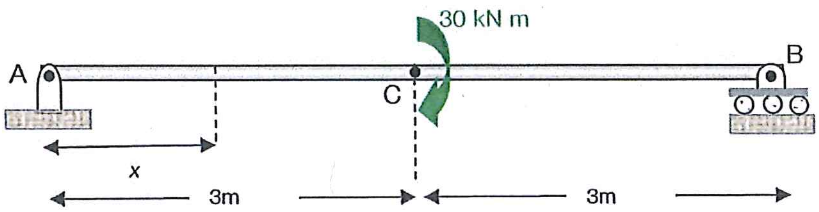
RMIT UNIVERSITY

WORKED SOLUTIONS

ENST2.4: SHEAR AND BENDING MOMENT DIAGRAMS

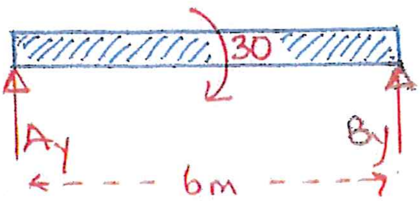
Question 1

Determine the shear and moment as a function of x, where $0 \leq x < 3$m and $3 < \leq x \leq 6$m, and then draw the shear and moment diagrams.
(Hibbeler, R.C, 2010 12th Ed., *Statics* , Pearson)



Worked Solution 1

Support Reactions

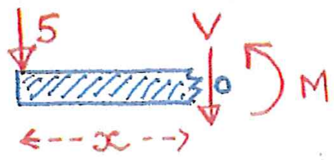


$+\circlearrowleft \Sigma M_A = 0$: $-30 + 6B_y = 0 \Rightarrow B_y = 5\text{KN}$

