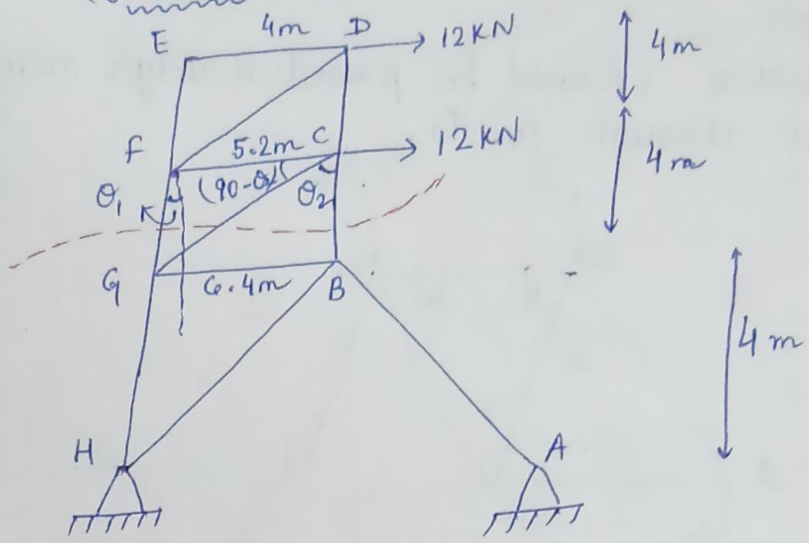
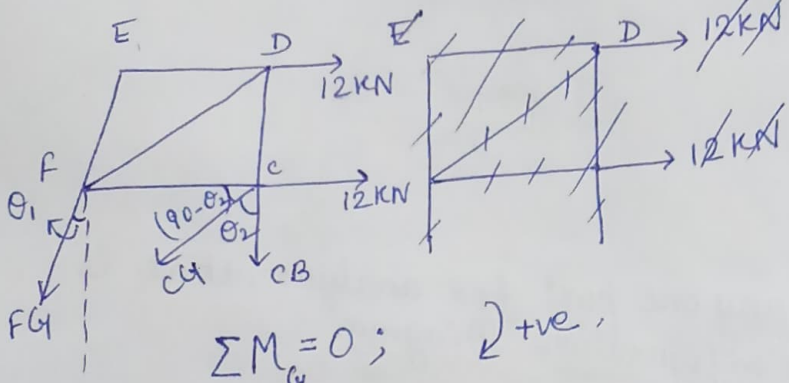
PROBLEM SHEET - 3.2
(Method of Sections)

① Find C_G = ?



$$\tan\theta_1 = \left(\frac{6.4 - 5.2}{4}\right) = \frac{1.2}{4} \Rightarrow \theta_1 = 16.69^\circ$$

$$\tan\theta_2 = \frac{6.4}{4} \Rightarrow \theta_2 = 58^\circ.$$



$\sum M_G = 0$; ↻ +ve.

$$BC \times 6.4 + (12 \times 4) + (12 \times 8) = 0.$$

$$BC = -22.5 \text{ KN}.$$

$\sum F_x = 0$; $12 + 12 - C_G \sin\theta_2 - F_G \sin\theta_1 = 0.$

$$C_G \sin\theta_2 + F_G \sin\theta_1 = 24.$$

$$2.95\, C_G + F_G = 83.57 \rightarrow ①$$

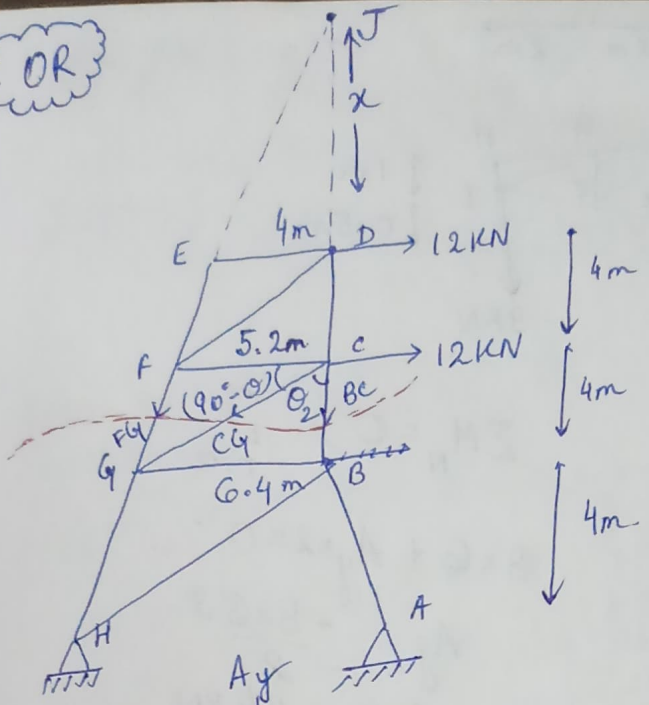
$\sum F_y = 0$; $C_B + C_G \cos\theta_2 + F_G \cos\theta_1 = 0.$

