Часть 1

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

Шифр: **21202174**

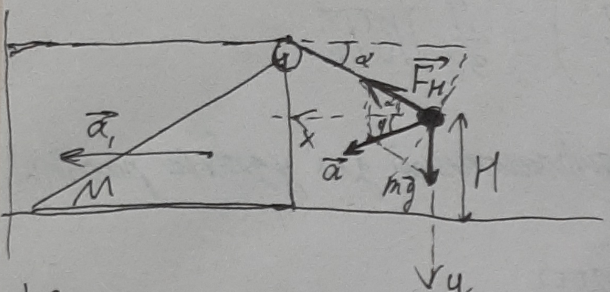
ID профиля: **871891**

Вариант 1

Чистовик

В 11-01

№1



$$\begin{cases} Ma_1 = F_H \cos\alpha \\ ma_x = F_H \cos\alpha \\ ma_y = mg - F_H \sin\alpha \end{cases}$$

$$Ma_1 = ma\cos\varphi$$

1) В первоначальный момент времени ускорение a будет направлено по касательной к окружности вращения нити, т.е. перпендикулярно $\vec{F_H}$, значит под углом $\varphi = 90-\alpha$; $\cos\varphi = \cos(90-\alpha) = \sin\alpha = \frac{4}{5}$

2) $ma\cos\varphi = F_H\cos\alpha$; $\frac{4}{5}ma = \frac{3}{5}F_H$; $4ma = 3F_H \Rightarrow F_H = \frac{4}{3}ma$

3) $Ma_1 = \frac{3}{5}F_H = \frac{4}{5}ma$; $\frac{m}{M} = \frac{5}{4}\frac{a_1}{a}$

$a_1 = a\cos\alpha$, т.к. нить нерастяжима и горизонтальна изначально.

$$\frac{m}{M} = \frac{5}{4}\frac{a\cos\alpha}{a} = \frac{5}{4}\cos\alpha = \frac{5\cdot 3}{4\cdot 5} = \frac{3}{4}$$

$$a = \omega^2 x = \frac{g}{l}x = \frac{g}{l}l\cos\alpha = \frac{3}{5}g$$

$$a_1 = \frac{9}{25}g$$

4) ЗСЭ

$$Mu^2/2 + mv^2/2 = mgH$$

$$M(a_1 t)^2/2 + m(a\sin\varphi t)^2/2 = mgH$$

$$\frac{4\cdot 27}{5\cdot 125}g^2t^2 + \frac{27}{125}g^2t^2 = 2gH$$

$$\frac{27}{125}g^2t^2\cdot\frac{9}{5} = 2gH$$

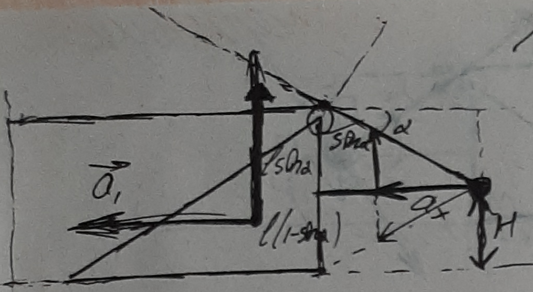
$$\frac{27\cdot 9}{125\cdot 5}gt^2 = 2H$$

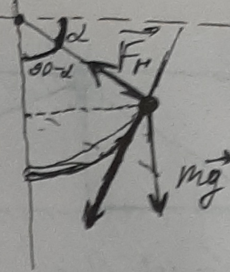
$$t^2 = \frac{2H\cdot 25^2}{27\cdot 9\cdot g} \Rightarrow t = \frac{25}{9}\sqrt{\frac{2H}{3g}}$$

Ответ: 1) $\cos\varphi = \frac{4}{5}$; 2) $a_1 = \frac{9}{25}g$; 3) $\frac{m}{M} = \frac{3}{4}$; 4) $t = \frac{25}{9}\sqrt{\frac{2H}{3g}}$

