Часть 1

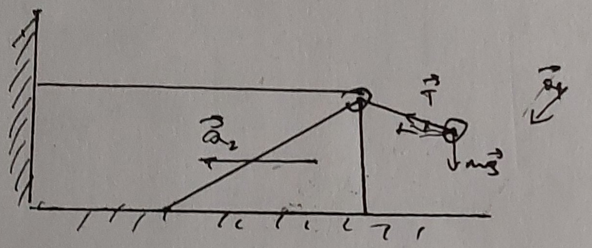
Олимпиада: **Физика, 11 класс (1 часть)**

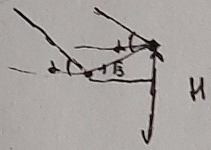
Шифр: **21202134**

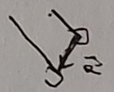
ID профиля: **379485**

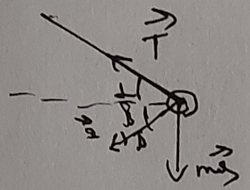
Вариант 3

Черновик









$\sin\alpha = \frac{12}{13}$

$\cos\alpha = \frac{5}{13}$

$tg\,\alpha = \frac{12}{5}$

$T\cos\alpha = ma \cdot \sin\beta$

$T\sin\alpha - mg = ma\sin\beta$

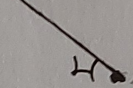
$T = \frac{ma\cos\beta}{\cos\alpha}$

$tg\,\alpha\; ma\cos\beta - mg = ma\sin\beta$

$\frac{12}{5} a\cos\beta - a\sin\beta = g$

$g + a$

5



$24 \cdot 24$
96
48
576

$169 \cdot 4$
676

21202134 (U379485 M1266824)

Черновик

νR

$$\Delta Q = C \cdot \Delta T = C_\nu \cdot \nu \, \Delta T$$

$$\langle C_\nu \rangle = \frac{C_{\nu_1} + C_{\nu_2}}{2} = \frac{3R\frac{T_0}{T_0} + 3R\frac{3}{5}\frac{T_0}{T_0}}{2} =$$

$$= \frac{3R + \frac{9}{5}R}{2} = 1{,}5R + 0{,}9R = 2{,}4R$$

$$\Delta T = \frac{3}{5}T_0 - T_0 = -\frac{2}{5}T_0$$

$$\Delta Q_- = 2{,}4R \cdot \nu \cdot \frac{2}{5}T_0 =$$

$$= 2{,}4 \cdot 0{,}4 \cdot \nu R T_0 =$$

$$= 0{,}96\,\nu R T_0$$

$2{,}4 \times 0{,}4 = 0{,}96$

2)

$$Q = A + \Delta U$$

$$A = Q - \Delta U = \cancel{0{,}96\nu R T_0 - \frac{3}{2}\nu R T} =$$

$$= \frac{3R\frac{T_0}{T_0} + 3R\frac{T_1}{T_0}}{2} \cdot \nu \cdot (T_1 - T_0) - \frac{3}{2}\nu R (T_1 - T_0) =$$

$$= \nu R (T_1 - T_0)\left(\frac{3 + 3\frac{T_1}{T_0}}{2}\right) - \frac{3}{2}\nu R (T_1 - T_0) =$$