$$0.553\, C_G + F_G = 23.49 \rightarrow ②$$

Solving ① & ②,

$$\boxed{C_G = 25.06 \text{ KN (T)}}$$

OR



from ΔJDE & ΔJBG,

$$\frac{x}{4} = \frac{x+8}{6.4}$$

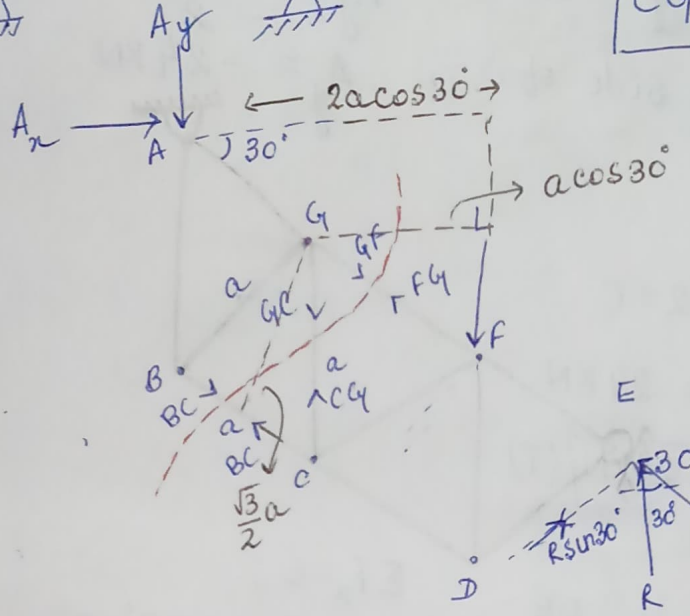
$$x = 13.33 \text{ m}$$

$\sum M_J = 0$; $\circlearrowleft$ +ve

$$CG \sin\theta_2 \times (13.33+4) - 12((13.33+4)+13.33) = 0$$

$$\boxed{CG = 25.08 \text{ KN}}$$

(2)



f_{BC} & f_{CG} = ?

from FBD of right side of section.

$\sum M_A = 0$; $\circlearrowleft$ +ve

$$L\cos30° \times 2a - R\sin30° \times 3a = 0$$

$$R = \frac{2L}{\sqrt{3}}$$

$\sum M_G = 0$; $\circlearrowleft$ +ve,

$$(L\cos30° \times a) - R\sin30° \times 2a + BC\frac{\sqrt{3}}{2}a = 0$$

$$BC = \left(-L\times\frac{\sqrt{3}}{2} + R\times 2\times\frac{1}{2}\right)\times\frac{2}{\sqrt{3}}$$

$$= \left(-L\times\frac{\sqrt{3}}{2} + \frac{2L}{\sqrt{3}}\right)\times\frac{2}{\sqrt{3}}$$

$$= \frac{L}{2\sqrt{3}}\times\frac{2}{\sqrt{3}} = \frac{L}{3}(T) \Rightarrow \boxed{BC = \frac{L}{3}(T)}$$

