(1) a) $L = 6$, $J_1 = 7$, $J_2 = 1$

$$M = 3(L-1) - 2J_1 - J_2 = 15 - 14 - 1 \Rightarrow \boxed{M = 0}$$

• mecanismo não se move

b) $L = 3$, $J_1 = 2$, $J_2 = 1$

$$M = 6 - 4 - 1 \Rightarrow \boxed{M = 1}$$

• atuador em qualquer junta J_1

c) $L = 4$, $J_1 = 4$, $J_2 = 0$

$$M = 9 - 8 \Rightarrow \boxed{M = 1}$$

• atuador na junta central do disco

d) $L = 8$, $J_1 = 9$, $J_2 = 0$

$$M = 21 - 18 \Rightarrow \boxed{M = 3}$$

• atuadores nas juntas fixas (2) + atuador linear no link branco

e) $L = 9$, $J_1 = 11$, $J_2 = 1$

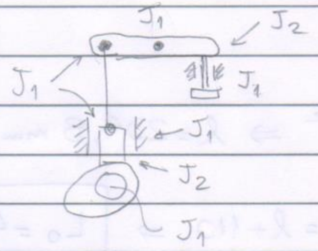
$$M = 24 - 22 - 1 \Rightarrow \boxed{M = 1}$$

• atuador no came

f) $L = 6$, $J_1 = 6$, $J_2 = 2$

$$M = 15 - 12 - 2 \Rightarrow \boxed{M = 1}$$

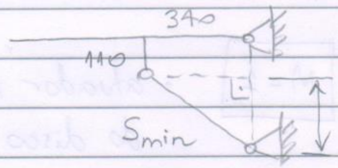
• atuador no came



g) $\left.\begin{array}{l} L=4 \\ J_1=3 \\ J_2=2 \end{array}\right\}$ $M = 9-6-2 \Rightarrow \boxed{M=1}$ • atuador no came

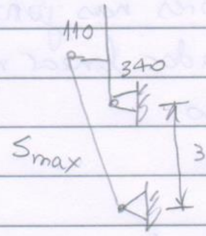
h) $\left.\begin{array}{l} L=4 \\ J_1=4 \\ J_2=0 \end{array}\right\}$ $M = 9-8 \Rightarrow \boxed{M=1}$ • atuador no cilindro

2) a) $\boxed{\theta = 0°}$



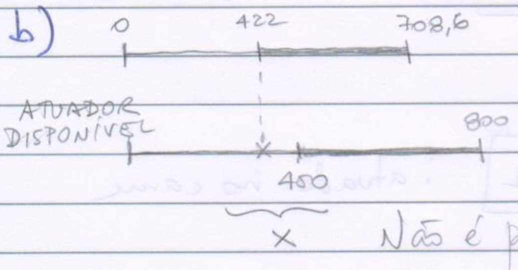
Assim: $S_{min}^2 = 340^2 + 250^2 \Rightarrow \boxed{S_{min} = 422 \text{ mm}}$

$\boxed{\theta = 90°}$



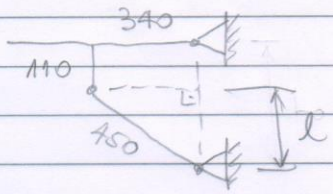
$S_{max}^2 = 110^2 + 700^2 \Rightarrow \boxed{S_{max} = 708{,}6 \text{ mm}}$

b)



Não é possivel utilizar!

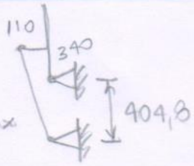
Assim, para $\underline{S_{min} = 450 \text{ mm}}$:



$450^2 = \ell^2 + 340^2 \Rightarrow \ell = 294{,}8 \text{ mm}$

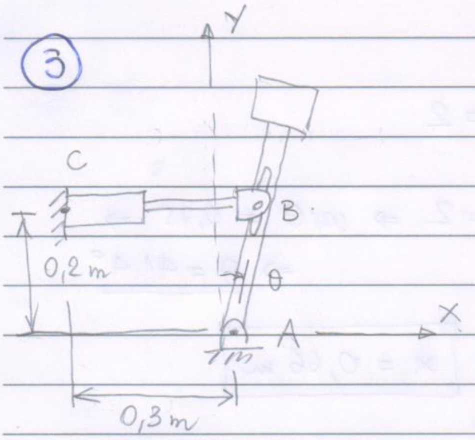
Portanto: $L_0 = \ell + 110 \Rightarrow \boxed{L_0 = 404{,}8 \text{ mm}}$

