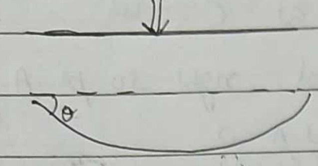
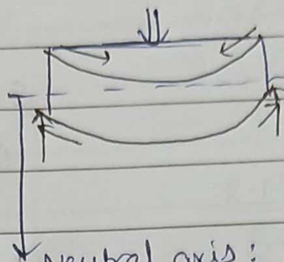
__/__/__

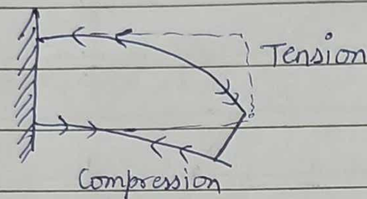
SHEER FORCE & BENDING MOMENT



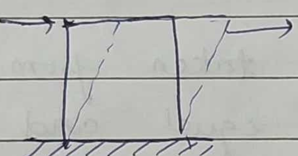


[Compression] - ve

[Tension] → + ve



<u>Neutral axis</u>: The axis at which there's no compression ~~and tension~~

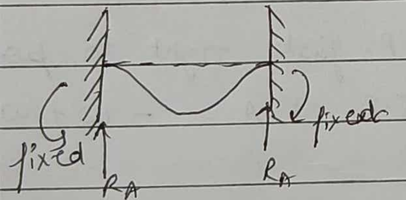


Sheer force : Force acting along surface

[At simple support] : we don't get moment but only reaction

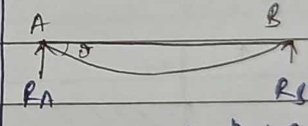
⇒ Sheer force & bending moment

[At fixed support] : both moment & reaction

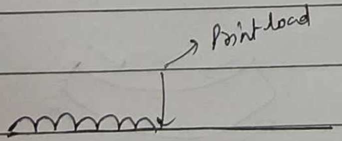


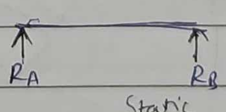
Moment & Reaction

[Fixed Support]



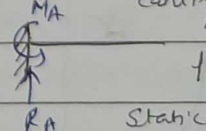
No Moment But only r^n





Simple supported

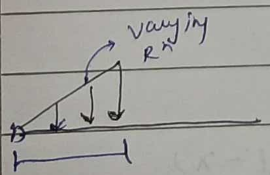
Static



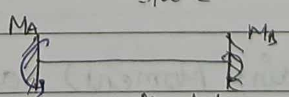
Cantilever beam

free

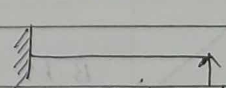
Static



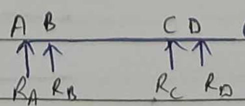
Simple support



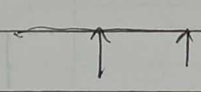
fixed beam



propped cantilever



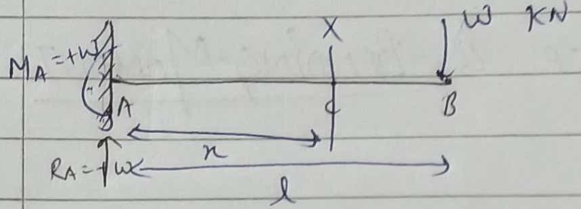
Continuous beam



Over-hanging beam

$$\begin{cases} \Sigma H = 0 \\ \Sigma V = 0 \\ \Sigma M = 0 \end{cases}$$

Static



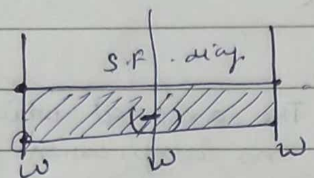
S.F.

S.F. at B = $-W$

S.F. at C = $-W$

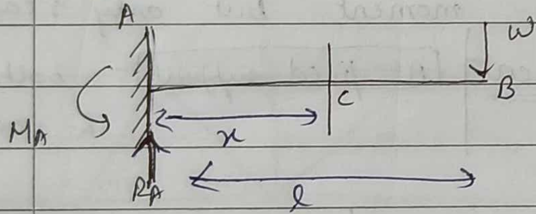
S.F. just right to pt. A. = $-W$

S.F. at A = 0
(fixed)



⟹ <u>Bending Moments</u>

Algebric sum of all moments either taken from right or left of the section should be equal and opposite



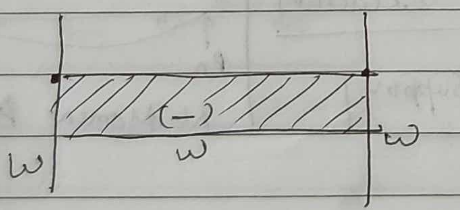
S.F.