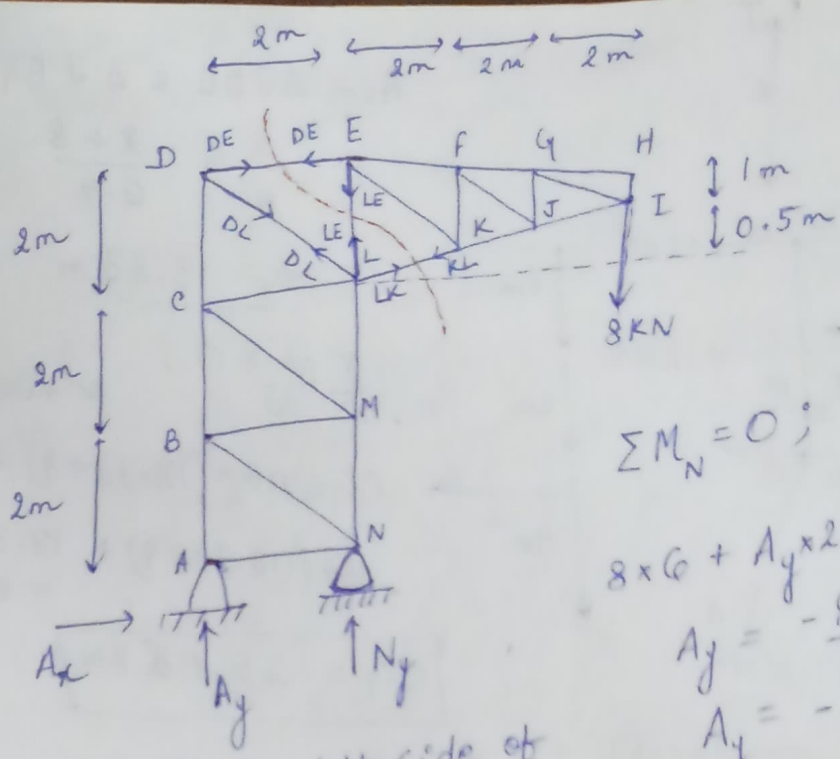
$\sum F_y = 0$;

$$CG\sin60° - L\sin60° + R\sin30° = 0$$

$$CG\left(\frac{\sqrt{3}}{2}\right) - L\times\frac{\sqrt{3}}{2} + \frac{2L}{\sqrt{3}}\times\frac{1}{2} = 0$$

$$\boxed{CG = \frac{L}{3}(T)}$$

(3)



$\Sigma M_N = 0$; ↻ +ve

$8 \times 6 + A_y \times 2 = 0$

$A_y = \frac{-8 \times 6}{2}$

$A_y = -24\ KN$

from FBD of left side of section :-

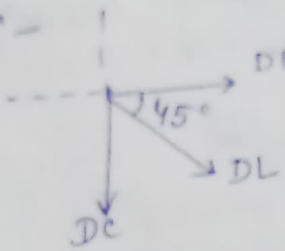
$\Sigma M_L = 0$;

$DE \times 2 + A_y \times 2 = 0$

$DE = -A_y = 24\ KN$

$\boxed{DE = 24KN\ (T)}$

FBD of D :-



$\Sigma F_x = 0$;

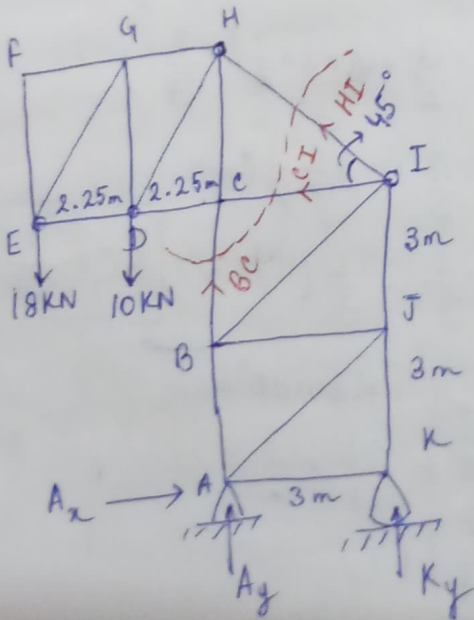
$DE + DL\cos 45^\circ = 0$

$DL = \frac{-DE}{\cos 45^\circ}$

$DL = -24\sqrt{2}\ KN$

$\therefore \boxed{DL = 24\sqrt{2}\ KN\ (C)}$

(4)



Find BC & CI?