1

черновик





$a = \omega^2 x$

$F_H \cos\alpha = m a_x = \frac{3}{5} F_H$

$mg - F_H \sin\alpha = m a_y = mg - \frac{4}{5} F_H$

$\frac{(g - a_y)}{a_x} = \frac{4}{3}$

$g - a_y = \frac{4}{3} a_x$

$a_y = g - \frac{4}{3} a_x$

$a_y = g - \frac{4}{3} a_x$

$a \sin\varphi = g - \frac{4}{3} a \cos\varphi$

$$\boxed{a\left(\sin\varphi + \frac{4}{3}\cos\varphi\right) = g}$$

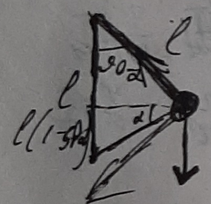
$a_x = a_1$

$\cancel{a = \sqrt{a_x^2 + g^2 + \frac{16}{9} a_x^2 - \frac{8}{3} a_x g}}$

$\cancel{= \sqrt{\frac{25}{9} a_x^2 - \frac{8}{3} a_x g + g^2}}$

$$\begin{cases} M a_1 = F_H \cos\alpha \\ m a \cos\varphi = F_H \cos\alpha \end{cases}$$

$M a_1 = m a \cos\varphi$



$\omega = \sqrt{\frac{g}{l}}$

$a = \omega^2 x = \frac{g}{l} x$

$F_H \cos\alpha = M a_1$

ma

F_H

$\cancel{a_x \cos}$

$a_1 = a \cos\alpha$

$M(a_1 t)^2/2 + m v^2/2 = mgH$

$\cancel{M(a_1 t)^2}$

$M(a_1 t)^2/2 + m(a \sin\varphi \cdot t)^2/2 = mgH$

$\frac{4}{3} m \frac{9^2 g^2}{25^2} t^2 + m\left(\frac{27}{125} g^2 t^2\right) = 2mgH$

$\frac{4 \cdot 27 g^2 t^2}{625} + \frac{27}{125} g^2 t^2 = 2mgH$

Чистовик

№2

1) $dQ = \nu \cdot C \cdot dT = \nu \cdot \frac{2R}{T_0} \cdot T \cdot dT$

$$Q = \frac{2\nu R}{T_0}\int_{\frac{5}{6}T_0}^{T_0} T\,dT = \frac{2\nu R}{T_0}\left(\frac{T_0^2}{2} - \frac{25}{36}\cdot\frac{T_0^2}{2}\right) = \frac{11}{36}\nu R T_0$$

2) $Q = A + \Delta U$ (меняем знак на противоположный для удобства расчёта)

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

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

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

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

$$\frac{dA}{dT} = 0;\quad \frac{3}{2} - \frac{2T_x}{T_0} = 0 \Rightarrow T_x = \frac{3}{4}T_0$$

3) $A_{min} = A(T_x) = A\left(\frac{3}{4}T_0\right) = \nu R\left(\frac{9}{8}T_0 - \frac{9}{16}T_0 - \frac{1}{2}T_0\right) = \frac{1}{16}\nu R T_0$

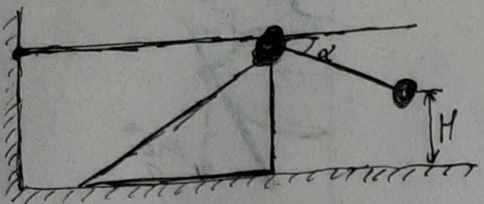
Ответ: 1) $\frac{11}{36}\nu R T_0$

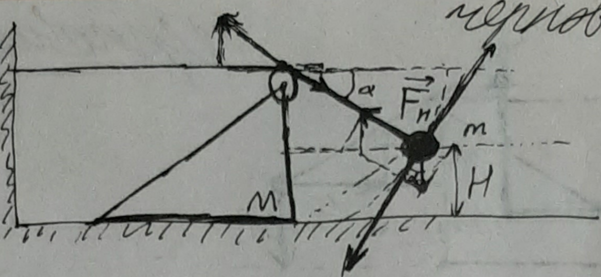
2) $\frac{3}{4}T_0$

3) $\frac{1}{16}\nu R T_0$

21202174 (U871891 M1265779)