$$= \frac{3}{2}\nu R (T_1 - T_0)\left(1 + \frac{T_1}{T_0} - 1\right) =$$

$$= \frac{3}{2}\nu R \frac{T_1}{T_0}(T_1 - T_0)$$

$$A' = \frac{3}{2}\frac{\nu R}{T_0}(T_1 - T_0 + T_1) =$$

$$= \frac{3}{2}\frac{\nu R (2T_1 - T_0)}{T_0}$$

$$A' = 0$$

$$2T_1 = T_0$$

$$T_1 = \frac{T_0}{2}$$

$$Q_+ = C_\nu \nu T_1 = 3R\frac{T_1}{T_0}\nu T_1 = \frac{3R\nu T_1^2}{T_0}$$

$$\frac{1}{2} \cdot \frac{3}{2} \cdot \frac{3}{2} = \frac{9}{8}$$

$$Q_1 = 3\nu R T_0$$

$$\Delta Q = 3\nu R\left(\frac{T_1^2}{T_0} - T_0\right)$$

$$A = \frac{3\nu R}{T_0}(T_1^2 - T_0^2) - \frac{3}{2}\nu R (T_1 - T_0) =$$

$$= 3\nu R (T_1 - T_0)\left(\frac{T_1 + T_0}{T_0} - \frac{1}{2}\right) =$$

$$= 3\nu R (T_1 - T_0)\left(\frac{2T_1 + 2T_0 - T_0}{2}\right) =$$

$$= \frac{3}{2}\nu R (T_1 - T_0)(2T_1 + T_0)$$

$$A' = \frac{3}{2}\nu R (2T_1 + T_0 + 2T_1 - 2T_0) =$$

$$= \frac{3}{2}\nu R (4T_1 - T_0)$$

$$4T_1 = T_0$$

$$T_1 = \frac{T_0}{4}$$

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

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

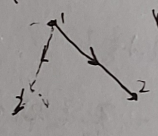
$$= -\frac{9}{8}\nu R T_0 + \frac{3}{4}\nu R T_0 =$$

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

Q

$\frac{3}{2}\nu R \cdot \frac{1}{3}$

$$\frac{p_1 V_1}{T_1} = \frac{p_2 V_2}{T_2}$$



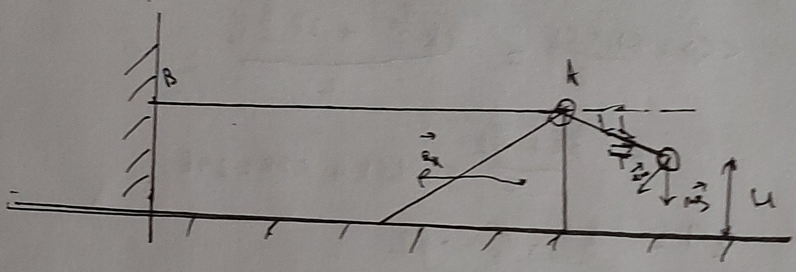
$$p_2 = \frac{p_1 V_1 T_2}{T_1 p_2}$$

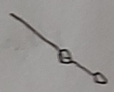
$$p V_1 > p_2 V_2$$

Черновик

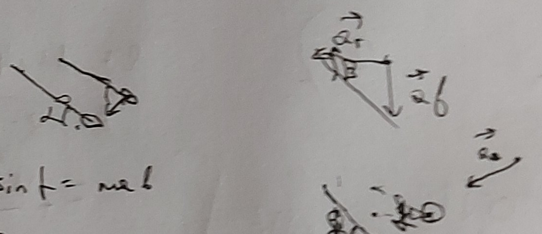
№1

$\cos\alpha = \frac{5}{13}$





1) Т.к. ~~угол наклона нити к горизонту не изменен, то~~ ~~ускорение шара~~



$mg - T\sin\alpha = ma_b$

$T\cos\alpha = ma_r$

$T = \frac{m(g-a_b)}{\sin\alpha}$

$\frac{\cos\alpha}{\sin\alpha} m(g - a_b) = ma_r$

$s = \frac{a_r t^2}{2}$

$s_b = \frac{a_b t^2}{2}$

№2

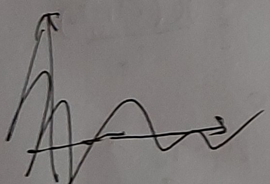
$C_\nu(T) = 3R\frac{T}{T_0}$

$C_\nu = \frac{C}{\nu} = \frac{Q}{T\nu}$

$C_1 = 3R$ $C_2 = 3R \cdot \frac{3}{5} = \frac{9}{5}R$

$C_\nu = \frac{\Delta Q}{\nu \Delta T}$

$C_1 = \frac{Q}{T_0\nu}$ $C_2 = \frac{5Q}{3T_0\nu}$



$\Delta Q = \frac{9}{5}R \cdot \frac{3T_0\nu}{5} - 3RT_0\nu =$

$A = \Delta Q - \Delta U =$

$= \frac{27}{25}RT_0\nu - 3RT_0\nu =$

$\Delta Q = C_\nu \cdot \nu \cdot \Delta T =$

$\langle C \rangle = \frac{3R + \frac{9}{5}R}{2} =$

$= -\frac{48}{25}RT_0\nu$

$= 2{,}4R \cdot \nu \cdot \frac{2}{5}T_0 =$

$= \frac{24}{10}R = 2{,}4R$

$= \frac{24}{10}\frac{2}{5}\nu RT_0 =$

$= \frac{48}{50}\nu RT_0 = 0{,}96\nu RT_0$

=

Чистовик (1)

