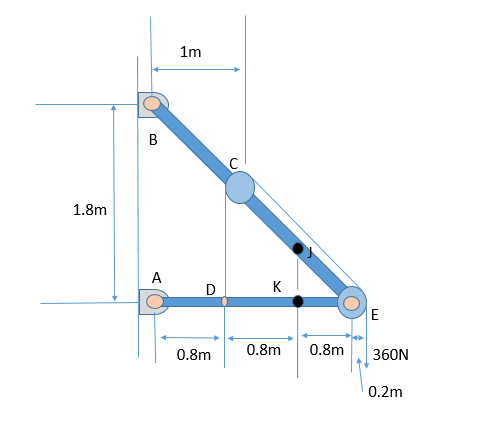
**WEEK 7: INTERNAL FORCES AND MOMENTS**

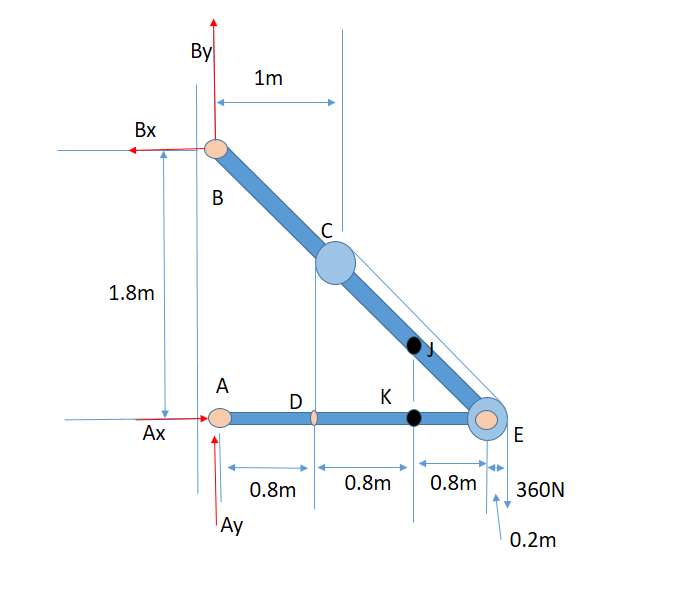
Question 1: Knowing that the radius of each pulley is 200 mm and neglecting friction, determine the internal forces at Point J of the frame shown.



**Theoretical Concept:**

**SOLUTION:**

Free Body Diagram:



∑MB = 0: Ax (1.8m) = 360N (0.8m + 0.8m + 0.8m + 0.2m)

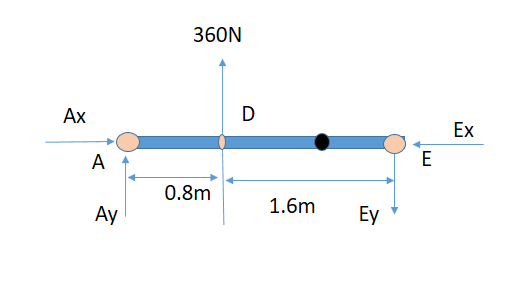
**Ax = 520N**

∑MA = 0: Bx (1.8m) = 360N (0.8m + 0.8m + 0.8m + 0.2m)

**Bx = 520N**

∑Fy = 0: Ay + By = 360N

Free body diagram of segment AE:



∑ME = 0: Ay (1.6m + 0.8m) + 360N ( 1.6m) = 0

Ay = -240N

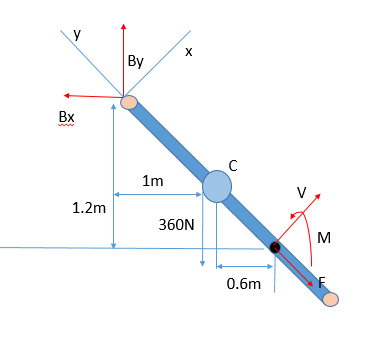
**Ay = 240N (downward)**

**From the free body diagram of the whole system:**

∑FV = 0: By = 360N + 240N

**By = 600N**

**Free Body Diagram of segment BJ:**



∑Fy = 0:

