Часть 1

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

Шифр: **21202961**

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Вариант 3

Вариант: 11-03 Чистовик Страница №1

Этап №1

Задача №2

① $dQ = C(T)\cdot \nu\, dT = 3R\,\frac{T}{T_0}\,\nu\cdot dT$

Теплота переданная газу $\rightarrow$ $Q = \int\limits_{T_0}^{\frac{3}{5}T_0} \frac{3R\nu}{T_0}\, T\,dT = \frac{3R\nu}{T_0}\,\frac{T^2}{2}\Big|_{T_0}^{\frac{3}{5}T_0} =$

$= -\frac{3R\nu}{2T_0}\cdot\left(T_0^2 - \left(\frac{3}{5}\right)^2 T_0^2\right) =$

$= -\frac{3R\nu}{2}\cdot T_0\left(\frac{25-9}{25}\right) = -\frac{3\cdot 8}{25}\,R\nu T_0 =$

$= -\frac{24}{25}\,\nu R T_0 = -Q_1$

②

$Q = \frac{3\nu R}{2T_0}\cdot\left(T_x^2 - T_0^2\right)$

$\Delta U = \frac{3}{2}\nu R\,\Delta T = \frac{3}{2}\nu R\,(T_x - T_0)$ $\Leftarrow$ степ свободы $= 3$

$A = Q - \Delta U = \frac{3\nu R}{2}\cdot\frac{T_x^2 - T_0^2}{T_0} - \frac{3}{2}\nu R\,(T_x - T_0) =$

~~Работа газа над газом $\Rightarrow A_1 = -A$ работа газа~~

$A - \min \Leftrightarrow \frac{dA}{dT_x} = 0$

$\frac{dA}{dT_x} = \frac{3}{2}\nu R\cdot\frac{2T_x}{T_0} - \frac{3}{2}\nu R = 0$

$\frac{2T_x}{T_0} = 1 \Leftrightarrow T_x = \frac{T_0}{2} \Leftrightarrow T_{min}$

③ $A = \frac{3\nu R}{2}\cdot\frac{\frac{T_0^2}{4} - T_0^2}{T_0} - \frac{3}{2}\nu R\left(\frac{T_0}{2} - T_0\right) =$

$= \frac{3}{2}\nu R\left(\frac{T_0}{4} - T_0 - \left(\frac{T_0}{2} - T_0\right)\right) = -\frac{1}{4}\cdot\frac{3}{2}\nu R T_0$

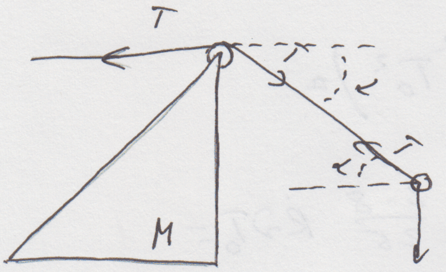
Вариант: 11-03   Чистовик

Этап №1

$A = -\frac{3}{8}\nu RT_0 \leftarrow$ min работа совершенная газом

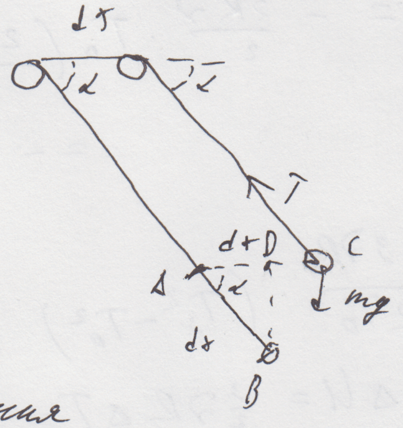
Ответы: 1) $Q_1 = \frac{24}{25}\nu RT_0$ 2) $T_{min} = \frac{T_0}{2}$ 3) $A_{min} = -\frac{3}{8}\nu RT_0$

Задача №2



} из нач. момента времени клин сдвинется на dx

$\Downarrow$



нить за клином удлинится на dx т.е. добавится кусок AB

$DC = dx - dx \cdot \cos\alpha$

$DB = dx \sin\alpha$

изменения координат шара

$DC = \underbrace{\frac{T\cos\alpha}{m}}_{a} \cdot \frac{dt^2}{2} \leftarrow$ время за кот. все произошло

$DB = \frac{g - \frac{T\sin\alpha}{m}}{2} dt^2$ кин. уравнение ускоренного движения $\Delta x = vt + \frac{at^2}{2}$

Для произвол момента времени

$\sin\alpha \cdot dx = \underset{\parallel}{v_y} dt + \frac{(g - \frac{T\sin\alpha}{2}) dt^2}{2}$