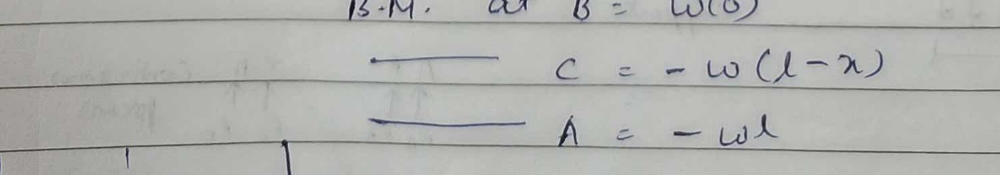
S.F. at B = $-W$

S.F. at C = $-W$

S.F. just right to point A = $-W$

S.F. at A = $-W + W = 0$



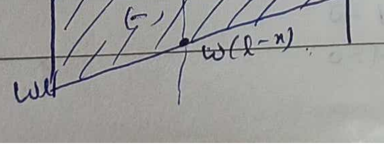
☆ 

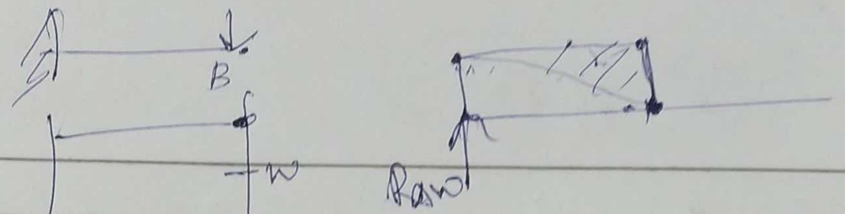
B.M. (Bending Moment) at B

B.M. at B = $W(0)$

——— C = $-W(l-x)$

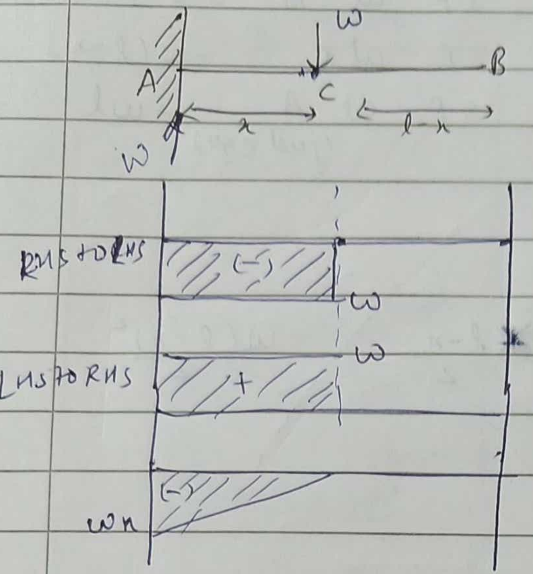
——— A = $-Wl$





Ques: Construct Shear force & Bending moment diag.

RHS to LHS



S.F. at B = 0

S.F. at C = ~~[illegible]~~ $-w$

S.F. just right at point A = $-w$

S.F. at A = 0

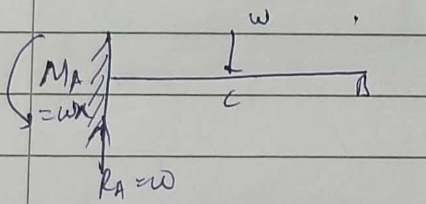
B.M.

B.M at B = 0

B.M at C = 0

B.M at A = ~~[illegible]~~ $-wx$

If L.H.S to R.H.S



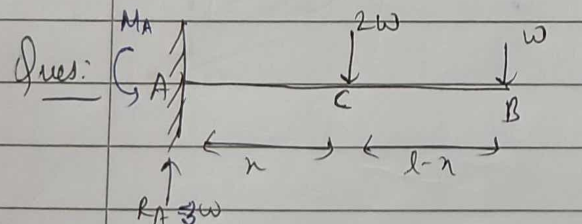
SF at B = $+w - w = 0$

C = $+w - w = 0$

Just right to A = $+w$

at A = 0 $(-w + w)$

Ques:



SF at B = $-w$

S.F. at C = $-2w - w = -3w$

SF just right to point = $-3w$

SF at A = 0

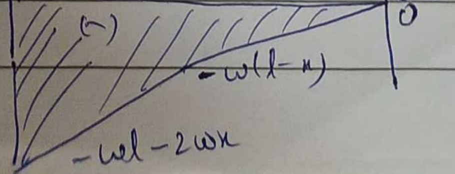
~~BM at B~~

BM at B = $-w(0)$

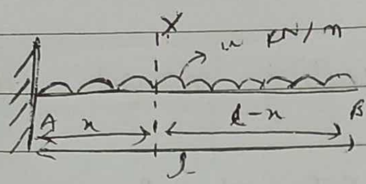
C = $-w(l-x)$

A = ~~$-2w(l)$~~

= $-wl - 2wx$



Ques:



S.F.

S.F. at $B = 0$

S.F. at $C = -w(l-x)$

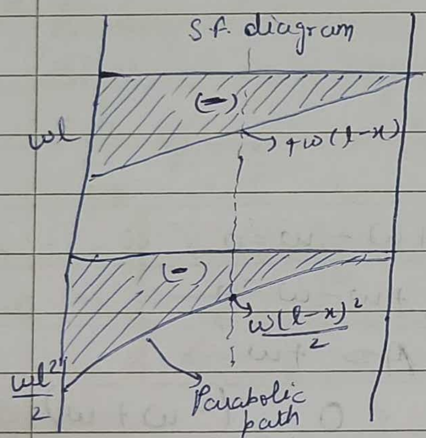
S.F. at $A = -wl$
(just right)

B.M.