черновик



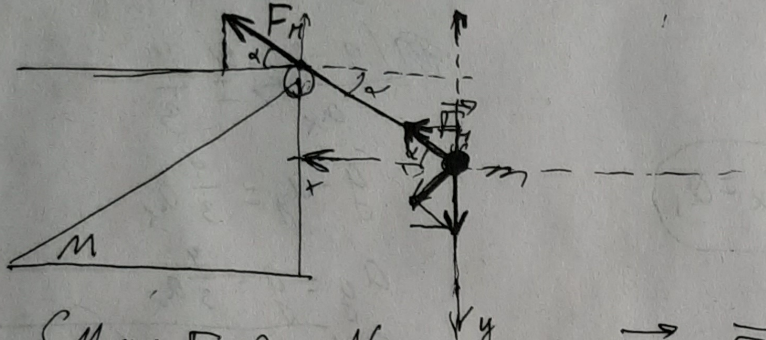


$2mgH = \cancel{\ } mv^2 + Mu^2$

$\sin\varphi = \frac{4}{5}$

1) $F_н \sin\alpha + Mg = N$

$F_н \cos\alpha = Ma$



$\cancel{\sin\alpha = \frac{4}{5}}$

$$\begin{cases} Mg + F_н \sin\alpha - N = 0 \\ F_н \cos\alpha = Ma \end{cases}$$

$m\vec{a_0} = \vec{F_н} + \vec{F_0}$

$ma_x = F_н \cos\alpha = \frac{3}{5}F_н$

$ma_y = mg - F_н \sin\alpha = mg - \frac{4}{5}F_н$

$\sin\alpha = \frac{4}{5}$

$ma_{0x} = \frac{3}{5}F_н$

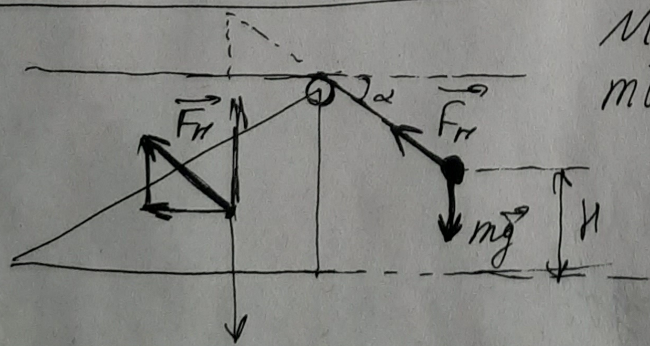
$m(a_{0y} - g) = -\frac{4}{5}F_н$

$m(g - a_{0y}) = \frac{4}{5}F_н$

$\frac{g - a_{0y}}{a_{0x}} = \frac{4}{3}$

$g - a_{0y} = \frac{4}{3}a_{0x}$

$\cancel{\frac{4}{3} m a_{0x} = \frac{4}{5} F_н}$

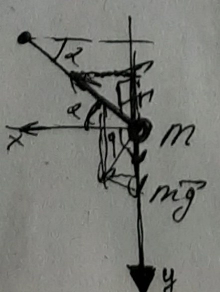


$Ma = F_н \cos\alpha$ $\cancel{mgH}$

$m\vec{a_0} = \vec{F_н} + m\vec{g}$

$\cancel{mgH}$ $\cancel{mg}$

$$\begin{cases} F_н \sin\alpha - mg = ma_0 \sin\varphi \\ F_н \cos\alpha = ma_0 \cos\varphi \end{cases}$$



$$\begin{cases} ma_0 = \frac{F_н \cos\alpha}{\cos\varphi} \\ Ma = F_н \cos\alpha \end{cases}$$

$\boxed{M = \frac{F_н \cos\alpha}{a}}$ $\boxed{\frac{m}{M} = \frac{a}{a_0 \cos\varphi}} = \frac{am}{F_н \cos\alpha}$