$(g - \frac{T\sin\alpha}{2}) t$

$\underbrace{\sin\alpha \frac{dx}{dt}}_{v_y} = (g - \frac{T\sin\alpha}{2})\cancel{dt} + (g - \frac{T\sin\alpha}{2})\frac{dt}{2}$

$\Updownarrow$

$0 = (g - \frac{T\sin\alpha}{2})\frac{dt}{2}$

$dt \to 0 \Rightarrow$ ур-е верное

$dx(-\cos\alpha + 1) \Leftrightarrow v_x dt + \frac{T\cos\alpha}{2m} dt^2$

$\frac{dx}{dt}(1 - \cos\alpha) = \cancel{v_x} + \frac{T\cos\alpha}{2m} dt$

$\frac{T\cos\alpha}{2m} dt = 0$ аналогично ур-е верное

$$dx(1-\cos\alpha) = DC = \frac{T\cos\alpha}{m}\frac{dt^2}{2} \Leftrightarrow dx\cdot\frac{8}{13} = \frac{T}{m}dt^2\cdot\frac{5}{26}$$

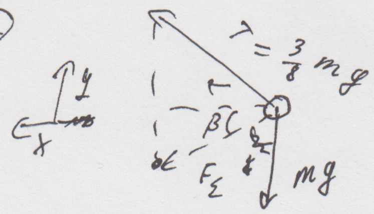
$$dx\sin\alpha = DB = \frac{g - \frac{T\sin\alpha}{m}}{2}dt^2 \qquad dx = \frac{5}{16}\frac{T}{m}dt^2$$

$$dx\sin\alpha = \frac{5}{16}\frac{T}{m}dt^2\cdot\sqrt{1-\frac{5^2}{13^2}} = \frac{5}{16}\cdot\frac{12}{13}\frac{T}{m}dt^2 = \frac{g}{2}dt^2 - \frac{T\frac{12}{13}}{2m}dt^2$$

$$\frac{T}{m}\left(\frac{5}{16}\cdot\frac{12}{13}+\frac{6}{13}\right) = \frac{g}{2}$$

$$T = \frac{mg}{2}\cdot\frac{156}{208} = \frac{12}{16}\cdot\frac{1}{2}\cdot mg = \frac{3}{8}mg$$

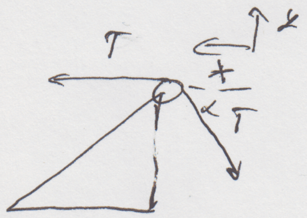
①



$$tg\beta = \frac{F_{\Sigma y}}{F_{\Sigma x}} \qquad F_{\Sigma y} = mg - T\sin\alpha$$
$$F_{\Sigma x} = T\cos\alpha$$

$$tg\beta = \frac{mg - \frac{12}{13}\cdot\frac{3}{8}mg}{\frac{3}{8}\cdot\frac{5}{13}mg} = \frac{8\cdot 13 - 12\cdot 3}{3\cdot 5} = \frac{68}{15}$$

②



по оси y все силы "гасятся" силой реакции опоры т.к. клин по вертикали не движется

$$Ma = T - T\cos\alpha = T(1-\cos\alpha)$$

так же

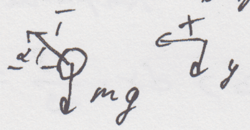
$$dx = \frac{adt^2}{2} = \frac{5}{16}\frac{T}{m}dt^2$$

$$a = \frac{5}{8}\frac{T}{m} = \frac{5}{8}\cdot\frac{3}{8}g = \frac{15}{64}g$$

③ $$M\cdot a = M\cdot\frac{15}{64}g = \frac{3}{8}mg\left(1-\frac{5}{13}\right) = \frac{3}{8}\cdot\frac{8}{13}mg$$

$$\frac{M}{m} = \frac{\frac{15}{64}g}{\frac{3}{13}g} = \frac{5\cdot 13}{64} = \frac{65}{64}$$

(4)



$$a_y = -\frac{T\sin\alpha}{m} + g = g\left(1 - \frac{3}{8}\cdot\frac{12}{13}\right) = \frac{68}{104}g$$

$$H = \frac{a_y t^2}{2} \qquad t = \sqrt{\frac{2H}{a_y}} = \sqrt{\frac{104H}{34g}} =$$

$$= \sqrt{\frac{52H}{17g}}$$

Ответы: 1) $\operatorname{tg}\beta = \frac{68}{15}$ 2) $a_{клин} = \frac{15}{64}g \approx 2.34375\ \frac{м}{с^2}$

