Sklopljeno nihanje

$$\ddot{\varphi}_a + \frac{g}{l}\varphi_a + \frac{k_v l'^2}{ml^2}\left(\varphi_a - \varphi_b\right) = 0$$

$$\ddot{\varphi}_b + \frac{g}{l}\varphi_b + \frac{k_v l'^2}{ml^2}\left(\varphi_b - \varphi_a\right) = 0$$

$$\varphi_+ = \varphi_a + \varphi_b \quad \varphi_- = \varphi_a - \varphi_b$$

$$\ddot{\varphi}_+ + \frac{g}{l}\varphi_+ = 0$$

$$\ddot{\varphi}_- + \frac{g}{l}\varphi_- + 2\frac{k_v l'^2}{ml^2}\varphi_- = 0$$
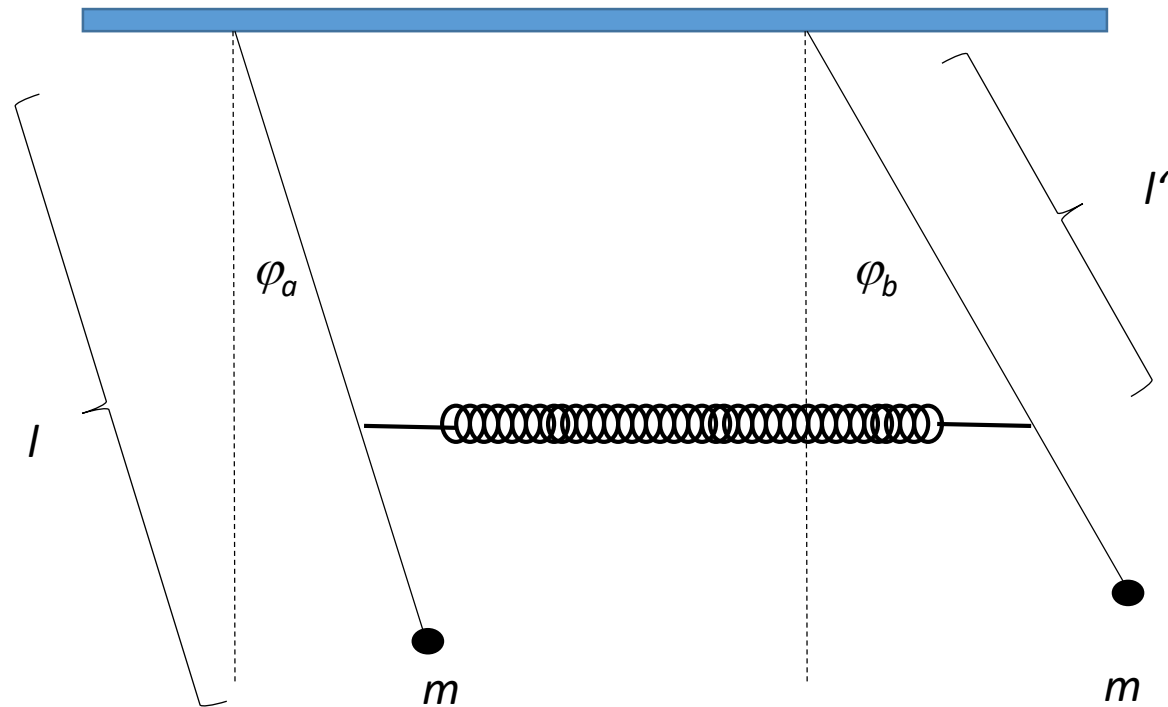

$\varphi_{a,b} \ll 1$

$$\varphi_a(t=0) = 0, \quad \varphi_b(t=0) = \varphi_0$$
$$\dot{\varphi}_a(t=0) = 0, \quad \dot{\varphi}_b(t=0) = 0$$

