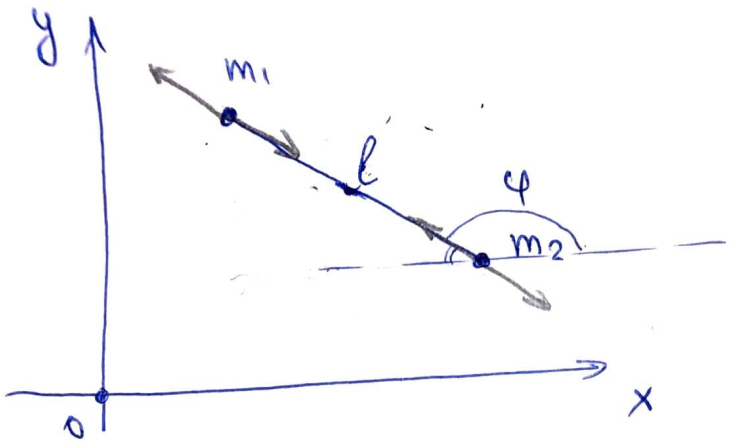

Обобщенные координаты:

$\underbrace{x, y}_{\text{коорд. } m_2}, \varphi$

a) $x_{m_1} = \ell \cos\varphi + x$

$y_{m_1} = \ell \sin\varphi + y$

$$T_{кин} = \frac{m_1\left(\left((\ell\cos\varphi + x)^{\cdot}\right)^2 + \left((\ell\sin\varphi + y)^{\cdot}\right)^2\right)}{2} + \frac{m_2(\dot{x}^2 + \dot{y}^2)}{2} =$$

$$= \frac{m_2}{2}(\dot{x}^2 + \dot{y}^2) + \frac{m_1}{2}(\dot{x}^2 + \dot{y}^2 + \ell^2\dot{\varphi}^2 + 2\ell\cos\varphi\,\dot{x}\,\dot{\varphi} + 2\ell\sin\varphi\,\dot{y}\,\dot{\varphi})$$

$$U = -G\frac{m_1 m_2}{\ell}$$

$$L = T_{кин} - U = \frac{m_1}{2}(\dot{x}^2 + \dot{y}^2 + \ell^2\dot{\varphi}^2 + 2\ell\cos\varphi\,\dot{x}\,\dot{\varphi} + 2\ell\sin\varphi\,\dot{y}\,\dot{\varphi}) + \frac{m_2}{2}(\dot{x}^2 + \dot{y}^2) + G\frac{m_1 m_2}{\ell}$$

$$L_x := \frac{d}{dt}(m_2\dot{x} + m_1\dot{x} + m_1\ell\dot{\varphi}\cos\varphi) = 0$$

$$L_y := \frac{d}{dt}((m_1+m_2)\dot{y} + m_2\ell\dot{\varphi}\sin\varphi) = 0$$

$$L_\varphi := \frac{d}{dt}(m_1\ell^2\dot{\varphi} + m_1\ell\cos\varphi\,\dot{x} + m_1\ell\sin\varphi\,\dot{y}) - (m_1\ell\cos\varphi\,\ddot{y}\,\dot{\varphi} - m_1\ell\sin\varphi\,\dot{x}\,\dot{\varphi}) = 0$$

$\frac{\partial L}{\partial t} = 0 \Rightarrow$ Выполняется закон сохр. энергии