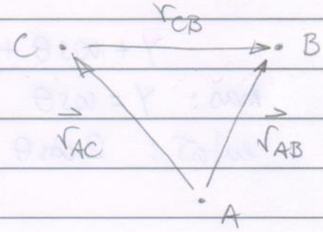
Neste caso:



$S_{max}^2 = 110^2 + 744{,}8^2 \Rightarrow \underline{S_{max} = 752{,}8 \text{ mm} < 800 \text{ mm}}$ OK

3





$$\boxed{\vec{r}_{AC} + \vec{r}_{CB} - \vec{r}_{AB} = \vec{0}}$$

$$\vec{r}_{AC} = \begin{Bmatrix} -0{,}3 \\ 0{,}2 \\ 0 \end{Bmatrix} \qquad \vec{r}_{CB} = \begin{Bmatrix} x_B \\ 0 \\ 0 \end{Bmatrix} \qquad \vec{r}_{AB} = \begin{Bmatrix} l \operatorname{sen}\theta \\ l\cos\theta \\ 0 \end{Bmatrix}$$

Então: $$\boxed{\begin{cases} -0{,}3 + x_B - l\operatorname{sen}\theta = 0 \\ 0{,}2 - l\cos\theta = 0 \end{cases}}$$

EQS. DE POSIÇÃO

Derivando no tempo:

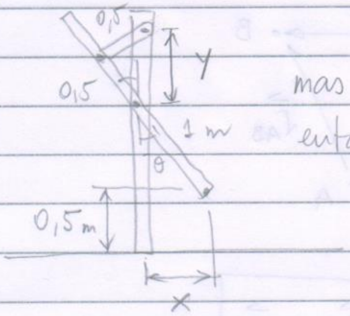
$$\frac{d}{dt}\left(\vec{r}_{AC} + \vec{r}_{CB} - \vec{r}_{AB}\right) = \vec{0} \Rightarrow \boxed{\begin{cases} \dot{x}_B - \dot{l}\operatorname{sen}\theta - l\dot{\theta}\cos\theta = 0 \\ -\dot{l}\cos\theta + l\dot{\theta}\operatorname{sen}\theta = 0 \end{cases}}$$

EQS. DE VELOCIDADE

Obs: $\boxed{tg\,\theta = \dfrac{x_B - 0{,}3}{0{,}2}}$ e $\boxed{l = \dfrac{0{,}2}{\cos\theta}}$

$\boxed{\dot{l} = l\dot{\theta}\,tg\,\theta}$ e $\boxed{\dot{\theta} = \dfrac{\dot{x}_B\cos\theta}{l}}$

4



$y + \cos\theta + 0{,}5 = 2$

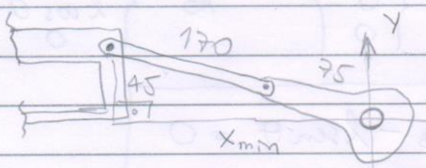
mas: $y = \cos\theta$

então: $2\cos\theta + 0{,}5 = 2 \Rightarrow \cos\theta = 0{,}75 \Rightarrow$

$\Rightarrow \underline{\theta = 41{,}4^\circ}$

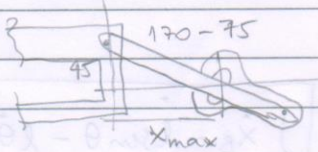
$x = \text{sen}\,\theta \Rightarrow \boxed{x = 0{,}66\ m}$

5 Mínimo:



$245^2 = x_{min}^2 + 45^2 \Rightarrow \underline{x_{min} = -240{,}8\ mm}$

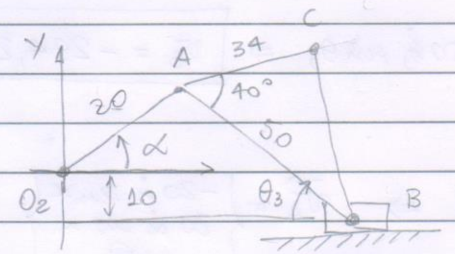
Máximo:



$95^2 = x_{max}^2 + 45^2 \Rightarrow \underline{x_{max} = -83{,}7\ mm}$

$\boxed{\text{STROKE} = 157{,}1\ mm}$

6

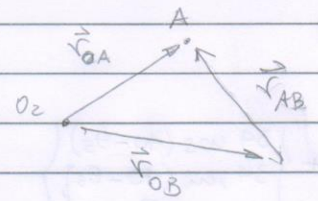


$\alpha = 34°$

$\dot{\alpha} = 15$ rad/s

Análise de Posição

$$\boxed{\vec{r}_{OA} - \vec{r}_{AB} - \vec{r}_{OB} = \vec{0}}$$



$$\vec{r}_{OA} = \begin{Bmatrix} 20\cos\alpha \\ 20\,\text{sen}\,\alpha \\ 0 \end{Bmatrix} \qquad \vec{r}_{AB} = \begin{Bmatrix} -50\cos\theta_3 \\ 50\,\text{sen}\,\theta_3 \\ 0 \end{Bmatrix}$$

$$\vec{r}_{OB} = \begin{Bmatrix} X_B \\ -10 \\ 0 \end{Bmatrix}$$

Então:

$$\boxed{\begin{cases} 20\cos\alpha + 50\cos\theta_3 - X_B = 0 & (1) \\ 20\,\text{sen}\,\alpha - 50\,\text{sen}\,\theta_3 + 10 = 0 & (2) \end{cases}}$$

De (2) : $50\,\text{sen}\,\theta_3 = 10 + 20\,\text{sen}\,\alpha \Rightarrow \theta_3 = \text{sen}^{-1}\left(\dfrac{10 + 20\,\text{sen}\,\alpha}{50}\right)$

$\Rightarrow \boxed{\theta_3 = 25{,}1°}$

Em (1) : $X_B = 20\cos\alpha + 50\cos\theta_3 \Rightarrow \boxed{X_B = 61{,}86 \text{ mm}}$

Análise de Velocidade

$$\frac{d}{dt}\left(\vec{r}_{OA} - \vec{r}_{AB} - \vec{r}_{OB}\right) = \vec{0} \Rightarrow \boxed{\begin{cases} -20\dot{\alpha}\,\text{sen}\,\alpha - 50\dot{\theta}_3\,\text{sen}\,\theta_3 - \dot{X}_B = 0 & (3) \\ 20\dot{\alpha}\cos\alpha - 50\dot{\theta}_3\cos\theta_3 = 0 & (4) \end{cases}}$$

De (4) : $\dot{\theta}_3 = \dfrac{20\dot{\alpha}\cos\alpha}{50\cos\theta_3} \Rightarrow \boxed{\dot{\theta}_3 = 5{,}49 \text{ rad/s}}$

De (3) : $\dot{x}_B = v_B = -20\dot{\alpha}\,\text{sen}\,\alpha - 50\dot{\theta}_3\,\text{sen}\,\theta_3 \Rightarrow \boxed{v_B = -284{,}2 \text{ mm/s}}$

Posição do Ponto A : $\vec{r}_{OA} = \begin{Bmatrix} 20\cos\alpha \\ 20\,\text{sen}\,\alpha \\ 0 \end{Bmatrix} \Rightarrow \vec{v}_A = \begin{Bmatrix} -20\dot{\alpha}\,\text{sen}\,\alpha \\ 20\dot{\alpha}\cos\alpha \\ 0 \end{Bmatrix} \Rightarrow$

$$\Rightarrow \boxed{\vec{v}_A = \begin{Bmatrix} -167{,}8 \\ 248{,}7 \\ 0 \end{Bmatrix} \text{mm/s}}$$

Posição de C : $\vec{r}_{OC} = \vec{r}_{OA} + \vec{r}_{AC} = \begin{Bmatrix} 20\cos\alpha \\ 20\,\text{sen}\,\alpha \\ 0 \end{Bmatrix} + \begin{Bmatrix} 34\cos(40-\theta_3) \\ 34\,\text{sen}(40-\theta_3) \\ 0 \end{Bmatrix}$

$$\Rightarrow \vec{r}_{OC} = \begin{Bmatrix} 20\cos\alpha + 34\cos(40-\theta_3) \\ 20\,\text{sen}\,\alpha + 34\,\text{sen}(40-\theta_3) \\ 0 \end{Bmatrix} \Rightarrow v_C = \begin{Bmatrix} -20\dot{\alpha}\,\text{sen}\,\alpha + 34\dot{\theta}_3\,\text{sen}(40-\theta_3) \\ 20\dot{\alpha}\cos\alpha - 34\dot{\theta}_3\cos(40-\theta_3) \\ 0 \end{Bmatrix}$$

$$\Rightarrow \boxed{\vec{v}_C = \begin{Bmatrix} -119{,}8 \\ 68{,}3 \\ 0 \end{Bmatrix} \text{mm/s}}$$