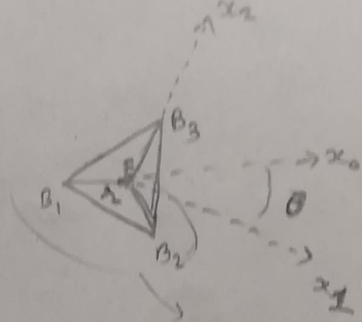
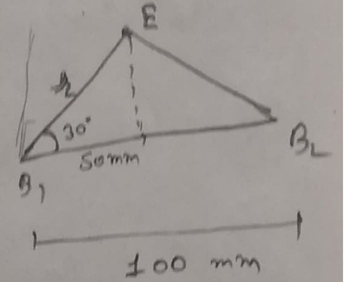
$G(0,0)$

$E(x,y)$



a) $B_1 = r \cdot \begin{bmatrix} \cos(\theta + 210) \\ \sin(\theta + 210) \end{bmatrix} + \begin{bmatrix} x \\ y \end{bmatrix}$

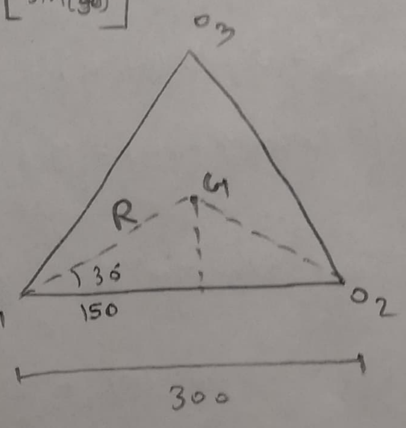


$B_2 = r \begin{bmatrix} \cos(\theta - 30) \\ \sin(\theta - 30) \end{bmatrix} + \begin{bmatrix} x \\ y \end{bmatrix}$

$B_3 = r \cdot \begin{bmatrix} \cos(\theta + 90) \\ \sin(\theta + 90) \end{bmatrix} + \begin{bmatrix} x \\ y \end{bmatrix}$

$r = \dfrac{50}{\cos(30^\circ)}$

b) $O_1 = R \cdot \begin{bmatrix} \cos(210) \\ \sin(210) \end{bmatrix}$; $O_2 = R \begin{bmatrix} \cos(-30) \\ \sin(-30) \end{bmatrix}$; $O_3 = R \begin{bmatrix} \cos(90) \\ \sin(90) \end{bmatrix}$



c) -> for one leg.

O_1, B_1 is known.

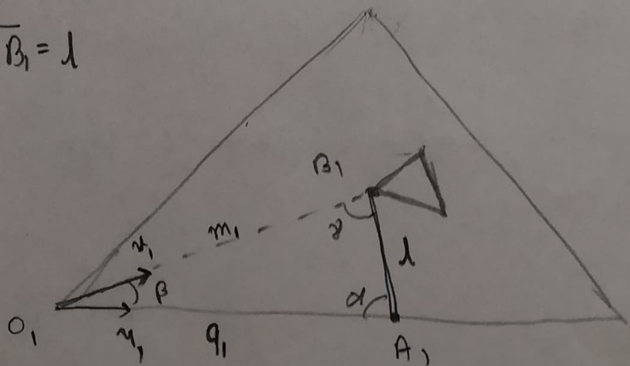
$\vec{u}_1$ is unit vector from O_1 to O_2

$\vec{v}_1$ is unit vector from O_1 to B_1

$\beta = \cos^{-1}\left(\dfrac{\vec{u}_1 \cdot \vec{v}_1}{\underbrace{\|\vec{u}_1\| \cdot \|\vec{v}_1\|}_{\to 1}}\right) = \cos^{-1}\left(\vec{u}_1 \cdot \vec{v}_1\right)$

$R = \dfrac{150}{\cos(30^\circ)}$

$m_1 = \|\overrightarrow{O_1 B_1}\|$; $q_1 = \|\overrightarrow{O_1 A_1}\|$; $\overline{A_1 B_1} = l$



$\dfrac{l}{\sin \beta_1} = \dfrac{m_1}{\sin \alpha_1} = \dfrac{q_1}{\sin \gamma_1}$

$\therefore \alpha_1 = \sin^{-1}\left(\dfrac{m_1 \cdot \sin \beta_1}{l}\right)$

$\gamma_1 = \pi - \alpha_1 - \beta_1$;

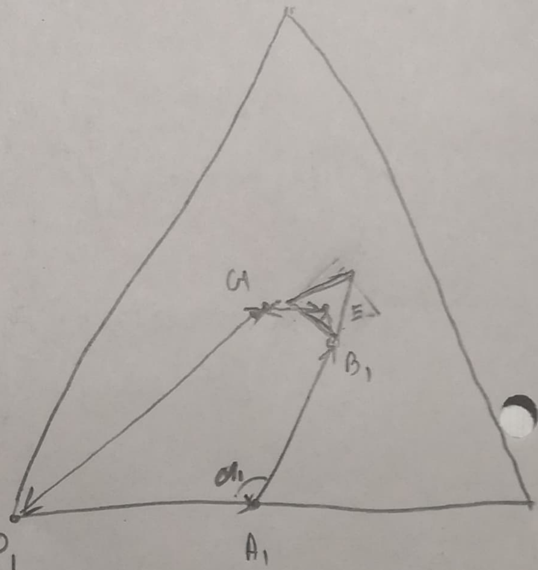
$$q_1 = \frac{l \cdot \sin(\gamma)}{\sin(\beta)}$$

$$A_1 = q_1 \cdot u_1 + O_1$$

Same for other 2 legs.

d)

→ loop closer eqⁿ



$$\vec{O_1A_1} + \vec{A_1B_1} + \vec{B_1E_1} + \vec{EG_1} + \vec{GO_1} = 0$$

$$\begin{bmatrix} q_1 \\ 0 \end{bmatrix} + l \begin{bmatrix} \cos\alpha_1 \\ \sin\alpha_1 \end{bmatrix} + r \begin{bmatrix} \cos(\theta+210) \\ \sin(\theta+210) \end{bmatrix} + \begin{bmatrix} x \\ y \end{bmatrix} + R \begin{bmatrix} \cos(210) \\ \sin(210) \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

$$\therefore \begin{bmatrix} q_1 + r\cos(\theta+210) + x + R\cos(210) \\ r\sin(\theta+210) + y + R\cos(210) \end{bmatrix} = -l \begin{bmatrix} \cos\alpha_1 \\ \sin\alpha_1 \end{bmatrix}$$

Sqare both the row and add them.

$$(q_1 + r\cos(\theta+210) + x + R\cos(210))^2 + (r\sin(\theta+210) + y + R\cos(210))^2 = l^2 \quad (1)$$

construint eqⁿ

$$h_1 = (q_1 + r\cos(\theta+210) + x + R\cos(210))^2 + (r\sin(\theta+210) + y + R\cos(210))^2 - l^2$$

Similar way for other 2 legs.

→ for next question.

with the constraints equation of the 3 legs you will have 3 unknown (x, y, θ) and 3 equations so It will give you unique solution.