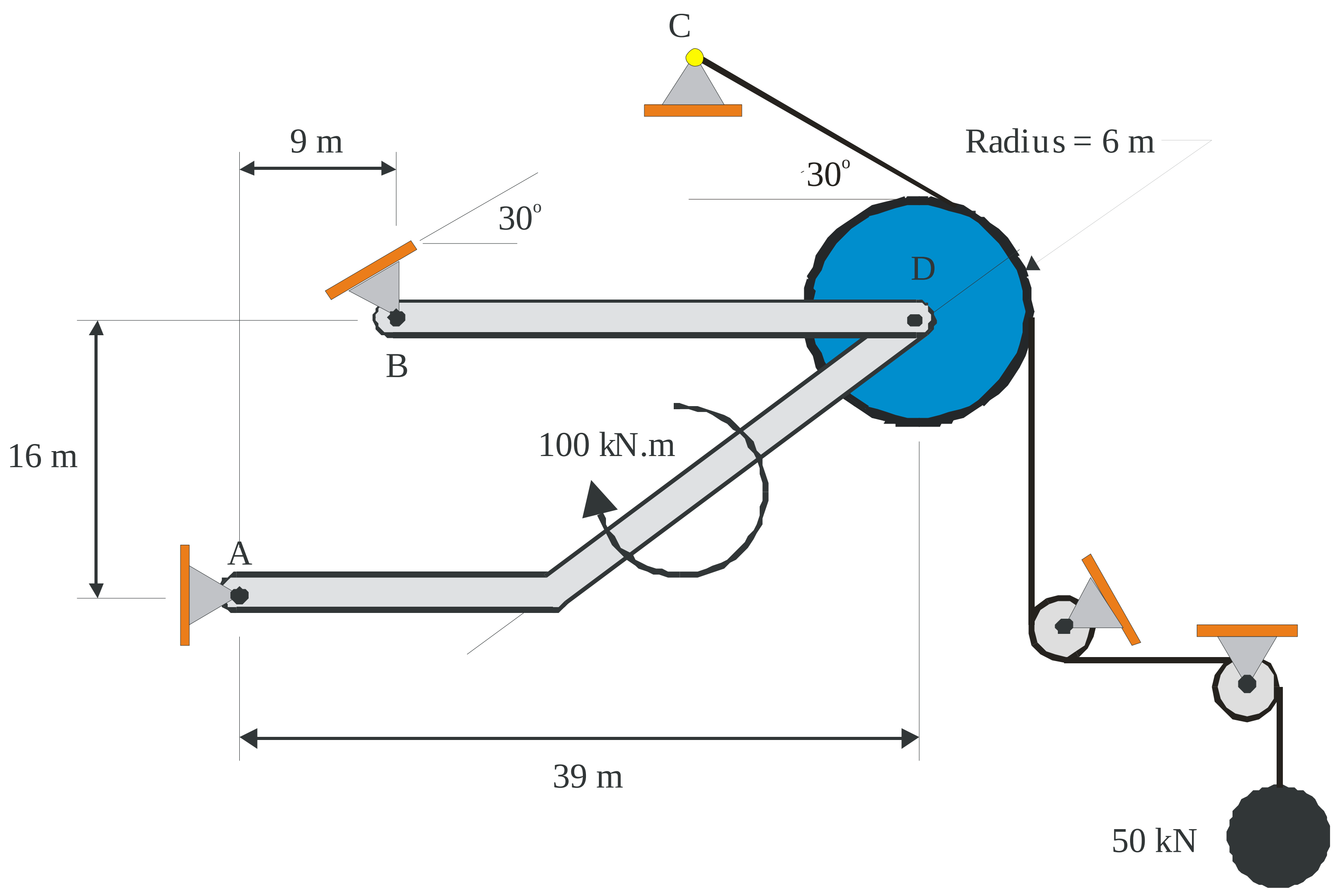
Example

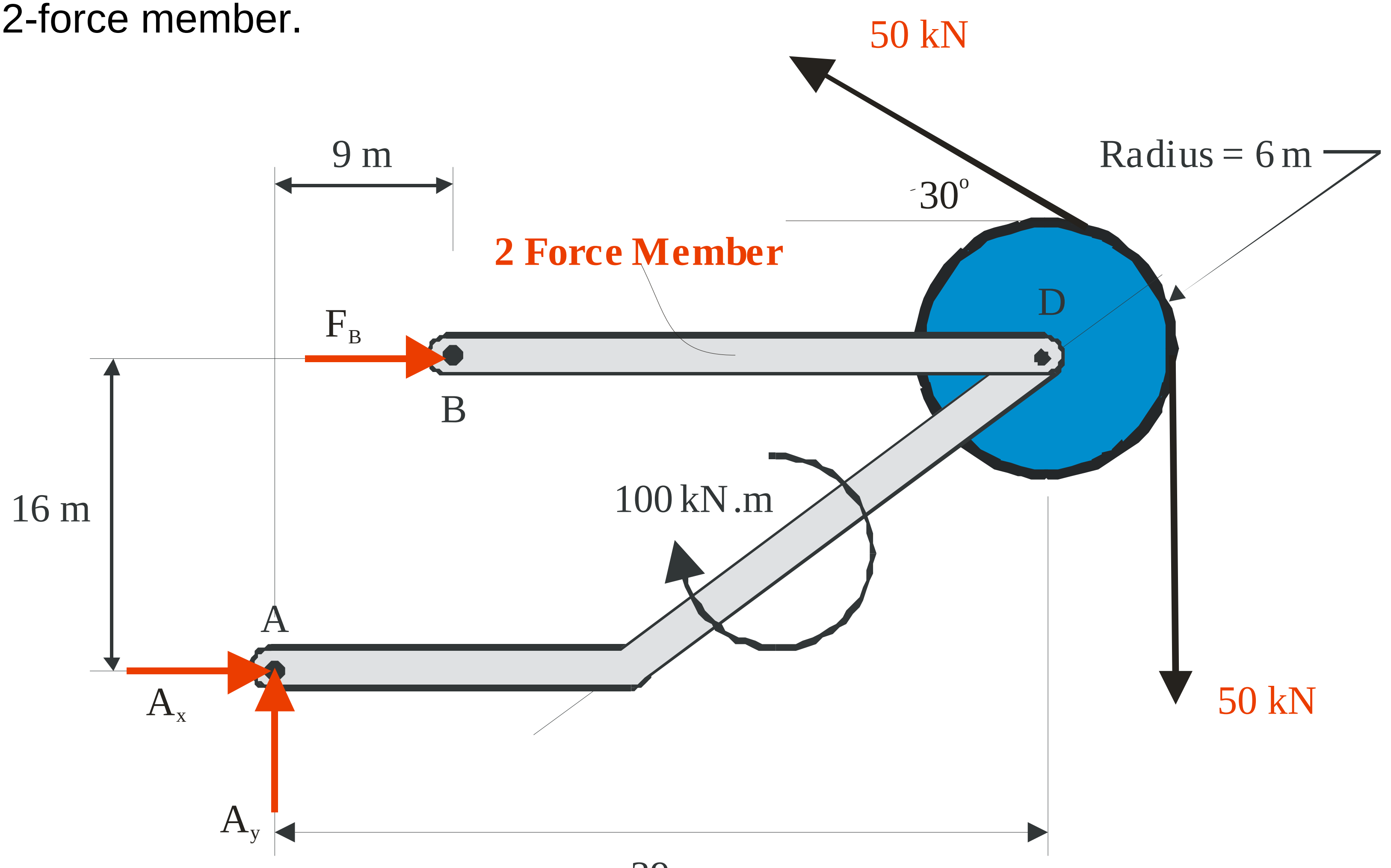
Determine the reactions at *A* and *B* for the frame shown and the forces exerted by the Pin at *D* on members AD, BD and on the Pulley for the frame shown.



C
Radius = 6 m
9 m
30°
30°
D
B
16 m
100 kN.m
A
39 m
50 kN

FBD for the entire frame.