$\Sigma M_A = 0$; $\circlearrowleft^{+ve}$ $\quad (K_y \times 3) + 10(2.25) + 18(4.5) = 0$

$K_y = -34.5$ KN

$\Sigma F_x = 0$; $A_x = 0$ N, $\quad \Sigma F_y = 0 \Rightarrow A_y + K_y - 10 - 18 = 0$

$A_y = +28 + 34.5$

$A_y = +62.5$ KN

from FBD of right side of section :—

$\Sigma M_I = 0$; $\quad BC \times 3 + A_y \times 3 = 0$

$BC = -A_y = -62.5$ KN

$\boxed{BC = 62.5 \text{ KN}}$ (C)

$\Sigma F_y = 0$; $\quad A_y + K_y + BC + HI \sin 45^\circ = 0$

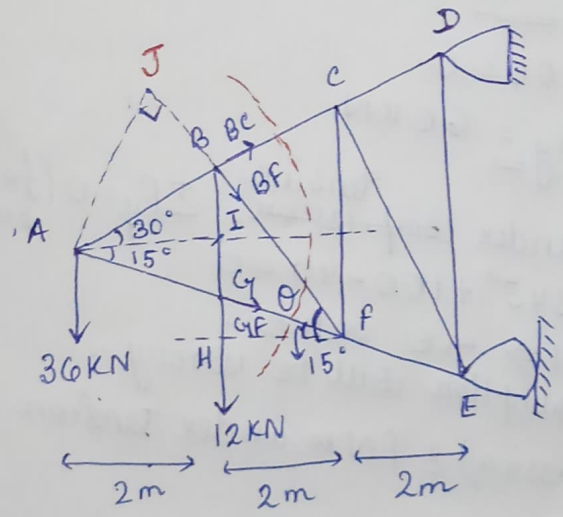
$HI = \dfrac{-K_y}{\sin 45^\circ} = +\sqrt{2} \times 34.5$ KN

$\Sigma F_x = 0$; $\quad CI + HI \cos 45^\circ = 0$

$CI = -HI \cos 45^\circ$

$\therefore \quad \boxed{CI = -34.5 \text{ KN (T)}} = 34.5$ KN (C)

(5)



BF = ?

Let $\angle BFA = \theta$

HF = 2m

BH = BI + IG + GH

$= 2\tan 30^\circ + 2\tan 15^\circ + 2\tan 15^\circ$

$= 2.2265$ m.

$\tan\theta = \dfrac{BH}{HF} = \dfrac{2.2265}{2}$

$\theta = 48.06^\circ$

$\sin(\theta - 15^\circ) = \dfrac{AJ}{AF} = \dfrac{AJ}{4/\cos 15^\circ}$

$\sin 33.06^\circ = \dfrac{AJ \cos 15^\circ}{4}$

$AJ = 2.2594$ m

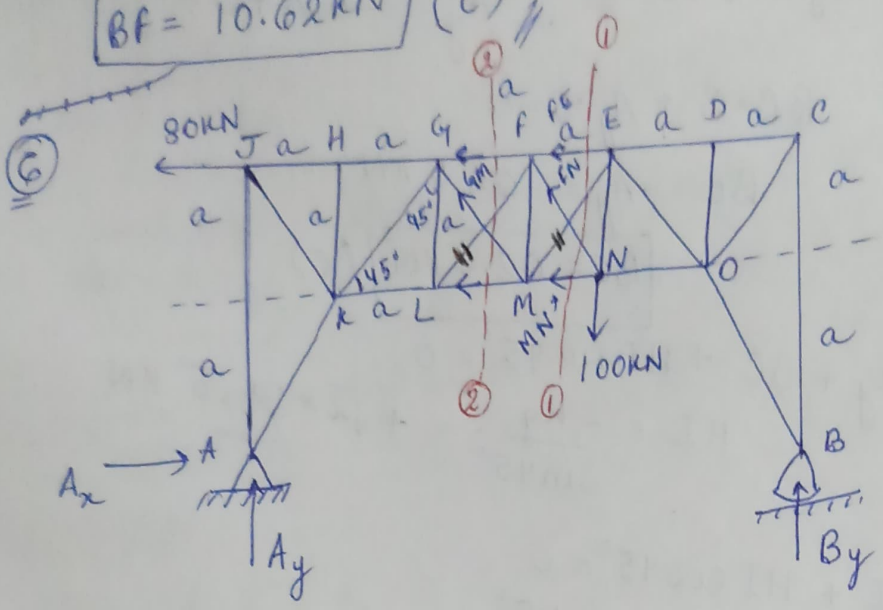
from FBD of left side of section,

$\Sigma M_A = 0$; ↻ +ve

$BF \times AJ + 12 \times 2 = 0$

$BF = -10.62\ KN$

$\boxed{BF = 10.62\ KN\ (C)}$ //



$\Sigma M_A = 0$; ↻ +ve

$(B_y \times 6a) + (80 \times 2a) - 100 \times 4a = 0$

$B_y = 40\ KN$

$\Sigma F_y = 0$; $A_y + B_y - 100 = 0$

$A_y = 60\ KN$.

