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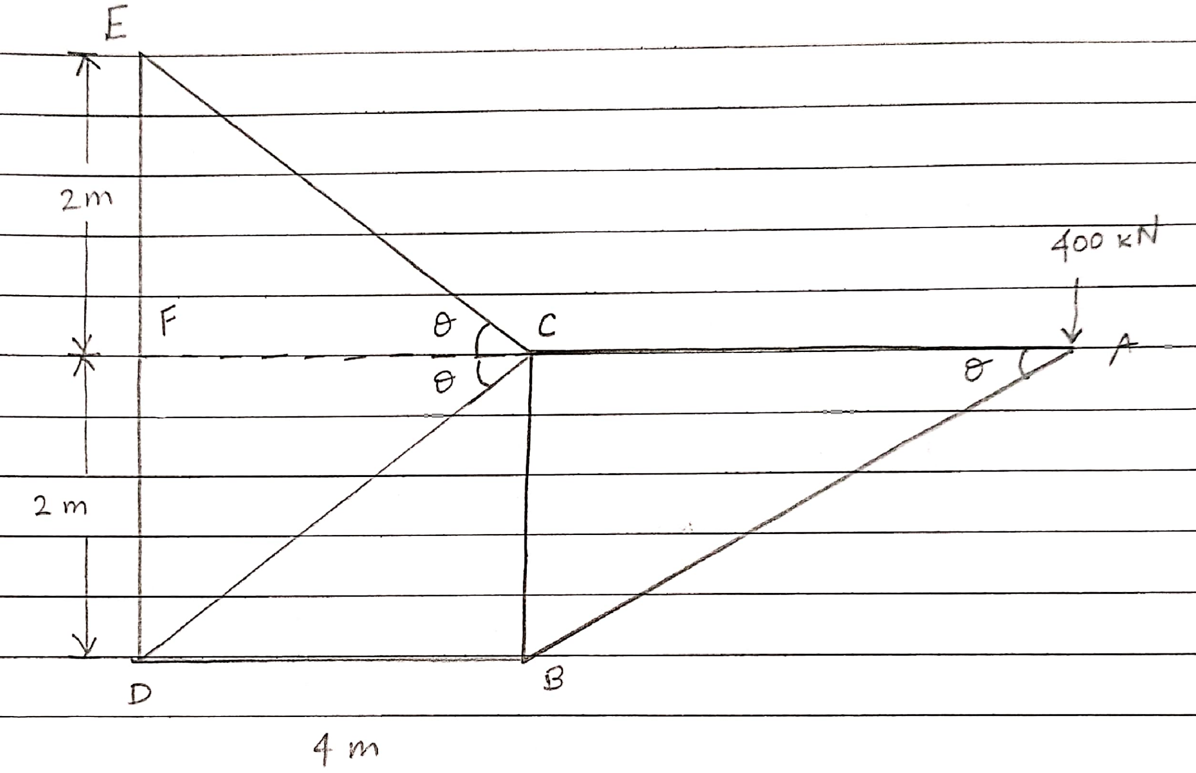
# Module - 2 - Conventional Questions

Q.1 Determine the support reactions and nature of and magnitude of forces in the members of the truss shown in figure by method of Joint.

ans



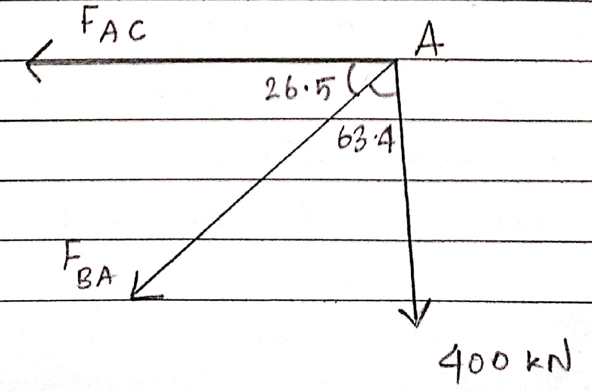

given $EF = 2m = FD$

$FC = 4m$

$\tan\theta = \dfrac{FD}{FC} = 0.5$

$\theta = \tan^{-1}(0.5) = 26.56^\circ$

Let us ~~the~~ now analyse joint A.