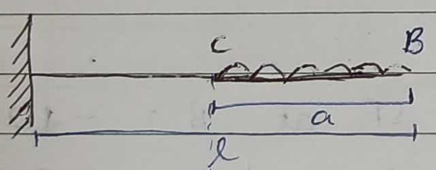
B.M. at $B = 0$

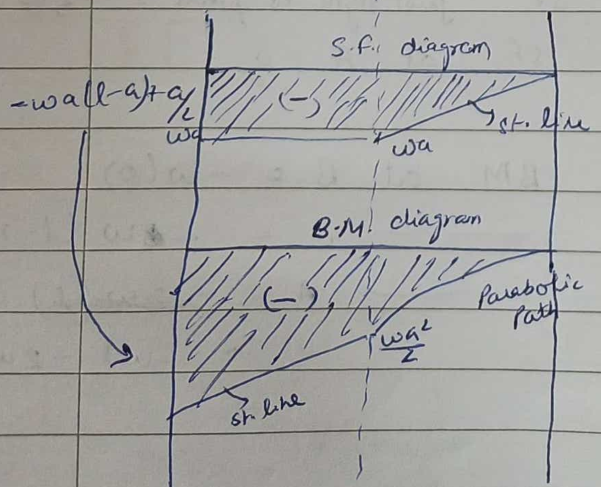
B.M. at $C = -w(l-x) \times \frac{l-x}{2} = \frac{-w(l-x)^2}{2}$

B.M. at $A = -\frac{wl^2}{2}$



Ques:

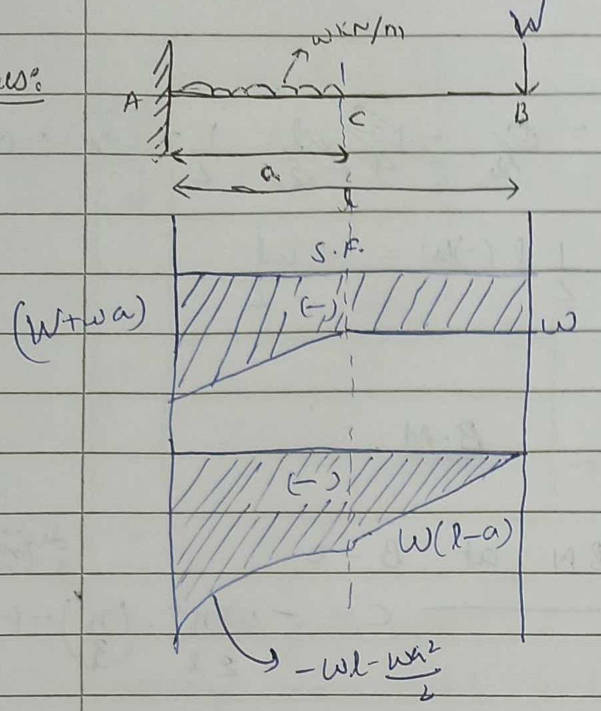




Hogging (−)

(+) Sagging Moment __/__/__

Ques:



S.F.

S.F. at B =

S.F. at C =

S.F. at A = (just right)

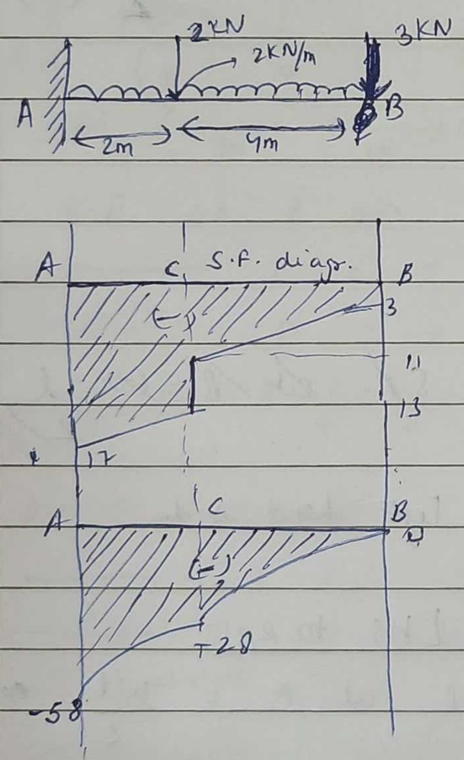
B.M.

B.M. at B =

B.M. at C =

B.M. at A =

Ques:



S.F.

S.F. at B = −3

S.F. at C (just right) = − 3 −2×4

S.F. at A = − 3 −2 ×6 −2

S.F. at C = − 3 − 2 − 2×4

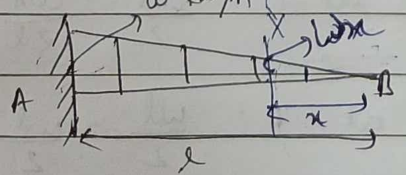
B.M. at B = 0

B.M. right at C = −(3)(4) − (2)(2)(4)

B.M at A = −(2)(2) − (2)(6)(3) −(3)(6)

= −58

Ques:



By similar triangle

$\frac{w}{w_x} \neq \frac{l}{x}$ $\frac{w}{l} = \frac{w_x}{x}$

or $\frac{w}{l} x$

$w_x = \frac{w}{l} x$

$\boxed{\text{area of } \Delta = \text{force}}$

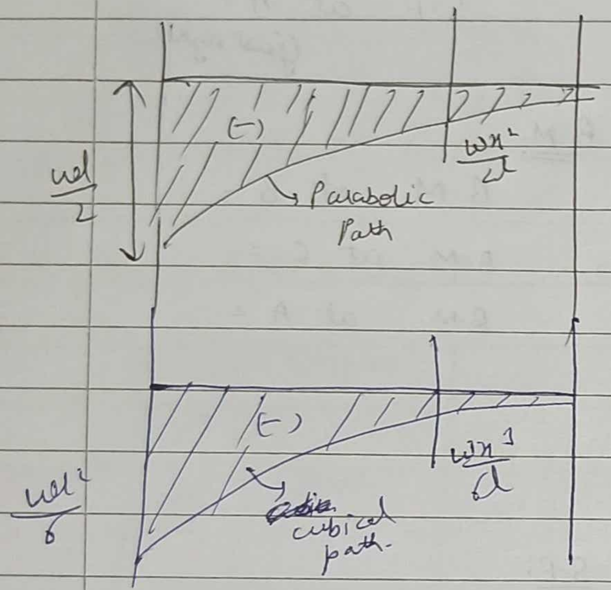
__/__/__

S.F.

