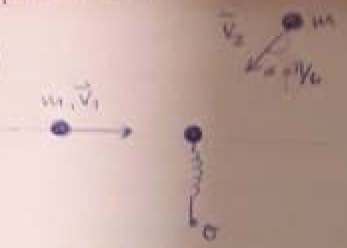
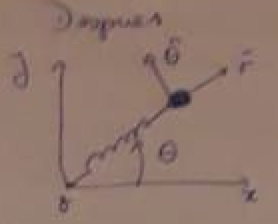
a)





conservaciones $\{m, m, 2m\}$

ANTES	DURANTE	DESPUÉS
• $\sum \vec{F}_{ext} = 0$ $\vec{P}_{TOT} = cte$	$\sum \vec{F}_{ext} = 0$ $\vec{P}_{TOT} = cte$	$\sum \vec{F}_{ext} = F_e \neq 0$ $\rightarrow \vec{P}_f \neq cte$ $\vec{P}$ no se conserva luego del choque
• $\sum \vec{\tau}^{(O)}_{ext} = 0$ $\vec{L}^{(O)}_{TOT} = cte$	$\sum \vec{\tau}^{(O)}_{ext} = 0$ $\rightarrow \vec{L}^{O}_{TOT} = cte$	$\sum \vec{\tau}^{(O)}_{ext} = \vec{r} \times \vec{F}_e = 0$ $\vec{L}^{(O)}_{TOT} = cte$
• $W_{FNC} = 0$ $\Rightarrow E = cte$	$\Delta E_c \neq 0$ (choque plástico) $\rightarrow E \neq cte$	$W_{FNC} = 0$ $\Delta E = 0$ $E = cte$

b) $\vec{V}_f$, $\dot{\theta}$

Conservación de $\vec{p}$ durante el choque

$$m_1 \vec{V}_1 + m_2 \vec{V}_2 = m(\vec{V}_1 + \vec{V}_2) \overset{\downarrow}{=} (m + m + 2m)\, \vec{V}_f$$

$\vec{V}_1 = V_0\, \hat{x}$ $\Rightarrow$ $V_{fx} = \dfrac{\cancel{m} V_0}{4 \cancel{m}} (1 - \text{sen}\,\alpha)$

$\vec{V}_2 = -V_0 (\text{sen}\,\alpha\, \hat{x} + \cos\alpha\, \hat{y})$ $\quad V_{fy} = -\dfrac{\cancel{m} V_0}{4 \cancel{m}} (\cos\alpha)$

$$\boxed{\vec{V}_f = \frac{V_0}{4} \left[1 - \text{sen}\,\alpha\, \hat{x} + \cos\alpha\, (-\hat{y}) \right]} \quad \alpha = \pi/6 \Rightarrow \boxed{V_f = \frac{V_0}{8} (\hat{x} - \sqrt{3}\, \hat{y})}$$

Conservación de $L^{(O)}$ después del choque

$\longrightarrow$

$\rightarrow$ $\vec{L}_0^{(o)} = 4m\ \vec{r}_0 \times (\vec{v}_0)$ — $\vec{v}_f$, la velocidad luego del choque

$= 4m\ l_0\ \hat{y} \times \frac{v_0}{4} (1 - \operatorname{sen}\alpha\ \hat{x} - \cos\alpha\ \hat{y})$

$= \cancel{4} m\ l_0 \frac{v_0}{\cancel{4}} (1 - \operatorname{sen}\alpha)\ (-\hat{z})$

$$\boxed{\vec{L}_0^{(o)} = m\ l_0\ v_0\ (\operatorname{sen}\alpha - 1)\ \hat{z}} \xrightarrow{\alpha = \pi/6} \boxed{L^{(o)} = \frac{m\ l_0 v_0}{2} (-\hat{z})}$$

. Conservación de $\vec{L}^{(o)}$ después — escribo para el tpo posterior

$\vec{L}^{o} = 4m\ \vec{r} \times \vec{v} = 4m\ \vec{r} \times (\dot{r}\hat{r} + r\dot{\theta}\hat{\theta})$

$= 4m\ r\ \hat{r} \times (\dot{r}\hat{r} + r\dot{\theta}\hat{\theta})$ $\quad r\theta z$

$\vec{L}^{o} = 4m\ r^2\dot{\theta}\ \hat{z}$

$\Rightarrow$

$\cancel{m}\ l_0\ v_0\ (\operatorname{sen}\alpha - 1) = 4\cancel{m}\ r^2\dot{\theta}$

$$\boxed{\dot{\theta} = \frac{l_0\ v_0\ (\operatorname{sen}\alpha - 1)}{4r^2}} \xrightarrow{\alpha = \pi/6} \boxed{\dot{\theta} = -\frac{l_0\ v_0}{8r^2}\ \hat{\theta}}$$

c).