$F_{AC}$ = Force in member AC (assume Tension)

$F_{BA}$ = Force in member BA (assume Tension)

Rainbow

Applying Lami's Theorem to point A and Forces 400 kN, $F_{BA}$ and $F_{AC}$,

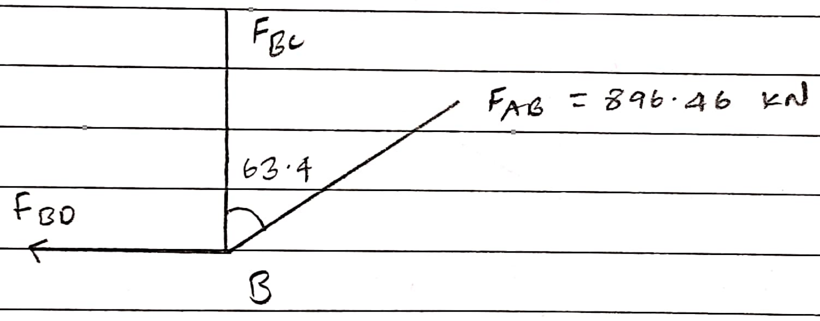
$$\frac{400}{\sin 26.5} = \frac{F_{BA}}{1} = \frac{F_{AC}}{\sin 63.5}$$

This gives upon rearranging,

$F_{BA} = 896.46$ kN (C) (compression)

$F_{AC} = 802.2728$ kN (T) (Tension)

Joint B




Again applying Lamis theorem

$$\frac{F_{BC}}{\sin(90 + 63.5^\circ)} = \frac{F_{DB}}{\sin(63.44^\circ)} = \frac{896.46}{1}$$

Solving, we get

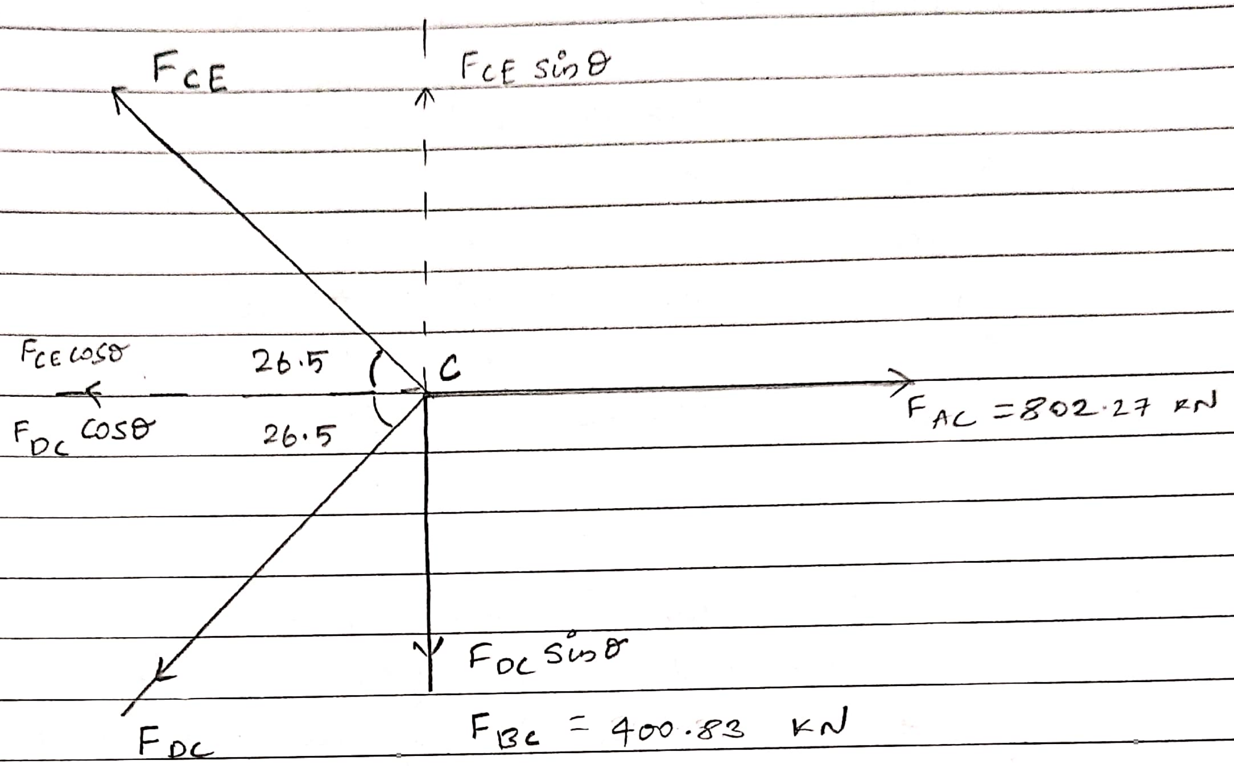
$F_{BC} = (896.46) \times (\sin(153.44))$

