Часть 1

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

Шифр: **21202421**

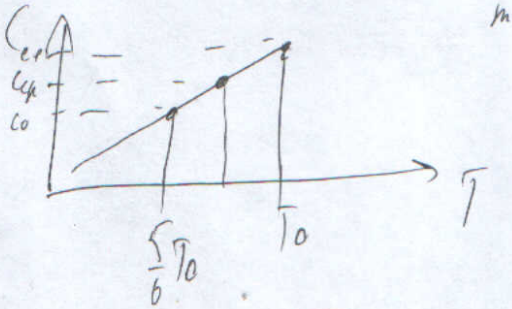
ID профиля: **825777**

Вариант 1

Черновик

№2

$Q = \Delta U + A$ $\quad pV = \nu RT$



т.к. зависимость линейная:

$C_{ср} = \frac{C(T_0) + C(\frac{5}{6}T_0)}{2}$

$\boxed{Q = C\nu\Delta T}$ $\quad \Delta T = -\frac{1}{6}T_0$

$C = C_{ср} = \frac{4 \cdot 2R + 2R\frac{5}{6}}{2} = R + R\cdot\frac{3}{6} = \frac{11}{6}R$

$A = p\Delta V = \nu R\Delta T = \nu R \cdot \frac{1}{6}T_0$

$\boxed{Q = \frac{11\nu T_0 R}{36} + \frac{\nu R T_0}{6} = \frac{17\nu T_0 R}{36}}$

1) $\boxed{Q = \nu \cdot \frac{11}{6}R \cdot \frac{1}{6}T_0 = \frac{11}{36}\nu T_0 R} > 0$

2)

$\frac{11\nu T_0 R}{36} - \frac{3}{2}\nu R T_0 = A$

~~$Q = \frac{3}{2}\nu R\Delta T$~~ $\quad C_{ср}\nu\Delta T = \frac{3}{2}\nu R\Delta T + \nu R\Delta T$???

$C_{ср} = \left(\frac{3}{2} + 1\right)R$

$C_{ср}\nu\Delta T - \frac{3}{2}\nu R\Delta T = A$???

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

$\left(\frac{RT_1}{T_0} + R\right)\nu(T_0 - T_1) - \frac{3}{2}\nu R(T_0 - T_1) = A$

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

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

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

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

$\nu R T_1 - \frac{\nu R T_0}{2} - \frac{\nu R T_1^2}{T_0} + \frac{\nu R T_1}{2} = A$

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

$A' = -2\frac{\nu R T_1}{T_0} + \frac{3}{2}\nu R = 0$

$\frac{3}{2}\nu R = 2\frac{\nu R T_1}{T_0}$ $\quad \frac{3}{4} = \frac{T_1}{T_0}$

$\boxed{T_1 = \frac{3}{4}T_0}$

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

Черновик

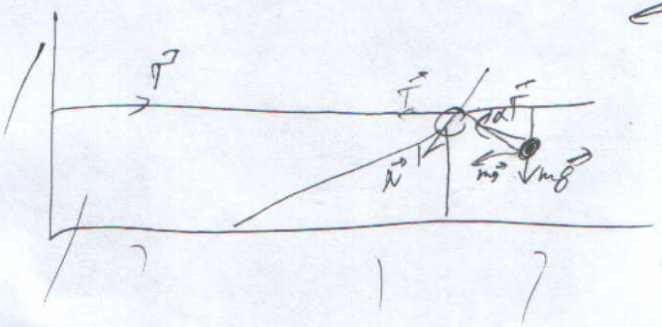
3) $(c_p \nu (T_1 - T_0) = \frac{3}{2} \nu R (T_1 - T_0) \pm A_{min}$