$+\uparrow \Sigma F_y = 0$: $A_y + 5 = 0 \Rightarrow A_y = -5\text{KN}$

Shear & Moment Reactions

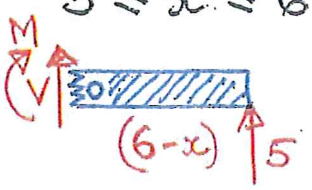
$0 \leq x < 3$



$+\uparrow \Sigma F_y = 0$: $-5 - V = 0 \Rightarrow V = -5\text{KN}$

$+\circlearrowleft \Sigma M_o = 0$: $M + 5x = 0 \Rightarrow M = -5x$

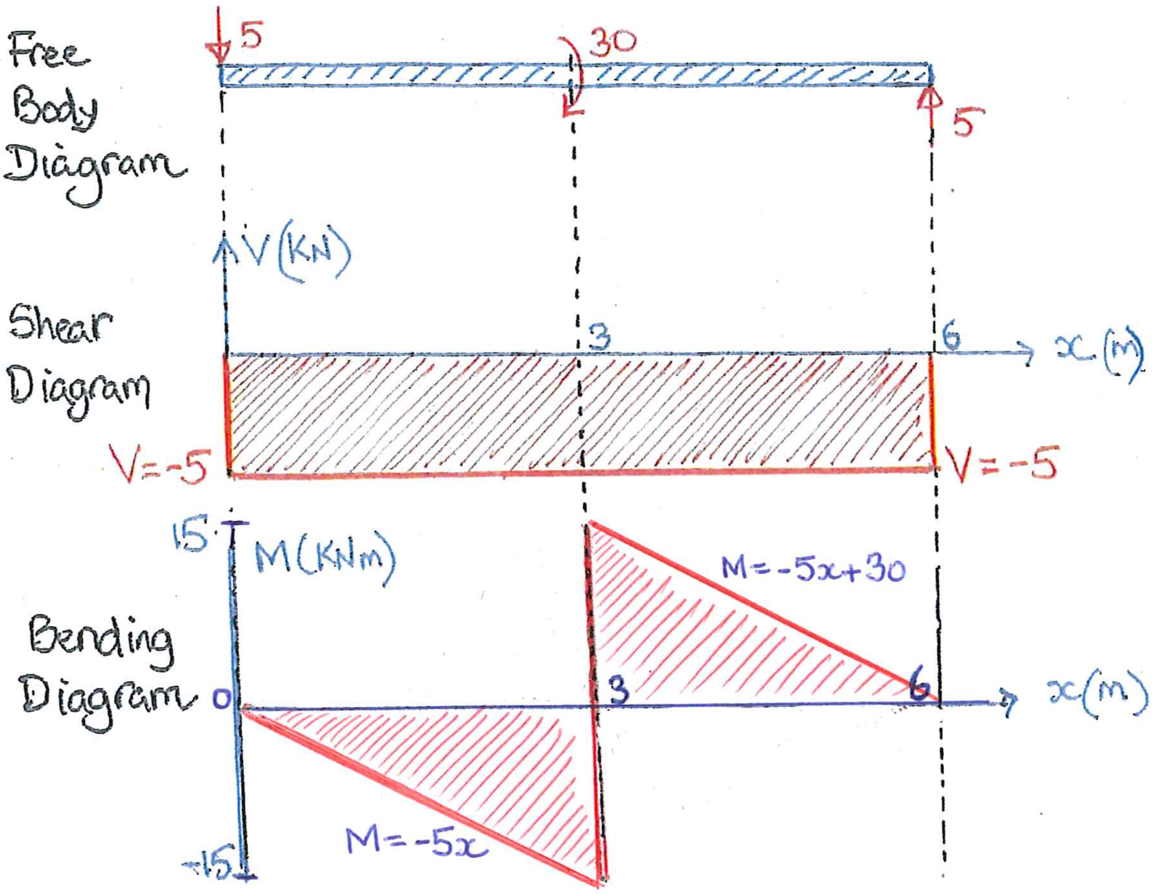
$3 \leq x \leq 6$



$+\uparrow \Sigma F_y = 0$: $V + 5 = 0 \Rightarrow V = -5\text{KN}$

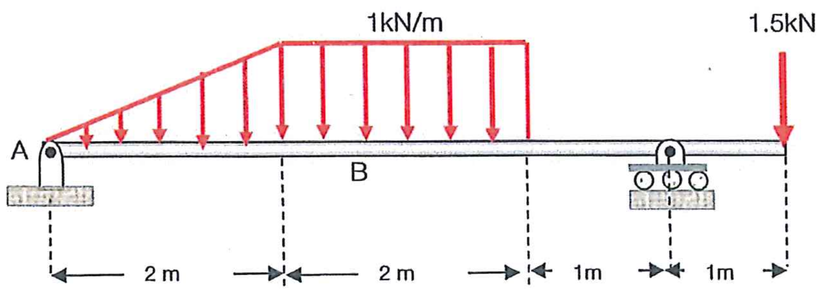
$+\circlearrowleft \Sigma M_o = 0$: $5(6-x) - M = 0$

$\Rightarrow M = -5x + 30$

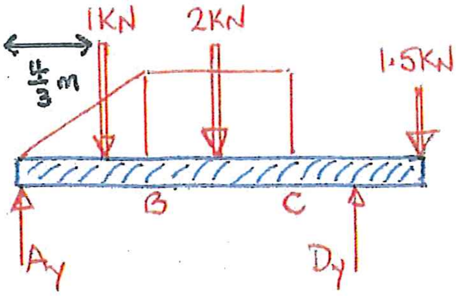


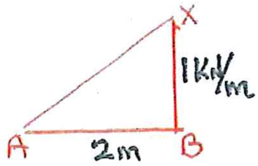
Question 2

Draw the shear and moment diagrams for the loaded beam below.
(Meriam, J.L, & Kraige, 2008 6th Ed., *Statics* , Wiley)



Worked Solution 2

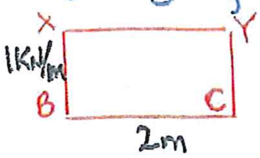




Load = Area Δ ABX

$= \frac{1}{2} \times 2 \times 1 = 1$ KN

This load acts through centroid of Δ, or $\frac{2}{3}$ of 2m = $\frac{4}{3}$ m.



