Часть 1

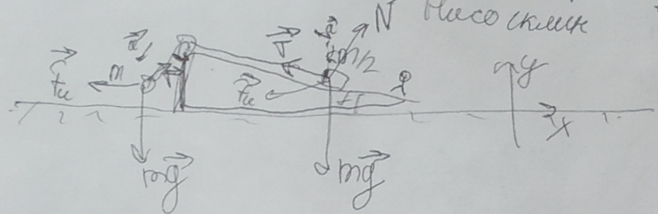
Олимпиада: **Физика, 11 класс (1 часть)**

Шифр: **21200433**

ID профиля: **282024**

Вариант 7

Черновик



$\cancel{\vec{T} + m\vec{g} + m\vec{a}_{кл} = m\vec{a}_{бк}}$

$\frac{m}{2}\vec{g} + \frac{m}{2}\vec{a}_{кл} = \frac{m}{2}$

$\vec{a}_{1,Ho} = \vec{a}_{1,по} + \vec{a}_{перенос}$

$mg - T\cos\beta = ma_{бк}\cos\beta$

$ma_{кл} - T\sin\beta = ma_{бк}\sin\beta$

$mg - ma_{бк}\cos\beta = T\cos\beta$

$ma_{кл} - ma_{бк}\sin\beta = T\sin\beta$

$tg\beta = \frac{a_{кл} - a_{бк}\sin\beta}{g - a_{бк}\cos\beta}$

$a_{кл} - a_{бк}\sin\beta = g\,tg\beta - a_{бк}\sin\beta$

$a_{кл} = g\,tg\beta$

$a_{бк} = \frac{mg - \frac{m(a_{кл} - tg\alpha\, g)\cos\alpha\cos\beta}{2(2\cos^2\alpha - 1)}}{m\cos\beta}$

$a_{бк} = \frac{g}{\cos\beta} - \frac{g(tg\beta - tg\alpha)\cos\alpha\cancel{\cos\beta}}{2(2\cos^2\alpha - 1)}$

$m g - T\sin\alpha - N\cos\alpha = m/2\, a_{бк}\sin\alpha$

$m/2\, a_{кл} + T\cos\alpha - N\sin\alpha = m/2\, a_{бк}\cos\alpha$

$N\cos\alpha = m/2\, g - T\sin\alpha - m/2\, a_{бк}\sin\alpha$

$N\sin\alpha = m/2\, a_{кл} + T\cos\alpha - m/2\, a_{бк}\cancel{\sin\alpha}\cos\alpha$

$tg\alpha = \frac{m/2\, a_{кл} - m/2\, a_{бк}\sin\alpha + T\cos\alpha}{g}$

$m/2\, a_{кл} - m/2\, a_{бк}\sin\alpha + T\cos\alpha = tg\alpha(m/2\, g - m/2\, a_{бк}\cos\alpha - T\sin\alpha)$

$m/2(a_{кл} - tg\alpha\, g) + T(\cos\alpha - tg\alpha\sin\alpha) = m/2\, a_{бк}(\sin\alpha - \sin\alpha)$

$m/2(a_{кл} - tg\alpha\, g) = T\left(\frac{\cos^2\alpha - \sin^2\alpha}{\cos\alpha}\right) = T\left(\frac{2\cos^2\alpha - 1}{\cos\alpha}\right)$

$a_{кл} = \frac{2T(2\cos^2\alpha - 1)}{m\cos\alpha} + tg\alpha\, g$

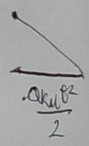
$T = \frac{m(a_{кл} - tg\alpha\, g)\cos\alpha}{2(2\cos^2\alpha - 1)}$

$\frac{4}{3} - \frac{12}{5} = \frac{20 - 36}{15} = -\frac{16}{15}\cdot\frac{5\cdot 3}{5\cdot 13} = \frac{16}{65} + 2 = \frac{146}{65}\cdot\frac{5}{3} = \frac{146}{13\cdot 3} = \frac{146}{13\cdot 9}$