№2

1)

$$C_\nu = 3R\frac{T}{T_0} = \frac{\Delta Q}{\nu \Delta T}$$

$$C_{\nu_1} = 3R\,\frac{T_0}{T_0} = 3R$$

$$C_{\nu_2} = 3R \cdot \frac{\frac{3}{5}T_0}{T_0} = \frac{9}{5}R$$

Т.к. C_ν зависит от температуры линейно, то при вычислении ΔQ можно взять среднее значение $\langle C_\nu \rangle$

$$\langle C_\nu \rangle = \frac{C_{\nu_1} + C_{\nu_2}}{2} = \frac{3R + \frac{9}{5}R}{2} = 2{,}4R$$

$$\Delta Q = \langle C_\nu \rangle \cdot \nu \cdot \Delta T = 2{,}4R \cdot \nu \cdot \left(\frac{3}{5}T_0 - T_0\right) =$$

$$= -2{,}4 \cdot 0{,}4\,\nu R T_0 =$$

$$= -0{,}96\,\nu R T_0$$ — количество теплоты, которое газ получил

Значит газ отдал $-\Delta Q = 0{,}96\,\nu R T_0$

2)

$$Q = A + \Delta U$$

$$A = Q - \Delta U = \langle C_\nu \rangle \cdot \nu \cdot \Delta T - \frac{3}{2}\nu R \Delta T$$

$$\langle C_\nu \rangle = \frac{C_{\nu_1} + C_{\nu_2}}{2} = \frac{3R\frac{T_0}{T_0} + 3R\frac{T_1}{T_0}}{2} =$$

$$= \frac{3}{2}R\left(1 + \frac{T_1}{T_0}\right)$$

$$A = \frac{3}{2}R\left(1 + \frac{T_1}{T_0}\right) \cdot \nu \cdot (T_1 - T_0) * - \frac{3}{2}\nu R (T_1 - T_0) =$$

$$= \frac{3}{2}\nu R (T_1 - T_0)\left(1 + \frac{T_1}{T_0} - 1\right) =$$

$$= \frac{3}{2}\nu R (T_1 - T_0) \cdot \frac{T_1}{T_0}$$

$$A' = \frac{3}{2}\nu R \left((T_1 - T_0)' \cdot \frac{T_1}{T_0} + (T_1 - T_0)\left(\frac{T_1}{T_0}\right)' \right) =$$

$$= \frac{3}{2}\nu R \left(\frac{T_1}{T_0} + \frac{T_1}{T_0} - 1 \right) =$$

$$= \frac{3}{2}\frac{\nu R}{T_0}(2T_1 - T_0)$$

$$A' = 0 \; ; \quad 2T_1 - T_0 = 0$$

$$T_1 = \frac{T_0}{2}$$

Чистовик ②

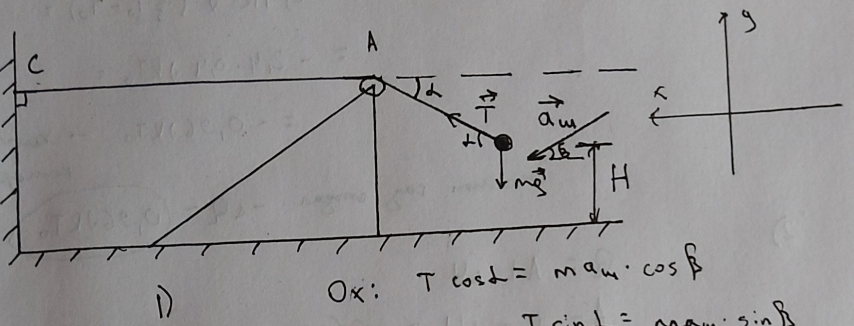
3)
$$A = \frac{3}{2}\nu R(T_1 - T_0)\frac{T_1}{T_0} =$$