Черновик

$T_0, \nu, \quad C(T) = 2R\frac{T}{T_0}$

$C = \frac{2R}{T_0} \cdot T$

$dQ = \nu C\,dT = \nu \frac{2R}{T_0} T\,dT$

$Q = \nu\frac{2R}{T_0}\int\limits_{5/6 T_0}^{T_0} T\,dT = \nu \frac{2R}{T_0}\left(\frac{T_0^2}{2} - \frac{25}{36}\cdot\frac{T_0^2}{2}\right) =$

$= \frac{\nu R T_0^{\cancel{2}}}{\cancel{T_0}}\left(1 - \frac{25}{36}\right) = \frac{11}{36}\nu R T_0$

$T_0 \searrow T_x, \quad A \to min$

$A = \int\limits_{V_1}^{V_2} P(V)\,dV = Q - \Delta U = Q - \frac{3}{2}\nu R \Delta T$

$A_{min} = \frac{\nu R}{T_0}\left(T_0^2 - T_x^2\right) - \frac{3}{2}\nu R T_0 + \frac{3}{2}\nu R T_x$

$A_{min} = \nu R\left(T_0 - \frac{T_x^2}{T_0} - \frac{3}{2}T_0 + \frac{3}{2}T_x\right) =$

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

$\left(\frac{3}{2}T_x - \frac{1}{T_0}T_x^2 - \frac{1}{2}T_0\right)' =$

$= \frac{3}{2} - \frac{2}{T_0}T_x = 0; \quad \frac{3}{2} = \frac{2T_x}{T_0}; \quad T_x = \frac{3T_0}{4} = \frac{3}{4}T_0$

$A_{min} = \nu R\left(\frac{3}{2}\cdot\frac{3}{4}T_0 - \frac{9}{16}T_0 - \frac{1}{2}T_0\right) =$

$\frac{9}{8} - \frac{9}{16} - \frac{1}{2} = \frac{9}{16} - \frac{8}{16} = \frac{1}{16}$

$= \frac{1}{16}\nu R T_0$

Часть 2

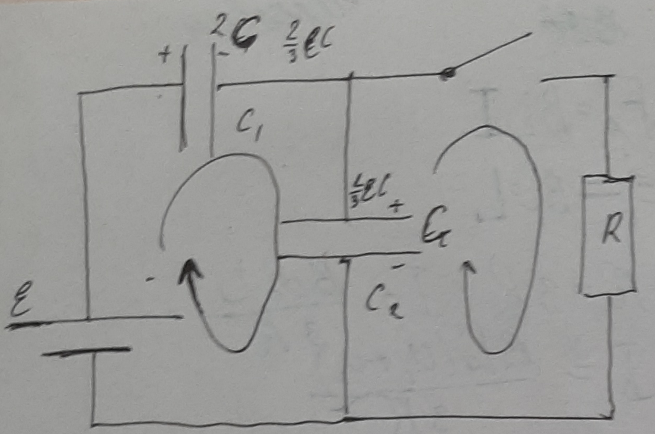
Олимпиада: **Физика, 11 класс (2 часть)**

Шифр: **21202174**

ID профиля: **871891**

Вариант 1

черновик



$C_2 = C$

$C_1 = 2C$

$C_{общ} = \frac{2C^2}{3C} = \frac{2}{3}C$

$q = \frac{2}{3}\mathcal{E}C$

$U_1 = \frac{2}{3}\mathcal{E}C / 2C = \frac{\mathcal{E}}{3}$

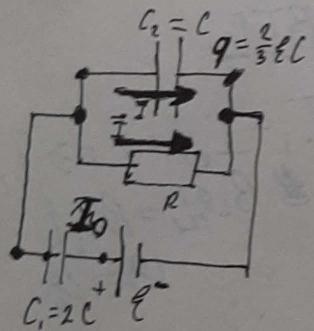
$U_2 = \frac{2}{3}\mathcal{E}$

$U_R = U_2 = \frac{2}{3}\mathcal{E}$

$I = \frac{2\mathcal{E}}{3R}$

$\frac{2}{9}\mathcal{E}$

$\boxed{\frac{2}{3}\mathcal{E}^2 C}$



$U_2 = \cdot$

$\frac{2}{3}\mathcal{E}C ; \frac{2}{3}\mathcal{E}C$

$q_{1к} = 2C\mathcal{E}$ $\quad 2\mathcal{E}C ; 0 \quad 2\mathcal{E}^2 C \quad \frac{4}{3}\mathcal{E}^2 C$