3) $\frac{m}{M} = \frac{65}{64}$ 4) $t = \sqrt{\frac{52}{17}\cdot\frac{H}{g}}$

$$dx\sqrt{\frac{13^2-25}{13^2}} = dx\,\frac{12}{13} = \frac{g}{2m}dt^2 - \frac{T\,6}{13m}dt^2$$

$$dx = \frac{T}{m}dt^2\,\frac{5}{16}$$

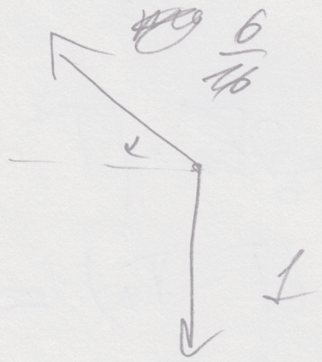
$$\cancel{d}\ \frac{T}{m}\cancel{dt^2}\cdot\frac{5}{16}\cdot\frac{12}{13} = \frac{g}{2\cancel{m}}\cancel{dt^2} - \frac{T\,6}{13\cancel{m}}\cancel{dt^2}$$

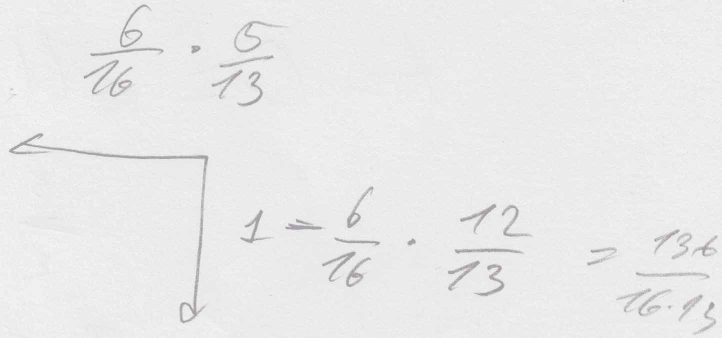
$$T\cdot\frac{5\cdot 12}{16\cdot 13} = \frac{g}{2} - T\,\frac{6}{13}$$

$$T = \frac{mg}{2}\left(\frac{5\cdot 12}{16\cdot 13}+\frac{6}{13}\right)^{-1}$$

$$\frac{60}{16\cdot 13}+\frac{16\cdot 6}{16\cdot 13} \qquad \frac{156}{16\cdot 13}$$

$$T = mg\,\frac{6}{16} \qquad \frac{12}{16}$$





$$c = 3R\frac{T}{T_0} \qquad T_0 \to \frac{3}{5}T_0$$

$$dQ = 3R\frac{T}{T_0}\nu\, dT = \frac{3R\nu}{T_0}\, T\, dT$$

$$Q = \frac{3R\nu}{T_0}\int_{T_0}^{\frac{3}{5}T_0} T\, dT =$$

$$= \frac{3R\nu}{T_0}\,\frac{T^2}{2}\Bigg|_{T_0}^{\frac{3}{5}T_0} =$$

$$= 3R\nu T_0 \cdot \left(\frac{\frac{9}{25}-1}{2}\right) =$$

$$= 3R\nu T_0\,\frac{9-25}{50} = \qquad 16$$

$$= -3R\nu T_0\,\frac{8}{25} = -\frac{24}{25}\nu R T_0$$

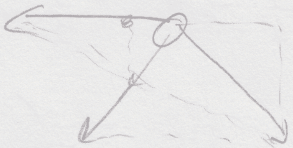
$$A = Q - \Delta U = \frac{3R}{2T_0}\nu \cdot \left(T^2 - T_0^2\right) - \frac{3}{2}\nu R\,(T - T_0) =$$

$$= \frac{3}{2}\nu R\left(\frac{(T^2 - T_0^2)}{T_0} - (T - T_0)\right) =$$

$$\cancel{= \frac{3}{2}\nu R\,(T - T_0)\left(\frac{T + T_0}{2}\right.}$$

$$\frac{6}{16} mg \cancel{(\Delta t)} \cancel{\frac{8}{16}} \left(1 - \frac{5}{13}\right) =$$

$$= \frac{6 \cdot 8}{16 \cdot 13} \cdot mg = \frac{3}{13} mg = Ma$$



$$\cancel{\Delta t} =$$

$$= \frac{T}{m} \cancel{\Delta t^2} \cdot \frac{5}{16} = \frac{a \cancel{\Delta t^2}}{2}$$

$$\frac{\frac{6}{16} \cancel{mg}}{\cancel{m}} \cdot \frac{5}{16} = \frac{a}{2}$$

$$a = \frac{\cancel{4} \cdot 3 \cdot 5}{16 \cdot 4 \cdot \cancel{4}} g \cdot 2 \quad \frac{15}{64} g$$

$$\frac{3}{13} m\cancel{g} = M \cdot \frac{15}{64} \cancel{g}$$

$$\frac{m}{M} = \frac{5 \cdot 13}{64} = \frac{65}{64}$$

$$1 - \frac{6}{16} \cdot \frac{12}{13} = \frac{136}{16 \cdot 13} = \frac{8,5}{13} = \frac{17}{26} g$$

$$H = \frac{\frac{17}{26} g}{2} t^2 \qquad t = \sqrt{\frac{2 \cdot 26}{17} \frac{H}{g}}$$