3/5 (600N) + 4/5 (520N) = 360N + 3/5 (600N) + F

**F = 200N angle -36.9°**

∑Fx = 0: 4/5 (600N) + V = 3/5 (520N) + 4/5(360N)

**V = 120N angle 53.1°**

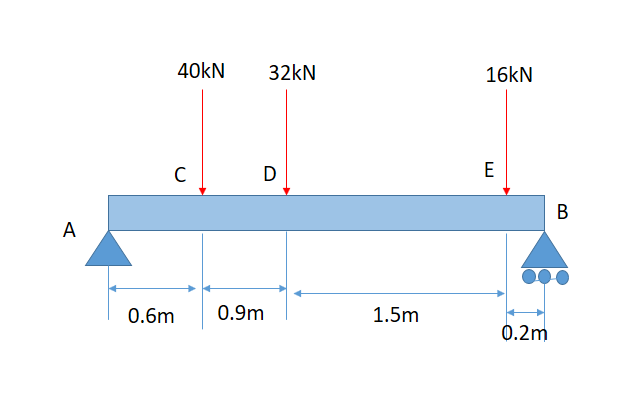
∑Mj = 0: (520N)(1.2m) + 360N(0.6m) + M = 600N(1.6m)

**M = +120 N.m**

**Critical thinking:**

The higher the values of the external force the higher the values experienced by the internal force. If not observed may cause to its breaking.

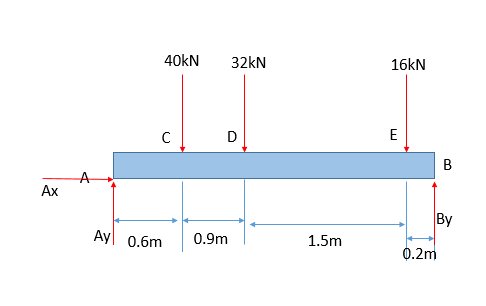
**Question 2: For the beam and loading shown, (a) draw the shear and bending moment diagrams, (b) determine the maximum absolute values of the shear and bending moment.**



**Theoretical Concept:**

**SOLUTION:**

**Free Body diagram of the whole system:**



∑MA = 0: By (0.6m + 0.9m + 1.5m + 0.2m) = 40kN (0.6m) + 32kN (0.9m) + 16kN (0.6m + 0.9m + 1.5m)

**By = 37.5 kN**

∑FH = 0: **Ax = 0 N**

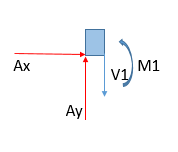
∑FV = 0: Ay + By = 40kN + 32kN + 16kN

**Ay = 50.5 kN**

**A = 50.5 kN**

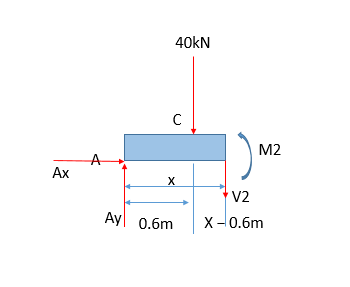
**Calculating the shear and moment diagram:**

**To the right of A:**

**V1 = Ay = 50.5 kN**

**M1 = 0 kN.m**

**To the right of C:**

∑Fy = 0: Ay = 40kN – V2

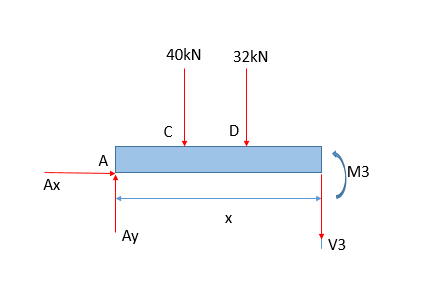
V2 = 50.5 kN – 40kN

**V2 = 10.5 kN**

∑M2 = 0: M2 = 50.5 kN (0.6m)