S.F. at $B = 0$

S.F. at C; $x = \cancel{\tfrac{l}{3}}$ $\cancel{\tfrac{w}{l} \times \tfrac{l}{2}}$ $\frac{1}{2} x (w_x) = (-) \frac{wx^2}{2l}$

S.F. at A ; $= \frac{1}{2} l (-)w = -\frac{wl}{2}$



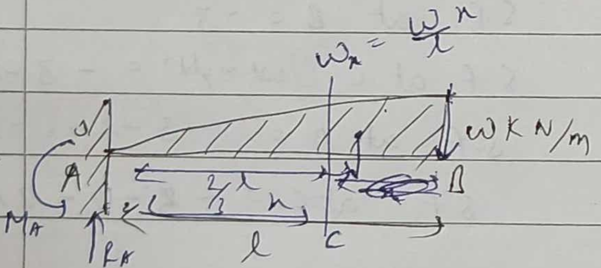
B.M.

B.M. at $B = 0$

—— $C = -\frac{wx^2}{2l} \cdot \left(\frac{x}{3}\right) = (-)\frac{wx^3}{6l}$ distance from centroid

—— $A = -\frac{wl}{2}\left(\frac{l}{3}\right) = -\frac{wl^2}{6}$

Ques:



S.F. at $B = (-)\frac{wl}{2}$

left hand side

$R_A = \frac{1}{2} w (l)$

LHS to RHS

$M_A = \frac{wl}{2}\left(\frac{2}{3}\right) l = \frac{wl^2}{3}$

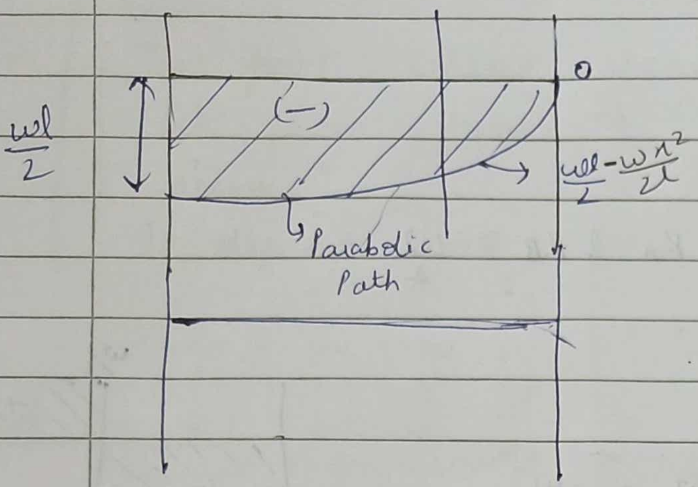
Force × distance

S.F. at $A = \frac{wl}{2}$

S.F at $C = \frac{wl}{2} - \frac{wx^2}{2l}$

SF at $B = \frac{wl}{2} - \frac{wl}{2} = 0$

__/__/____



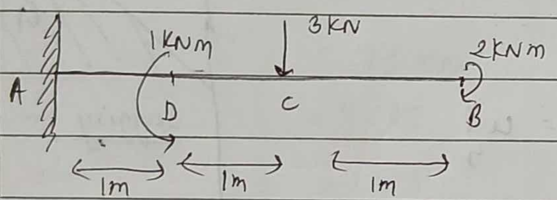
B.M. at A = $\frac{wl^2}{3}$

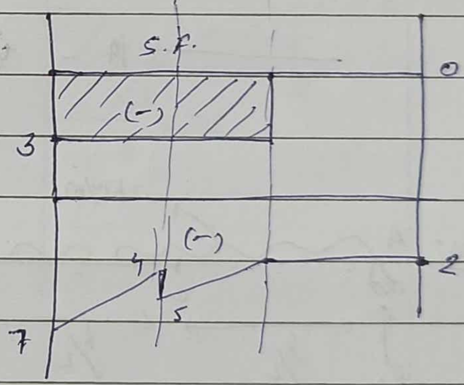
B-M at C = $\left(\frac{2l}{3}\right)\left(\frac{wl}{2} - \frac{wx^2}{2l}\right)$

B.M at B = 0

At free end and at hinge point, the moment is always zero, until external moment is applied.