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$$\frac{T^2 - T_0^2}{T_0} - (T - T_0)$$

$Q < 0 \quad \Delta U < 0$

$A = Q - \Delta U$

$$\frac{2T}{T_0} - 1 = 0$$

$$2T = T_0$$

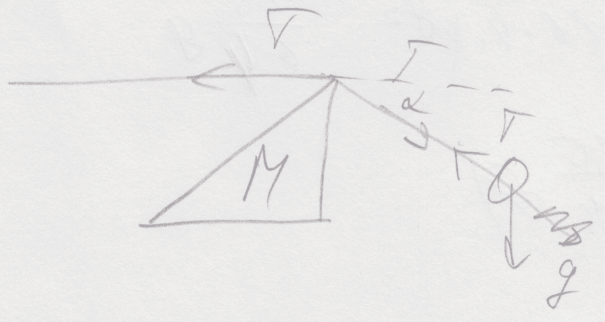
$$T = \frac{T_0}{2}$$

$$\frac{1}{4} - \cancel{1} - \frac{1}{2} + \cancel{1} =$$

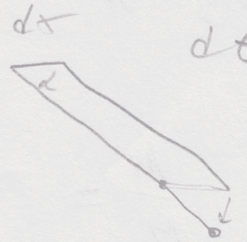
$$= -\frac{1}{4}$$

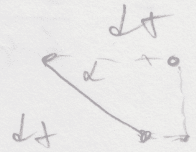
$$\frac{3}{2} \nu R (T - T_0)\left(\frac{T + T_0}{T_0} - 1\right) =$$

$$= \frac{3}{2} \nu R (T - T_0)\left(\frac{T + \cancel{T_0} - \cancel{T_0}}{T_0}\right)$$



$T(1 - \cos\alpha) = Ma$





$$dx \sin\alpha = \frac{g - T\sin\alpha}{2m} dt^2$$

$$\frac{T\cos\alpha}{2m} dt^2 = dx(1 - \cos\alpha)$$

$$\frac{T}{m} dt^2 = \qquad \frac{T}{m} dt^2 \cdot \frac{5}{\cancel{26}\,2} = dx \cdot \frac{8}{\cancel{13}}$$

$$= dx \cdot \frac{16}{5}$$

Часть 2

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

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Вариант 3

Вариант: 11-03 Чистовик этап №2

Задача №3

$$\varepsilon = \frac{q_1}{4C} + \frac{q_2}{C} \Rightarrow \frac{dq_1}{4C} + \frac{dq_2}{C} = 0$$

$$\Downarrow$$

$$-4dq_2 = dq_1$$

$$\frac{q_2}{C} = I_R \cdot R$$

$$\frac{dq_1}{dt} = I_1 = I_R + \frac{dq_2}{dt}$$

$$q_2(0) = q_1(0)$$

$$\Downarrow$$

$$\frac{q_2(0)}{C} + \frac{q_2(0)}{4C} = \varepsilon$$

$$q_2(0) = \frac{4}{5}\varepsilon C$$

$$-\frac{4\,dq_2}{dt} = \frac{q_2}{CR} + \frac{dq_2}{dt}$$

$$\frac{q_2}{CR} = -\frac{5\,dq_2}{dt}$$

$$\Downarrow$$

$$-\frac{dt}{5CR} = \frac{dq_2}{q_2} \quad \Big| \cdot \int$$

$$-\frac{t}{5CR} = \ln q_2$$

$$q_2(t) = \text{"}C\text{"} \exp\left(-\frac{t}{5CR}\right)$$

$$\Downarrow$$

$$\text{"}C\text{"} = \frac{4}{5}\varepsilon C$$

$$q_2(t) = \frac{4}{5}\varepsilon C \exp\left(-\frac{t}{5CR}\right)$$

$$I_2 = -\frac{4\varepsilon C}{5 \cdot 5CR}\exp\left(-\frac{t}{5CR}\right) = -\frac{4}{25}\frac{\varepsilon}{R}\exp\left(-\frac{t}{5CR}\right)$$

$$I_R = \frac{4}{5}\frac{\varepsilon C}{CR}\exp\left(-\frac{t}{5CR}\right)$$

$$q_2(\infty) = 0$$

$$\Downarrow$$

$$\varepsilon = \frac{q_1(\infty)}{4C}$$

$$q_1(\infty) = 4C\varepsilon$$

(1) $I_R(0) = \frac{4}{5}\frac{\varepsilon}{R}\exp(0) = \frac{4\varepsilon}{5R}$

(2) $\cancel{Q = \Delta W = -(W_к - W_н) = -\left(\frac{q_1^2(\infty)}{4C \cdot 2} - \frac{q_1^2(0)}{4C \cdot 2} - \frac{q_2^2(0)}{C \cdot 2}\right) = -\left(\frac{4C\varepsilon^2}{2} - \frac{16C\varepsilon^2}{25 \cdot 4 \cdot 2} - \frac{4^2 C\varepsilon^2}{25 \cdot 2}\right) = -(2C\varepsilon^2 -}$