**M2 = +30.3 kN**

**To the right of D:**

∑Fy = 0: Ay = 40kN + 32kN + V3

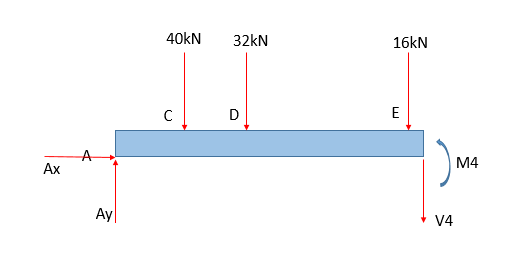
V3 = 50.5 KN − 40kN – 32Kn

**V3 = −21.5Kn**

∑M3 = 0: M3 = 40kN (0.9m) + 50.5kN (1.5m)

**M3 = 39.8 kN**

**To the right of E:**



∑Fy = 0: Ay = 40kN + 32kN + 16kN + V4

V4 = 50.5kN – 40kN − 32kN – 16kN

**V4 = −37.5 kN**

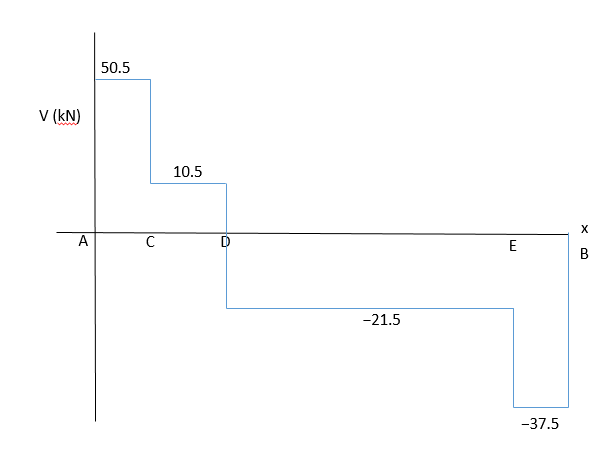
∑M4 = 0: M4 = 37.5kN (0.2m)

M4 = 7.50kN

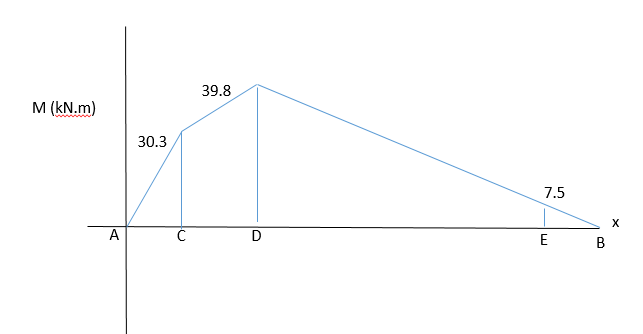
**At B:**

**VB = MB = 0**

**Shear Diagram:**



**Moment Diagram:**

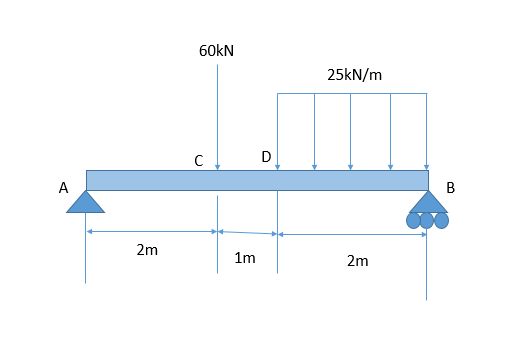


**Vmax = 50.5 kN ; Mmax = 39.8 kN.m**

**Critical Thinking:**

Since no distributed force applied, the shear and moment diagram doesn’t experienced any curves. Just linear.