Let $ME \neq 0$ If EM is under ~~compression~~ tension, $\Sigma F_y = 0$ (for section ①)

$EM \cos 45° + 100 - 40 = 0$

$EM \Rightarrow$ -ve value.

Hence our assumption will be wrong.

$\therefore$ EM = 0 (compression) & FN is under Tension.

Section ① :- from FBD of right side

$\Sigma F_y = 0$;

$FN \sin 45° + B_y - 100 = 0$

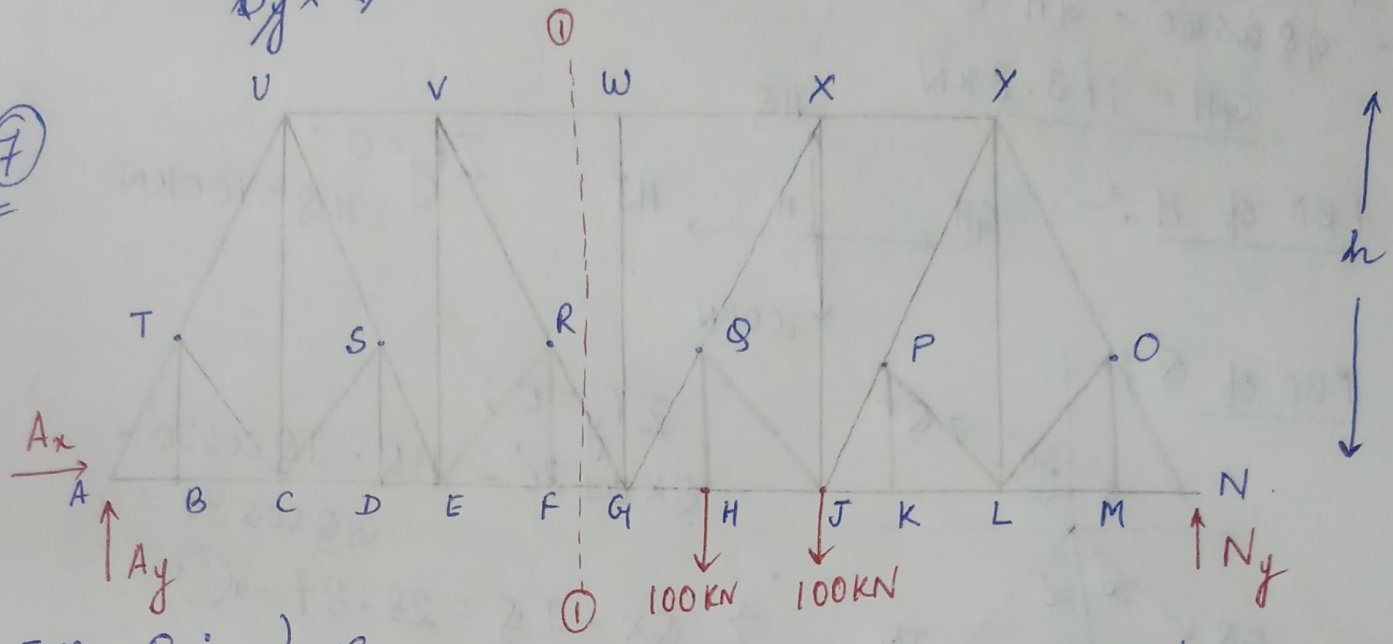
$FN = 84.85\ KN\ (T)$

$\Sigma M_E = 0$; ↻ +ve

$B_y \times 2a - MN \times a - NF \cos 45° \times a = 0$

$\therefore$ $\boxed{MN = 20\ KN\ (T)}$

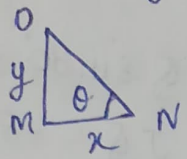
(7)



$\Sigma M_A = 0$; ↺ +ve

$100 \times 7x + 100 \times 8x - N_y \times 12x = 0 \Rightarrow \underline{N_y = 125\ KN}$