$S = \frac{H}{\cos\beta}$

$S = \frac{at^2}{2}$

$t = \sqrt{\frac{2H}{a\cos\beta}}$



$\frac{a_{кл}t^2}{2}$

$\cos^2\alpha + \sin^2\alpha = 1$

$1 + tg^2\alpha = \frac{1}{\cos^2\alpha}$

$tg\alpha = \sqrt{\frac{1}{\cos^2\alpha} - 1}$

проекция $a_y = a\cos\beta$

$H = \frac{a\cos\beta\, t^2}{2}$

$13 \times 9 = 117$

$13 \times 9 = 117$, $117 : 3 = 39$

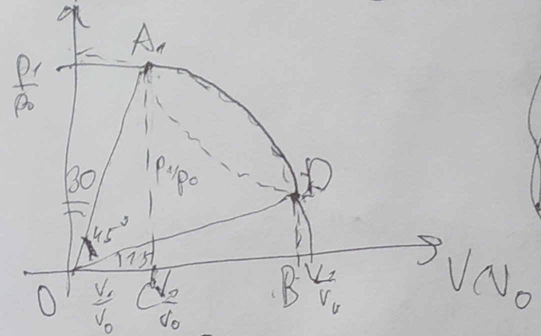
$39 \times 5 = 195$

21200433 (U282024 M1264125)

$S_{сект} = \frac{\pi R^2}{360} \cdot \alpha$

Черновик

$p_0 V_0 = \nu R T_0$



$p_1 V_1 = \nu R T_1$

$p_2 V_2 = \nu R T_2$

$Q_{12} = A_{12} + \frac{3}{2}\nu R(T_2 - T_1) = \cancel{C\mu\nu(T_2-T_1)}$ x

$A_{21} = -\frac{3}{2}\nu R(T_2 - T_1) = \frac{3}{2}\nu R(T_1 - T_2)$

$\eta = \frac{A_{12} - A_{21}}{A_{12}}$

$A_{12} = \cancel{S_{A_1OD}} \cdot S_{A_1OD} + S_{ODB} - S_{A_1OC}$

$R^2 = \frac{p_1^2}{p_0^2} + \frac{V_1^2}{V_0^2} = \frac{p_2^2}{p_0^2} + \frac{V_2^2}{V_0^2}$

$A_{12} = \frac{\pi R^2}{8} + \frac{1}{2}\frac{p_2}{p_0} \cdot \frac{V_2}{V_0} - \frac{1}{2}\frac{p_1 V_1}{p_0 V_0}$

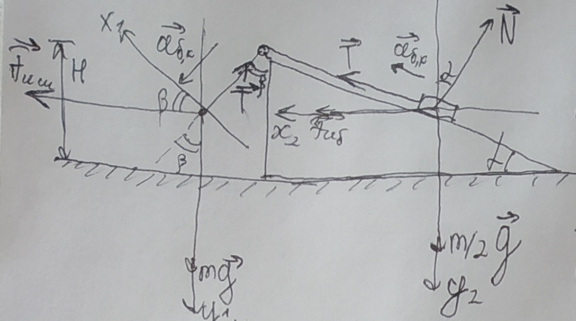
$A_{12} - Q_{12} = A_{21}$

$A_{12} = \frac{\pi}{8}\left(\frac{\cancel{V_1}}{p_0 \cancel{\cos 30^\circ} \sin 30^\circ}\right)^2 + \frac{1}{2}\frac{T_2}{T_0} - \frac{1}{2}\frac{T_1}{T_0}$

$\frac{\pi}{2} \frac{V_1^2}{V_0^2}$ 4

Чистовик

№ 1



Перейдём в неинерциальную систему отсчёта, связанную с клином. В ней клин покоится, ко всем остальным телам приложена сила инерции $F_и = Ma_{кл}$

Т.к. нить нерастяжима, ускорения бруска и шарика равны по модулю.