Вариант: 11-03 Чистовик этап №2 страница №2

$$\cancel{=C\left(\frac{4C\mathcal{E}^2}{2}\right) - \frac{25\,C\mathcal{E}^2}{16}}$$

②

$$W_1 + A = W_2 + Q \qquad Q - ? \qquad W_1 = \frac{C_{\mathcal{E}_1}\mathcal{E}^2}{2} \qquad C_{\mathcal{E}_1} = \frac{4C\cdot C}{4C+C} = \frac{4}{5}C$$

$$W_2 = \frac{q_1^2(\infty)}{4C\cdot 2} = 2\mathcal{E}^2 C \qquad A = \Delta q\,\mathcal{E}$$

$$\Delta q = q_1(\infty) - q_1(0) = 4C\mathcal{E} - \frac{4}{5}\mathcal{E}C = \frac{16}{5}C\mathcal{E}$$

$$Q = \frac{16}{5}C\mathcal{E}^2 + \frac{4}{5}\frac{\mathcal{E}^2}{2}C - 2\mathcal{E}^2 C = $$

$$= \frac{18}{5}C\mathcal{E}^2 - 2C\mathcal{E}^2 = \frac{8}{5}C\mathcal{E}^2$$

3)

$$I_0 = I_R + I_2 = \frac{4}{5}\frac{\mathcal{E}}{R}\exp\left(-\frac{t}{5CR}\right) - \frac{4}{25}\frac{\mathcal{E}}{R}\exp\left(-\frac{t}{5CR}\right) =$$

$$= \frac{16}{25}\exp\left(-\frac{t}{5CR}\right)\cdot\frac{\mathcal{E}}{R} = I_0$$

$$\frac{\mathcal{E}}{R}\exp\left(-\frac{t}{5CR}\right) = \frac{25}{16}I_0$$

$$I_R = \frac{25}{16}I_0\cdot\frac{4}{5} = \frac{5}{4}I_0$$

Ответы: 1) $\frac{4}{5}\mathcal{E} = I_R(0)$ 2) $Q = \frac{8}{5}C\mathcal{E}^2$ 3) $I_R(t) = \frac{5}{4}I_0$

$I_1(t) = I_0$

Задача №4

$$\dot{\Phi} = -\mathcal{E} = \frac{dBS}{dt} = B\frac{dS}{dt} = BL\cdot\frac{dy}{dt} = -BLV_{отн}$$

$V_{отн}$ – ~~относительная~~ скорость рейки 1 ~~от~~ в сист отсчета ~~рейки 2~~ связанной с рейкой 2

$$\mathcal{E} = I\cdot 4R \qquad I = \frac{BLV_{отн}}{4R} \qquad V_2 - V_1 = -V_{отн}$$

$$-2m\frac{dV_1}{dt} = -ILB$$

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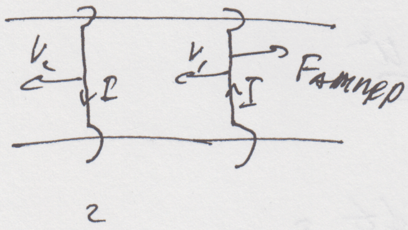
$$m\frac{dV_2}{dt} = ILB \qquad \cancel{-dV_{отн} = dV_2 - dV_1} \qquad dV_2 - dV_1 = -dV_{отн}$$

Вариант: 11-03 Чистовик

Этап №2

$\odot B$



$V_1(0) > V_2(0) \Rightarrow V_2 - V_1 = -V_{отн}$

$$-\frac{dV_1}{dt} = \frac{ILB}{2m} \text{ "–" т.к. } a_1 \uparrow\uparrow F_{ампер}$$