From Δ OMN,



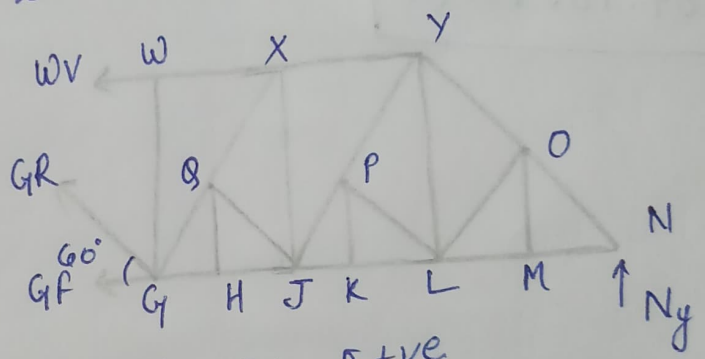
$y = x \tan 60^\circ$

$= x\sqrt{3}$

From observation, $YL = 20m \Rightarrow h = \underline{2x\sqrt{3}}$.

(*) Section ①-① :-

From FBD of Right side of section



From FBD of W :-

$WV = WX$ ($\Sigma f_x = 0$)

$WG = 0$ ($\Sigma f_y = 0$)

$\Sigma M_G = 0$; ↻ +ve

$N_y \times 6x + WV \times 2x\sqrt{3} = 0$

$- 100(x + 2x)$

$\underline{WV = -130\ KN} \rightarrow (\#)$

For entire truss :-

$\Sigma f_x = 0$;

$WV + GF + GR \cos 60^\circ = 0$

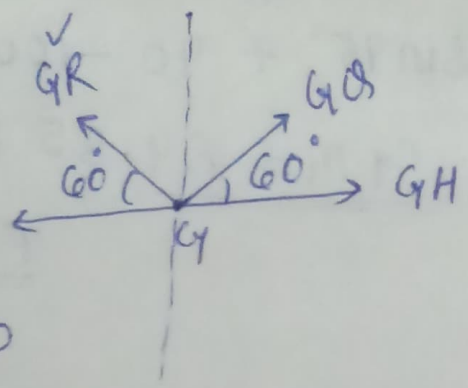
$\Rightarrow 2GF + GR = 260 \rightarrow (i)$

$\Sigma f_y = 0$; $GR \sin 60^\circ + N_y - 200 = 0 \rightarrow (ii)$

$GR = 86.6\ KN$

& $\underline{GF = 86.7\ KN}$.

FBD of G :-



$\Sigma F_x = 0$;

$GR\cos 60^\circ + GF - GQ\cos 60^\circ - GH = 0$

$GH = 173.3$ kN

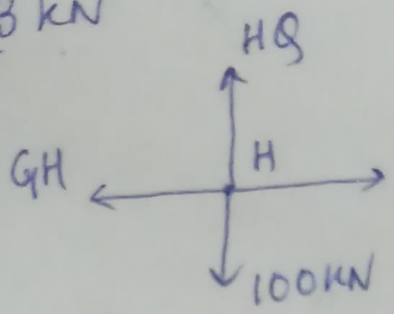
$\Sigma F_y = 0$;

$GR\sin 60^\circ + GQ\sin 60^\circ =$

$GQ = -GR$

$= -86.6$ kN

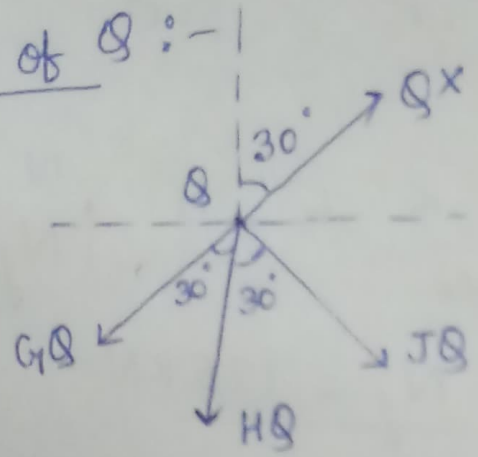
FBD of H :-



$\Sigma F_y = 0$;

$HQ = 100$KN

FBD of Q :-



$\Sigma F_y = 0$;

$QX\cos 30^\circ - HQ - JQ\cos 30^\circ - GQ\cos 30^\circ = 0$

$\Rightarrow QX - JQ = 28.87 \rightarrow (i)$

$\Sigma F_x = 0$;

$QX\sin 30^\circ + JQ\sin 30^\circ - GQ\sin 30^\circ = 0$

$QX + JQ = -86.6$ KN $\rightarrow (ii)$

From (i) & (ii),

$JQ = 57.735$ KN (C)