$q ; U = \frac{q}{C} = \frac{1}{C}\cdot q \quad dQ = q\,dU ; \quad Q = \int \frac{1}{C} q\,dq = \frac{q^2}{2C}$

$\frac{\left(\frac{2}{3}\mathcal{E}C\right)^2}{2C} = \frac{4\mathcal{E}^2 C^2}{18C} = \frac{2\mathcal{E}^2 C}{9}$

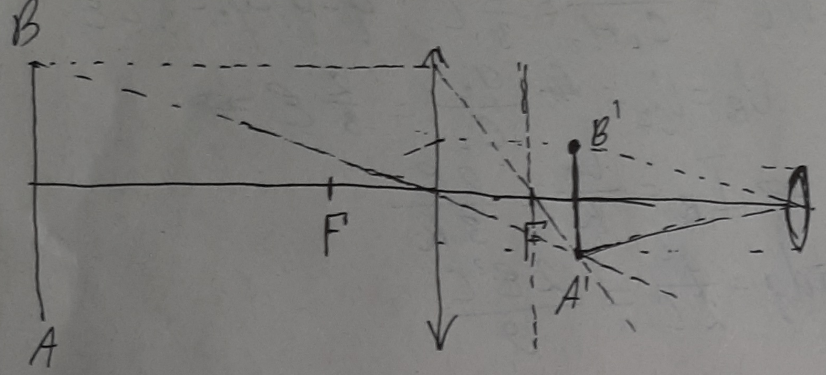
$I_0 = \frac{U}{R} + \frac{dq}{dt} = \frac{q}{CR} + \frac{dq}{dt}$

$I_0 = \frac{dQ}{dt} = \frac{d(2C\cdot(\mathcal{E}-U))}{dt} = \frac{2C\,d(\mathcal{E}-U)}{dt} = \frac{-2C\,dU}{dt} = \frac{-2dq}{dt}$

$\cancel{dQ = Q_2 - Q_1 = 2C(\mathcal{E}-U)}$

$Q = 2C(\mathcal{E}-U) \quad dQ = 2C\,dU \Rightarrow I_0 = 2C\frac{dU}{dt}$

№5 чистовик



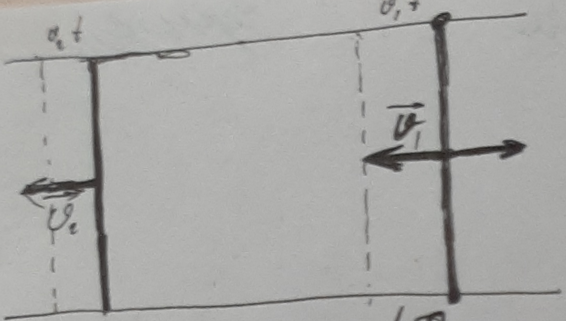
1) $\frac{1}{F}=\frac{1}{d}+\frac{1}{f}$; $\frac{1}{9\,см}=\frac{1}{36\,см}+\frac{1}{f}$ $\Rightarrow f=12\,см \Rightarrow x=(24+12)\,см=36\,см$

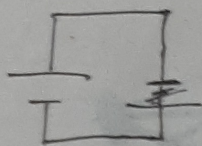
2) $D_м=D\cdot\frac{f}{d}=\frac{D}{3}=3\,см$

3) На расстоянии $F=9$ см правее линзы

Ответ: 1) 36 см; 2) 3 см; 3) 9 см правее линзы.