$= 400.83$ kN (C) (compressive)

$F_{DB} = (896.46) \times \sin(63.44)$

$= 802.27$ kN (C) (compressive)

Joint C




Applying equilibrium conditions here,

$\Sigma F_x = 0 \Rightarrow$

$F_{CE}\cos\theta + F_{DC}\cos\theta = 802.27$ kN — (1)

$\Sigma F_y = 0 \Rightarrow$

$F_{CE}\sin\theta = F_{DC}\sin\theta + F_{BC}$

$F_{CE}\sin\theta = F_{DC}\sin\theta + 400.83$ — (2)

(1) $\Rightarrow$ $\cos\theta = \cos 26.44^\circ = 0.89$

$\sin\theta = \sin 26.56^\circ = 0.44$

$(F_{CE} + F_{DC})(0.89) = 802.27$

$F_{CE} + F_{DC} = 896.92$ (3)

(2) $(F_{CE} - F_{DC})(0.44) = 400.83$

$F_{CE} - F_{DC} = 896.92$ (4)

From (3) and (4),

$F_{DC} = 0$ and $F_{CE} = 896.92$ (T) Tensile

Being a cantelever truss, we dont have to find Reaction Forces.

$F_{EC} = 896.92$ kN (T)

$F_{DC} = 0$

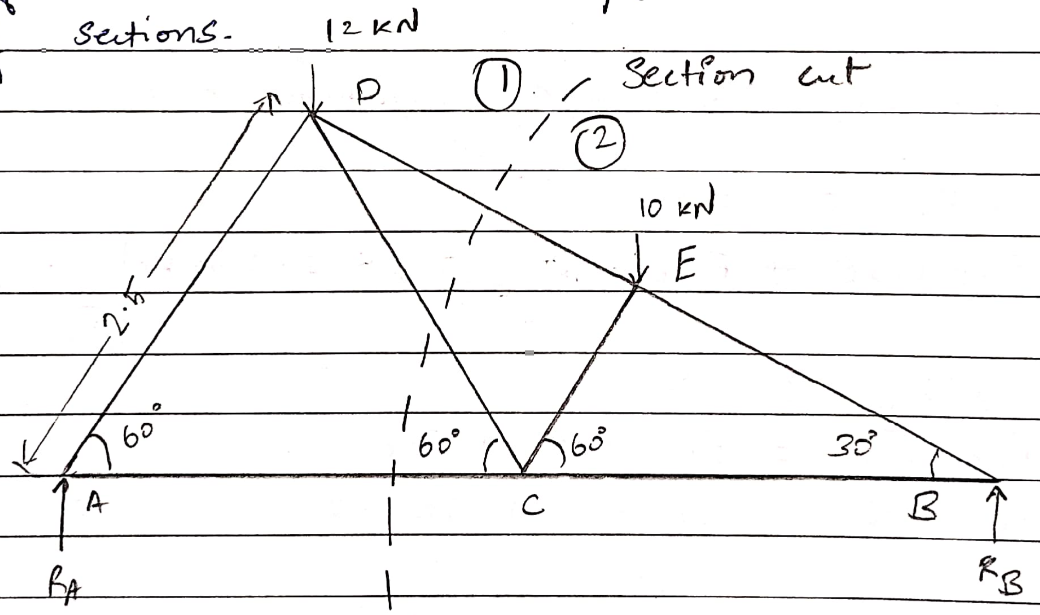
$F_{DB} = 802.27$ kN (C)

$F_{BC} = 400.83$ kN ~~400~~ (C)

$F_{AC} = 802.27$ kN (T)

