Часть 1

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

Шифр: **21202323**

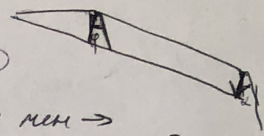
ID профиля: **807503**

Вариант 2

Черновик

$\cos\frac{\alpha}{2} = \sqrt{\frac{1+\cos\alpha}{2}} = \frac{3}{\sqrt{10}}$

$v_0 = 0 \Rightarrow \vec{a} \uparrow\uparrow \Delta\vec{x}$

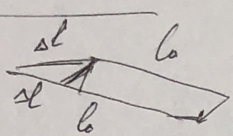


1) $\varphi = \cancel{90^\circ} - 90 + \frac{\alpha}{2}$

если α не мен $\rightarrow$

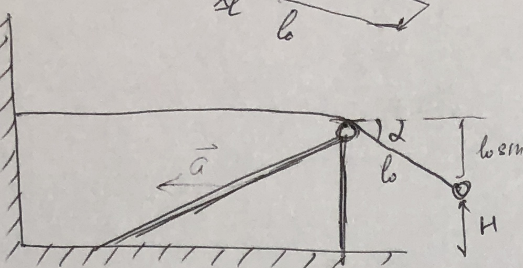
$\rightarrow a_ц = const \Rightarrow v^2 \sim R$

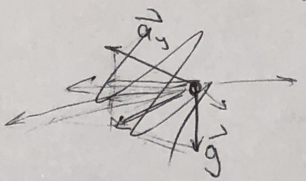
$\frac{?}{\sqrt{10}}$

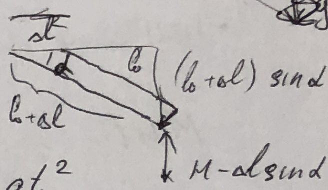


№1

2) $a =$







4 $\Delta l\sin\alpha = \frac{at^2}{2}$

$\Delta l \sin\alpha < H$

№2

$C = \frac{5}{2}R\frac{T}{T_0}$

$Q = \nu\int_{1/2T_0}^{T_0} C(T)dT = \frac{5}{2}\frac{\nu R}{T_0}\int_{1/2T_0}^{T_0} T^2 dT = \cancel{\frac{5}{2}\frac{\nu R}{T_0}\frac{T^3}{3}\Big|_{1/2T_0}^{T_0}} =$

$T^2 - T_0T$

$\frac{5}{2}\frac{\nu R}{T_0}\left(\frac{T^3}{3} - \frac{T_0T^2}{2}\right)\Big|_{1/2T_0}^{T_0}$

$= \cancel{\frac{\frac{5}{2}\nu R}{3T_0}\left(T_0^3 - \frac{1}{8}T_0^3\right) = \frac{35\nu R T_0^2}{48}}$

$\frac{5}{2}\frac{\nu R}{T_0}\left(\frac{T_0^3}{3} - \frac{T_0^3}{2} - \frac{T_0^3}{24} - \frac{T_0^3}{16}\right)$

$\cancel{\operatorname{tg}2\alpha = \frac{2\operatorname{tg}\alpha}{1-\operatorname{tg}^2\alpha}}$

$Q = \cancel{\frac{\nu T_0}{2}\int_{1/2T_0} C dT} =$

$= \cancel{\frac{\nu T_0 5R}{4T_0}}$

$\cancel{C\nu\Delta T = \frac{i}{2}\nu R\Delta T + A}$

$Q = \nu\int_{T_0/2}^{T_0} C\,dT = \frac{5}{2}\frac{\nu R}{T_0}\int_{T_0/2}^{T_0} T\,dT = \frac{5}{4}\frac{\nu R}{T_0}T^2\Big|_{T_0/2}^{T_0} =$

$= \frac{5}{4}\frac{\nu R}{T_0}\left(T_0^2 - \frac{T_0^2}{4}\right) = \frac{15\nu R T_0}{16}$

$Q = \cancel{\frac{5}{4}\frac{\nu R}{T_0}\left(T_0^2 - \frac{T_0^2}{k^2}\right) = \frac{3}{2}\nu R\left(T_0 - T_0/k\right) + A}$

$A = \cancel{\frac{\nu R}{4}(T_0 k\ ?)}$

$Q = \frac{5}{4}\nu R\left(T_0 k^2 - T_0\right) = \frac{3}{2}\nu R\left(T_0 k - T_0\right) + A$