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

$$= \frac{3}{2}\nu R(-0{,}5T_0)\cdot 0{,}5 =$$

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

N1



$$Ox: \quad T\cos\alpha = ma_м\cdot\cos\beta$$

$$Oy: \quad mg - T\sin\alpha = ma_м\cdot\sin\beta$$

$$T = \frac{ma_м\cos\beta}{\cos\alpha}$$

$$mg - \frac{ma_м\cos\beta}{\cos\alpha}\cdot\sin\alpha = ma_м\sin\beta$$

$$g - a_м\cos\beta\cdot\frac{12}{13}\cdot\frac{13}{5} = a_м\cdot\sqrt{1-\cos^2\beta}$$

$$g^2 - 2g\cdot a_м\cdot\cos\beta\cdot\frac{12}{5} + a_м^2\cos^2\beta\cdot\frac{144}{25} = a_м^2 - a_м^2\cos^2\beta$$

$$g^2 - 2g\,a_м\cos\beta\cdot\frac{12}{5} + a_м^2\left(\frac{169}{25}\cos^2\beta - 1\right) = 0$$

$$D = \frac{24^2}{25}g^2\cos^2\beta - 4g^2\left(\frac{169}{25}\cos^2\beta - 1\right) =$$

$$= \frac{576}{25}g^2\cos^2\beta - \frac{676}{25}g^2\cos^2\beta + 4g^2 =$$

$$= 4g^2 - 4g^2\cos^2\beta =$$

$$= 4g^2(1-\cos^2\beta) =$$

$$= 4g^2\sin^2\beta$$

$$a_м = \frac{2g\cos\beta\cdot\frac{12}{5} \pm 2g\sin\beta}{2g^2} =$$

$$=$$

Часть 2

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

Шифр: **21202134**

ID профиля: **379485**

Вариант 3

Черновик

№1

$\mathcal{E} = U_{C_1} + U_{C_2}$

$\frac{U_{C_1}}{U_{C_2}} = \frac{C_2}{C_1}$ $\qquad C = \frac{q}{U}$

$\frac{U_{C_1}}{U_{C_2}} = \frac{C}{4C} = \frac{1}{4}$

$U_{C_2} = 4 U_{C_1}$

$U_{C_1} = \frac{\mathcal{E}}{5}$

$\mathcal{E} = U_{C_1} + U_R$

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

$I_R = \frac{4\mathcal{E}}{5R}$

W_{C_1}: 1) $\frac{C\mathcal{E}^2}{50}$ => 2) $\frac{C\mathcal{E}^2}{2}$

W_{C_2}: 1) $\frac{16C\mathcal{E}^2}{50}$ => 2) 0

q_1 1) $q_1 = CU = \frac{C\mathcal{E}}{5}$

2) $q_2 = C\mathcal{E}$

$\mathcal{E} \cdot (q_2 - q_1) = \Delta W_1 + \Delta W_2 + Q$

$Q = \frac{4}{5}C\mathcal{E}^2 - \left(\frac{C\mathcal{E}^2}{2} - \frac{C\mathcal{E}^2}{50}\right) - \left(0 - \frac{16C\mathcal{E}^2}{50}\right) =$

$= \frac{4}{5}C\mathcal{E}^2 - \frac{C\mathcal{E}^2}{2} + \frac{C\mathcal{E}^2}{50} + \frac{16C\mathcal{E}^2}{50} =$

$= \frac{C\mathcal{E}^2}{50}(40 - 25 + 1 + 16) = \frac{32}{50}C\mathcal{E}^2 = 0{,}64\,C\mathcal{E}^2$

$\begin{array}{r} 57 \\ -25 \\ \hline 32 \end{array}$

Черновик

37

$\varepsilon = U_R + U_{C_1} = U_{C_1} + U_{C_2}$ $\quad U_{C_2} = U_R$

$I_0 = I_{C_1} = I_{C_2} + I_R$

$I = \frac{\Delta q}{\Delta t}$

~~$\varepsilon I_0 \Delta t = \frac{CU_{C_1}^2}{2} + \frac{CU_R^2}{2} + \ldots$~~

~~$\varepsilon I_0 \Delta t = \Delta W_{C_1} + \Delta W_{C_2}$~~

~~$\Delta W_{C_1} = \frac{q_2^2}{2C} - \frac{q_1^2}{2C} = \frac{1}{2C}(q_2^2 - q_1^2)$~~