черновик





$I = \frac{F}{BL}$

BIL

$B \quad \mathcal{E} = -\frac{d\Phi}{dt} = -\frac{dB(v_1 t - v_2 t)L}{dt} = B(v_1 - v_2)L$

$l = \frac{S}{L}$; $|\mathcal{E}| = \frac{dS}{dt} B$; $dS = \frac{\mathcal{E} dt}{B}$

$v_1 = v_2$;

$v_2 = \frac{\mathcal{E}_2}{BL}$ $\quad S = \frac{\mathcal{E} t}{B} - \frac{3IRt}{B} =$

$\frac{B^2 v_2 L^2}{3R}$ $\quad =$

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v_0 ; $\frac{B^2 v_0 L^2}{3R}$ $\quad 0 \uparrow v_2 \quad v_2 = \frac{B^2 L^2}{6mR}\left(\int v_1 dt - \int v_2 dt\right)$

v_1 ; $\frac{B^2 L^2 v_1}{3R}$ $\quad \frac{6mRv_0}{3B^2L^2} = 2\frac{mRv_0}{B^2L^2}$ $\quad \Delta S = \cancel{\frac{3B^2L^2}{6mRv_0}}$

$\mathcal{E} = BLv_0$

$I = \frac{BL}{3R} v_0 \quad F_{A1} = \frac{B^2L^2}{3R} v_0 = F_{A2}$; $a_2 = \frac{B^2L^2}{6mR} v_0 = \frac{dv_2}{dt}$

1 $\quad$ 2

$v_0 \quad 0$ $\quad \cancel{v_2 = \int \frac{B^2L^2}{6mR} v_0 dt}$

$v_1 = v_2$ $\quad \mathcal{E} = BL(v_1 - v_2)$

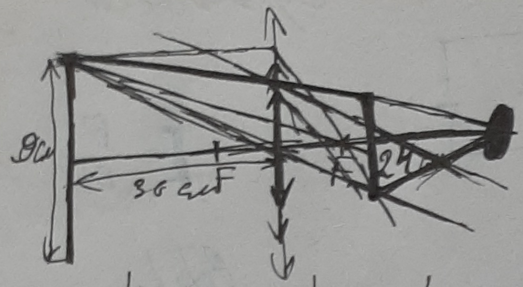
$a_2 = \frac{B^2L^2(v_1 - v_2)}{6mR}$; $a_1 = \frac{B^2L^2(v_1 - v_2)}{3mR}$

$a_2 = \frac{dv_2}{dt}$ $\quad a_1 = 2a_2$

$\cancel{a_2 =} \frac{B^2L^2}{6mR}(v_1 - v_2) = \frac{dv_2}{dt} = \frac{dv_1}{2dt}$

черновик

$F = 0{,}09м$



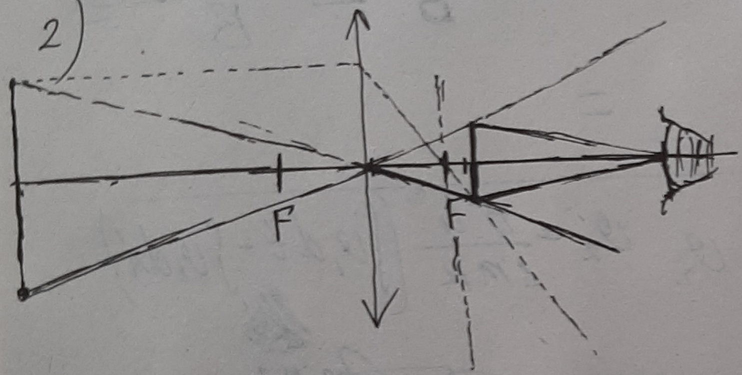
1) $\frac{1}{F} = \frac{1}{d} + \frac{1}{f}$

$\frac{4}{36} = \frac{1}{36} + \frac{1}{f}$

$f = 12 \Rightarrow \boxed{x = 36 см}$

3 см

2)



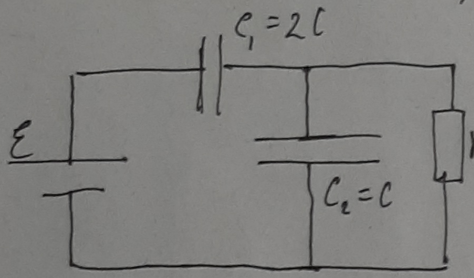
3) $mv_0 = 3mv$

$v = \frac{v_0}{3}$

$mv_0^2/2 = 2mv_2^2/2 + mv_1^2/2$

21202174 (U871891 M1265780)