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

$= \frac{\nu R T_0}{4}\left(5k^2 - 6k + 1\right)$

MIN при $k = \frac{6}{10} = \frac{3}{5}$

$T = \frac{3}{5}T_0$

$A_{MIN} = \frac{16}{20}\cdot\frac{\nu R T_0}{4} = \frac{\nu R T_0}{5}$

$\frac{9}{5} - \frac{18}{5} + 1 = \ldots$

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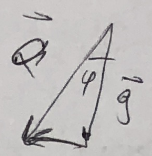
Черновик

$\cancel{mgH = mg\, Mv_1^2/2 + m}$

$$\begin{cases} mgH = \frac{mv_1^2}{2} + \frac{Mu^2}{2} \\ mv \sin\varphi = Mu \end{cases}$$



Mut

$\frac{mg}{3} = Mu$

$\frac{mg^2}{g} = M^2u^2$

$\frac{m\, g^2 10}{2 \cdot g} = \frac{Mu^2}{2}$

$mg^2 \cdot \frac{10}{g} = Mu^2$

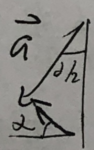
$10m = M$

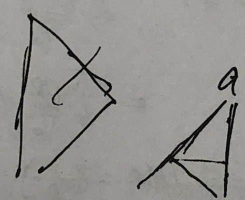
$mgH = m$

$mgH = \frac{m a_1^2 t^2}{2} + \frac{M a_2^2 t^2}{2}$

m

$MgH = \frac{mv^2}{2} + \frac{Mu^2}{2}$





$mgH = t^2/2\,(m a_1^2 + M a_2^2)$

$m a_2$

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

$\cancel{mv \sin}$

$mgH = \frac{m}{2} t^2 (a_1^2 + a_2^2) =$

$t = \frac{2gH}{a_1^2 + a_2^2}$

$gt^2 = H$

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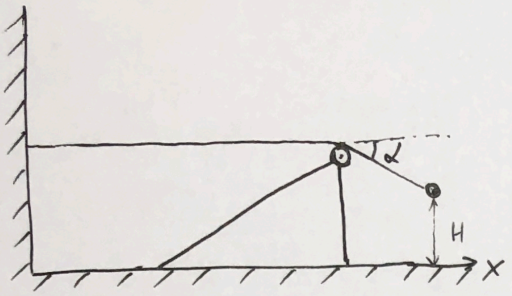
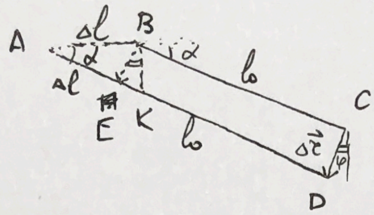
Чистовик ①

№1



1) Т.к. $\upsilon_0 = 0$, то $\Delta\vec{r}$ – перемещение шарика сонаправлено с ускорением $\vec{a}_1$.

Пусть изначально свисающая часть нити имеет длину l_0, а за какое-то время удлинилась на Δl ~~< H/sinα~~, тогда т.к. $\alpha = const$:



Проведем $BE \parallel CD$; т.к. $BC \parallel ED$, $BE \parallel CD$, то $BCDE$ – параллелограмм, $ED = BC = l_0$, тогда $AE = \Delta l = AB$, т.е. $\triangle ABE$ равнобедренний, $\angle ABE = \angle AEB = \frac{180° - \alpha}{2} =$

$= 90° - \frac{\alpha}{2}$;

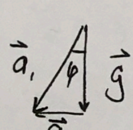
$\angle KBE = \angle \varphi = 90° - \angle ABE = 90° - 90° + \frac{\alpha}{2} = \frac{\alpha}{2}$

$\cos\alpha = 2\cos^2 \alpha/2 - 1 = 1 - 2\sin^2 \alpha/2$.

$\sin \alpha/2 = \sqrt{\frac{1-\cos\alpha}{2}} = \frac{1}{\sqrt{10}}$, $\cos\frac{\alpha}{2} = \sqrt{\frac{1+\cos\alpha}{2}} = \sqrt{\frac{1+\frac{4}{5}}{2}} = \frac{3}{\sqrt{10}}$

$\sqrt{\frac{1-4/5}{2}} = \frac{1}{\sqrt{10}}$

$tg\,\alpha/2 = \frac{\sin\alpha/2}{\cos\alpha/2} = \frac{1/\sqrt{10}}{3/\sqrt{10}} = 1/3$.