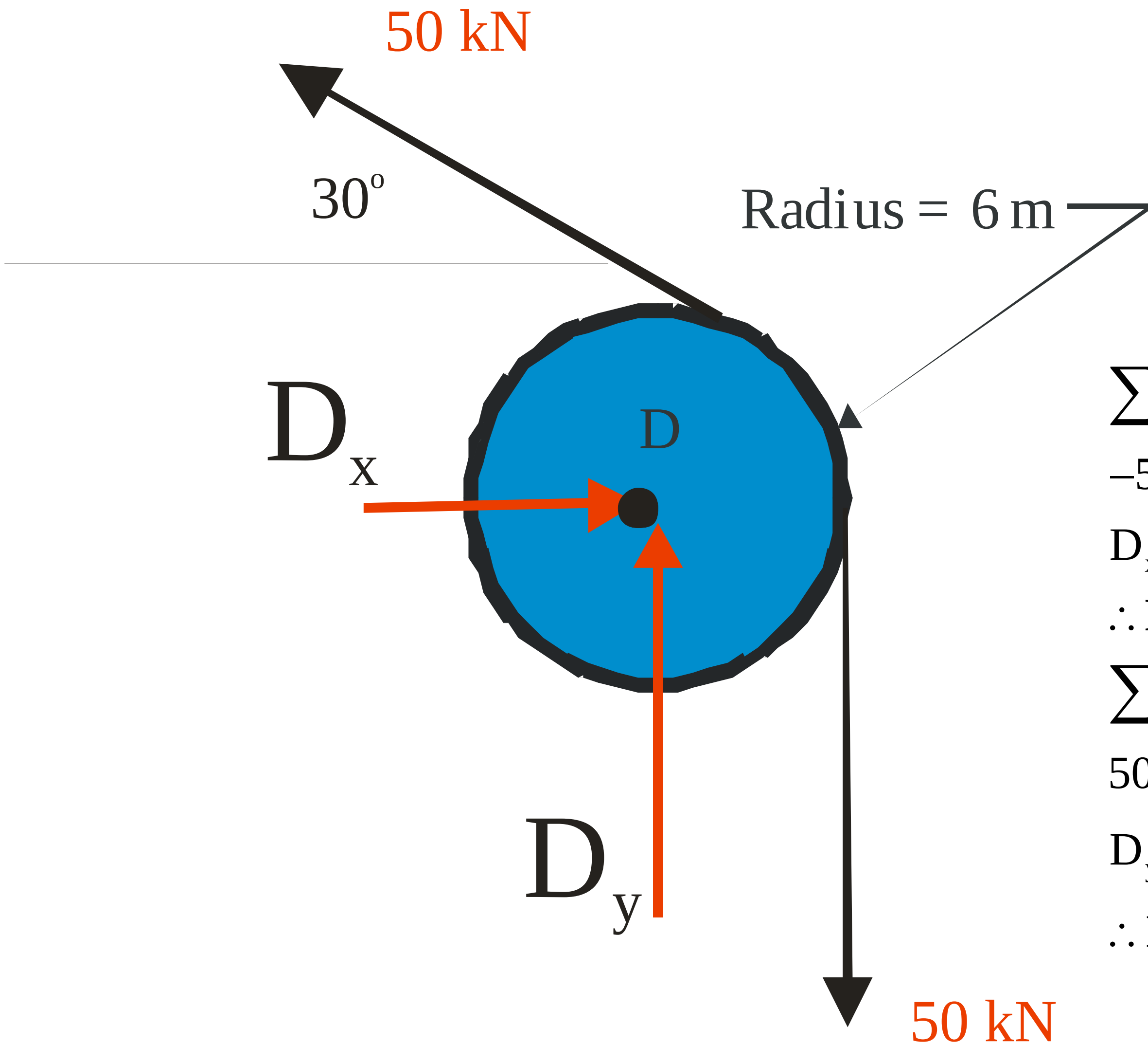
Note: We have identified BD as a 2-force member.



We only have 3 unknown reactions and therefore can solve for all unknowns with the equations of equilibrium applied to the entire frame.

However, because the radius of the pulley is 6 m and the cable is at an angle to the pulley, it is difficult to calculate the perpendicular distance of each of the components of the 50 kN force from Point A in taking moment about A.