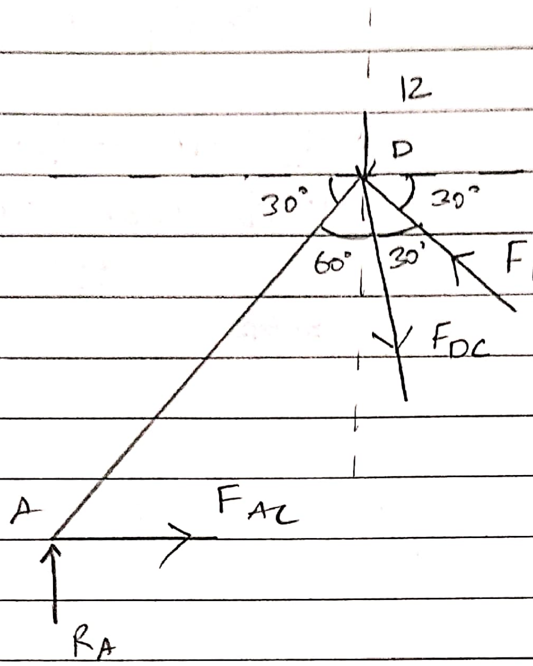
$F_{AB} = 896.46$ kN (C)

Q.2. Determine the support reactions and nature and magnitude of forces in the members of truss shown in figure by method of sections.




(PTO.)

→ Section - 1




$F_{DE}$ - Force is members DE assume (C)

$F_{DC}$ - Force is member DC (T)

$F_{AC}$ - Force is member AC.

Equilibrium conditions are applied

$\Sigma F_x = 0 \Rightarrow$

$F_{AC} + F_{DC}\cos 60° - F_{DE}\cos 30° = 0$ (1)

$\Sigma F_y = 0 \Rightarrow$

$RA - 12 - F_{DC}\sin 60 + F_{ED}\sin 30° = 0$

$R_A - F_{DC}\sin 60 + F_{ED}\sin 30 = \cancel{R_A} + 12$ (2)

$\Sigma M_A = 0 \Rightarrow$

$-(12)(2.5\cos 60) - (F_{DC}\cos 30)(2.5\cos 60)$
$+ (F_{DE}\cos 60)(2.5\cos 60) = 0$ (3)

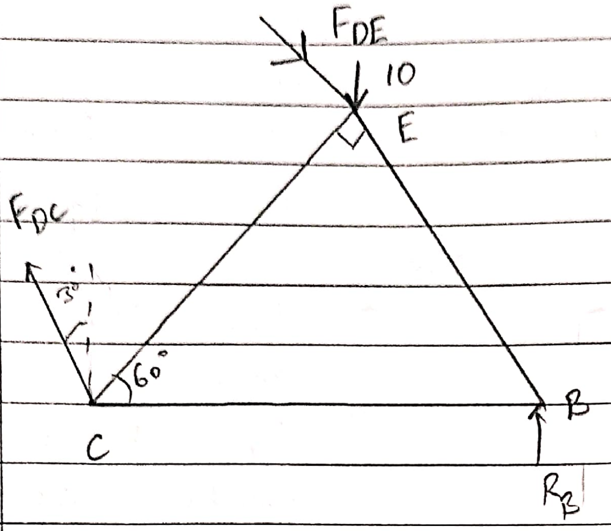
Simplifying

(1) $\Rightarrow$ $F_{AC} + F_{DC}/2 = (0.866) F_{DE}$

(2) $\Rightarrow$ $R_A + F_{DE}/2 = 12 + F_{DC}(0.866)$

(3) $\Rightarrow$ $-1.08 F_{DC} + 0.625 F_{DE} = 15$

Section (2) (CED)




$\Sigma F_y = 0 \Rightarrow$

$R_B - 10 - F_{DE}\cos 45 + F_{DC}\cos 30 = 0$ — (5)

~~Subst~~

$\Sigma M_B = 0 \; ; \Rightarrow$

(4) → $(10)(2.5) + F_{DE}\cos 45\,(2.5) - (DC\cos 30)(2.5) = 0$

$-1.767\,F_{DE} + 2.165\,F_{DC} = 25$ — (4)

Solving (4) and (3) we get $F_{DC}$ and $F_{DE}$

$F_{DC} = -75.8$ kN $= 75.8$ kN (C)

$F_{DE} = -107.1$ kN $= 107.1$ kN (T)

Substituting these in (1), we get

$F_{AC} = 54.8$ kN (T)