Ques:





S.F. at B = 0

—— C = −3

—— D = −3

—— A (just right) = 3

B.M. at B = −2

—— C = −2

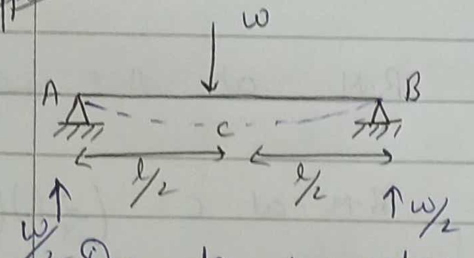
—— D = −2 − 3×1
(just right) = −5

—— at D = −5 + 1 = −4

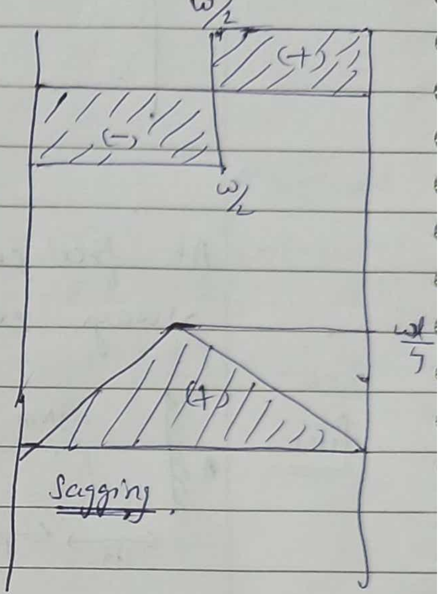
—— A = −2 − 3×2 + 1
(right) = −7

Fixed Support

Ques:



Due to symmetry ; R_A & $R_B = \frac{w}{2}$



S.F. at $B = \frac{w}{2}$

S.F. at $C = -w + \frac{w}{2} = -\frac{w}{2}$

S.F. at $A = -w + \frac{w}{2} + \frac{w}{2} = 0$

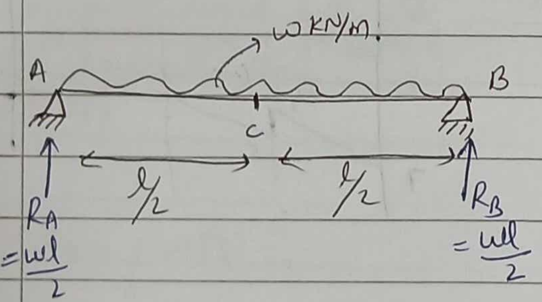
S.F. at A (just right) $= -w + \frac{w}{2} = -\frac{w}{2}$

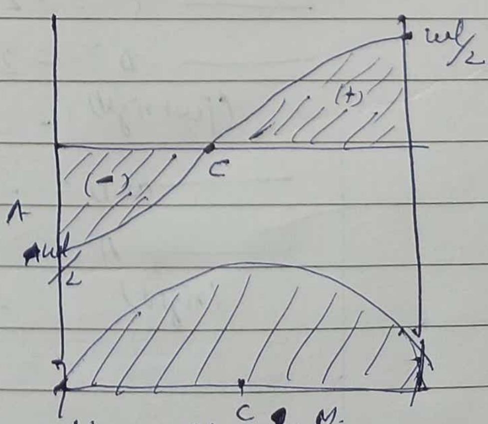
B.M. at $B = 0$

B.M. at $C = \frac{w}{2}\left(\frac{l}{2}\right) = \frac{wl}{4}$

—— $A = \frac{w}{2}(l) - w\left(\frac{l}{2}\right) = 0$

Ques:





S.F. at $B = \frac{wl}{2}$

—— $C = -\frac{wl}{2} + \frac{wl}{2} = 0$

—— $A = -w + \frac{wl}{2} = -\frac{wl}{2}$

B.M. at $B = 0$

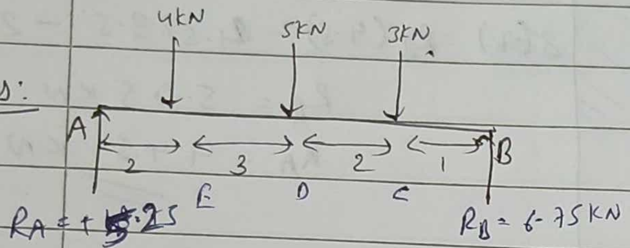
—— $C = \frac{wl}{2}\left(\frac{l}{2}\right) - \frac{wl}{2} \times \frac{l}{4} = \frac{wl^2}{4} - \frac{wl^2}{8}$

—— A (just right) $= \frac{wl}{2}(l) - wl\left(\frac{l}{2}\right) = 0$

__/__/__

Note:
The point where shear force is low / changing its sign from + to −, max. bending moment occurs
It depends only when there is no ext. moment.

Ques:



$R_A + R_B = +12$ KN

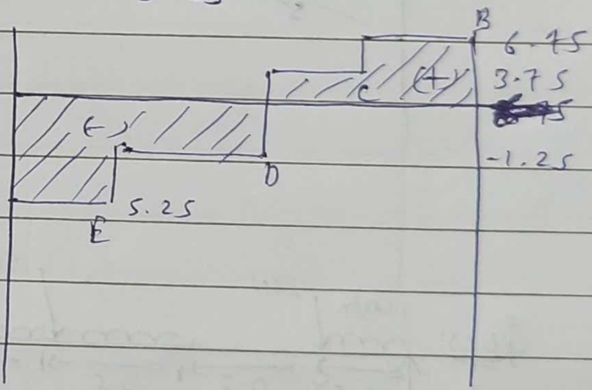
$\Sigma M_A = 0$

$4(2) + 5(5) + 3(7) - R_B(8) = 0$

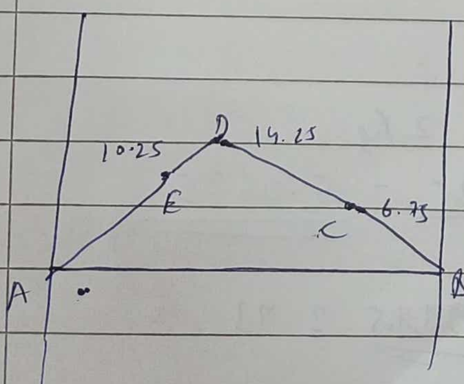
$R_B = 6.75$ KN

$\therefore R_A = ~~18.75~~$ KN
5.25

S.F. at B = 6.75 KN
——— C = +3.75
——— D = −1.25
——— E = −5.25



B.M. at B = 0
B.M. at C = $6.75 \times 1 = 6.75$
——— D = $6.75 \times 3 - 3(2)$
$= 14.25$
——— E = $6.75 \times 6 - 3 \times 5 - 5 \times 3 = 10.25$
——— A = $6.75 \times 8 - 3 \times 7 - 5 \times 5 - 4 \times 2 = 0$