We therefore first draw a separate FBD of the pulley and calculate the reactions of the pin on the pulley at D. We then apply these reactions at Point D on the frame.



$$\sum F_x = 0$$

$$-50\cos 30^{o} + D_x = 0$$

$$D_x = +43.3\ \text{kN}$$

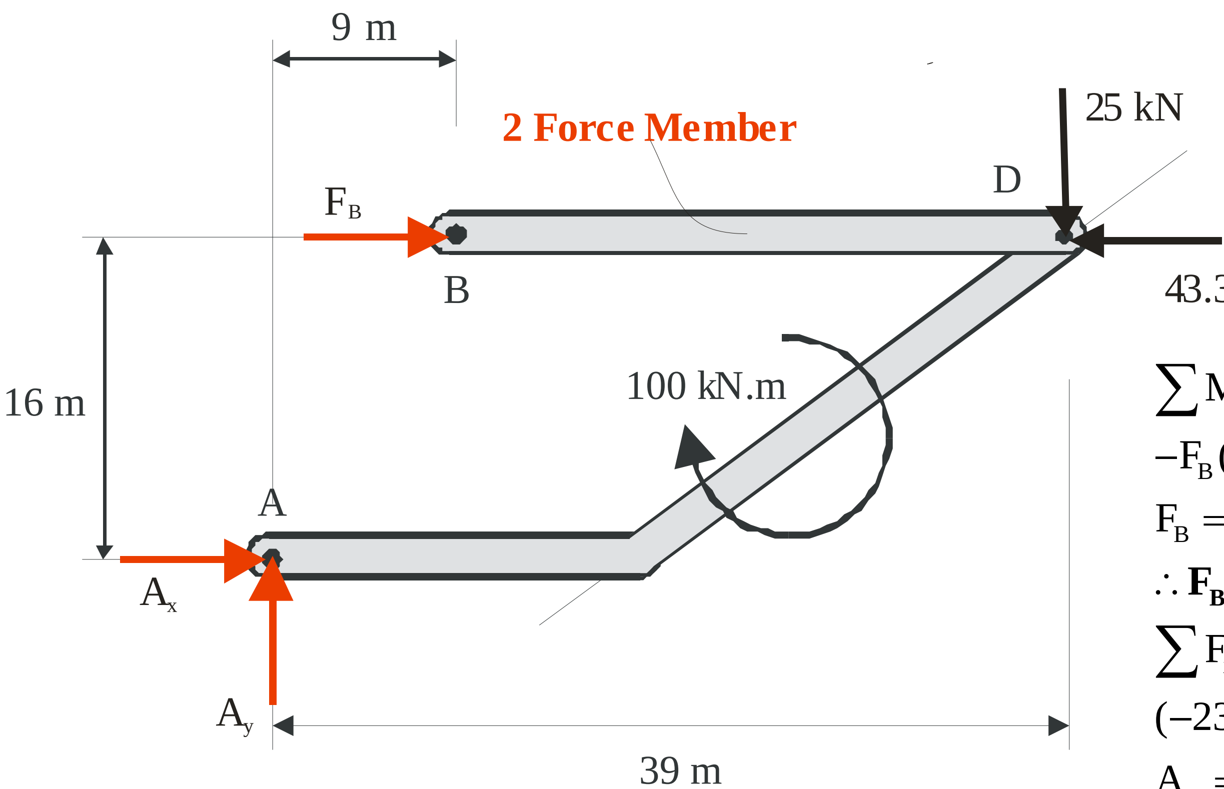
$$\therefore \mathbf{D_x} = 43.3\ \text{kN} \rightarrow \text{on the pulley}$$

