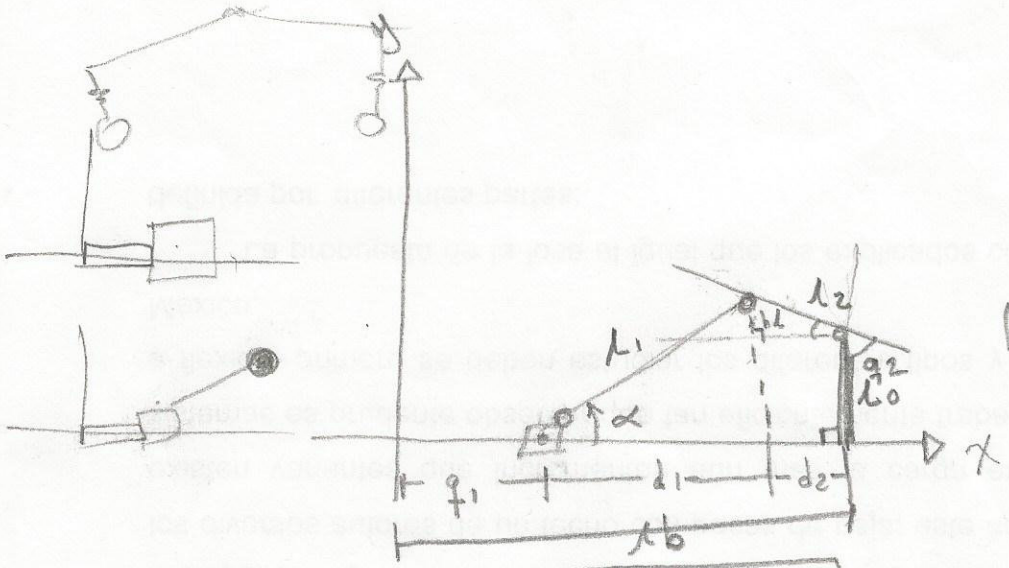
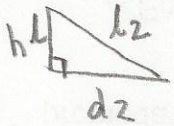


$h_L = l_1 \sin\alpha - l_0$



$$d_2 = \sqrt{l_2^2 - h_L^2}$$

$$= \sqrt{l_2^2 - (l_1 \sin\alpha - l_0)^2}$$

$$= \sqrt{l_2^2 - l_1^2 \sin^2\alpha + 2 l_1 l_0 \sin\alpha - l_0^2}$$

$$l_b = q_1 + d_1 + d_2$$

$$d_2 = l_b - q_1 - d_1$$

$$l_2^2 - l_1^2 \sin^2\alpha + 2 l_1 l_0 \sin\alpha - l_0^2 = (l_b - q_1 - l_1 \cos\alpha)^2$$

$$= l_b^2 + q_1^2 + l_1^2 \cos^2\alpha - 2 l_b q_1 - 2 l_1 l_b \cos\alpha + 2 l_1 q_1 \cos\alpha$$

$$[l_1^2 \cos^2\alpha + l_1^2 \sin^2\alpha] + 2 l_1 q_1 \cos\alpha - 2 l_1 l_b \cos\alpha - 2 l_1 l_0 \sin\alpha$$

$$= l_2^2 - l_0^2 - l_b^2 - q_1^2 + 2 l_b q_1$$

$$[2 l_1 l_0] \sin\alpha + [2 l_1 l_b - 2 l_1 q_1] \cos\alpha = l_b^2 + l_0^2 + q_1^2 - l_2^2 + l_1^2 - 2 l_b q_1$$

$$l_0 \sin\alpha + [l_b - q_1] \cos\alpha = \frac{l_b^2 + l_0^2 + q_1^2 + l_1^2 - l_2^2 - 2 l_b q_1}{2 l_1}$$

$$\sqrt{l_0^2 + [l_b - q_1]^2}\,\sin\left[\alpha + \tan^{-1}\left[\frac{l_b - q_1}{l_0}\right]\right] = \frac{l_b^2 + l_0^2 + q_1^2 + l_1^2 - l_2^2 - 2l}{2l_1}$$

$$\sin\left[\alpha + \tan^{-1}\left[\frac{l_b - q_1}{l_0}\right]\right] = \frac{l_b^2 + l_0^2 + q_1^2 + l_1^2 - l_2^2 - 2 l_b q_1}{2 l_1 \sqrt{l_0^2 + [l_b - q_1]^2}}$$

$$\alpha = \sin^{-1}\left[\frac{l_b^2 + l_0^2 + q_1^2 + l_1^2 - l_2^2 - 2 l_b q_1}{2 l_1 \sqrt{l_0^2 + [l_b - q_1]^2}}\right] - \tan^{-1}\left[\frac{l_b - q_1}{l_0}\right]$$

$$\phi = 90 - q_2$$

$$\frac{\sin 90^\circ}{l_2} = \frac{\sin\phi}{l_1 \sin\alpha - l_0}$$

$$\Rightarrow l_2 \cos q_2 = l_1 \sin\alpha - l_0$$

$$\alpha = \sin^{-1}\left[\frac{l_2 \cos q_2 + l_0}{l_1}\right]$$

$$\frac{l_2 \cos q_2 + l_0}{l_1} = \sin\left[\sin^{-1}\left[\frac{l_b^2 + l_0^2 + q_1^2 + l_1^2 - l_2^2 - 2 l_b q_1}{2 l_1 \sqrt{l_0^2 + [l_b - q_1]^2}}\right] - \tan^{-1}\left[\frac{l_b - q_1}{l_0}\right]\right]$$

$$\cos q_2 = l_1 \sin\left[\sin^{-1}\left[\frac{l_b^2 + l_0^2 + q_1^2 + l_1^2 - l_2^2 - 2 l_b q_1}{2 l_1 \sqrt{l_0^2 + [l_b - q_1]^2}}\right] - \tan^{-1}\left[\frac{l_b - q_1}{l_0}\right]\right] - l_0$$

$$l_2$$

$$q_2 = \cos^{-1}\left[\frac{l_1 \sin\left[\sin^{-1}\left[\frac{l_b^2 + l_0^2 + q_1^2 + l_1^2 - l_2^2 - 2 l_b q_1}{2 l_1 \sqrt{l_0^2 + [l_b - q_1]^2}}\right] - \tan^{-1}\left[\frac{l_b - q_1}{l_0}\right]\right] - l_0}{l_2}\right]$$

$$l_2 \sin q_2 = l_b - l_1 \cos\alpha - q_1$$

$$q_2 = \sin^{-1}\left[\frac{l_b - l_1 \cos\alpha - q_1}{l_2}\right]$$

$$q_2 = \sin^{-1}\left[\frac{l_b - l_1 \cos\left[\sin^{-1}\left[\frac{l_b^2 + l_o^2 + q_1^2 + l_1^2 - l_2^2 - 2 l_b q_1}{2 l_1 \sqrt{l_o^2 + [l_b - q_1]^2}}\right] - \tan^{-1}\left[\frac{l_b - q_1}{l_o}\right]\right] - q_1}{l_2}\right]$$

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