2) 

$\vec{a}_1 = \vec{g} + \vec{a}_2$, $a_2 = g\,tg\varphi = g/3$, $a_1 = g/\cos\varphi = \frac{g\sqrt{10}}{3}$

~~Тогд υ_x шарика $= a_2 t$, клина $a_k t$, υ шарика $= a_1 t$~~

~~По ЗСИ по оси OX: $ma_2 t = Ma_k t$, m – масса шарика,~~

~~$\frac{mg}{3} = Ma_k$ M – клина~~

~~По ЗСЭ: в момент перед столкновением шарика со столом $E_п = 0$~~

Т.к. α не изменяется, то ускорение клина $= a_2 = \frac{g}{3} = 3.33$ м/с²

3) По ЗСИ отн-о оси OX: $ma_2 t = Ma_2 t \Rightarrow m = M$

4) по ЗСЭ в момент перед падением: $mgH = \frac{ma_1^2 t^2}{2} + \frac{Ma_2^2 t^2}{2}$, $m = M$

$t = \sqrt{\frac{2gH}{a_1^2 + a_2^2}} = \sqrt{\frac{2gH}{g^2 \cdot \frac{10}{9} + g^2/9}} = \sqrt{\frac{18}{11}\frac{H}{g}}$

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Ответ: 1) $tg\varphi = 1/3$ 2) $a_2 = g/3$ 3) $m = M$ 4) $t = \sqrt{\frac{18}{11}\frac{H}{g}}$

Чистовик

№2

1) $Q = -C\nu\Delta T = \nu\int\limits_{T_0/2}^{T_0} C\,dT = \nu\int\limits_{T_0/2}^{T_0}\frac{5}{2}R\frac{T}{T_0}\,dT = \frac{5\nu R}{2T_0}\int\limits_{T_0/2}^{T_0} T\,dT =$

$= \cancel{\frac{5}{4}\frac{\nu R}{T_0}(T_0^2 - T_0^2)}\ \frac{5}{4}\frac{\nu R}{T_0}T^2\Big|_{T_0/2}^{T_0} = \frac{5}{4}\nu R\left(T_0 - T_0/4\right) = \frac{15\nu R T_0}{16}$

2) Аналогично при охлаждении газа $Q = \frac{5}{4}\nu R T_0(1-k^2)$,

где kT_0 – конечная температура.

Тогда $Q = \frac{5}{4}\nu R T_0(1-k^2) = \frac{3}{2}\nu R T_0(1-k) + A$

$A = \frac{\nu R T_0}{4}(5k^2 - 5 - 6k + 6) = \frac{\nu R T_0}{4}(5k^2 - 6k + 1)$

$A = \min$ при $5k^2 - 6k + 1 = \min$, т.к. $\frac{\nu R T_0}{4} = const$,

$5k^2 - 6k + 1 = \min$ в вершине параболы:

$k = \frac{6}{2\cdot 5} = \frac{3}{5}$ $\qquad T = \frac{3}{5}T_0$

3) A при этом $= \frac{\nu R T_0}{4}\left(\frac{9}{5} - \frac{18}{5} + 1\right) = -\frac{\nu R T_0}{5}$

т.е. газ отдал $\frac{\nu R T_0}{5}$

Ответ: 1) $Q = \frac{15\nu R T_0}{16}$ 2) $T = \frac{3}{5}T_0$ 3) $A = \frac{\nu R T_0}{5}$

Часть 2

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

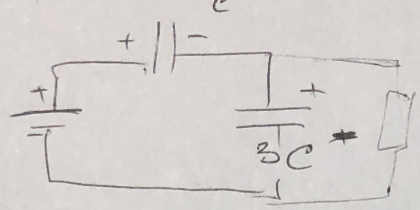
Шифр: **21202323**

ID профиля: **807503**

Вариант 2

Черновик

№3



1) $U_1+U_2=\mathcal{E}$

$\frac{q}{C_1}+\frac{q}{C_2}=\mathcal{E}$

$q=\frac{3C\mathcal{E}}{4}$

$U_1=\frac{3\mathcal{E}}{4},\ U_2=\frac{\mathcal{E}}{4}$

$IR=U_2$, $I=U_2/R=\mathcal{E}/4R$

2)