$$\sum F_y = 0$$

$$50\sin 30^{o} + D_y - 50 = 0$$

$$D_y = +25\ \text{kN}$$

$$\therefore \mathbf{D_y} = 25\ \text{kN} \uparrow \text{on the pulley}$$



$$\sum M_A = 0A$$

$$-F_B(16) - 25(39) + 43.33(16) - 100 = 0$$

$$F_B = -23.86 \text{ kN}$$

$$\therefore \mathbf{F_B} = 23.86 \text{ kN} \leftarrow$$

$$\sum F_x = 0$$

$$(-23.86) - 43.33 + A_x = 0$$

$$A_x = +67.19 \text{ kN}$$

$$\therefore \mathbf{A_x} = 67.19 \text{ kN} \rightarrow$$

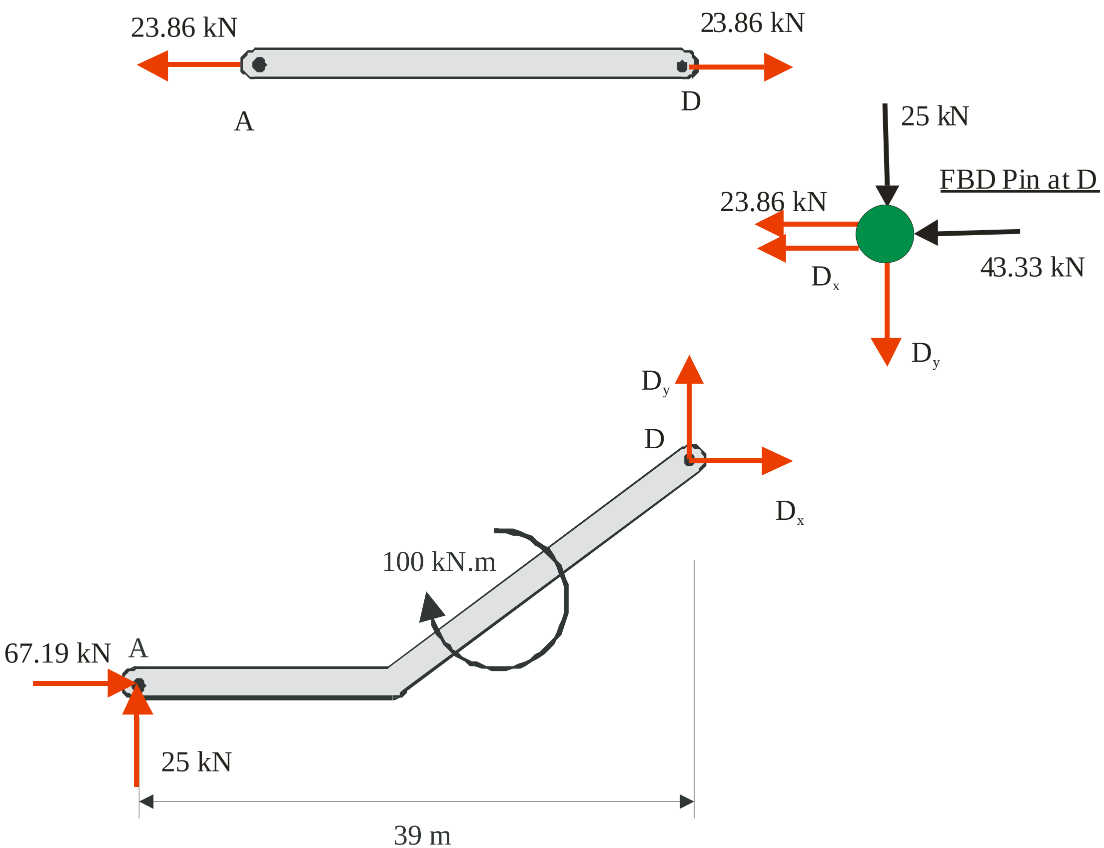
$$\sum F_y = 0$$

$$A_y - 25 = 0$$

$$A_y = +25 \text{ kN}$$