Substituting in (2), we get

$R_A = 23.59$ kN

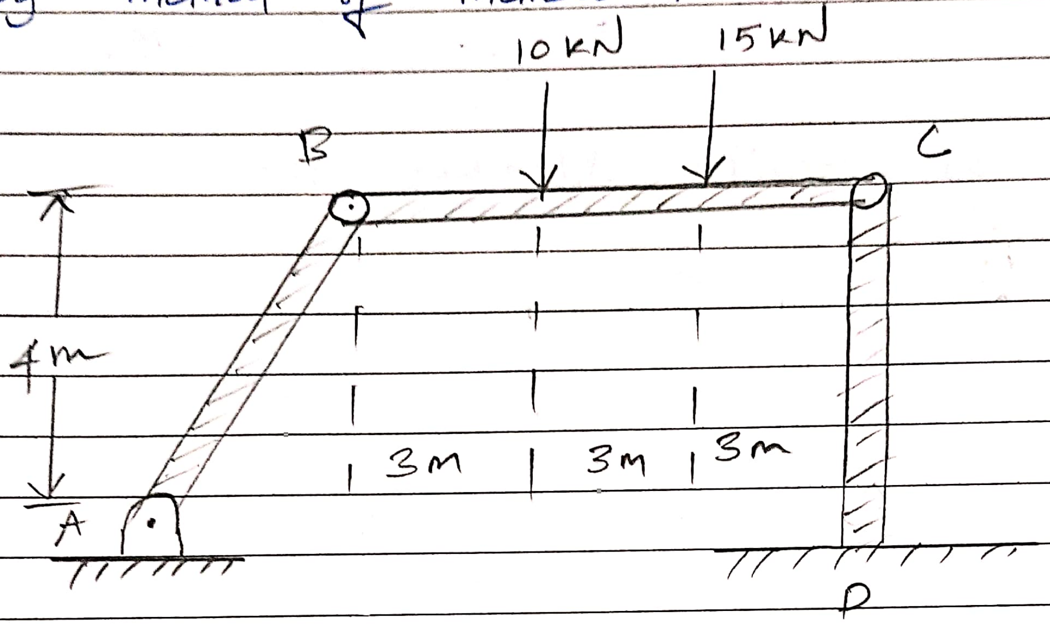
Substituting in (5) we get

$R_B = 20.08$ kN

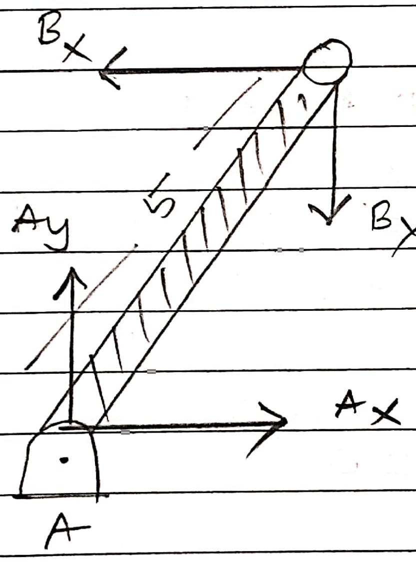
So forces in all members are found.

Q.3 Determine the support reactions and forces in the members of frame shown in figure by method of members?

→




Let us first consider ~~AC~~ Member AB.




AB = hypotenuse.

So $AB = \sqrt{4^2 + 3^2}$

$= \sqrt{25}$

$= 5\,m$.