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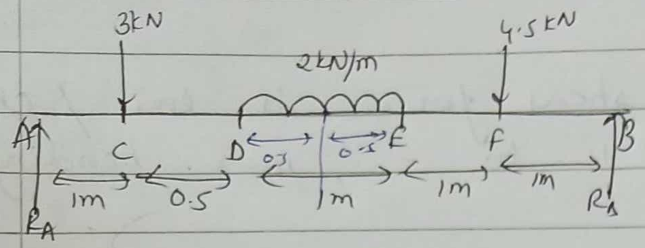
Ques:



$\Sigma V = 0$

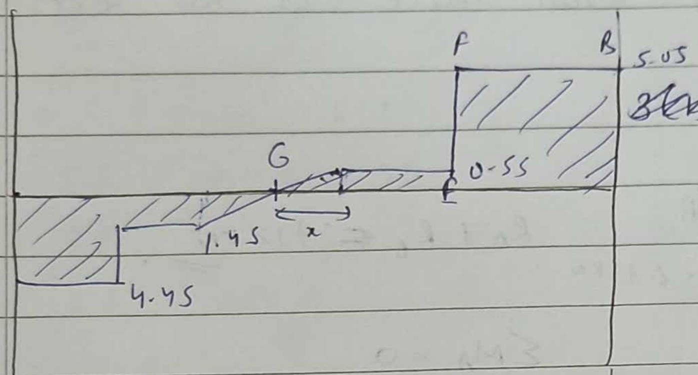
$R_A + R_B = 9.5\,kN$

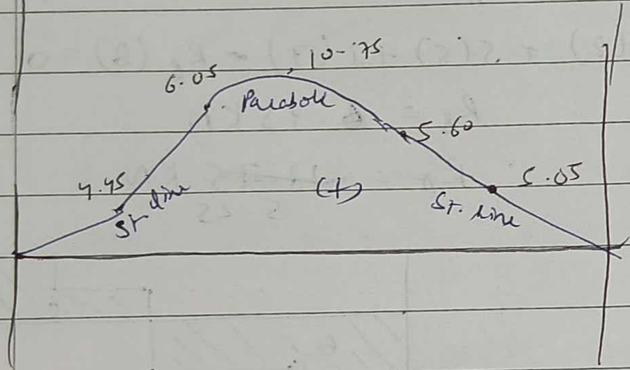
$\Sigma M_A = 0$

$R_B(4.5) - 4.5 \times 3.5 - 2 \times 2 - 3 \times 1 = 0$

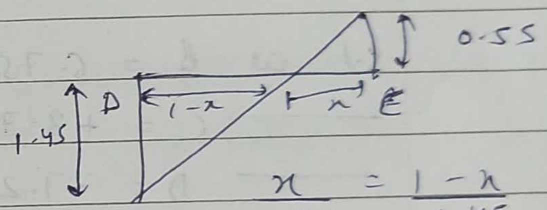
$R_B = 5.05\,kN$

$R_A = 4.45\,kN$





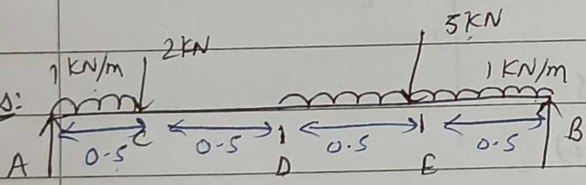
By similar triangles



$$\frac{x}{0.55} = \frac{1-x}{1.45}$$

or $x = 0.275$

Ques:



$\Sigma V = 0$

$R_A + R_B = 8.5$

$\Sigma M_A = 0$

$$1 \times \frac{(0.5)}{2} \times \frac{1}{4} + 2 \times 0.5 + 5 \times 1.5 + 1 \times 1 \times 1.5 - R_B(2) = 0$$

$$\frac{1}{8} + 1.0 + 7.5 + 1.5 = 2R_B$$

$$10 + 0.125 = 2R_B$$

$$R_B = \frac{10.125}{2} = 5.0625$$

$R_A = \cancel{3.4375}\ 3.43$

Point load
couple
Varying load

4 ques
1 MOI
2 Truss
3 Cantilever
4 Simply supported

S.F. at $B = 5.06 \uparrow$

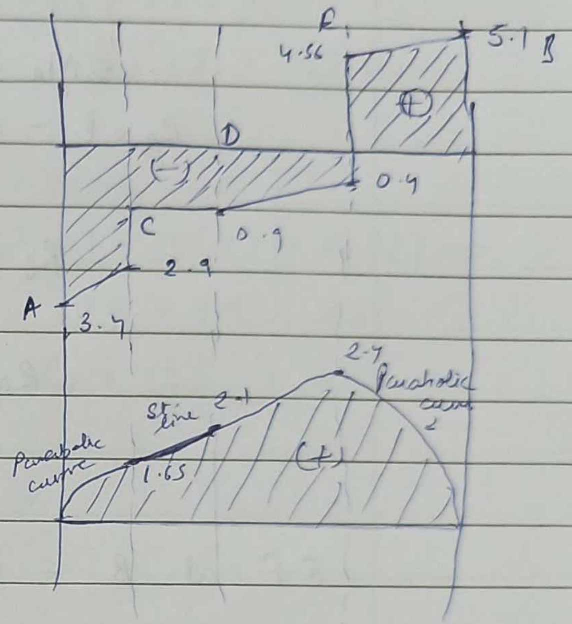
—— $E = 5.0625 - (5 + 1 \times 0.5) = -0.4376$

