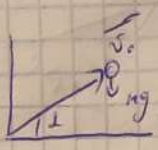
4 семинар

1.153

m, α

v_0

$\langle p \rangle, P(t) - ?$



$y_0 = y_k = 0 \Rightarrow \mathcal{E}_n^{нач} = \mathcal{E}_n^{кон} \Rightarrow A = 0 \Rightarrow$

$\Rightarrow \langle p \rangle = 0$

$P(t) = \bar{F}\bar{v} = m\bar{g}(\bar{v}_0 + \bar{g}t) =$

$= m\bar{g}\bar{v}_0 + mg^2 t = mg^2 t - mgv_0 \sin\alpha =$

$= mg(gt - v_0 \sin\alpha)$

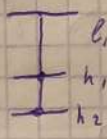
Ответ: $\langle p \rangle = 0 \quad P(t) = mg(gt - v_0 \sin\alpha)$

1.180

l, M, m

$\Delta x - ?$

$\mathcal{E}_1, \mathcal{E}_2 - ?$



$mg(l + \Delta x) = \frac{M\Delta x^2}{2}$

$\frac{M\Delta x^2}{2} - mg\Delta x - mgl = 0$

$\Delta x_{1,2} = \frac{mg \pm \sqrt{m^2g^2 + 2mglM}}{M}$

$\Delta x = \left(\frac{mg}{M}\left(1 + \sqrt{1 + \frac{2lM}{mg}}\right)\right)$

$mg = Mx_2 \Rightarrow x_2 = \frac{mg}{M}$

$\mathcal{E}_1 - \mathcal{E}_2 = \frac{x}{2} \cdot \frac{m^2g^2}{x^2}\left[\left(1 + \sqrt{1 + \frac{2Ml}{mg}}\right)^2 - 1\right] =$

$= \frac{m^2g^2}{2M}\left\{1 + \frac{2Ml}{mg}\right\} =$

$= \frac{m^2g^2}{2M} + mgl = \left(mgl\left(1 + \frac{m}{2M}\right)\right)$

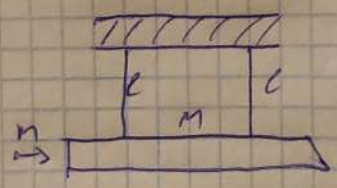
1.194

m, M, l

$m \ll M$

$u - ?$

$\eta - ?$



$mu = MV_R$

$V_{1c} = \frac{mv}{M+m}$

$\frac{M+m}{2} \cdot \frac{m^2u^2}{(M+m)^2} = (M+m)gl(1 - \cos\theta) =$

$= (M+m)gl \cdot 2\sin^2\frac{\theta}{2}$

$v^2 = \frac{(M+m)^2 gl \cdot 4\sin^2\frac{\theta}{2}}{m^2}; \quad v = \left(\frac{2(M+m)\sin\frac{\theta}{2}}{m}\sqrt{gl}\right)$

$\eta = \frac{\frac{mu^2}{2} - \frac{(M+m)}{2} \cdot \frac{m^2u^2}{(M+m)^2}}{\frac{mv^2}{2}} = \left(1 - \frac{m}{M+m}\right)$

1.211

m_1, v_1

m_2, v_2

$P_1 - ?$

$P_2 - ?$

$\mathcal{E}_к - ?$

1.310

ω_0

I_1, I_2

$E_1 - ?$

5 сем

3.27

$l = 0,1$

$k = 0,1$

$T - ?$

1.211

$m_1 \vec{v}_1$

$m_2 \vec{v}_2$

$p_1 - ?$

$p_2 - ?$

$\varepsilon_k - ?$

$$\vec{p}_1 = m_1 \left(\vec{v}_1 - \frac{m_1 \vec{v}_1 + m_2 \vec{v}_2}{m_1 + m_2} \right) = \frac{m_1 m_2 (\vec{v}_1 - \vec{v}_2)}{m_1 + m_2}$$

$$p_2 = m_2 \left(\vec{v}_2 + \frac{m_1 \vec{v}_1 + m_2 \vec{v}_2}{m_1 + m_2} \right) = \frac{m_1 m_2 (\vec{v}_2 - \vec{v}_1)}{m_1 + m_2}$$

$$|\vec{p}| = \mu \sqrt{v_2^2 + v_1^2}$$

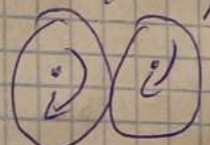
$$\varepsilon_k = \frac{p^2}{2m_1} + \frac{p^2}{2m_2} = \frac{p^2}{2\mu} = \frac{\mu (v_1^2 + v_2^2)}{2}$$

1.310 (б)

ω_0

I_1, I_2

$E_1 - ?$ $E_2 - ?$



$$\frac{J M_1}{\partial t} = -N = -F_{тр} R$$

$$\frac{J M_2}{\partial t} = -N = -F_{тр} R$$

$$\frac{J (M_1 - M_2)}{\partial t} = 0$$

$$I_1 \omega_R + I_2 \omega_R = I_1 \omega_0 - I_2 \omega_0$$

$$\omega_R = \omega_0 \frac{I_1 - I_2}{I_1 + I_2}$$

$$\varepsilon_1 - \varepsilon_2 = \frac{I_1 + I_2}{2} \omega_0^2 - \frac{I_1 + I_2}{2} \omega_R^2 = \frac{\omega_0^2}{2(I_1 - I_2)} \cdot (4 I_1 I_2) =$$

$$= \frac{2 \omega_0^2 I_1 I_2}{I_1 + I_2}$$

5 семинар.

