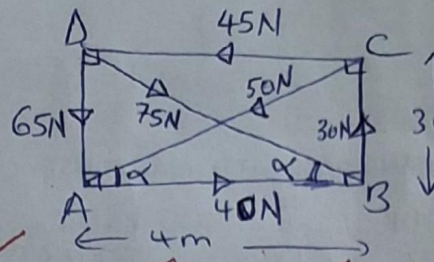
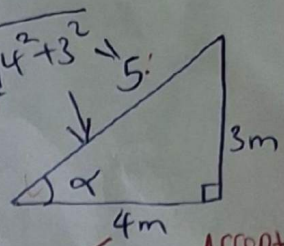
ITEM 4 (a)



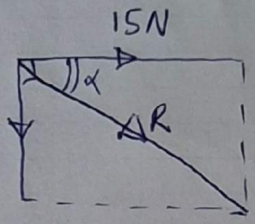


$\sin\alpha = \frac{3}{5}$ $\cos\alpha = \frac{4}{5}$

Accept Angle given

$$\begin{pmatrix}\rightarrow\\ \uparrow\end{pmatrix} \begin{pmatrix}40\\0\end{pmatrix}+\begin{pmatrix}0\\30\end{pmatrix}+\begin{pmatrix}-45\\0\end{pmatrix}+\begin{pmatrix}0\\-65\end{pmatrix}+\begin{pmatrix}-50\times\frac{4}{5}\\-50\times\frac{3}{5}\end{pmatrix}+\begin{pmatrix}75\times\frac{4}{5}\\-75\times\frac{3}{5}\end{pmatrix}$$

$$= \begin{pmatrix}15\\-110\end{pmatrix}N$$



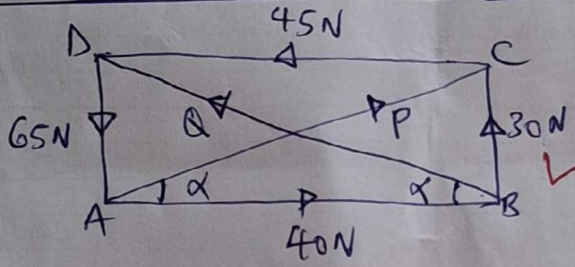
$\alpha = \tan^{-1}\left(\frac{110}{15}\right)$

$\alpha = 82.2348°$

Since angle between Resultant and AB $(82.2348°) > 5°$, then the engineer will revisit the frame.

11

(b)



Since new system is in equilibrium, resultant $= \begin{pmatrix}0\\0\end{pmatrix}$

$$\begin{pmatrix}\rightarrow\\ \uparrow\end{pmatrix} \begin{pmatrix}40\\0\end{pmatrix}+\begin{pmatrix}0\\30\end{pmatrix}+\begin{pmatrix}-45\\0\end{pmatrix}+\begin{pmatrix}0\\-65\end{pmatrix}+\begin{pmatrix}P\times\frac{4}{5}\\P\times\frac{3}{5}\end{pmatrix}+\begin{pmatrix}-Q\times\frac{4}{5}\\Q\times\frac{3}{5}\end{pmatrix}=\begin{pmatrix}0\\0\end{pmatrix}$$

$$-5+\frac{4P}{5}-\frac{4Q}{5}=0 \quad \text{(Equating } \underset{\sim}{i} \text{ components)}$$

$$4P-4Q = 25 \quad \text{---- (1)}$$

$$-35+\frac{3P}{5}+\frac{3Q}{5}=0$$

$$3P+3Q = 175 \quad \text{---- (2)}$$

$3\times(1) + 4\times(2)$ gives

$$24P = 775 \Rightarrow P = \frac{775}{24}N \ (32.2917N)$$

07

From (2) $Q = \frac{1}{3}\left(3\times\frac{775}{24}-175\right) = \frac{625}{24}\ (26.0417N)$