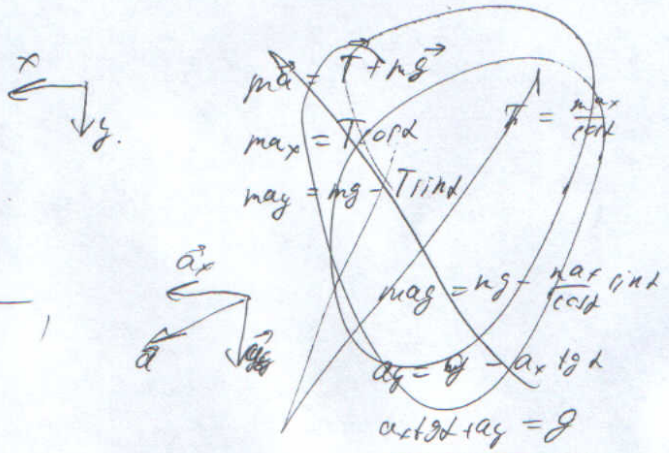
$A_{min} = \nu \left(-\frac{1}{4}R\right)\left(c_p - \frac{3}{2}R\right)$

$c_p = \frac{7K\frac{3}{4} + 2R}{2} = \frac{3}{4}R + R = \frac{7}{4}R$

$A_{min} = \Phi - \frac{\nu T_0}{4}\left(\frac{7}{4}R - \frac{6}{4}R\right) = -\frac{\nu R T_0}{16}$

№1.



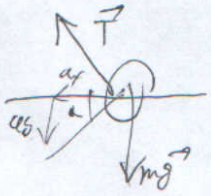


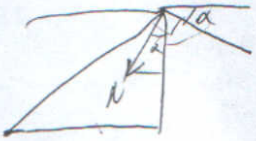
$\sin\alpha = \frac{4}{5}$

$\beta = \frac{\pi}{2} - \alpha$

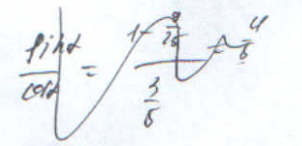
$\sin\beta = \frac{3}{5}$

$\cos\beta = \frac{4}{5}$

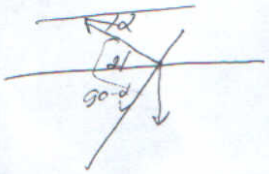




$\frac{a_y}{a_x} = \text{ctg}\alpha = \text{tg}\beta = \frac{4}{3}\frac{3}{4}$



Т.к. нить нерастяж. $a_{н} = a_x = g\cos\beta = \frac{3}{5}g$



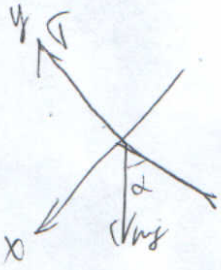
3) $ma_x = mg\sin\beta$ $\quad a_1 = g\sin\beta = \frac{3}{5}g$

$Ma_1 = ma_1$

$\frac{m}{M} = \frac{a_1}{a_1} = \frac{\frac{3}{5}mg}{\frac{5}{8}g} = \frac{3}{5}\cdot\frac{8}{5} = \frac{12}{25}$

4) $a_y = g\sin\beta = g\cdot\frac{3}{5}$

$H = \frac{at^2}{2} = \frac{g\frac{3}{5}t^2}{5\cdot 2}$ $\quad t = \sqrt{\frac{10H}{3g}}$



$a_x = g\sin\alpha$

$ma_y = T - mg\cos\alpha$

(1)

Чистовик

N1.

Дано:

ν_0, ν, T_0, R

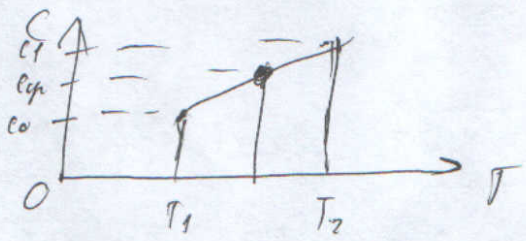
1) Q_1 - ?

2) T_1 - ?

3) A_{min}

Решение:

т.к. зависимость линейная.