3.27

$l = 0{,}2$

$k = 0{,}1$

$T - ?$

$$\begin{cases} N_2 l_2 = N_1 l_1 \ (1) \\ N_1 + N_2 = mg \end{cases} \qquad l_1 + l_2 = l$$

$$ma = k N_2 + k N_1$$

$$N_2 l_2 = N_1 (l - l_2)$$

$$N_1 + \frac{N_1 (l - l_2)}{l_2} = mg$$

$$N_1 + N_1 \frac{l}{l_2} - N_1 = mg$$

$$\begin{cases} N_1 = mg \frac{l_2}{l} \\ N_2 = mg \left(1 - \frac{l_2}{l}\right) = mg \frac{l_1}{l} \end{cases}$$

$$ma = k\Delta\ell \qquad \Delta\ell = \ell_2 - \ell_1$$

$$\ddot{x} = kg\,\frac{\ell - x - x}{\ell} \qquad a = kg\,\frac{\ell_2 - \ell_1}{\ell}$$

$$\ddot{x} = kg - \frac{2kg}{\ell}x \qquad \ell_2 = \ell - x$$

$$\ell_1 = x$$

$$\ddot{x} = \frac{2kg}{\ell}x = kg$$

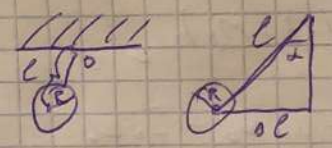
$$x_0 = \frac{\ell}{2}$$

$$T = \frac{2\pi}{\omega_0} = \frac{2\pi}{\sqrt{\frac{2kg}{\ell}}} = \pi\sqrt{\frac{2\ell}{kg}} = 1{,}5\ell$$

3.64

R, ℓ

$\frac{T}{T_0} - ?$



$$\frac{\Delta\ell}{\ell} = \operatorname{tg}\alpha$$

$$\Delta\ell \sim \ell\alpha$$

$$v = \ell\dot{\alpha}$$

$$\frac{mv^2}{2} + mg\ell(1-\cos\alpha) = 0 \qquad m\dot{v}\ell = mg\ell\sin\alpha$$

$$\ell^2\dot{\alpha}^2 + 2g\ell\cdot 2\sin^2\frac{\alpha}{2} = 0 \qquad \dot{v} + g\sin\alpha = 0$$

$$\omega_0^2 = \frac{mg\ell}{I} = \frac{g}{\ell} \qquad \ell\ddot{\alpha} + g\sin\alpha = 0$$

$$\ddot{\alpha}^2 + \frac{g}{\ell}\alpha^2 = 0$$

$$2\dot{\alpha}\ddot{\alpha} + 2\alpha\frac{g}{\ell}\dot{\alpha} = 0$$

$$I = \frac{2}{5}mR^2 + m\ell^2$$

$$\omega_0 = \sqrt{\frac{mg\ell}{\ell\left(\frac{2}{5}mR^2 + m\ell^2\right)}} = \sqrt{\frac{g}{\ell}}\cdot\frac{1}{\frac{2}{5}\frac{R^2}{\ell^2} + 1}$$

$$\omega_0' = \sqrt{\frac{mg\ell}{I}} = \sqrt{\frac{mg\ell}{m\ell^2 + \frac{1}{5}mR^2}} = \sqrt{\frac{g}{\ell\left(1 + \frac{2R^2}{5\ell^2}\right)}}$$

$$\frac{T'}{T_0} = \frac{\omega_0}{\omega'} = \sqrt{1 + \frac{2R^2}{5\ell^2}}$$

3.15

$l = 0{,}1\ м$

$\lambda = 0{,}02$

$\xi - ?$

$x = a_0 e^{-\beta t} \cos(\omega t + \alpha)$ $\quad \lambda = \beta T$

$\xi = l + 2le^{-\frac{\beta}{2}} + 2le^{-\frac{\beta}{2}} \cdot e^{-\frac{\beta}{2}} + \dots =$

$= l + 2l\left(e^{-\frac{\lambda}{2}} + e^{-\frac{\lambda}{2}} \cdot e^{-\frac{\lambda}{2}} + \dots\right)$

$x \cdot e^{-\frac{\lambda}{2}} \cdot x = e^{-\frac{\lambda}{2}} \cdot e^{-\frac{\lambda}{2}} \cdot x_M$

$x = \frac{e^{-\frac{\lambda}{2}}}{1 - e^{-\frac{\lambda}{2}}}$

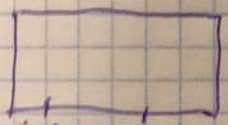
$\xi = l + 2l\frac{e^{-\frac{\lambda}{2}}}{1 - e^{-\frac{\lambda}{2}}} = e\frac{1 + e^{-\frac{\lambda}{2}}}{1 - e^{-\frac{\lambda}{2}}} = 2м$

3.186

$\xi = a\cos(\omega t - kx)$

$t = 0$

$\begin{cases} \xi = a\cos(\omega t - kx) \\ \xi'_x = ak\sin(\omega t - kx) \\ \xi'_t = -a\omega\sin(\omega t - kx) \end{cases}$



$t = 0$ $\begin{cases} \xi = a\cos kx \\ \xi'_x = -ak\sin kx \\ \xi'_t = a\omega\sin kx \end{cases}$

$\rho_0 = \frac{e}{\Delta x}$

$\rho' = \frac{e}{\Delta x + \Delta\xi}$

$\rho'' = \frac{e}{\Delta x(1 + \frac{\Delta\xi}{\Delta x})} = \frac{\rho_0}{1 + \frac{\partial\xi}{\partial x}}$

$\rho'' = \rho_0\left(1 - \frac{\partial\xi}{\partial x}\right)$