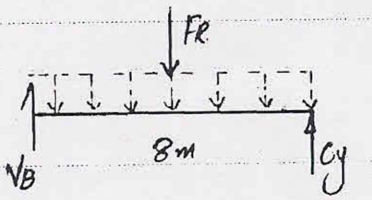
Solution:

First, we need to calculate the reactions. (why?!)

To be able to find the reactions, we need to sperate the beam from the pin at B. (why?!).

without the "internal" pin at B, the problem is statically indeterminate. (How?!)

We take the right part from B (why?!)



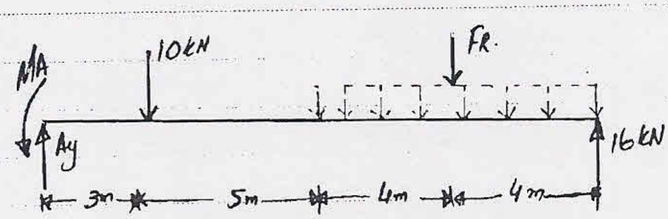
$F_R = 4(8) = 32kN$
No M @ B. (why?!)

$+\circlearrowleft \Sigma M_B = 0$ (why B?!)

$8C_y - 32(4) = 0 \Rightarrow$

$C_y = 16\ kN \uparrow$

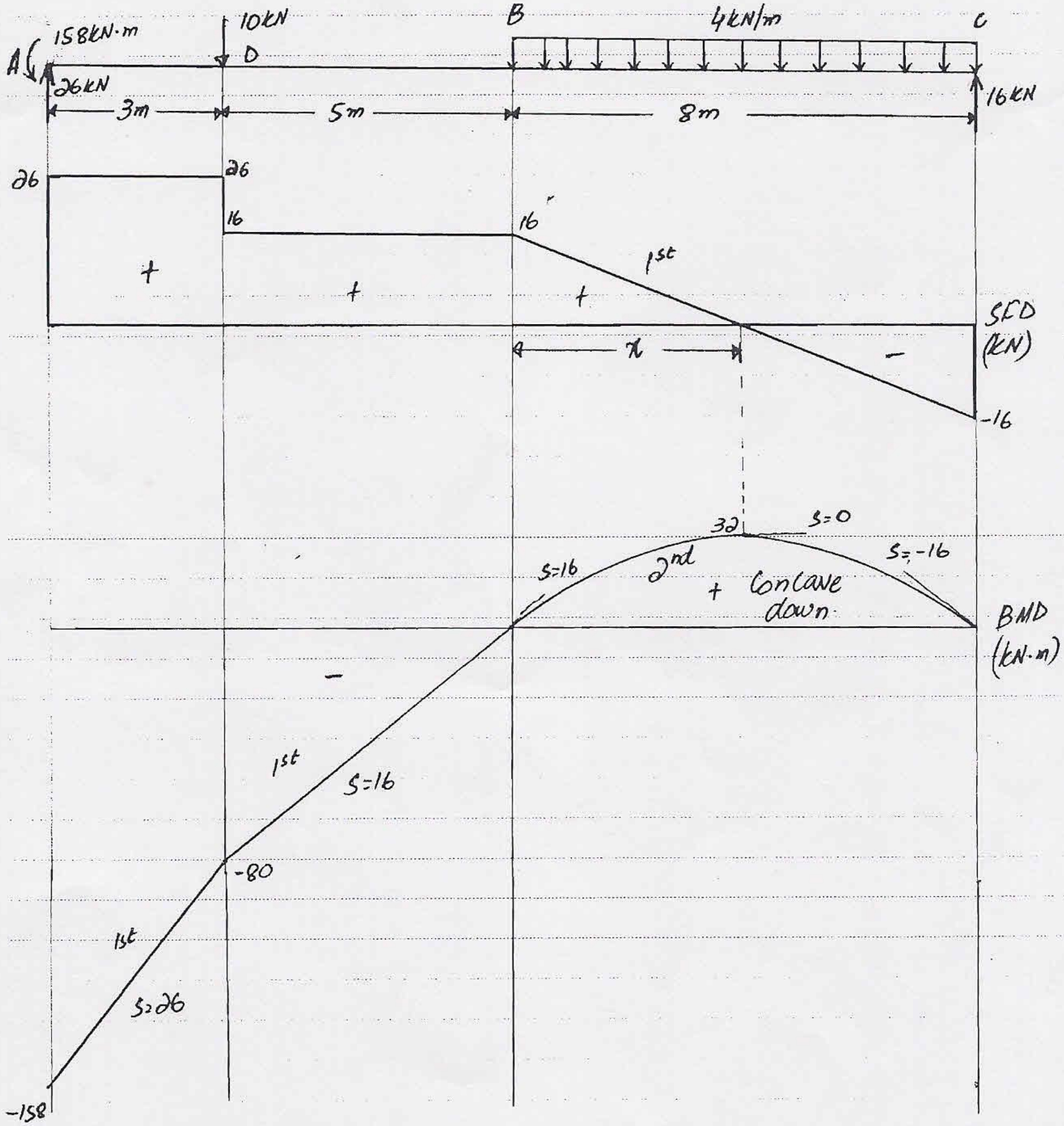
Now, the entire Beam