$C_{ср} = \frac{C_1 + C_0}{2}$

$Q = \Delta U + A = C_{ср} \nu \Delta T$ $\quad pV = \nu RT$ $\quad \Delta U = \frac{3}{2} \nu R \Delta T$

1) $\Delta T = -\frac{1}{6} T_0$; $\quad C_{ср} = \frac{2R + 2R\frac{5}{6}}{2} = \frac{11R}{6}$

$Q = -\frac{C_{ср} \nu T_0}{6} = -\frac{11R}{6} \frac{\nu T_0}{6} = -\frac{11 \nu T_0 R}{36}$

$Q_1 = |Q| = \frac{11 \nu R T_0}{36}$ отдает газ

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

$\nu \left(R + \frac{RT_1}{T_0}\right)(T_1 - T_0) - \frac{3}{2} \nu R (T_1 - T_0) = A_{min}$

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

$\frac{T_1 \nu R T_1}{T_0} - \frac{1}{2} T_1 \nu R - \frac{T_0 \nu R T_1}{T_0} + \frac{T_0 \nu R}{2} = A_{min}$

$\frac{\nu R T_1^2}{T_0} - \frac{T_1 \nu R}{2} - \nu R T_1 + \frac{T_0 \nu R}{2} = A_{min}$

$\frac{\nu R T_1^2}{T_0} - \frac{3}{2} T_1 \nu R + \frac{T_0 \nu R}{2} = A_{min}$

$A_{min} = \frac{2 \nu R T_1}{T_0} - \frac{3}{2} \nu R = 0$

$\frac{T_1}{T_0} = \frac{3}{4}$; $\quad \boxed{T_1 = \frac{3T_0}{4}}$

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

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

$\frac{7}{4} R \nu T_0 \left(-\frac{1}{4}\right) = -\frac{3}{8} \nu R T_0 + A_{min}$

$-\frac{7 R \nu T_0}{16} + \frac{6}{16} \nu R T_0 = A_{min}$

$\boxed{A_{min} = -\frac{1}{16} \nu R T_0}$

Ответ: 1) $Q_1 = \frac{11 \nu R T_0}{36}$; 2) $T_1 = \frac{3T_0}{4}$; 3) $A_{min} = -\frac{1}{16} \nu R T_0$.

(2)

Человек

N1.

Дано:

$\cos\alpha = \frac{3}{5}$;

H

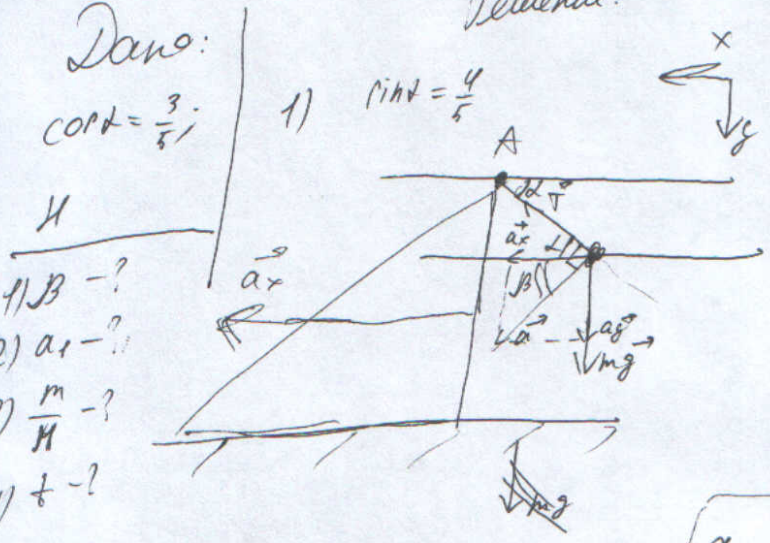
1) β – ?

2) a_1 – ?

3) $\frac{m}{M}$ – ?

4) t – ?

Решение:



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

$\Rightarrow \angle\beta = 90^\circ - \alpha \Rightarrow \cos\beta = \frac{4}{5}$, $\sin\beta = \frac{3}{5}$

2) т.к. нить нерастяжима $\Rightarrow a_к = a_1 = g\cos\beta = \frac{4}{5}g$ – ускор. клина.