№ 4

$\varepsilon = -\frac{\Delta \Phi}{\Delta t}$

$\Delta \Phi = B \Delta S$

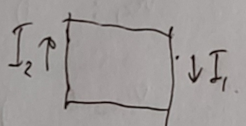
$\Delta S = S_2 - S_1 =$

$= L \cdot (a_2 - a_1) =$

$= L(a_1 - v_0 \Delta t - a_1) =$

$= -L v_0 \Delta t$

$\varepsilon = \frac{L v_0 \Delta t}{\Delta t} = L v_0$



~~$I_1 = \frac{\varepsilon}{R_1} = \frac{L v_0}{R}$~~ $\quad I_0 = \frac{\varepsilon}{4R} = \frac{L v_0}{4R}$

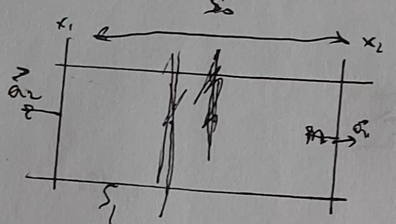
~~$I_2 = \frac{\varepsilon}{R_2} = \frac{L v_0}{3R}$~~

~~$F_1 = I_1 B L$~~ $\quad F_2 = I_2 B L$

~~$F_R = BL(I_1 + I_2) = BL\left(\frac{L v_0}{R} + \frac{L v_0}{3R}\right) = \frac{4 L v_0 B L^2}{3R}$~~ $= ma$

~~$a = \frac{4 v_0 B L^2}{3Rm}$~~

Черновик



$\Delta\Phi = J$

1) 2) 3)

$\Delta\Phi = -B \cdot L \frac{(S_2 - S_1)}{\Delta t} = -BL \frac{(S_1 - v_0 t - \frac{at^2}{2})}{\Delta t} = BL(v_0 + \frac{at}{2})$

$S_2 = S_1 - v_0 t - \frac{at^2}{2}$

1) $2ma_1 = F_{A_1} = IBL = \frac{Lv_0}{4R} BL = \frac{v_0 BL^2}{4R}$

$a_1 = \frac{v_0 BL^2}{8Rm}$

2) $a_2 = \frac{Lv_0}{4R} \cdot \frac{BL}{m} = \frac{Bv_0 L^2}{4Rm}$

$\mathcal{E} = \frac{BL(l_1 - l_2)}{\Delta t}$

$\mathcal{E} = L(a_2 - a_1 - a_0) = L(\frac{a t^2}{2} - \frac{a_1 t^2}{2} - a_0)$

$a_{отн} = \cancel{\frac{v_0 BL^2}{8Rm}} \; \frac{3}{8} \frac{v_0 BL^2}{Rm}$

$I = \frac{BL(l_1 - l_2)}{4R}$

$v_1 = 0 \quad v_2 = 0$

$\frac{B^2L^2(l_1 - l_2)}{4R} = ma_2$

a_0

$a_0 + a_2 - a_1$

$a_2 - a_1$

$\frac{a_1}{a_2} = 2$

$L \cdot \frac{3a_2 t^2}{2} = 1{,}5$

$\Delta\varphi = 1{,}5 BL a_2 t^2$

$\mathcal{E} = 1{,}5$

3) $v = v_0 - a_{отн} t$

$\Delta t = \frac{v_0}{a_{отн}} = \frac{8 v_0 Rm}{3 v_0 BL^2} = \frac{8Rm}{3BL^2}$

$\Delta S = v_0 \Delta t - \frac{a \Delta t^2}{2} =$

$a_2 = \frac{B^2L^2(l_1 - l_2)}{4R}$

$= \frac{8 v_0 Rm}{3BL^2} - \frac{3 v_0 BL^2}{8 Rm} \cdot \frac{64 R^2 m^2}{9 B^2 L^4} \cdot \frac{1}{2} =$

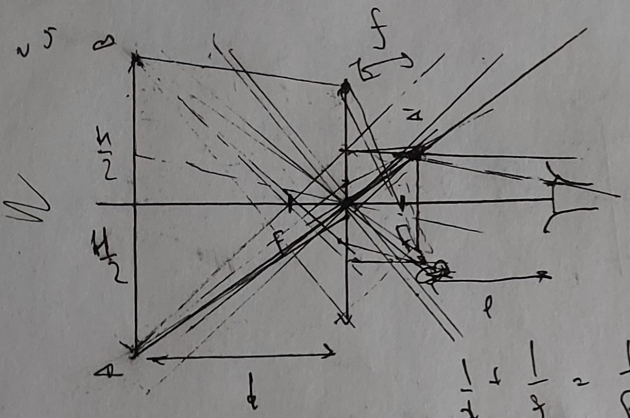
$= \frac{8 v_0 Rm}{3BL^2} - \frac{8 Rm \cdot v_0}{6 BL^2} =$