$+\uparrow \Sigma F_y = 0 \Rightarrow A_y - 10 - 32 + 16 = 0 \Rightarrow A_y = 26\ kN \uparrow$

$+\circlearrowleft \Sigma M_A = 0 \Rightarrow M_A - 10(3) - 32(12) + 16(16) = 0 \Rightarrow M_A = 158\ kN\cdot m \circlearrowleft$

Now, the SFD & BMD are drawn.

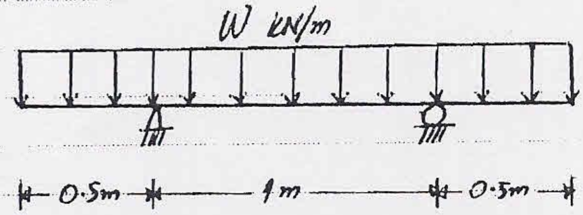


Explanation:

S = Slope ; 1st, 2nd, etc. = degree of curve

Even though, it is clear that x = 4m, we will use the general method to find it.

Problem #05:



Given:

The beam shown

$V_{\substack{max\\min}} = \pm 5\,kN$; $M_{\substack{max\\min}} = \pm 2\,kN\cdot m$

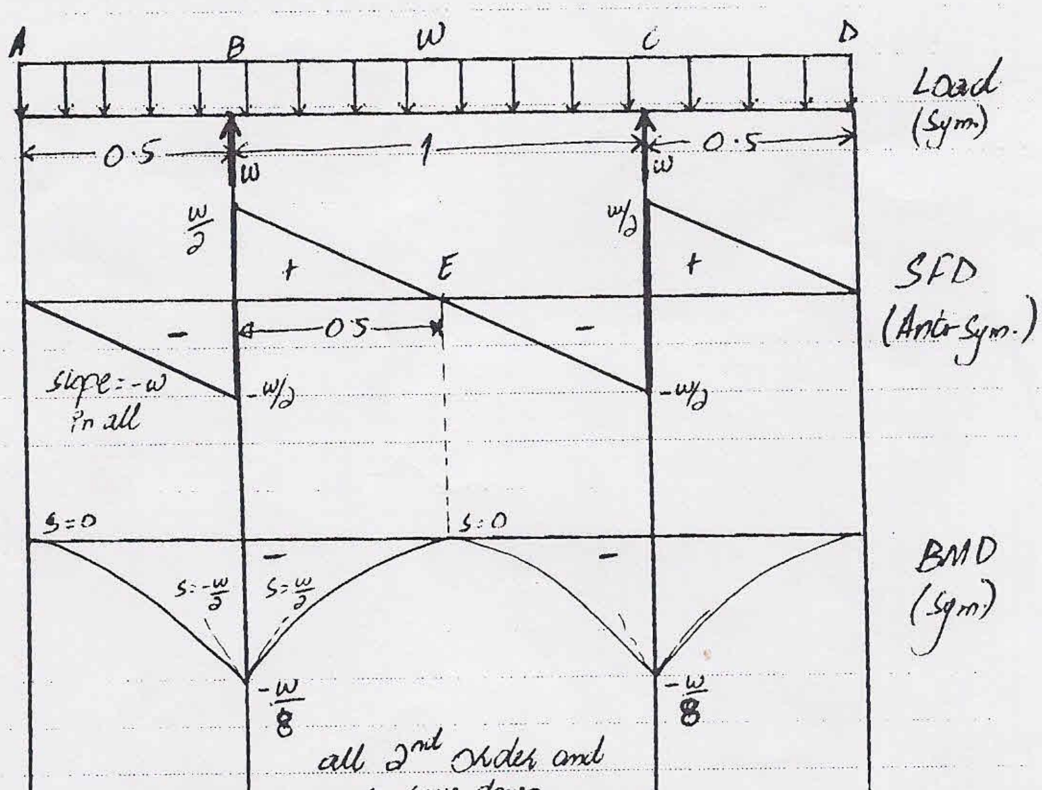
Required:

a) SFD and BMD by the graphical method

b) W_{max}

Solution:

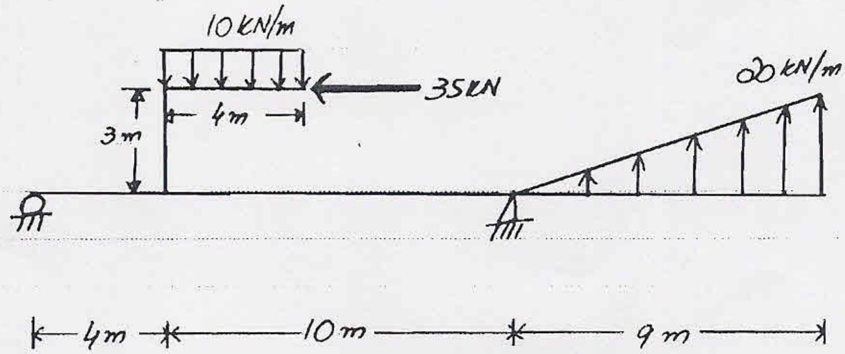
a) Due to Symmetry, $B_y = C_y = \frac{\Sigma W}{2} = \frac{2W}{2} = W\,kN$



Problem #06:

Given:
The beam shown

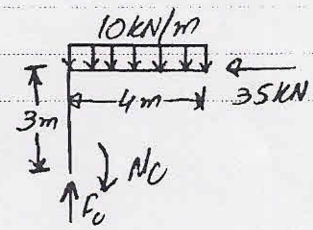
Required:
SFD and BMD by the graphical method.



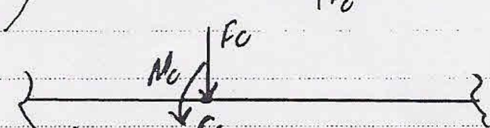
Solution:

First we need to determine the effect of the "extension" at C on the beam.

* Remember "equal and opposite"!

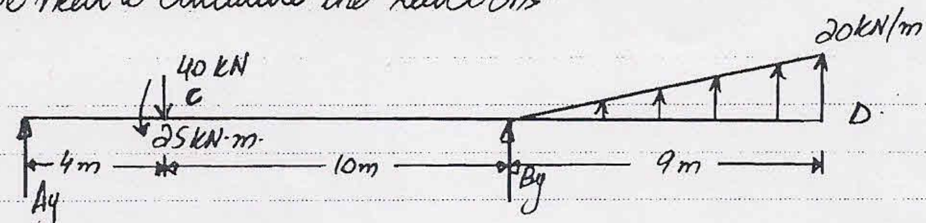


$+\uparrow \Sigma F_y = 0 \Rightarrow F_C = 40\ kN$ ($\uparrow$ on Extension, $\downarrow$ on beam)



$\circlearrowleft \Sigma M = 0 \Rightarrow M = -10(4)(2) + 35(3)$
$= 25\ kN\cdot m$ ($\circlearrowright$ on Extension, $\circlearrowleft$ on beam)

Now we need to calculate the reactions.



$+\circlearrowleft \sum M_B = 0 \Rightarrow -14A_y + 25 + 40(10) + \frac{(20)(9)}{2}\left(\frac{2}{3}\times 9\right) = 0$

$\Rightarrow A_y = 68.929\ kN \cong 68.93\ kN(\uparrow)$

$+\uparrow \sum F_y = 0 \Rightarrow 68.929 - 40 + \frac{20(9)}{2} + B_y = 0 \Rightarrow$

$B_y = -118.93\ kN = 118.93\ kN\ (\downarrow)$