3) $a_2 = \frac{g}{\sin\beta} = \frac{5g}{3}$

$Ma_1 = ma_2$

$\frac{m}{M} = \frac{a_1}{a_2} = \frac{\frac{4}{5}g}{\frac{5}{3}g} = \frac{12}{25}$

4) $a_y = g\sin^2\beta = \frac{g}{5}$; $H = \frac{at^2}{2} = \frac{3gt^2}{5\cdot 2}t \Rightarrow t = \sqrt{\frac{10H}{3g}}$

Ответ: 1) $\cos\beta = \frac{4}{5}$; 2) $a_1 = \frac{4}{5}g$; 3) $\frac{m}{M} = \frac{12}{25}$; 4) $t = \sqrt{\frac{10H}{3g}}$

Часть 2

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

Шифр: **21202421**

ID профиля: **825777**

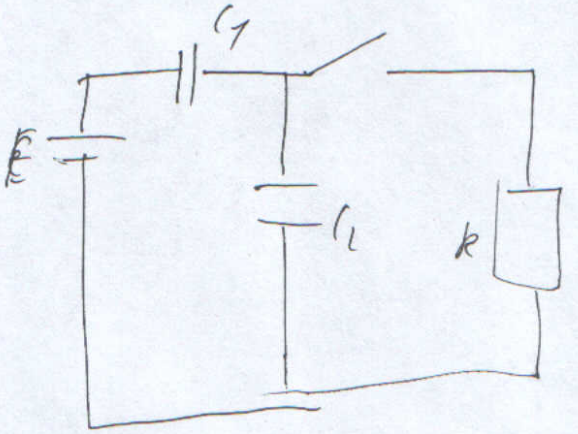
Вариант 1

Черновик

Вар

~~$E = U_2 = U_2$~~

$R, C_2 = C; C_1 = 2C$ № 3



$C = \frac{q}{U}$

1) Пусковой режим.

$q_1 = q_2 = C_1 U_1 = C_2 U_2$

$U_2 + U_1 = E \qquad U_1 = \frac{C_2 U_2}{C_1}$

$U_2 = E - U_1 = E - \frac{C_2 U_2}{C_1}$

~~$\chi = \frac{U_2}{R} = E = C_2 U_2$~~

$U_2 \left(1 + \frac{C_2}{C_1}\right) = E$

$U_2 = \frac{E}{1 + \frac{C_2}{C_1}}$

2) $C_1 C_2$ зарядили ~~от U_2~~ до E

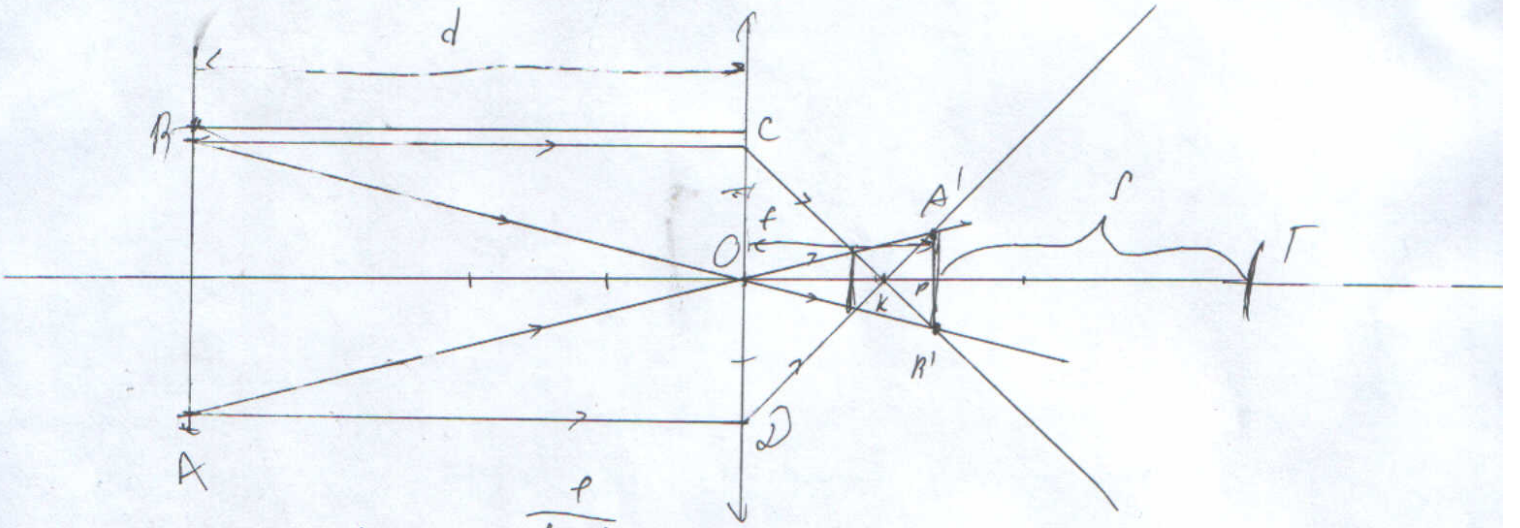
$\Delta Q = Q = C_1 E + \frac{C_1 U_1^2}{2}$