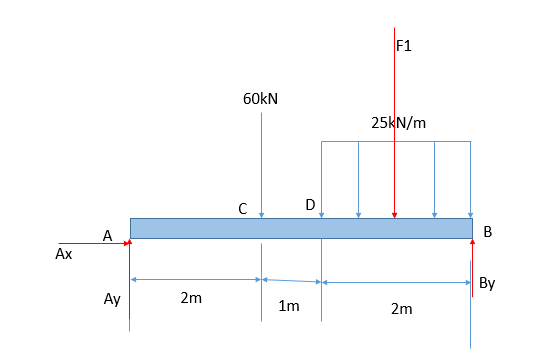
**Question 3:** **For the beam and loading shown, (a) draw the shear and bending-moment diagrams, (b) determine the maximum absolute values of the shear and bending moment.**



**Theoretical Concept:**

SOLUTION:

Free body diagram of the whole system:



F1 = 25kN/m (2m) = 50kN

∑MA = 0: By (2m + 1m + 2m) = 50kN(4m) + 60kN (2m)

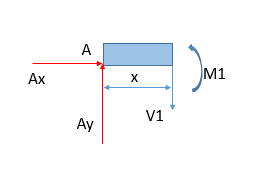
**By = 64 kN**

∑Fy = 0: Ay + By = 60kN + 50kN

**Ay = 46 kN**

∑Fx = 0: **Ax = 0 kN**

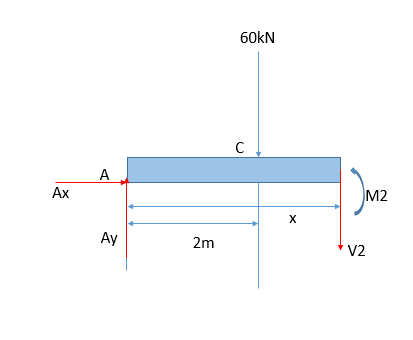
**To the right of A:**



∑Fy = 0: V1 = Ay = 46kN

∑M1 = 0: M1 = 46x

From C to D:



∑Fv = 0: V2 + 60kN = 46 kN

**V2 = −14 kN**

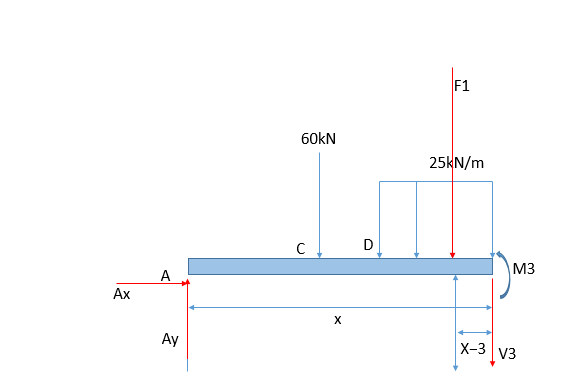
∑M2 = 0: M2 + 60kN(x−2) = 46x

M2 = (120 – 14x) kN.m

For x = 2, Mc = 92kN.m

For x = 3, MD = 78kN

**From B to D:**



∑Fy = 0: V3 +60kN + 50kN = 46 kN

**V3 = −64kN**

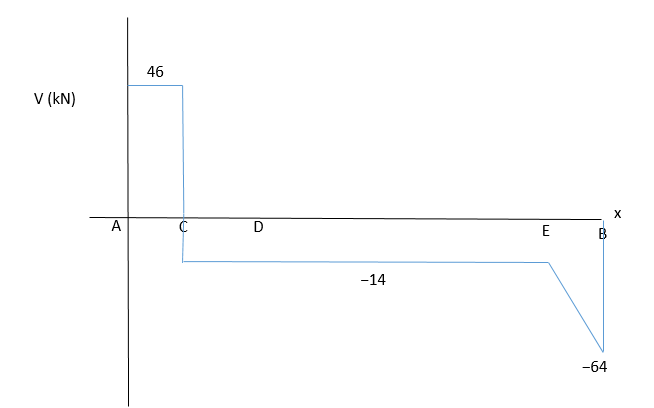
∑M3 = 0: M3 + 60kN (x−2) + 50kN(x−3) = 46 kN x