$$\varphi_a = \frac{\varphi_0}{2}\left[\cos(\omega_+ t) - \cos(\omega_- t)\right]$$
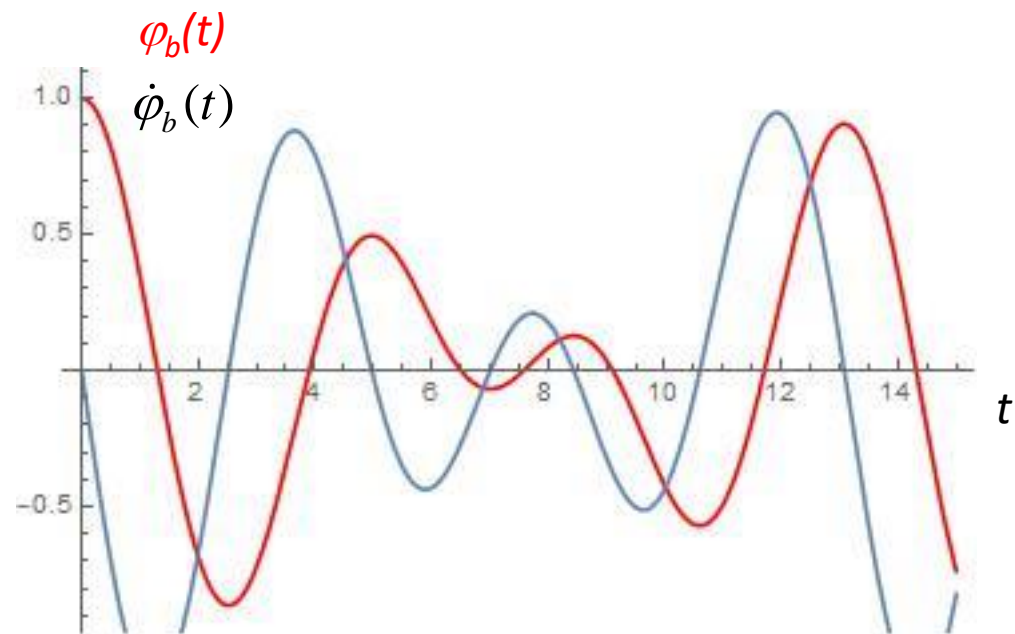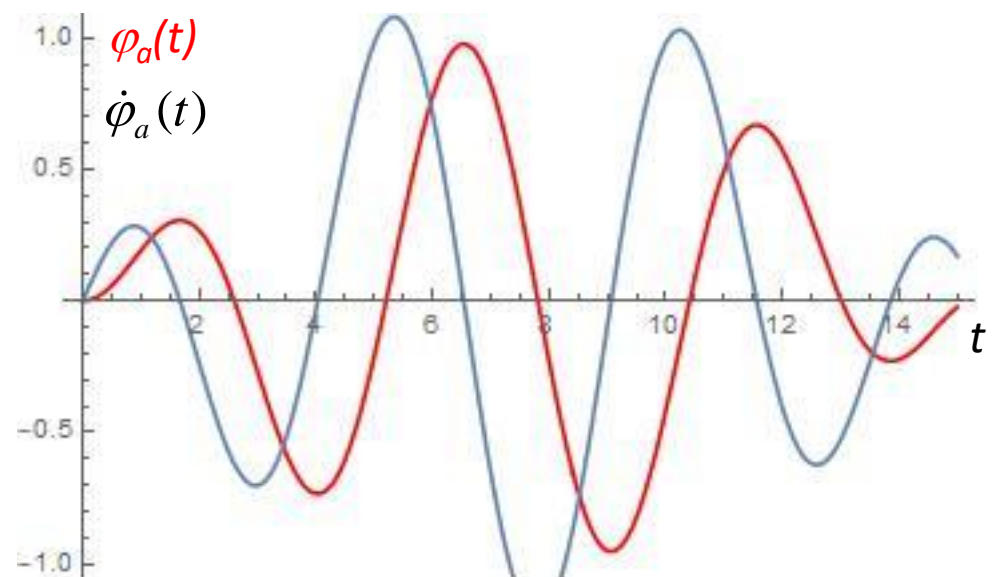
$$\varphi_b = \frac{\varphi_0}{2}\left[\cos(\omega_+ t) + \cos(\omega_- t)\right]$$