—— $D = -6 + 5.0625 = -0.9375 \downarrow$

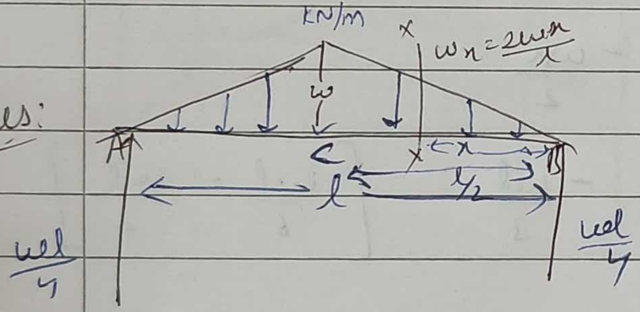
—— $C = -2.4875$

—— $A = 0$

just right of A) $= -3.4375$



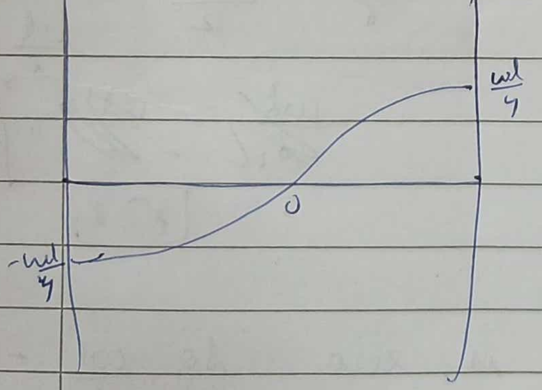
Ques:



$\frac{x}{w_x} = \frac{l/2}{w}$

$w_x = \frac{2wx}{l}$

$2R_A = \frac{wl}{2}$



S.F. at $B = \frac{wl}{4}$

S.F. at section XX $= \frac{1}{2}\left(\frac{wx}{l}\right) \cdot x + \frac{wl}{4}$

$= \frac{wx^2}{2l} + \frac{wl}{4}$

—— $C = -\frac{wl}{4} + \frac{wl}{4} = 0$

$\left(\frac{\frac{1}{2} \times base \times ht}{}\right)$

B.M. at $C = \frac{wl}{4} \times \frac{l}{2} - \left[\frac{wl}{2} \cdot \frac{l}{2}\right] \times l = \frac{wl^2}{12}$

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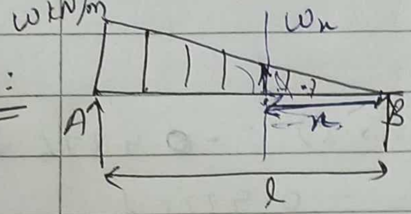
Ques: I



$$\frac{x}{w_x} = \frac{l}{w}$$

$$w_x = \frac{xw}{l} \quad \text{---} (1)$$

$\Sigma V = 0$

$R_A + R_B = \frac{wl}{2}$

$\Sigma M_A = 0$

$$R_B \times l - \frac{wl}{2} \times \frac{l}{3} = 0$$

$\therefore \; R_B = \frac{wl}{6}$ & from eqⁿ (1)

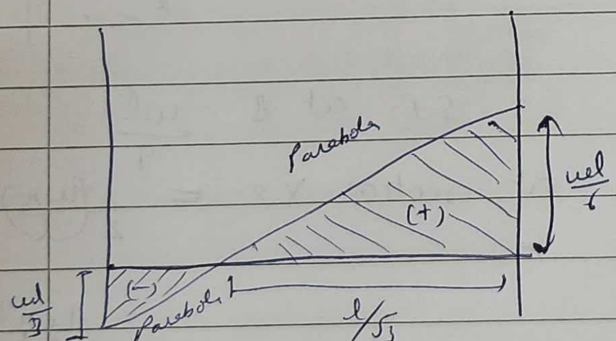
$R_A = \frac{wl}{3}$

w_x is the load at section x–x. By similar triangle, we get $w_x = \frac{wx}{l}$

S.F. at B $= \frac{wl}{6}$

——— x-x section $= \frac{wl}{6} - \frac{wx}{2}$

——— A (just right) $= -\frac{wl}{3}$ $\left[\frac{wl}{6} - \frac{wl}{2}\right]$



$$\frac{wl}{6} - \frac{w_x x}{2} = 0$$

$$\frac{wl}{6_3} = \frac{wx^2}{2}$$

$$x = \frac{l}{\sqrt{3}}$$

$\frac{1}{2} \times x \times w_x \times \frac{2h}{\sqrt{3}}$

$\frac{w x^2}{4}$

$\frac{wl}{9\sqrt{3}}$

B.M. at C where S.F. is zero; so $\frac{wl}{6} - \frac{w_x x}{2} = 0$

or $\boxed{x = l/\sqrt{3}}$

Max bending moment at C = $\cancel{\frac{w}{2}\left(\frac{l}{\sqrt{3}}\right)}$ w