а $dV_1 < 0$

$$\frac{dV_2}{dt} = \frac{ILB}{m}$$

$$-\frac{dV_{отн}}{dt} = \frac{dV_1 - dV_2}{dt} = \frac{3}{2}\frac{ILB}{m} = \frac{3}{2}\frac{LB}{m}\cdot\frac{BL}{4R}V_{отн}$$

$$\frac{dV_{отн}}{V_{отн}} = -\frac{3(LB)^2}{8Rm}dt$$

$$V_{отн} = \text{"}C\text{"} \cdot \exp\left(-\frac{3(LB)^2 t}{8Rm}\right)$$

$$V_{отн}(0) = V_0 \Rightarrow \text{"}C\text{"} = V_0$$

$$V_{отн}(t) = V_0 \exp\left(-\frac{3(LB)^2 t}{8Rm}\right)$$

①

$$2ma_1(t) = ILB = LB\,V_0 \exp\left(-\frac{3(LB)^2 t}{8Rm}\right)\cdot\frac{BL}{4R}$$

$$a_1(0) = \frac{(BL)^2}{8Rm}V_0 \exp(0) = \frac{(BL)^2 V_0}{8Rm}$$

② ~~т.к. в цепи с сопр $4R$ течет ток~~

~~$\Downarrow$~~

~~$\exists$ тепло потери через рейки~~

~~$\Downarrow$~~

~~через $t \to \infty$ вся энергия системы перейдет в тепло~~

~~$\Downarrow$~~

~~$V_1(\infty) = V_2(\infty) = 0$~~

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② $W_1 = \frac{2mV_0^2}{2}$ $\quad W_2 = \frac{2mU^2}{2} + \frac{mU^2}{2}$

$W_1 = W_2 + Q \qquad Q = \int_0^\infty 4RI^2 dt =$

$$= \int_0^\infty 4R \cdot \left(\frac{BL}{4R}\right)^2 \cdot \left(V_0 \exp\left(-\frac{3}{8}\frac{(BL)^2}{Rm}t\right)\right)^2 dt =$$

$$= \frac{(BL)^2}{4R} V_0^2 \int_0^\infty \exp\cdot(-2kt)\,dt =$$

$$= -\frac{(BL)^2}{4R} V_0^2 (2k)^{-1} \exp(-2kt)\Big|_0^\infty =$$

$\exp(-\infty) = 0 \quad \exp(0) = 1$

$$= \frac{(BL)^2 V_0^2}{\cancel{8}R \cdot \frac{3(BL)^2}{8Rm}} = \frac{mV_0^2}{3}$$

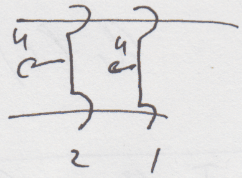
$\Downarrow$

$mV_0^2 - \frac{mV_0^2}{3} = \frac{3}{2}mU^2 \qquad U^2 = \frac{4}{9}V_0^2$

$U = \frac{2}{3}V_0$

③

$$l_k = \frac{S_0}{L} - \int_0^\infty V_{отн}\,dt =$$



$$= \frac{S_0}{L} - V_0 \int_0^\infty \exp(-kt)\,dt =$$

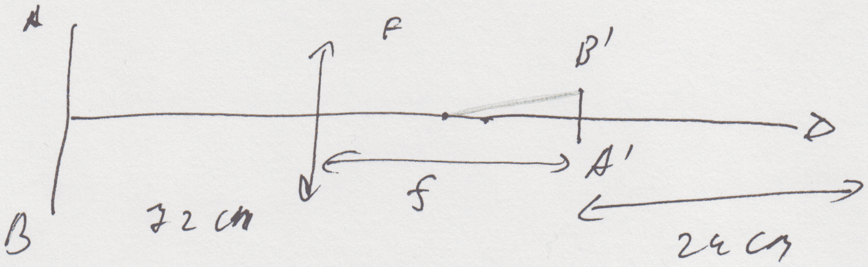
$$= \frac{S_0}{L} + \frac{V_0}{k}(0-1) = \frac{S_0}{L} - \frac{V_0}{\frac{3(BL)^2}{8Rm}} =$$

$$= \frac{S_0}{L} - \frac{8RmV_0}{3(BL)^2}$$

Ответ: 1) $a_1(0) = \frac{(BL)^2 V_0}{8Rm}$ 2) $U = \frac{2}{3}V_0$ 3) $l_k = \frac{S_0}{L} - \frac{8RmV_0}{3(BL)^2}$

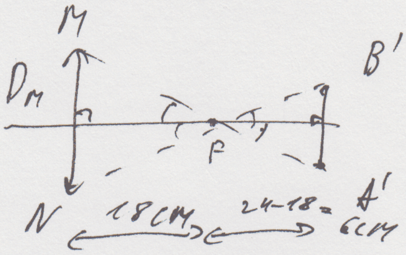
Вариант: 11-03 Чистовик этап №2

Задача №5



$$\frac{1}{F} = \frac{1}{d} + \frac{1}{f} \qquad f = \frac{Fd}{d-F} = 24 \text{ см}$$

$$x = 24 + 24 = 48 \text{ см}$$



$$H \cdot \frac{Fd}{(d-F)d} = H \cdot \frac{72}{54} = B'A' = 12$$

$\triangle MNF \sim \triangle FA'B' \Rightarrow$ $$\frac{D_M}{B'A'} = \frac{18}{6} = 3$$

$$D_M = 3 \cdot B'A' = 36 \text{ см}$$

Ответы: 1) $x = 48$ см 2) $D_M = 36$ см 3) в фокусе справа от линзы

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$\cancel{V = V_0 \exp -\frac{B^2L^2}{2mR} t}$