Load = Area □ BCYX

$= 2 \times 1 = 2$ KN, which acts through centroid of □

Support Reactions

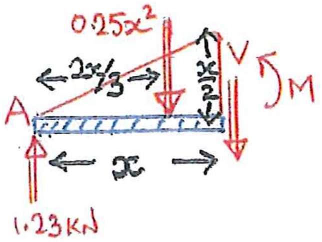
$+\circlearrowleft \Sigma M_A = 0 \quad : \left(-1 \times 4/3\right) - (2 \times 3) - (1.5 \times 6) + (D_y \times 5) = 0$

$\Rightarrow D_y = 3.27\ \text{KN}$

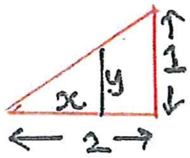
$+\uparrow \Sigma F_Y = 0 \quad : A_y + 3.27 - 1 - 2 - 1.5 = 0 \quad \Rightarrow A_y = 1.23\ \text{KN}$

Shear & Moment Reactions

$0 \le x < 2$



Using similar Δ's :



$y = x/2\ \text{KN/m}$

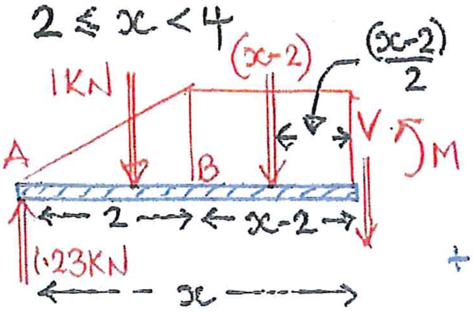
Area of $\Delta = \frac{1}{2} \times x \times x/2 = 0.25x^2$

which acts through centroid of Δ : $2/3$ of $x = 2x/3$

$+\uparrow \Sigma F_y = 0 : 1.23 - 0.25x^2 - V = 0 \Rightarrow V = 1.23 - 0.25x^2$

$+\circlearrowleft \Sigma M = 0 : \quad M + (0.25x^2 \times x/3) - 1.23x = 0 \Rightarrow M = 1.23x - 0.083x^3$

$2 \le x < 4$



Area of

$= (x-2) \times 1 = (x-2)$

which acts through centroid of $\square = \frac{(x-2)}{2}$

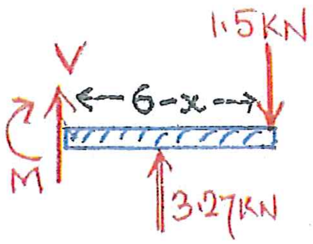
$+\uparrow \Sigma F_y = 0 : 1.23 - 1 - (x-2) - V = 0$

$\Rightarrow V = 2.23 - x$

$+\circlearrowleft \Sigma M = 0 : \quad M + \{(x-2)(x-2)/2\} + \{1 \times (x - 2/3 \cdot 2)\} - (1.23 \times x) = 0$