II закон Ньютона для шарика: $\vec{F}_{иш} + m\vec{g} + \vec{T} = m\vec{a}_{б,к}$

$$(x_1): F_{иш}\cos\beta = mg\sin\beta$$

$$ma_{кл}\cos\beta = mg\sin\beta$$

$$a_{кл} = g\,tg\,\beta.$$

II закон Ньютона для бруска: $\vec{F}_{иб} + \frac{m}{2}\vec{g} + \vec{T} + \vec{N} = m\vec{a}_{б,к}$

$$\begin{cases}(x_2): \frac{m}{2}a_{кл} + T\cos\alpha - N\sin\alpha = \frac{m}{2}a_{б,к}\cancel{\sin\alpha}\cos\alpha \\ (y_2): \frac{m}{2}g - T\sin\alpha - N\cos\alpha = -\frac{m}{2}a_{б,к}\cancel{\cos\alpha}\sin\alpha\end{cases}$$

$$\begin{cases}N\sin\alpha = \frac{m}{2}a_{кл} \cancel{+\frac{m}{2}a_{б,к}\frac{\sin\alpha\cos\alpha}{\sin\alpha} + T\cos\alpha} + T\cos\alpha - \frac{m}{2}a_{б,к}\cos\alpha \\ N\cos\alpha = \frac{m}{2}g + \frac{m}{2}a_{б,к}\sin\alpha - T\sin\alpha\end{cases}$$

$$tg\,\alpha = \frac{\frac{m}{2}a_{кл} + \frac{m}{2}a_{б,к}\cos\alpha + T\cos\alpha}{\frac{m}{2}g + \frac{m}{2}a_{б,к}\sin\alpha - T\sin\alpha}$$

$$\frac{m}{2}a_{кл} - \frac{m}{2}a_{б,к}\cos\alpha + T\cos\alpha = \frac{m}{2}g\,tg\,\alpha + \frac{m}{2}a_{б,к}\,tg\,\alpha\sin\alpha - T\sin\alpha\,tg\,\alpha$$

$$T(\cos\alpha + \sin\alpha\,tg\,\alpha) = \frac{m}{2}(g\,tg\,\alpha - a_{кл}) + \frac{m}{2}a_{б,к}(\cos\alpha + tg\,\alpha\sin\alpha)$$

$$T = \frac{m}{2}a_{б,к} + \frac{m(g\,tg\,\alpha - a_{кл})}{2(\cos\alpha + \sin\alpha\,tg\,\alpha)}$$

II закон Ньютона для шарика, (y_1): $mg - T\cos\beta = ma_{б,к}\cos\beta$

$$mg - \frac{m}{2}a_{б,к}\cos\beta - \frac{mg(tg\,\alpha - tg\,\beta)\cos\beta}{2(\cos\alpha + \sin\alpha\,tg\,\alpha)} = ma_{б,к}\cos\beta$$

$$\frac{3}{2}ma_{б,к}\cos\beta = mg\left(1 - \frac{(tg\,\alpha - tg\,\beta)\cos\beta}{2\left(\cos\alpha + \frac{\sin^2\alpha}{\cos\alpha}\right)}\right)$$

$$a_{б,к} = \frac{mg\left(1 - \frac{(tg\,\alpha - tg\,\beta)\cos\alpha\cos\beta}{2}\right)}{\frac{3}{2}m\cos\beta}$$

(см. стр. 2)

Чистовик

№1 (продолж.)

$$tg^2\alpha + 1 = \frac{1}{\cos^2\alpha}; \quad tg\,\alpha = \sqrt{\frac{1}{\cos^2\alpha} - 1}$$

$$tg\,\alpha = \sqrt{\frac{1}{\frac{9}{25}} - 1} = \frac{4}{3}$$

$$tg\,\beta = \sqrt{\frac{1}{\frac{25}{169}} - 1} = \frac{12}{5}$$

$$a_{\delta,\kappa} = g\,\frac{(2 - (tg\,\alpha - tg\,\beta)\cos\alpha\cos\beta)}{3\cos\beta}$$

$$a_{\delta,\kappa} = \frac{146}{117}g$$

$$a_{\kappa\mu} = g\,tg\,\beta = \frac{12}{5}g$$

$$H = \frac{a_{\delta,\kappa}\cos\beta\, t^2}{2}$$

$$t = \sqrt{\frac{2H}{a_{\delta,\kappa}\cdot\cos\beta}}$$

$$t = \sqrt{\frac{2H}{\frac{73}{39}\cdot\frac{1}{5}g}} = \sqrt{\frac{195}{73}\frac{H}{g}}$$

Ответ: 1) $\frac{12}{5}g$;

2) $\frac{146}{117}g$;

3) $\sqrt{\frac{195}{73}\frac{H}{g}}$.