$\mathcal{E} = BL(V_1 - V_2)$

$Q = \int_0^\infty 4R \cdot \left(\frac{BLV_0}{4R} \cdot e^{-\frac{B^2L^2}{2mR}t}\right)^2 dt =$

$= \frac{B^2L^2V_0^2}{4R} \int_0^\infty e^{-2kt} dt =$

$(e^{kt})' = \frac{e^{kt}}{k}$ $\quad = -\frac{B^2L^2V_0^2}{4R} 2k\, e^{-2kt}\Big|_0^\infty =$

$= \frac{B^2L^2V_0^2}{4R} \cdot 2 \cdot \frac{B^2L^2}{2mR}$

$\mathcal{E} = BLV = -4RI$

$-2m \frac{dV_1}{dt} = I_1 LB$ $\quad -2m \frac{dV_1}{dt} = ILB$

$-m \frac{dV_2}{dt} = I_2 LB$ $\quad m \frac{dV_2}{dt} = ILB$

$3m \frac{dV}{dt}$ $\quad -dV = dV_2 - dV_1$

$m \frac{dV}{dt} = \frac{ILB}{2} = \frac{(LB)^2}{2} \frac{V}{4R} =$

$= \frac{(LB)^2}{8R} V = -m\frac{dV}{dt}$

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$$3CR\,\frac{dq_2}{dt} = \left(q_2 - \frac{I_0}{CR}\right)$$

$$\frac{dq_2}{\left(q_2 - \frac{I_0}{CR}\right)} = -\frac{dt}{3CR}$$

$$\frac{\frac{4}{5}C\mathcal{E}^2}{2}$$

$$q_2 - \frac{I_0}{CR} = c \cdot \exp\left(\frac{t}{3CR}\right)$$

$$\frac{4C^2}{5C} = \frac{4}{5}C$$

$$q_2 - \frac{I_0}{CR} = c\,\exp\left(-\frac{t}{CR}\right)$$

$q_2 \varkappa$

$$W_1 + A = W_2 + Q$$

$A = \Delta q \mathcal{E}$

$$\frac{dq_1}{dt} = I + \frac{dq_2}{dt} \qquad \frac{dq_2}{C} + \frac{dq_1}{4C} = 0$$

$\Delta q = 4C\mathcal{E}_1 - \frac{4}{5}\mathcal{E}C$

$$-\frac{4dq_2}{dt} = \frac{q_2}{CR} + \frac{dq_2}{dt} \qquad -4dq_2 = dq_1$$

$$-5\,\frac{dq_2}{q_2} = \frac{dt}{CR} \qquad q_2 = {}^{\prime\prime}C^{\prime\prime}\exp\left(-\frac{t}{5CR}\right.$$

$$\frac{4}{5}\mathcal{E}C = {}^{\prime\prime}C^{\prime\prime}\,\cancel{\exp}$$

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

$$q_2(t) = \frac{4}{5}\mathcal{E}C\,e^{-\frac{t}{5CR}}$$

$$-\frac{4}{5}\,\frac{\mathcal{E}\cancel{C}}{5\cancel{C}R}\,e^{-\frac{t}{5CR}} = I_2$$

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$$\frac{dV}{V} = -\frac{(LB)^2}{8Rm}\,dt$$

$$V = V_0 \exp\left(-\frac{(LB)^2}{8Rm}t\right)$$

$$I = \frac{BLV_0}{4R} \exp\left(-\frac{(LB)^2}{8Rm}t\right)$$

$$Q = \int_0^\infty 4R \cdot I^2\,dt = \frac{(BLV_0)^2}{4R}\int_0^\infty \exp(-2kt)\,dt$$