Applying conditions of equilibrium,

$\Sigma F_x = 0$; so $A_x - B_x = 0$

we get $A_x = B_x$

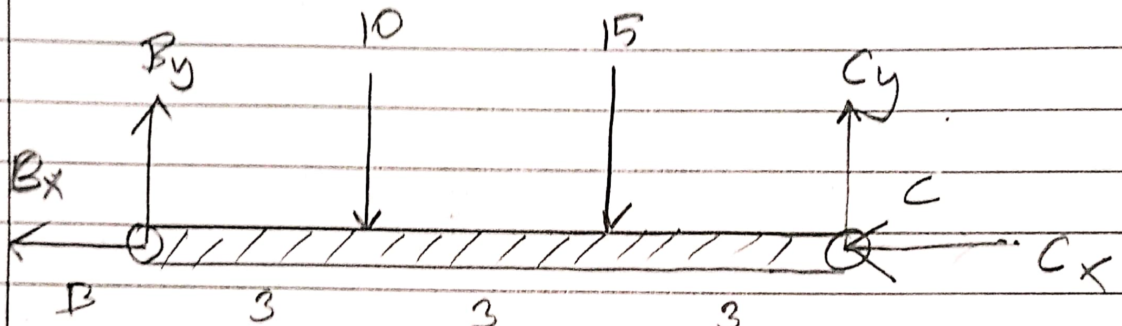
$\Sigma F_y = 0$; so $A_y - B_y = 0$

we get $A_y = B_y$.

$\Sigma M_A = 0$ ;

we get $-B_y(3) + 4(B_x) = 0$ — (1)

(2) Let us consider Member BC




Applying equations of equilibrium,

$\Sigma F_y = 0$ ;

$-(10 + 15) + C_y + B_y = 0$

$C_y + B_y = 25$ — (2)

$\Sigma M_C = 0$ ;

$45 + 60 - B_y(9) = 0$

$\Rightarrow B_y = \frac{105}{9} = 11.6 \text{ kN}$ — (3)

Putting (3) in (1),

$4B_x = +3B_y = +34.8$

$B_x = \frac{+34.8}{4} = +8.7 \text{ kN}$

Rainbow

Putting (3) in (2),

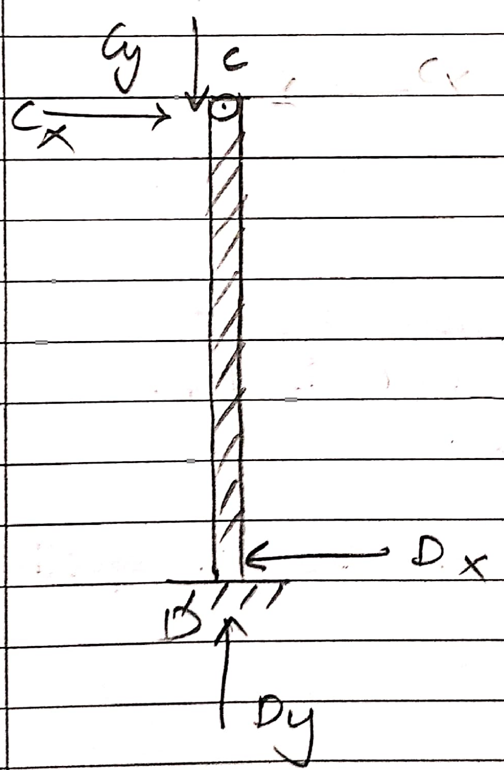
$C_y = 25 - 11.6$
$= 25 - B_y$
$C_y = 13.4$ kN