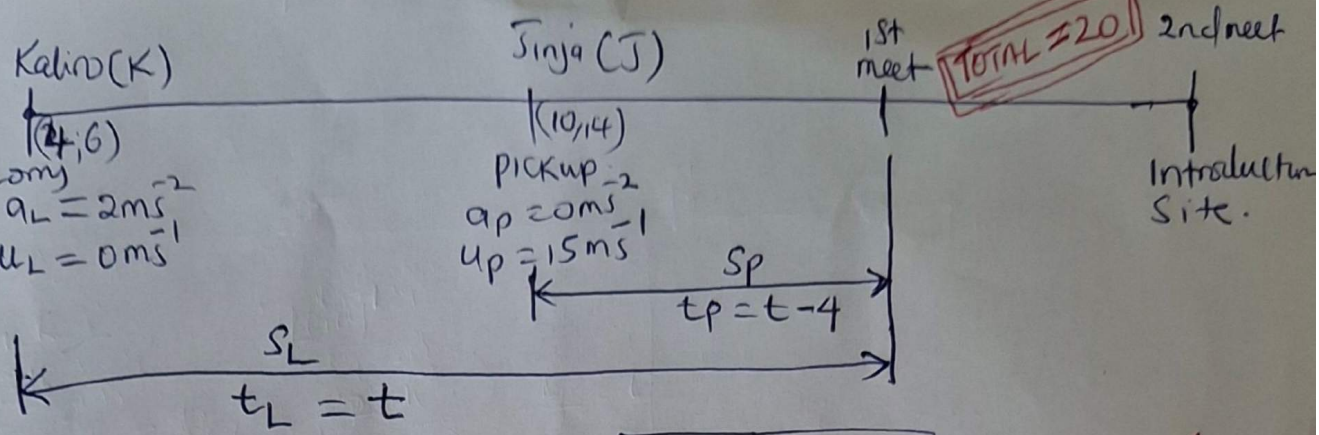
(c) Number of men $= \frac{75}{10} = 7.5 \simeq 8$

02

20

Total

(a)



Distance between Jinja & Kalino $= \sqrt{(14-6)^2 + (10-4)^2} = 10m$ ✓

$\overrightarrow{KJ} = \begin{pmatrix}10\\14\end{pmatrix} - \begin{pmatrix}4\\6\end{pmatrix} = \begin{pmatrix}6\\8\end{pmatrix}$ ✓ unit vector

Velocity of lorry $= 15 \times \frac{1}{10}\begin{pmatrix}6\\8\end{pmatrix} = \begin{pmatrix}9\\12\end{pmatrix} ms^{-1}$ ✓ (05)

Since overnight separation (10m) < 11m and the lorry's velocity component parallel to y-axis ($12ms^{-1}$) > horizontal velocity component, the vehicles will meet twice based on Lusirata's logic. ✓

(b) Let t be time taken by Lorry in motion before meeting PICKup

$S_L = \frac{1}{2} \times 2t^2 = t^2$ ✓

$S_P = 15(t-4)$ ✓

But $10 + 15(t-4) = t^2$ ✓ Equating

$t^2 - 15t + 50 = 0$ ✓ Solving

$(t-5)(t-10) = 0$ ✓

$t = 5$ or $t = 10$ ✓ (08)

Position vector of Introduction Site $= \begin{pmatrix}10\\14\end{pmatrix} + (10-4)\begin{pmatrix}9\\12\end{pmatrix}$ ✓

$= \begin{pmatrix}10\\14\end{pmatrix} + 6\begin{pmatrix}9\\12\end{pmatrix}$

$= \begin{pmatrix}64\\86\end{pmatrix} m$ ✓

OR (ACCEPT)

$\begin{pmatrix}4\\6\end{pmatrix} + \frac{1}{2} \cdot 2 \cdot \frac{1}{10}\begin{pmatrix}6\\8\end{pmatrix} \times 10^2$

$\begin{pmatrix}4\\6\end{pmatrix} + \begin{pmatrix}60\\80\end{pmatrix}$

$\begin{pmatrix}64\\86\end{pmatrix} m$

(c) Velocity of lorry on accessing venue $= 0 + 2 \times 10 = 20ms^{-1}$ ✓ ✓

Since 20 > 19, the attendees were not safe at ceremony ✓

Forward force $= \frac{1000}{20} = 50N$ ✓

No of robots needed $= \frac{50}{1.5}$ ✓ (07)

$= 33.3333 \approx 34$ ✓