$\Rightarrow M = -0.67 + 2.23x - 0.5x^2$

$4 \le x \le 6$

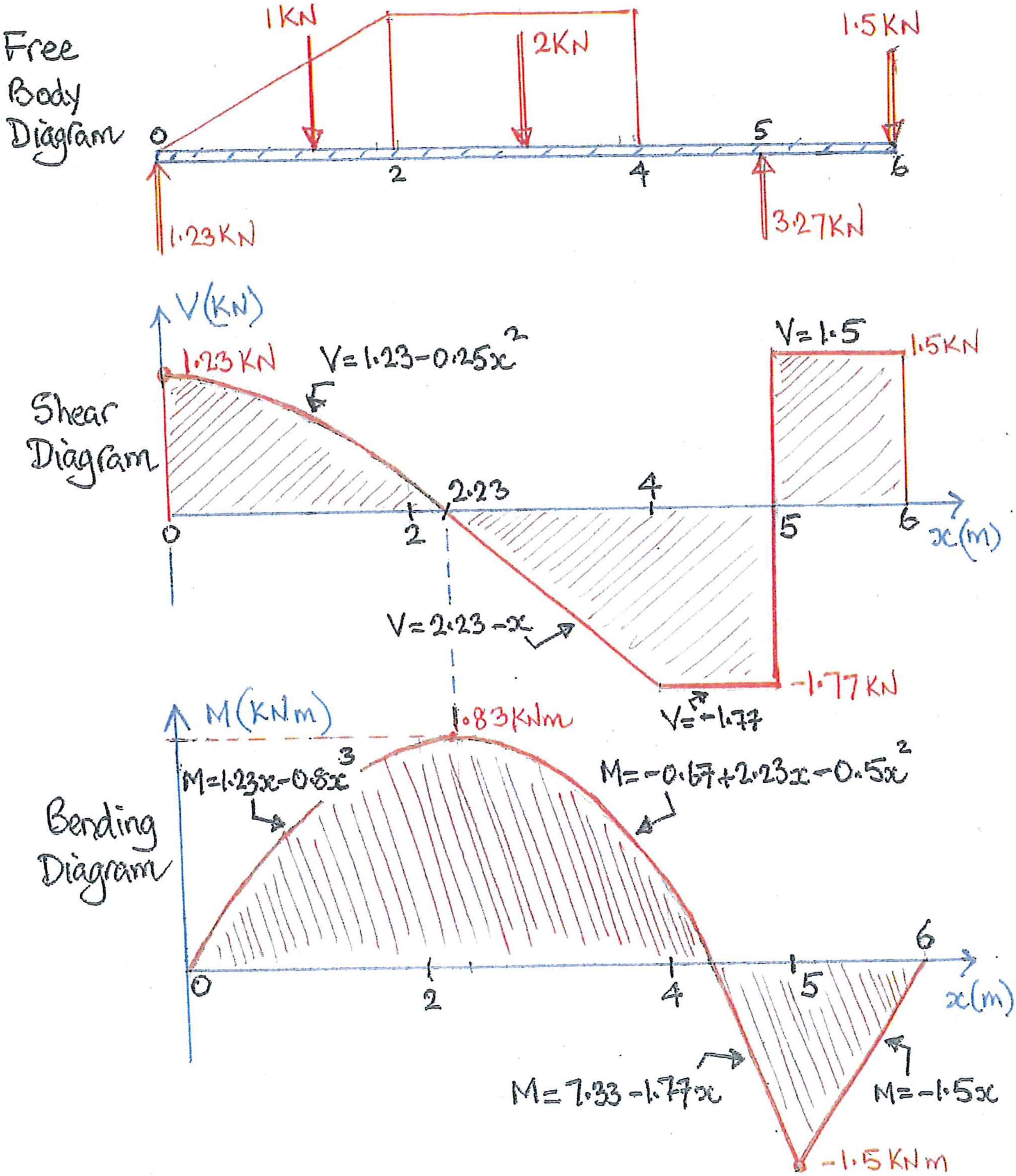


$+\uparrow \Sigma F_y = 0 : \quad V + 3.27 - 1.5 = 0$

$\Rightarrow V = -1.77\ \text{KN}$

$+\circlearrowleft M = 0 : \quad -M - 1.5(6-x) + 3.27 \times \frac{6-x}{2} = 0$

$\Rightarrow M = 7.33 - 1.77x$



Note: • Maximum moment occurs at $x = 2.23$m where shear curve crosses the X-axis, $M_{MAX} = 1.83$KNm

• Change in moment ΔM up to any section equals the area under the shear diagram up to that section.