$\mathcal{E}_1+\mathcal{E}_2=\mathcal{E}_i$

$\mathcal{E}_1/R_1$

№4

$\mathcal{E}\ \frac{\Delta\Phi}{\Delta t}=\frac{B\Delta S}{\Delta t}=Bl\upsilon_0$

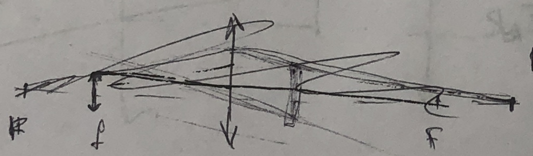
$F=BIl=\frac{B\mathcal{E}l}{4R}$

$a=\dot{\upsilon}$

$a_2=\frac{B\mathcal{E}l}{2mR}=\frac{B^2l^2\upsilon_0}{2mR}$

№5

$\frac{12^4\cdot 4}{12\cdot 3}=16$



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

$f=\frac{Fd}{F+d}=\frac{48\cdot 12}{48+12}=\frac{12^2\cdot 4}{12\cdot 5}=$

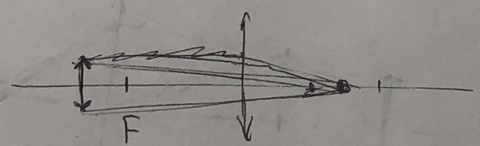
$=\frac{48}{5}=9{,}6$ см

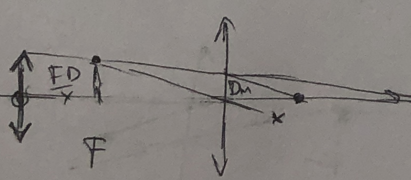
$l=s+f\Rightarrow s=l-f=24-9{,}6=$

$=\cancel{14{,}4\text{ см}}$

8см

3)





$\frac{9}{3}=3$

2) $\cancel{D_м=\frac{9{,}6}{48_{16}}\cdot 9^3=1{,}8\text{ см}}$

21202323 (U807503 M1265264)