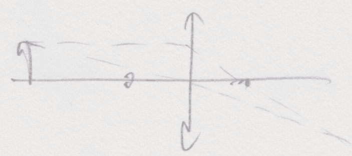
$$= -\frac{(BLV_0)^2}{4R} \cdot (2k)^{-1} \exp(t)\Big|_0^\infty =$$

$$= \frac{(BLV_0)^2}{\cancel{8R}\,\frac{(LB)^2}{(8Rm)}} = \frac{V_0^2 m}{k}$$

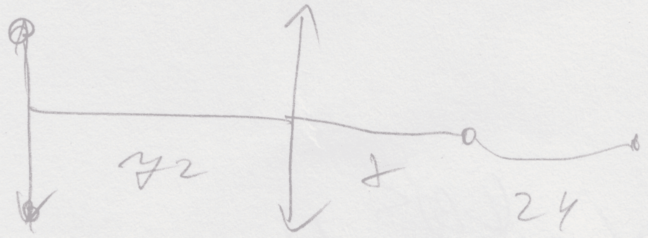
$$(e^{at})' = a e^{at}$$

$$\int e^{at}\,d\cancel{t} = \int e^{at}\frac{d\,at}{a} = \frac{e^{at}}{a}$$

$$\frac{V_2 - V_1}{t} = a$$



$$\frac{-dV}{dt} = \frac{V_1 - V_2}{dt} = a = \frac{F}{2m}$$



$$\frac{1}{F} = \frac{1}{d} + \frac{1}{f} \qquad f = x + 24$$

$$\cancel{\frac{d-F}{F}} \qquad \cancel{x} + l = \frac{Fd}{d-F}$$

$$x = \frac{Fd}{d-F} + l =$$

$$\frac{\frac{72}{\cancel{18}}}{64} \qquad = \frac{18 \cdot 72}{72-18} + 24$$

$$\frac{S_0}{L} - \int_0^V V_0 \exp^{-kt} dt =$$

$$= \frac{S_0}{L} + \cancel{k} \frac{V_0}{k} \exp t \Big|_0^\infty =$$

$$= \frac{S_0}{L} - \frac{V_0}{\frac{(LB)^2}{8Rm}} =$$

$$= \frac{S_0}{L} - \frac{8RmV_0}{(LB)^2}$$

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

$$\mathcal{E} = \frac{5}{4}\frac{q_1}{C}$$

$$q_1 = \frac{4}{5}\mathcal{E}C$$

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

$$\frac{q^2}{2C}$$

$$\frac{4}{5}\frac{\mathcal{E}}{C} = I_1$$

$$\frac{q_1^2}{2\cdot 4C} + \frac{q_1^2}{2\cdot C} = \frac{q_1^2}{2}\cdot\frac{5}{4C}$$

$$\mathcal{E} = \frac{q_2}{4C} \qquad q_2 = 4C\mathcal{E}$$

$$\frac{q_1^2}{2}\frac{5}{4C} - \frac{4C\mathcal{E}^2}{2} = \Delta W$$

$$\frac{q_2}{C} = IR$$

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

$$I_0 = I + \frac{dq_1 + dq_2}{dt} = \qquad \frac{dq_1}{4C} = -\frac{dq_2}{C}$$

$$dq_1 = -4dq_2$$

$$= \frac{q_2}{CR} + \frac{dq_1}{dt} + \frac{dq_2}{dt} =$$

$$3\frac{dq_2}{dt} = \left(\frac{q_2}{CR} - I_0\right)$$

$$= \frac{q_2}{CR} + \cancel{3}\frac{dq_2}{dt}$$

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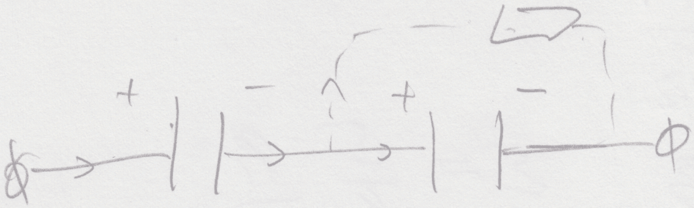
$$\frac{4}{5}\frac{\varepsilon}{R} e^{-\frac{t}{5CR}} = I_R$$



$$I_0 = \frac{4}{5}\frac{\varepsilon}{R} e - \frac{4}{25}\frac{\varepsilon}{R} e =$$

$$= \left(\frac{20}{25} - \frac{4}{25}\right)\frac{\varepsilon}{R} e =$$

$$= \frac{16}{25}\frac{\varepsilon}{R} e$$

$$\frac{\varepsilon}{R} e = \frac{25}{16} I_0$$

$$I_R = \frac{4}{5}\cdot\frac{25}{16} I_0 = \frac{5}{4} I_0$$

$$\varphi = d(BS) = B\,dS = BL\cdot V_0 = 4\varepsilon_i$$

$$BLV_0 = I_1 \cancel{R}\, 4R$$

$$2ma_1 = \frac{BLV_0}{4R} L B$$

$$\cancel{V}qB$$

$$q = I\,dt$$

$$a_1 = \frac{B^2L^2V_0}{8mR}$$

$$2\frac{mV_0^2}{2} = \frac{2mU^2}{2} + \frac{mU^2}{2}$$

$$\cancel{V_x = V_0 - \frac{B^2L^2}{2mR} V\,dt}$$

$$dV = -\frac{B^2L^2}{2mR} V\,dt$$