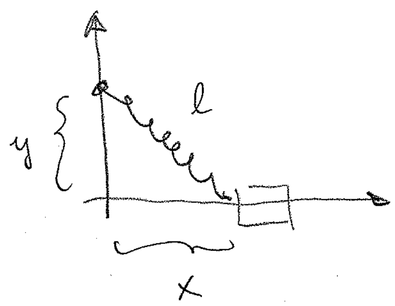
(1)



$$l^2 = (x^2+y^2)$$

$$V = \frac{1}{2} k (l - l_0)^2$$

$$= \frac{1}{2} k \left(l^2 - 2 l l_0 + l_0^2 \right)$$

$$= \frac{1}{2} k \left(x^2+y^2 - 2 l_0 \left(\sqrt{x^2+y^2} - \frac{l_0}{2} \right) \right)$$

$$L = K - V = \frac{1}{2} m \dot{x}^2 - \frac{1}{2} k \left(x^2+y^2 - 2 l_0 \left(\sqrt{\ } - \frac{l_0}{2} \right) \right)$$

egyensúly: V minimuma (y = áll.)

$$\frac{\partial V}{\partial x} = kx - k l_0 \frac{1}{\cancel{2}\sqrt{x^2+y^2}} \cancel{2} x$$

$$= kx - \frac{k l_0 x}{\sqrt{x^2+y^2}}$$

ha $\sqrt{x^2+y^2} = l_0$

akkor $\frac{\partial V}{\partial x} = 0$

tehát: egyensúly: ahol nyújtatlan a rugó

$$x_0^2 = l_0^2 - y^2$$

kis rezgések frekvenciája: itt kvadratikus sorfejtés, $\xi = x - x_0$

$$L \approx \frac{1}{2} m \dot{\xi}^2 - \frac{1}{2} k \frac{l^2 - y^2}{l^2} \xi^2 + \dots$$

$$\omega^2 = \frac{k}{m} \frac{l^2 - y^2}{l^2}$$

② Harmonikus oszcillátor

$$L = \frac{1}{2} m \dot{x}^2 - \frac{1}{2} k x^2$$

$$\Rightarrow \quad \underbrace{\frac{d}{dt}\frac{\partial L}{\partial \dot{x}}}_{m\ddot{x}} - \underbrace{\frac{\partial L}{\partial x}}_{+\, kx} = 0 \qquad \frac{\partial L}{\partial \dot{x}} = m\dot{x} \qquad \underbrace{\frac{\partial L}{\partial x} = -kx}_{\text{erő!}}$$

legyen tehát

$$L = \frac{1}{2} m \dot{x}^2 - \frac{1}{2} k x^2 - F(t)x \qquad F(t) = A \sin \Omega t$$

ekkor $\frac{\partial L}{\partial x} = -kx - F(t)$

$$m\ddot{x} = -kx + F(t)$$

$$\boxed{m\ddot{x} + kx = F(t)}$$

$$H = p\dot{x} - L \qquad p = \frac{\partial L}{\partial \dot{x}} = m\dot{x}$$

$$H = \frac{1}{m} p^2 - \left(\frac{1}{2} m \left(\frac{p}{m}\right)^2 - \frac{1}{2} k x^2 - F(t)x \right)$$

$$= \frac{1}{2m} p^2 + \frac{1}{2} k x^2 + F(t)x$$

$$\frac{\partial H}{\partial t} = x(t)F'(t) \neq 0 \quad \Rightarrow H \text{ nem mozgásállandó}$$

$$\left(\text{ui. } \frac{\partial L}{\partial t} = -F'(t)x \neq 0 \right)$$

3 ld. az A csoportnál

4 ld. az A csoportnál

5 ld. az A csoportnál