2

21200433 (U282024 M1264125)

Часть 2

Олимпиада: **Физика, 11 класс (2 часть)**

Шифр: **21200433**

ID профиля: **282024**

Вариант 7

Черновик

$\mathcal{E}_i = \frac{BS}{\cancel{\Delta t}\,\Delta t} = \varphi'$

$\frac{S'}{\Delta t} = \frac{\ell' d}{\Delta t} = \frac{d \cdot (v_0 \Delta t)'}{\Delta t} = d \cdot t \cdot v' = d \cdot t \cdot a$

~~$\mathcal{E}_i = B \cdot d \cdot t \cdot a$~~ $\frac{S_0}{\Delta t}$ $d \cdot v_0$

$\mathcal{E}_{i_0} = B d v_0$

$S' = \ell' d =$

$y_0 = \frac{B d v_0}{R};$

$\mathcal{E}(t) = \frac{-BS'}{t} = \frac{B \cdot d \cdot \ell'}{t}$

$S(t) = \ell(t) d$

$F = B^2 \frac{d^2 v_0}{R}$

$a_0 = \frac{B^2 d^2 v_0}{mR}$

$y(t) = \frac{-BS'}{t \cdot R} = \frac{B d \ell'}{tR}$

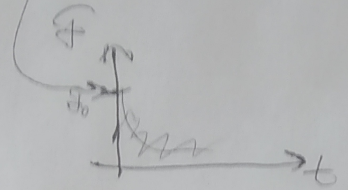
$F = B y \ell$

$F(t) = B^2 \frac{d^2 v(t)}{R}$

$F(t) = \frac{B^2 d^2}{tR} \ell'$

$t \to 0$

$\ell \to v_0 t$



$a(t) = \frac{B^2 d^2}{tRm} \ell'$

$\ell = \int v(t)\,dt$

$a(t) = \frac{B^2 d^2}{Rm} \ell'(t) = v'(t)$

$v_2: \quad v_2 = v_0 - 2(v_0 - v_1) - 0 =$

$= 2v_1 - v_0$

$\Delta v = \int a(t)\,dt =$

$v(\ell) = \int a(\ell)\,d\ell = \frac{B^2 d^2}{RM} \int \ell'(t)\,d\ell = \frac{B^2 d^3}{RM} \ell$

$v = v_0 + \Delta v(\ell)$

$\ell = H \to \Delta v_1$

$v_1 = v_0 - \Delta v_1$

$v = \int a(t) = -\frac{B^2 d^2 \ell(t)}{RM} + C$

$v_2 = v_0 - 2\Delta v_1$

$S = \ell' d$

$S = v_0 t$

$\mathcal{E}_i = B \ell' d$

$v(0) = v_0$

$a(t) = \frac{B^2 d^2}{Rm} v(t)$

$v = 3t \quad a = 3$

$y = \frac{B\ell' d}{R}$

$\ell(0) = 0$

$C = v_0$

~~$S = 3t^2$~~ $S = \frac{3}{2} t^2 + C$

$F = \frac{B^2 d^2}{R} \ell'$

$v = v_0 - \frac{B^2 d^2 \ell}{Rm}$

$a = \frac{B^2 d^2}{mR} \ell' = \frac{B^2 d^2}{mR} v(t), \quad v(0) = v_0 = 0$

$\ell = H \quad \ell' = 0 \quad a = 0$

$v(t) = v_0 - X$

$v = 0 \quad v =$

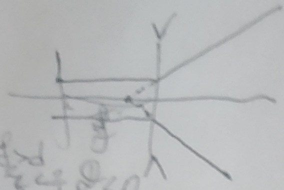
$v_0 = X$

21200433 (U282024 M1264126)