Черновик

$$a_1 = \frac{B\cdot\frac{1}{5}BLv_0L}{mR}$$

$$v_0 - a_1t = a_2t$$

$$t = \frac{v_0}{a_1+a_2}$$

$$s_1 = \frac{v^2 - v_0^2}{2a_1} = \frac{4}{9}v_0^2 - v_0^2$$

$$s_2 = \frac{v^2}{2a_2}$$

$$\frac{C^2}{M}\cdot\frac{M^2}{C^2} = M$$

$$s_1 - s_2 =$$

$$I_1 = \frac{\mathcal{E}+U_1}{R}$$

$$U_1 + U_2 = \mathcal{E}$$

$$U_1 + U_R = \mathcal{E}$$

$$\frac{q_1}{C_1} + \frac{q_2}{C_2} = \mathcal{E}$$

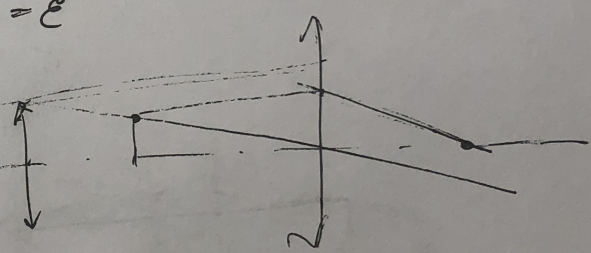
$$q_2 + q_R = q_1$$

$$q_1 = q_2 + q_R$$

$$\frac{q_1}{C_1} + \frac{q_2}{C_2} = \mathcal{E}$$

$$\Delta q =$$

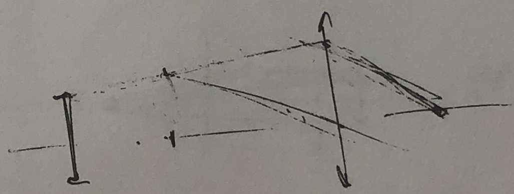
$$q_2/C_2 = I_R R$$

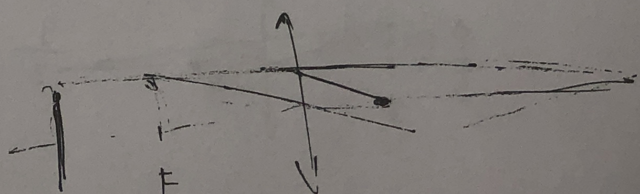


$$U_1 + I_2R = \mathcal{E}$$

$$I_2R = U_2$$

$$\Delta q\mathcal{E} = \frac{CU_2^2 - CU_1^2}{2}$$





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

$$f = \frac{Fd}{d-F} = \frac{12\cdot 8}{8-12} = -24 \text{ см}$$

$$\frac{24}{24+}$$

21202323 (U807503 M1265264)

Чистовик

①

№3

Дано:

$C_2 = C$

$C_1 = 3C$

$\mathcal{E}$

R

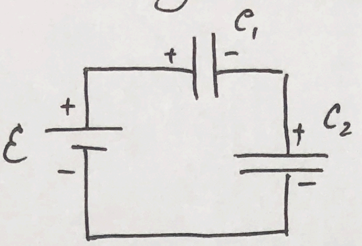
1) I_R - ?

2) Q - ?

3) $I_2 = I_0$: U_R - ?

Решение:

До замыкания:



$\mathcal{E} = U_1 + U_2$, $U_1 = q/C_1$, $U_2 = q/C_2$

$q\left(\frac{1}{C_1} + \frac{1}{C_2}\right) = \mathcal{E}$

$q = \frac{\mathcal{E}C_1C_2}{C_1 + C_2} = \frac{3\mathcal{E}C}{4}$

$U_2 = \frac{3\mathcal{E}C}{4 \cdot C} = \frac{3\mathcal{E}}{4}$

Резистор соед. параллельно 2 конденсатору

$U_R = U_2 = \frac{3\mathcal{E}}{4} = I_R R$

$I_R = \frac{3\mathcal{E}}{4R}$

~~Ответ: 1) $I_R = \frac{3\mathcal{E}}{4R}$~~

2)

$q_1 = q_2 + q_R$

$\frac{q_1}{C_1} + \frac{q_2}{C_2} = \mathcal{E}$

$q_2/C_2 = I_R R$

$I_1 = \frac{\mathcal{E} - U_1}{R} = \frac{\mathcal{E} - q_1/C_1}{R}$

21202323 (U807503 M1265264)

Чистовик

№5

Решение:

3

Дано:

$F = 12\text{см}$

$H = 9\text{см}$

$d = 48\text{см}$

$s = 24\text{см}$

1) x - ?

2) $D_м$ - ?

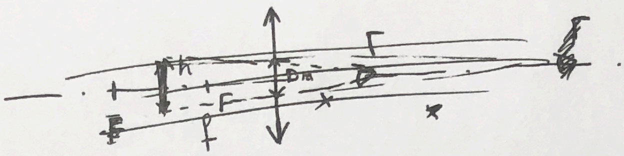
3) l - ?

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

$f = \frac{Fd}{d-F}$

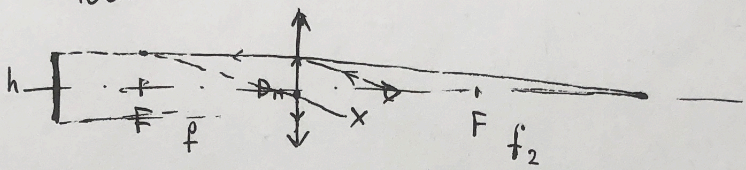
$x = s - f = s - \frac{Fd}{d-F} =$

$= 24\text{см} - \frac{12 \cdot 48\text{см}^2}{48\text{см} - 12\text{см}} = 8\text{см}$



2) $\Gamma = \frac{f}{d} = \frac{F}{d-F}$; $h = \Gamma H = \frac{FH}{d-F} = \frac{12 \cdot 9\text{см}^2}{48\text{см} - 12\text{см}} = 3\text{см}$

~~$f = \frac{12 \cdot 48\text{см}^2}{(48-12)\text{см}} = 16\text{см}$, $\frac{D_м}{h} = \frac{x}{x+f}$, $D_м = \frac{xh}{x+f} = \frac{8 \cdot 3\text{см}^2}{8\text{см} + 16\text{см}} = 1\text{см}$~~



$\frac{1}{x} + \frac{1}{f_2} = \frac{1}{F}$

$f_2 = \frac{Fx}{x-F} = \frac{12 \cdot 8\text{см}^2}{(8-12)\text{см}} = -24\text{см}$

$f = \frac{12 \cdot 48\text{см}^2}{(48-12)\text{см}} = 16\text{см}$

$\frac{-f_2}{-f_2 + f} = \frac{D_м}{h}$

т.е.