$$\omega_+^2 = \frac{g}{l} \quad \omega_-^2 = \frac{g}{l} + 2\frac{k_v}{m}\frac{l'^2}{l^2}$$
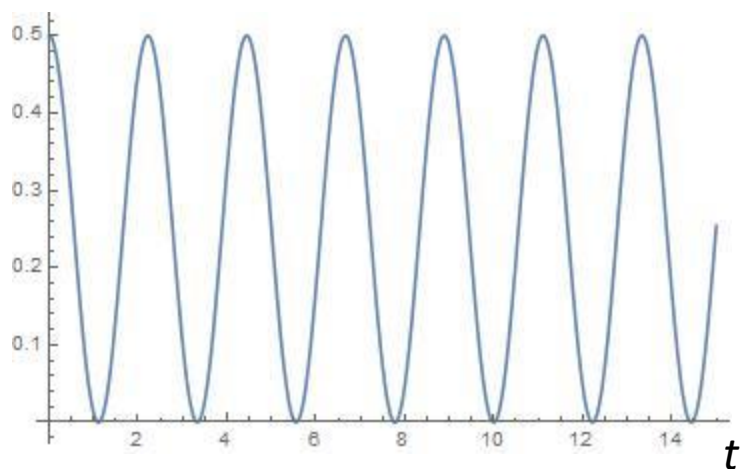
Sklopljeno nihanje

$$\varphi_a = \frac{\varphi_0}{2}\left[\cos(\omega_+ t) - \cos(\omega_- t)\right]$$

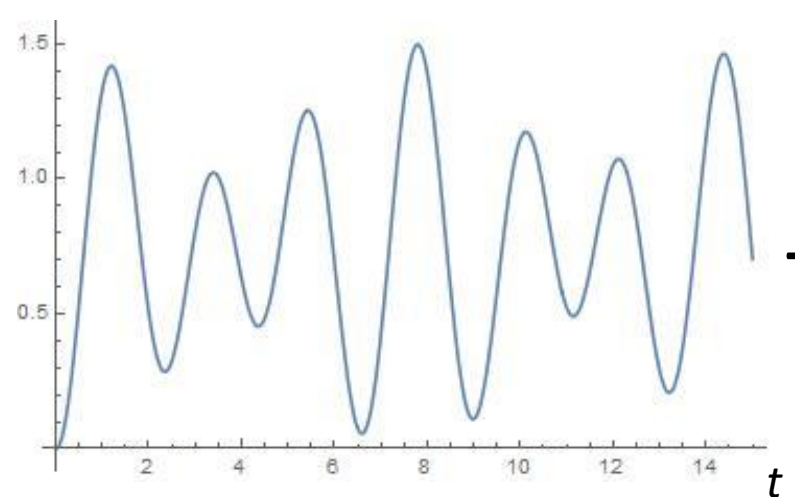$$\varphi_b = \frac{\varphi_0}{2}\left[\cos(\omega_+ t) + \cos(\omega_- t)\right]$$

$$\varphi_a(t=0) = 0, \quad \varphi_b(t=0) = \varphi_0$$

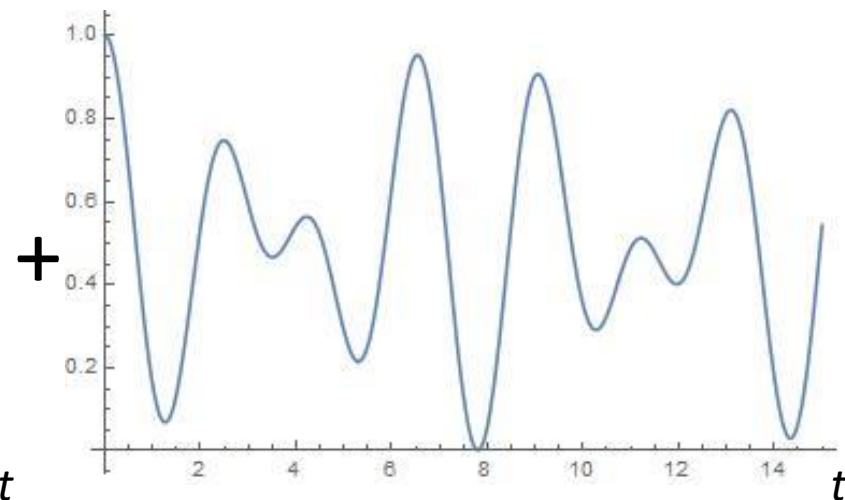$$\dot{\varphi}_a(t=0) = 0, \quad \dot{\varphi}_b(t=0) = 0$$