Черновик

$D_1 \quad f = \infty$

$D_2 \quad f = 25$ см



$\frac{1}{f} - \frac{1}{d} = \frac{1}{D}$

$\frac{1}{f} + \frac{1}{d_0} = D_2 + D_0$

$\frac{1}{\infty} + \frac{1}{d_0} = D_1 + D_0$

$D_1 = \frac{1}{d_0} - D_0$

$D_2 - \frac{1}{f} = D_1$

$D_2 - D_1 = 4$

$\frac{D_1}{D_2} = 3 \quad \Rightarrow D_2 = 4 \quad D_2 = 6$

$D_1 = 2$

$\frac{1}{f} + \frac{1}{d_0} = D_0 + D_2$

$\frac{1}{d_0} = D_0 - D_1$

$-\frac{1}{f} - D_2 = -D_1$

$\frac{1}{f} = D_1 - D_2$

$4 = D_2 - D_1$

$4 + \frac{1}{d_0} = 6 + D_0$

$4 + 6 = D_0 - \frac{1}{d_0} = 10$

$\frac{1}{x} + \frac{1}{d_0} = D_0$

$\frac{1}{x} = 10$

$x = \frac{1}{10} = 10$ см

$\frac{1}{d_0} = 2 + D_0$

без очков: $\frac{1}{x} + \frac{1}{d_0} = D_0$

$\frac{1}{d_0} - D_0 = 2$

$D_0 = \frac{1}{d_0} - 2$

$\frac{1}{X} = -2$

$\frac{1}{f_2} + \frac{1}{d_0} = D_3 + D_0$

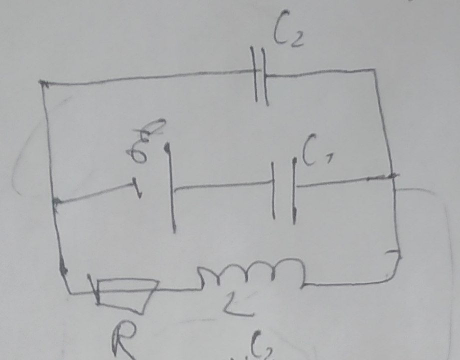
$\frac{1}{f_2} + \frac{1}{d_0} = D_x + D_0$

$D_x = 2 + 2 = 4$

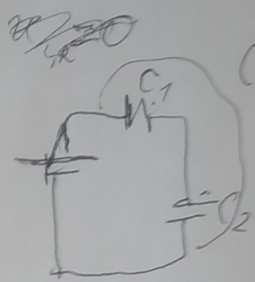
$D_3 = -10 + \frac{1}{\frac{1}{2}} =$

$= -8$

Черновик



$\mathcal{E}_{si} = L I'(t)$



$C_1 = C, C_2 = 4C$

$C_{посл} = \frac{C_1 C_2}{C_1 + C_2} = \frac{4C^2}{5C} = \frac{4}{5}C, \ U = \mathcal{E}$

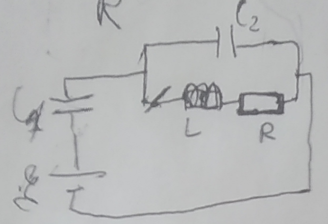
$q_{общ} = \frac{4}{5}C\mathcal{E}$

$U_{общ} = \mathcal{E}$

$q_1 = q_2$

$U_1 = \frac{\frac{4}{5}C\mathcal{E}}{C} = \frac{4\mathcal{E}}{5}$

$U_2 = \frac{\frac{4}{5}C\mathcal{E}}{4C} = \frac{\mathcal{E}}{5}$



$\cancel{\mathcal{E}_{si}} + IR = \frac{\mathcal{E}}{5}$

$\cancel{\ldots} + \frac{\mathcal{E}}{5}, \ I = 0 \quad \mathcal{E}_{si} = \frac{\mathcal{E}}{5}. \quad I' = \frac{\mathcal{E}}{5L}$

$I = \frac{\Delta q}{\Delta t} = \quad \Delta q = I_{cp} t$

$t = \frac{\mathcal{E}}{5 I_{max}} ?$

Уст. режим $\mathcal{E}_L = U_L = 0$

$q\mathcal{E} = \frac{(q_1^2 - q_0^2)}{2C} + \frac{5(q_2^2 - q_0^2)}{8C} + \frac{LI_c^2}{2} + I_c^2 R t + Q$

$= I_c R \cdot q$

$\mathcal{E} = \frac{q_1}{C} + \frac{q_2}{4C}$

$\mathcal{E} = \frac{q_1}{C} + LI' + IR$

$I_{max}: \ \mathcal{E}_L = 0 \quad IR = \frac{\mathcal{E}}{5} \quad I = \frac{\mathcal{E}}{5R}$