$= \frac{4}{3} \frac{Rm v_0}{BL^2}$

$S_1 = S_0 - \frac{4}{3} \frac{Rm v_0}{BL^2}$

$\int v dt$

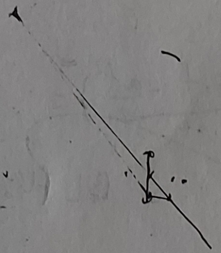
$a_0 t$



0,1296

1)

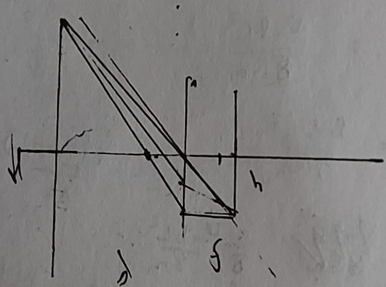
$$\frac{1}{d} + \frac{1}{f} = \frac{1}{F}$$



$$f = \frac{1}{\frac{1}{F} - \frac{1}{d}} = \frac{dF}{d-F} = 0,144$$

$$x = f + l = 0,334 \text{ m}$$

2)



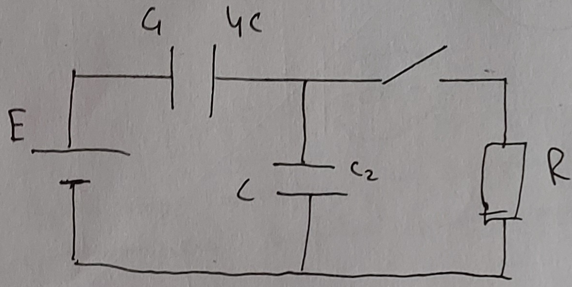
$$\Gamma = \frac{h}{H} = \frac{f}{d} = 0,2$$

$$h = 0,2H = 0,01 \text{ m}$$

3)

Чистовик ①

N3



1) В установившемся режиме $E = U_{C_1} + U_{C_2}$

$$\frac{U_{C_1}}{U_{C_2}} = \frac{C_2}{C_1} = \frac{C}{4C} = \frac{1}{4}$$

$$U_{C_2} = 4U_{C_1}$$

$$E = 5U_{C_1}$$

$$U_{C_1} = \frac{E}{5}$$

По закону Кирхгофа сразу после замыкание:

$$E = U_{C_1} + U_R = \frac{E}{5} + U_R$$

$$U_R = \frac{4E}{5}$$

$$I_R = \frac{U_R}{R} = \frac{4E}{5R}$$

2)

В конечный момент времени напряжение на конденсаторе $C_1 = E$, а на $C_2 = 0$

$$\Delta W_{C_1} = \frac{CE^2}{2} - \frac{CE^2}{50} = \frac{24}{50}CE^2$$

$$\Delta W_{C_2} = 0 - \frac{16CE^2}{50} = -\frac{16}{50}CE^2$$

На C_1: $q_1 = CU_{C_1} = \frac{CE}{5}$; $q_2 = CE \Rightarrow \Delta q = \frac{4}{5}CE$

По ЗСЭ

$$E \cdot \Delta q = \Delta W_{C_1} + \Delta W_{C_2} + Q$$

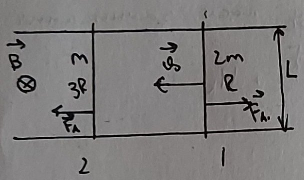
$$\frac{4}{5}CE^2 = \frac{24}{50}CE^2 - \frac{16}{50}CE^2 + Q$$

Чистовик ②

$$Q = \frac{4}{5} CE^2 - \frac{8}{50} CE^2 =$$

$$= \frac{32}{50} CE^2 = 0{,}64 CE^2$$

№4



1) Из-за движения перемычки 1 в контуре возникает ток

$$\mathcal{E} = -\frac{\Delta\Phi}{\Delta t} = -\frac{B\Delta S}{\Delta t} = -\frac{B \cdot L(a_2 - a_1)}{\Delta t} =$$

$$= \frac{BLv_0\Delta t}{\Delta t} = BLv_0$$

$$I_0 = \frac{\mathcal{E}}{R_0} = \frac{BLv_0}{4R}$$

На проводник с током в магнитном поле начинает действовать сила Ампера

$$F_A = I_0 BL = \frac{B^2L^2v_0}{4R} = m_1 a_1 = 2ma_1$$

$$a_1 = \frac{B^2L^2v_0}{8Rm}$$

2) Ускорение перемычки 2 $a_2 = \frac{B^2L^2v_0}{4Rm}$

Когда скорости двух перемычки станут равны, магнитный поток перестанет изменятся, следовательно они будут двигатся равномерно