№ 3 В 11-01 чистовик



1) $C = \frac{C_1 C_2}{C_1 + C_2} = \frac{2}{3}C$; $q = q_1 = q_2 = \frac{2}{3}C\mathcal{E}$

$U_R = U_{C_2} = \frac{q_2}{C_2} = \frac{2}{3}\mathcal{E} \Rightarrow$

$\Rightarrow I_R = \frac{U_R}{R} = \frac{2\mathcal{E}}{3R}$

2) $dQ = U \cdot dq \Rightarrow Q = \int \frac{1}{C} q\,dq = \frac{q^2}{2C} = \frac{2\mathcal{E}^2 C}{9}$

3) $I_0 = I_{R0} + \frac{dq}{dt}$

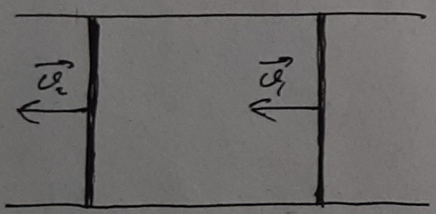
$I_0 = \frac{dq_1}{dt} = \frac{d(2C(\mathcal{E}-U))}{dt} = \frac{2dq}{dt}$ (q_1 – заряд на C_1)

$\frac{2dq}{dt} = I_{R0} + \frac{dq}{dt}$; $I_{R0} = \frac{I_0}{2}$

Ответ: 1) $\frac{2\mathcal{E}}{3R}$; 2) $\frac{2}{9}\mathcal{E}^2 C$; 3) $\frac{I_0}{2}$

№ 4

1) $|\mathcal{E}_0| = B\vartheta_0 L \Rightarrow F_{A2} = \frac{B^2 L^2 \vartheta_0}{3R} \Rightarrow a_2 = \frac{B^2 L^2 \vartheta_0}{6mR}$



2) Сила Ампера, действующая на правый проводник, будет уменьшать его скорость, а на левый – увеличивать, до тех пор, пока эдс индукции в обоих проводниках не станут равны, и проводники будут двигаться с одной скоростью. Т.к. $\mathcal{E}_{общ} = B\vartheta_1 L - B\vartheta_2 L$, то $\vartheta_1 = \vartheta_2$. По ЗСИ $m\vartheta_0 = 3m\vartheta_1 \Rightarrow \vartheta_1 = \frac{\vartheta_0}{3}$

3) $\mathcal{E}_{общ} = BL(\vartheta_1 - \vartheta_2)$; $a_2 = \frac{B^2 L^2 (\vartheta_1 - \vartheta_2)}{6mR} = \frac{d\vartheta_2}{dt}$

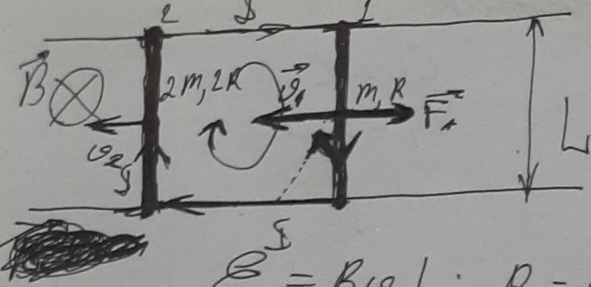
$\vartheta_2 = \frac{B^2 L^2}{6mR} \int (\vartheta_1 - \vartheta_2) dt = \frac{B^2 L^2}{6mR} \cdot \Delta S \Rightarrow$

$\Rightarrow \Delta S = \frac{6mR \cdot \vartheta_0}{3B^2 L^2} = 2\frac{mR\vartheta_0}{B^2 L^2} \Rightarrow S = S_0 - \Delta S = S_0 - \frac{2mR\vartheta_0}{B^2 L^2}$