$D_м = \frac{h f_2}{f_2 - f} = \frac{3 \cdot 24\text{см}^2}{(24+16)\text{см}} = 1.8\text{см}$

3) на расстоянии x от линзы со стороны часов (тогда глаз ничего не увидит)

Ответ: 1) $x = 8\text{см}$ 2) $D_м = 1.8\text{см}$ 3) 8см (вплотную к глазу)

Чистовик

№4

2

Дано:

B

L

$m_1 = m$

$R_1 = R$

$m_2 = m/2$

$R_2 = 4R$

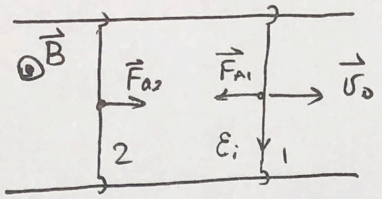
$v = v_0$

1) a_2 – ?

2) v_1 – ? v_2 – ?

3) Δx – ?

Решение:



1) $|\varepsilon_i| = \frac{\Delta \Phi}{\Delta t} = \frac{B \Delta S}{\Delta t} = \frac{B L \Delta s}{\Delta t} = B L v_0$

$F_{a2} = m_2 a_2 = B I_2 L$, $\cancel{I_2 = \frac{\varepsilon_i}{R_2}}$

$\cancel{\varepsilon}$ $U_1 + U_2 = \varepsilon_i$

$I_1 = I_2$

$U_1/R_1 = U_2/R_2 \quad U_1 = \frac{U_2 \cancel{R}}{4\cancel{R}}$

$\frac{5}{4} U_2 = \varepsilon_i$, $U_2 = \frac{4}{5}\varepsilon_i$, $I_2 = \frac{U_2}{R_2}$

$$a_2 = \frac{F_{a2}}{m_2} = \frac{B \cdot \frac{4}{5}\varepsilon_i / R_2 \, L}{m_2} = \frac{B \cdot \frac{4}{5} \cdot B L v_0 L}{m/2 \cdot 4R} = \frac{2}{5}\frac{B^2 L^2 v_0}{mR}$$

2) Через долгий промежуток времени их скорости сравняются, т.к. ~~сила~~ возникающие силы ~~возникают~~ в ~~следствие~~ изменению Ф.
~~для~~ препятствуют

$$a_1 = \frac{F_{a1}}{m_1} = \frac{B \cdot \frac{1}{5}\varepsilon_i / R_1 \, L}{m_1} = \frac{B \cdot \frac{1}{5} B L v_0 \cdot L}{mR} = \frac{1}{5}\frac{B^2 L^2 v_0}{mR}$$

$v_1 = v_0 - a_1 t$, $v_2 = a_2 t$

$v_0 - a_1 t = a_2 t$, $t = \frac{v_0}{a_1 + a_2} = \frac{5mR}{3B^2L^2}$

$$v_1 = v_2 = \frac{2}{5}\frac{B^2L^2v_0}{mR} \cdot \frac{5mR}{3B^2L^2} = \frac{2}{3} v_0$$

3) $\Delta x = \Delta x_1 - \Delta x_2$, $\Delta x_1 = a_1 t^2/2$, $\Delta x_2 = a_2 t^2/2$

$$\Delta x = \frac{t^2}{2}(a_1 - a_2) = \frac{25 m^2 R^2}{18 B^4 L^4}\left(\frac{1}{5} - \frac{2}{5}\right)\frac{B^2L^2v_0}{mR} =$$

$$= -\cancel{\frac{1}{5}} - \frac{5mRv_0}{18B^2L^2}$$

Ответ: 1) $a_2 = \frac{2}{5}\frac{B^2L^2v_0}{mR}$ 2) $v_1 = v_2 = \frac{2}{3}v_0$ 3) $-\frac{5mRv_0}{18B^2L^2}$