$\cancel{v_2 = a_2 \Delta t}$ $\cancel{v_1 = v_0 - a_1\Delta t}$

$\cancel{\Delta t(a_2 + a_1) = v_0 = \Delta t \cdot \frac{3}{8} \frac{B^2L^2v_0}{Rm}}$

Чистовик 3

$\Delta t = \frac{8Rm}{3B^2L^2}$

$\Delta S = L\cdot(b_2 + b_0 - b_1 - b_0) = L(b_2 - b_1)$, где b_2 и b_1 – пройденные перемещения

$b_2 =$

$\vartheta_2 = a_2 \Delta t \qquad \vartheta_1 = \vartheta_0 - a_1 \Delta t$

$$\Delta t(a_2 + a_1) = \vartheta_0 = \Delta t \cdot \frac{3}{8}\frac{B^2L^2\vartheta_0}{Rm}$$

$$\Delta t = \frac{8Rm}{3B^2L^2}$$

$$\vartheta_2 = \frac{B^2L^2\vartheta_0}{4Rm}\cdot\frac{8Rm}{3B^2L^2} = \frac{2}{3}\vartheta_0$$

3)

$$S_2 = \frac{a_2t^2}{2} = \frac{1}{2}\frac{B^2L^2\vartheta_0}{4Rm}\cdot\frac{64}{9}\frac{R^2m^2}{B^4L^4} =$$

$$= \frac{1}{2}\frac{\vartheta_0 Rm\cdot 16}{9B^2L^2} = \frac{8}{9}\frac{\vartheta_0 Rm}{B^2L^2}$$

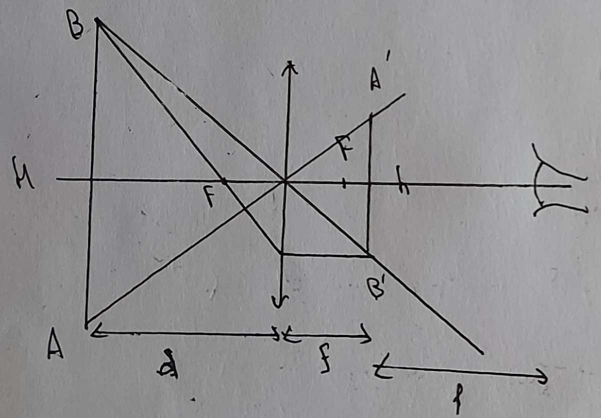
$$S_1 = \vartheta_0 t - \frac{a_1t_1^2}{2} = \frac{8\vartheta_0 Rm}{3B^2L^2} - \frac{1}{2}\frac{B^2L^2\vartheta_0}{8Rm}\cdot\frac{64R^2m^2}{9B^4L^4} =$$

$$= \frac{8}{3}\frac{\vartheta_0 Rm}{B^2L^2} - \frac{4}{9}\frac{\vartheta_0 Rm}{B^2L^2} =$$

$$= \frac{20}{9}\frac{\vartheta_0 Rm}{B^2L^2}$$

$$S = S_2 + S_0 - S_1 = S_0 - \frac{12}{9}\frac{\vartheta_0 Rm}{B^2L^2}$$

№5



1) $f = \frac{dF}{d-F} = 0{,}144\text{м}$; $\quad x = f + l = 0{,}144\text{м} + 0{,}24\text{м} = 0{,}384\text{м}$

Чистовик 4

2) ~~Чтоб~~ Чтобы наблюдатель смог целиком увидеть картину, диаметр линзы должен быть больше или равен диаметру изображения

$$\Gamma = \frac{f}{d} = \frac{h}{H}$$

$$h = \frac{fH}{d} = 0{,}2h = 0{,}018 \text{ м}$$

3) Экран надо поместить на фокусном расстоянии линзы и расположить его в левом фокусе линзы (между предметом и линзой)