From Member AB,

$A_x = B_x = 8.4$ kN

$A_y = B_y = 11.6$ kN

Member CD,

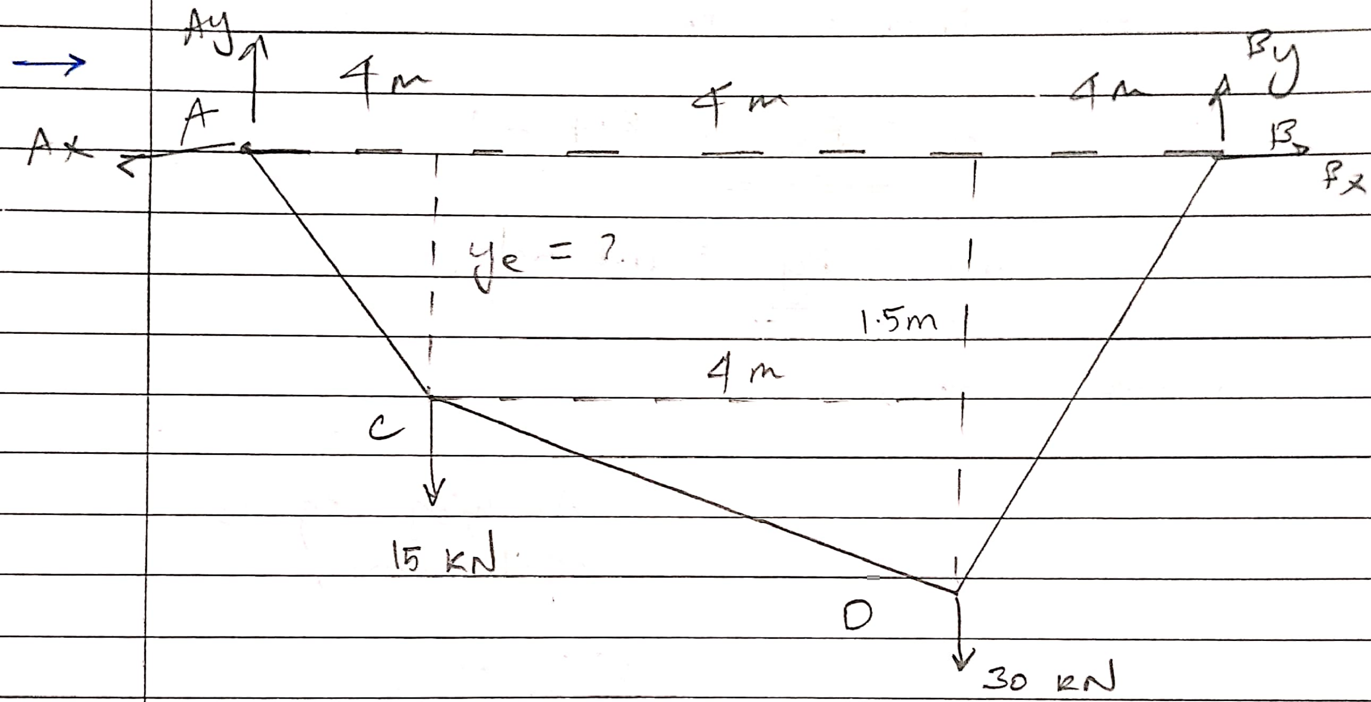



Applying eq of equilibrium,

$\Sigma F_x = 0$,
$C_x = D_x = 8.4$ kN

$\Sigma F_y = 0$,
$C_y = D_y = 13.4$ kN

Q.4. A light flexible cable shown below is supported at 2 ends at the same level and 12 m apart. The cable is subjected to 2 loads of 15 kN and 30 kN as shown. Determine the horizontal component of tension in cable. Also calculate total length of cable.




let tension in ~~str~~ cable be T
then horizontal component is $T_H$.

then, $A_x = T_H = B_x$.

as cable is assumed to be in equilibrium

$\Sigma M_c = 0$;

$$(-B_x)(1.5) + (B_y)(8) - (30)(4) = 0 \quad \text{—(1)}$$

(as we can consider only on 1 side of a point in a ~~bt~~ cable for moments)

Rainbow

So ① =>

$8B_y - 1.5\,B_x - 120 = 0$

Taking Moment about D, (on right side)

$\Sigma M_D = 0,$

$(B_y)(4) - B_x(1.5) = 0 \quad -②$

Solving equation ① and ②,

$-4B_y + 8B_y - 120 = 0$

$$B_y = \frac{120}{4} = \underline{\underline{30\ kN}}$$

$-1.5\,B_x = -4B_y = -120$

$$B_x = \frac{120}{1.5} = \underline{\underline{80\ kN}}$$

So $B_x = A_x$ = Tension's $T_H$ horizontal component

$= \underline{\underline{80\ kN}}$

Now, $\Sigma F_y = 0$

So $A_y + B_y - 45 = 0$

$A_y + 30 - 45 = 0$

$\underline{\underline{A_y = 15\ kN}}$

ibow

→ Taking Moment about point D again on left side, (to find $y_c$)

$\Sigma M_D = 0$;

$\Rightarrow 0 = (15)(4) + (A_x)(y_c) - (A_y)(8)$

$60 + 80 y_c - 128 = 0$

so $y_c = \frac{68}{80} = 0.85\ m$

Now, to find total length,

$AC = \sqrt{y_c^2 + 4^2}$

$= \sqrt{0.85^2 + 4^2}$

$= 4.089\ m$

$CD = \sqrt{4^2 + (1.5 - 0.85)^2}$

$= \sqrt{4^2 + 0.65^2}$

$= 4.052\ m$

$DB = \sqrt{4^2 + 1.5^2}$

$= 4.27\ m.$

AC + DB + CD = length of cable

$4.27 + 4.052 + 4.089 = 12.410\ m$