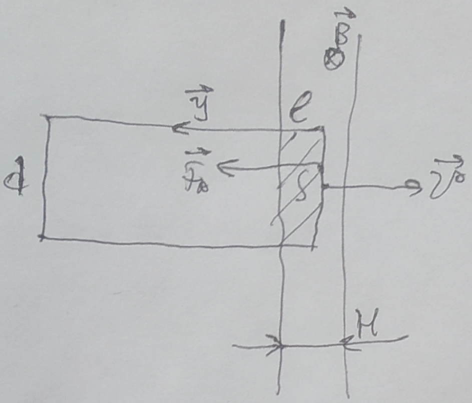
$\cancel{q\mathcal{E} = \frac{L\mathcal{E}^2}{50R^2} + \frac{\mathcal{E}}{5}q} + Q$

$\cancel{Q = q\mathcal{E} - \frac{L\mathcal{E}^2}{50R^2}}$

Чистовик

№4

Вариант 11-07



$\mathcal{E}_i = -BS'(t) = -Bd\,\ell'(t)$

$I(t) = \frac{\mathcal{E}_i}{R} = \frac{-Bd\,\ell'(t)}{R}$

$F(t) = -\frac{B^2d^2\ell'(t)}{R}$ $\qquad (F_A = BId)$

$a(t) = -\frac{B^2d^2\ell'(t)}{mR}$

$t \to 0 \quad \ell'(t) \to v_0$

$|a_0(0)| = \frac{B^2d^2v_0}{mR}$

$v(t) = \int a(t)\,dt = -\frac{B^2d^2}{mR}\int \ell'(t)\,dt = -\frac{B^2d^2}{mR}\ell(t) + C$

$\ell(0) = 0,\ v(0) = v_0 \Rightarrow C = v_0$

$v(\ell) = -\frac{B^2d^2}{mR}\ell + v_0$

$v_1 = v\left(\frac{d}{5}\right) = v_0 - \frac{B^2d^3}{5mR}$

При $\frac{d}{5} < \ell < \cancel{\frac{4}{5}}\, 3d - \frac{d}{5}$ S не изменяется, индукции нет, v не изменяется

При $3d > \ell > 3d - \frac{d}{5}$ рамка тормозит аналогично.

$v_2 = v_0 - 2\cdot\frac{B^2d^3}{5mR}$

1

Ответ: 1) $\frac{B^2d^2v_0}{mR}$; 2) $v_0 - \frac{B^2d^3}{5mR}$; 3) $v_0 - \frac{2B^2d^3}{5mR}$

Чистовик

Вариант 11-07

№5

D_1 - очки на даль ($f \to \infty$)

D_2 - очки на $f_1 = 0,25$ м

d_0 - расстояние от очков до сетчатки

D_0 - собственная опт. сила глаза

$$\boxed{\frac{1}{f} + \frac{1}{d} = D}$$

$$\begin{cases} \cancel{\frac{1}{\infty}}^{\to 0} + \frac{1}{d_0} = D_1 + D_0 \quad (1) \\ \frac{1}{f_1} + \frac{1}{d_0} = D_2 + D_0 \quad (2) \end{cases}$$

$$D_2 - D_1 = \frac{1}{f_1}$$

Чем ближе предмет, тем слабее нужны очки; $D_1 = 3D_2$

$$-2D_2 = \frac{1}{f_1} = \cancel{4}$$

$$D_2 = -2 \text{ дптр}$$

$$D_1 = -6 \text{ дптр}$$

Без очков: $\frac{1}{x} + \frac{1}{d_0} = \cancel{\frac{1}{d_0}} D_0$; из (1) и (2) $D_0 - \frac{1}{d_0} = -D_1$

$$\frac{1}{x} = -D_1$$

$$x = \frac{1}{6} \text{ м}$$

$f_2 = 0,5$ м: $\frac{1}{f_2} + \frac{1}{d_0} = D_x + D_0$

$$D_x = -D_0 + \frac{1}{d_0} - \frac{1}{f_2}$$

$$D_x = -6 - 2 = -8 \text{ дптр}$$

Ответ: 1) $\frac{1}{6}$ м; -6 дптр; 2) -8 дптр.

2