$E = \frac{1}{2} \underbrace{M}_{=4m} \dot{r}^2 + \frac{M}{2} r^2 \dot{\theta}^2 + \frac{1}{2} k (r - l_0)^2$ — potencial efect

$= \frac{1}{2} M \dot{r}^2 + \left(\frac{M}{2} r^2 \left[\frac{l_0\ v_0\ (\operatorname{sen}\alpha - 1)}{4r^2} \right]^2 + \frac{1}{2} k (r - l_0)^2 \right)$

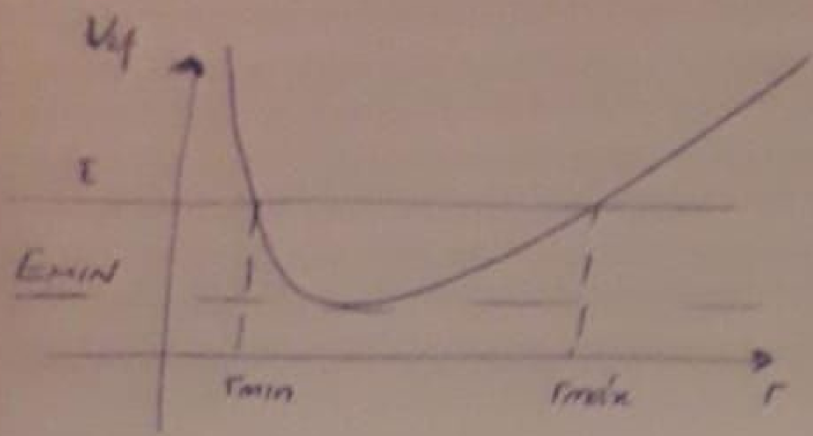
$V_{ef} = \frac{2M\ [l_0\ v_0\ (\operatorname{sen}\alpha - 1)]^2}{16r^2} + \frac{1}{2} k (r - l_0)^2$

$$\Rightarrow V_{ef} = \frac{m}{8}\frac{\left(l_0 V_0 (\operatorname{sen}\alpha - 1)\right)^2}{r^2} + \frac{1}{2}k\,(r-l_0)^2 \; ⊛$$

$$V_{ef} \propto \frac{1}{r^2} + r^2$$

⊛ $\alpha = \pi/6$

$$\boxed{V_{ef} = \frac{m}{8}\left(\frac{l_0 V_0}{4 r^2}\right)^2 + \frac{k}{2}(r-l_0)^2}$$



Si $E > E_{min}$

$\Rightarrow$ mov ligado, es decir, las masas oscilan en 2 valores de r (r_{min}, $r_{máx}$)

$\Rightarrow r_{min} < r < r_{máx}$ x 6 > bien

Si la distancia de máximo alejamiento es $r = \frac{3}{2} l_0$

$\Rightarrow$ Uso conservación de la energía

- Después del choque ⊛ $E_0 = \frac{1}{2}(2m+2m) V_f^2$

$$= \frac{1}{2} 4m V_f^2 = 2m\left(\frac{V_0^2}{16}\right)$$

$$\boxed{E_0 = \frac{m V_0^2}{8}}$$ ⊛ un instante después

- $$E\left(r = \tfrac{3}{2} l_0\right) = \frac{4m}{2}\dot{r}^2 + \frac{m}{8}\frac{\cancel{l_0^2} V_0^2}{4\left(\tfrac{3}{2}\cancel{l_0}\right)^2} + \frac{k}{2}\left(\tfrac{3}{2}l_0 - l_0\right)^2$$

$$= 2m\dot{r}^2 + \frac{1}{8}\frac{m V_0^2}{9} + \frac{k l_0^2}{8}$$

$$E(r = 3/2\, l_0) = E_0 \Rightarrow 2\cancel{m}\dot{r}^2 + \frac{1}{8}\frac{\cancel{m} V_0^2}{9} + \frac{k l_0^2}{8m} = \frac{\cancel{m} V_0^2}{8}$$

$$\Rightarrow \dot{r}^2 = \frac{V_0^2}{16}\left(1 - \frac{1}{9}\right) - \frac{k l_0^2}{16 m}$$

$\vdots$

$$\dot{r}^2 = \left(\frac{8}{9}V_0^2 - \frac{k l_0^2}{m}\right)\frac{1}{16}$$

Máximo alejamiento $\dot{r} = 0$

$$\Rightarrow \frac{8}{9} V_0^2 - \frac{k\, l_0^2}{m} = 0 \Rightarrow \boxed{V_0^2 = \frac{9}{8}\frac{k\, l_0^2}{m}}$$

V_0/ $r = \frac{3}{2} l_0$ es el máximo alejamiento

* Velocidad en ese punto:

$$\bar{V} = \dot{r}\,\hat{r} + r\,\dot{\theta}\,\hat{\theta} = 0\,\hat{r} + \frac{3}{2} l_0 \cdot \dot{\theta}\left(\frac{3}{2} l_0\right)\hat{\theta}$$

$$\Rightarrow \vec{V} = 0\,\hat{r} + \underbrace{\frac{3}{2}\cancel{l_0}\left(-\frac{\cancel{l_0}\, V_0}{8\left(\frac{3}{2} l_0\right)^2}\right)}_{\frac{3}{2}\frac{V_0}{8\,\frac{9}{4}} = \frac{V_0}{12}}\hat{\theta} = 0\,\hat{r} + \frac{V_0}{12}(-\hat{\theta})$$