Sklopljeno nihanje

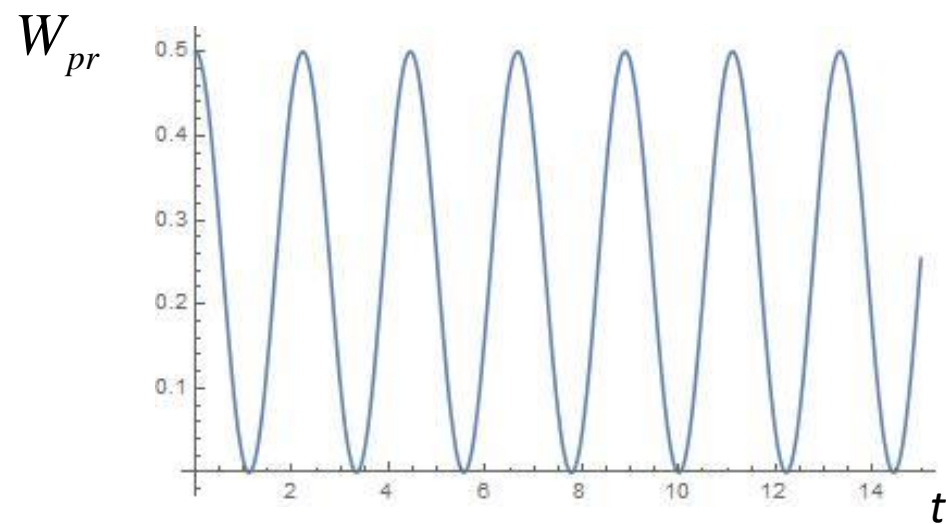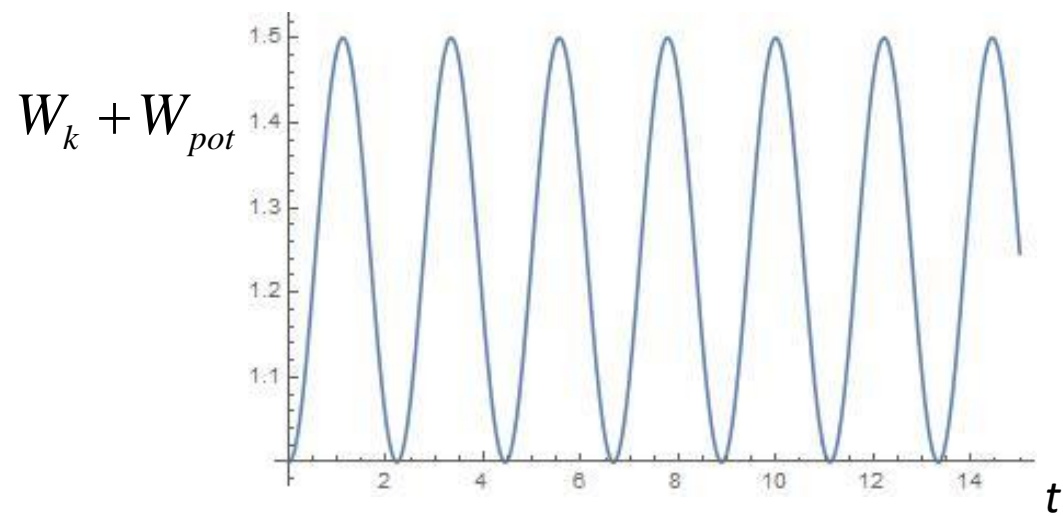
$$W_{pr} \propto (\varphi_a - \varphi_b)^2$$

$$W_k \propto \dot{\varphi}_a^2 + \dot{\varphi}_b^2$$

$$W_{pot} \propto \varphi_a^2 + \varphi_b^2$$

Sklopljeno nihanje

$W_k + W_{pot}$

W_{pr}

$$W_{pr} + W_k + W_{pot} = konst.$$

Utripanje

$$\frac{k_v l'^2}{mgl} << 1 \Rightarrow \omega_- - \omega_+ << \omega_- + \omega_+$$

$$\omega_- + \omega_+ \approx 2\omega_+, \quad \omega_- - \omega_+ = 2\Delta\omega$$

$$\varphi_a = \varphi_0 \sin(\omega_+ t)\sin(\Delta\omega t)$$

$$\varphi_b = \varphi_0 \cos(\omega_+ t)\cos(\Delta\omega t)$$

https://www.walter-fendt.de/html5/phen/coupledpendula_en.htm

$\varphi_a(t)$

$\phi_0 \sin(\Delta\omega t)$

t

$\varphi_b(t)$

t