Ответ: 1) $\frac{B^2 L^2 \vartheta_0}{6mR}$; 2) $\frac{\vartheta_0}{3}$; 3) $S_0 - \frac{2mR\vartheta_0}{B^2 L^2}$

черновик

~~Bdl~~



$F_A = BLI$

$|\mathcal{E}| = B\upsilon L$

$\mathcal{E}_0 = B\upsilon_0 L;\ R_0 = R + 2R = 3R;\ I = \frac{B\upsilon_0 L}{3R}$

$F_{A2} = BLI = \frac{B^2 L^2 \upsilon_0}{3R}$

$\mathcal{I} = \frac{BL(\upsilon_1 + \upsilon_2)}{3R}$

$a_{20} = \frac{B^2 L^2 \upsilon_0}{6mR}$

$\frac{B^2 L^2 (\upsilon_1 + \upsilon_2)}{3R}$

$\cancel{\mathcal{E}_1 = BL\upsilon_1,\ \mathcal{E}_2 = BL\upsilon_2}$

$\cancel{\mathcal{E} = \mathcal{E}_1 + \mathcal{E}_2 = BL(\upsilon_1 + \upsilon_2)}$

$\cancel{\mathcal{E}_1 = BL\upsilon_1\ \ \mathcal{E}_2 = BL\upsilon_2}$

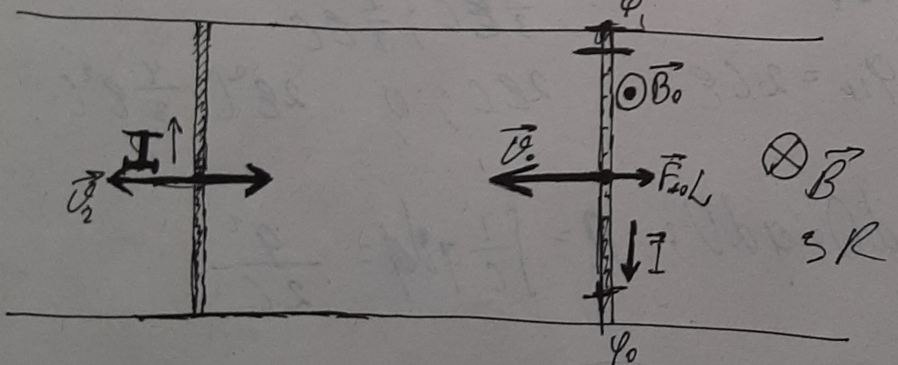
$\cancel{\frac{B^2 L^2 \upsilon_1}{3R}}$

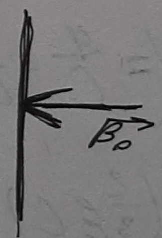
$F = BIL$

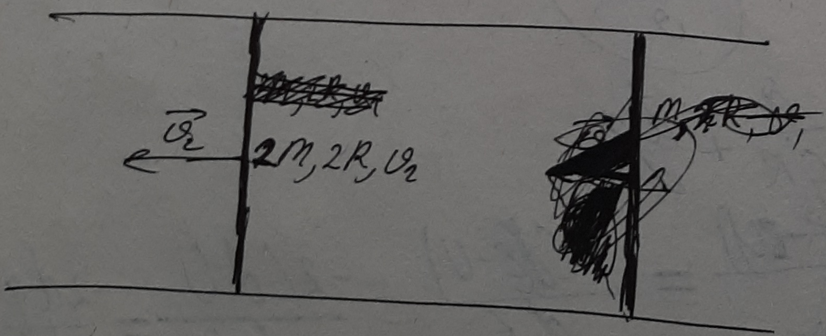
$BL(I_1 - I_2) = 0 \Rightarrow I_1 = I_2$

$B\upsilon_1 L = B\upsilon_2 L$

$\upsilon_1 = \upsilon_2$







$2ma_2 = F_{A2} = BIL$

$\mathcal{E} = -\frac{d\Phi}{dt} = -\frac{dBS}{dt} =$

$= -\frac{B\,dS}{dt} = -\frac{B\,dL\upsilon t}{dt} =$

$= -B\upsilon l$