$$\therefore \mathbf{A_y} = 25 \text{ kN} \uparrow$$

Apply the 25 kN and 43.33 kN directly on the FBD of the Pin at D



For the Pin at D

$$\sum F_x = 0$$

$$-23.86 - 43.33 - D_x = 0$$

$$D_x = -67.19 \text{ kN}$$

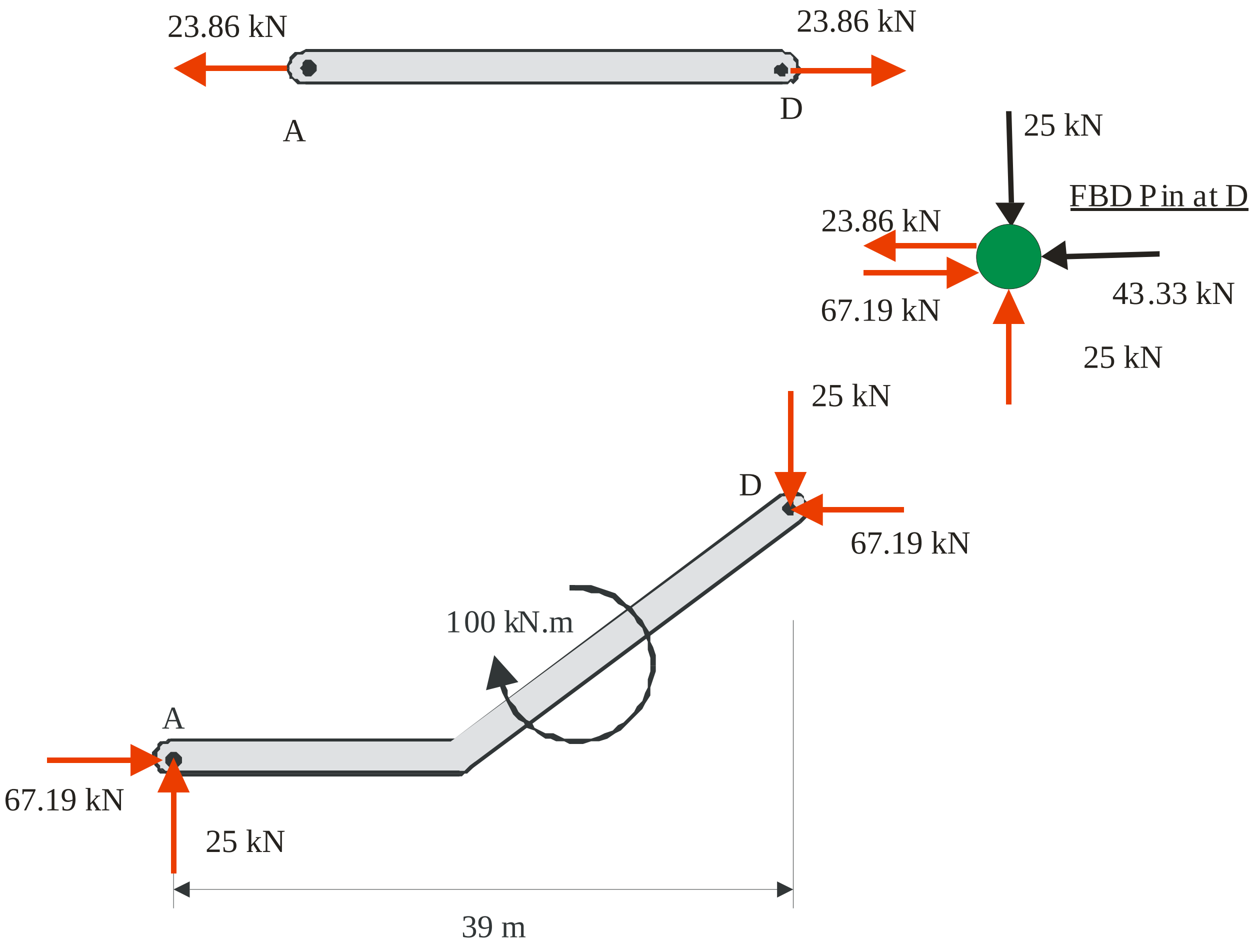
$$\therefore \mathbf{D_x} = 67.19 \text{ kN} \rightarrow \text{on the Pin at D}$$

$$\sum F_y = 0$$

$$-25 - D_y = 0$$

$$D_y = -25 \text{ kN}$$

$$\therefore \mathbf{D_y} = 25 \text{ kN} \uparrow \text{on the Pin at D}$$


23.86 kN
23.86 kN
A
D
25 kN
FBD Pin at D
23.86 kN
43.33 kN
67.19 kN
25 kN
25 kN
D
67.19 kN
100 kN.m
A
67.19 kN
25 kN
39 m