M3 = (46x − 50x – 60x) + 150 + 120

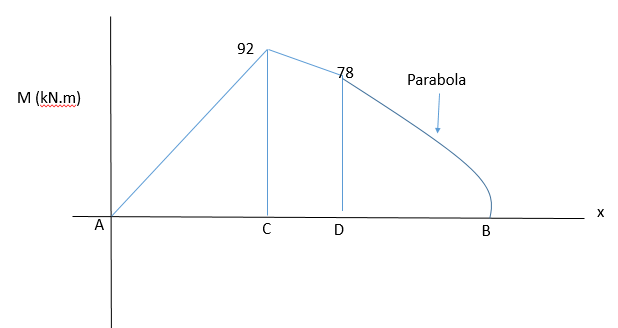
**M3 = (−64x)+270 kN**

**MB = 0**

**Shear Diagram:**



**Moment Diagram:**



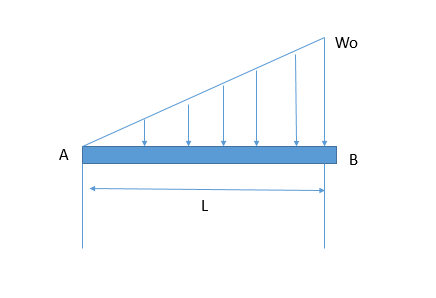
**Vmax = 64 kN**

**Mmax = 92 kN.m**

**Critical Thinking:**

**A beam with linear and uniform distributed force experiences both linear and 1st degree curve on its shear and moment diagram.**

**Question 4: For the beam and loading shown, (a) draw the shear and bending moment diagrams, (b) determine the maximum absolute values of the shear and bending moment**

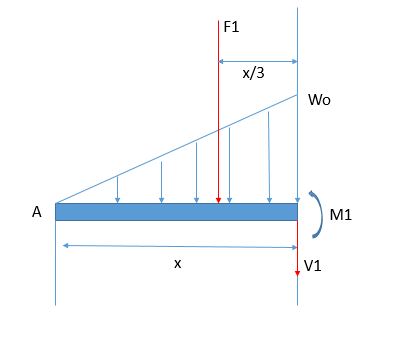
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**Theoretical Concept:**

**SOLUTION:**

**By similar triangle:**

**½ wx = ½ (Wo x/L) x = ½ Wo x2/L**



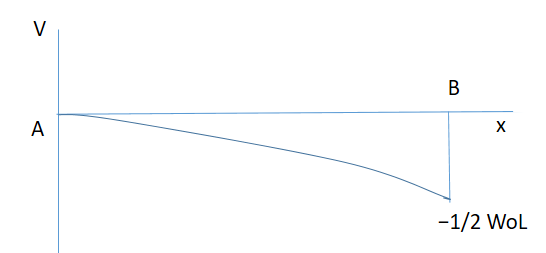
∑Fy = 0: − ½ Wo x2L – V1 = 0

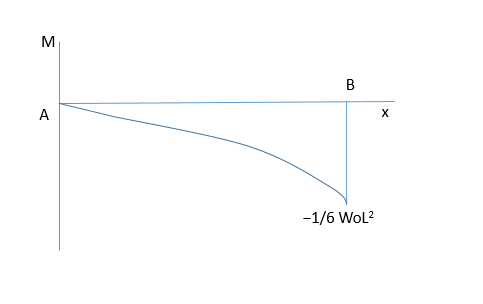
**V1 = − ½ Wo x2/L**

∑M1 = 0: ½ Wo x2/L (x/3) + M1 =0

**M1 = − 1/6 Wo x3/L**

**Shear Diagram:**





**Vmax = −1/2 WoL**

**Mmax = −1/6 WoL2**

**Critical Thinking:**

Beam loading with pinned the same side as this example has a negative values of shear and moment as shown in the graph.