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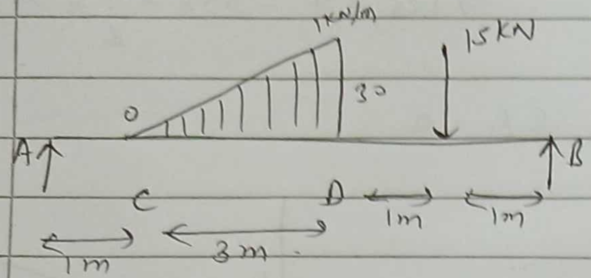
Ques:



$R_A + R_B - 15 - 30 = 0$

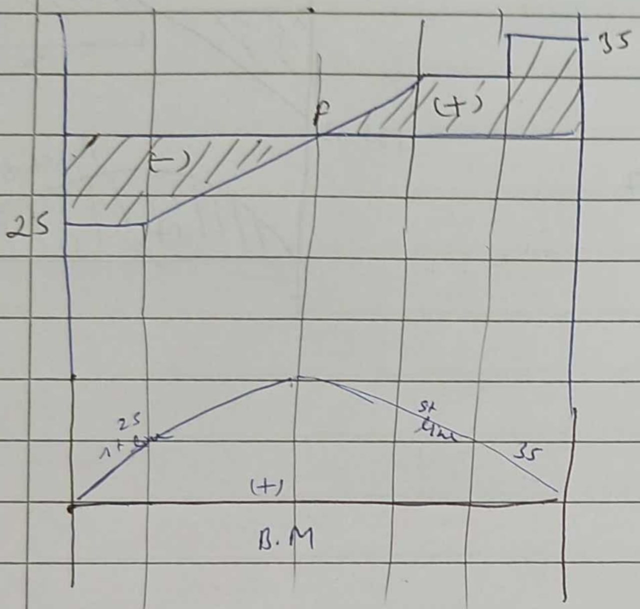
$R_A + R_B = \underline{45\ kN/m}$

$\Sigma M_A = 0$

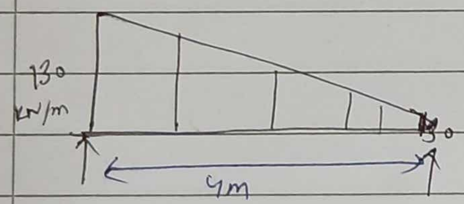
$30(4) + 15(5) - R_B(6) = 0$

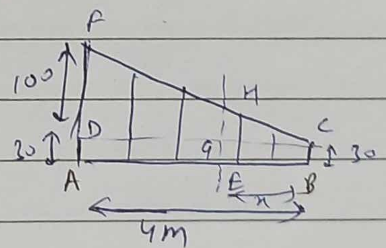
$120 + 75 = 6R_B$

$R_B = \frac{195}{6} = 3$



Ques:





$\Sigma V = 0$

$R_A + R_B = \underbrace{30 \times 4}_{udl} + \underbrace{\frac{1}{2} \times 100 \times 4}_{varying\ load}$

$\Sigma M_A = 0$

$R_B \times 4 = (30 \times 4) \times \frac{4}{2} + \frac{4}{3}\left(\frac{1}{2} \times 4 \times 400\right)$ 4/3

$R_B = 126.67\ kN$

$\& R_A = 193.33$

By similar Δ;

$\frac{DF}{DC} = \frac{GH}{GC}$ or $\frac{100}{4} = \frac{W_x}{x}$

Rate of load changing at sec X–X

$= \underline{25x + 30}$

Beams & load

MoI
Truss
BM → Cantilever & simply support

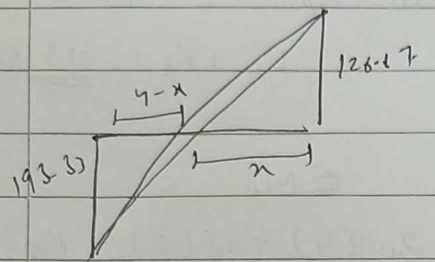
__/__/____

S.F. at B = 126.67 KN (just righ

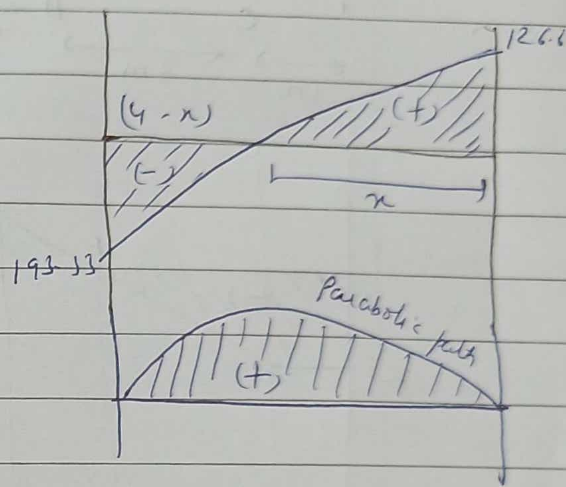
———— A = (−) 193.33

OB distance : S.F. at X − X distance

$\Rightarrow 126.67 - 30x - \frac{1}{2} x\, 25x$



S.F. = 0



B.M. at A = 0

———— B = 0

Max. B.M at = 0 ⇒ 161.7