$\frac{C_2 \cdot U_2^2}{2} = \frac{C_2 E^2}{\left(1 + \frac{C_2}{C_1}\right)^2 2} = \frac{2 C_2 E^2}{\ldots}$

$\chi = \frac{U_1}{k} = \frac{E}{\left(1 + \frac{C_2}{C_1}\right) k} = \frac{E}{\frac{3}{2} k} = \frac{2E}{3k}$

3)

№ 5. $f = 24$ см



1) $\frac{1}{F} = \frac{1}{d} + \frac{1}{f} \qquad f = \frac{1}{\frac{1}{F} - \frac{1}{d}} = 0{,}12$ м

$\Rightarrow \chi = f + f = 0{,}12 + 0{,}24 =$ 0,36 м.

$OK + PK = f$

$PK = f - OK$

$OK = \frac{H \cdot (f - OK)}{H'}$

$OKH' = Hf - HOK$

$OK(H' + H) = Hf$

$OK = \frac{Hf}{\ldots} = 0{,}9 =$

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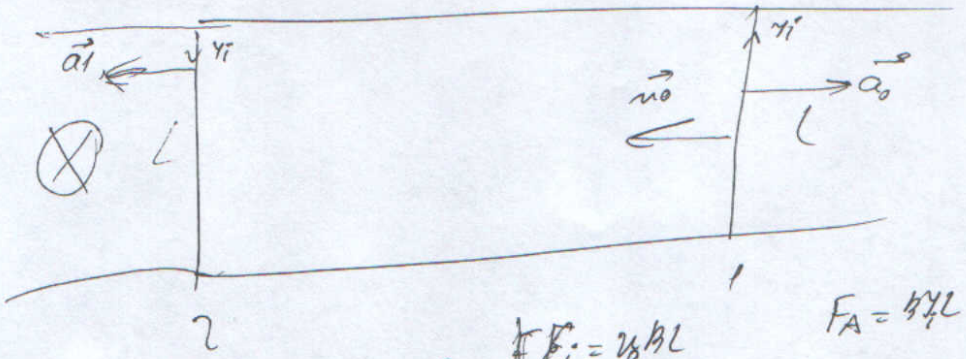
3) $\Gamma = \frac{f}{d} = \frac{H'}{H} = \frac{1}{3} \Rightarrow H' = 3$ см ; $\frac{OD}{OK} = \frac{A'B'}{PK}$

перший



$y_i = \frac{v_0 B l}{k}$

m, k, B
$2m, 2k$
L, l_0

1) a_0
2) $v - ?$
3) $S - ?$

$F_A = B y_i l$

1) ~~$\mathcal{E}_i = v_0 B l$~~

$\mathcal{E}_i = y_i R \Rightarrow F_A = B \frac{v_0 B l}{R} l = \frac{v_0 B^2 l^2}{R} = m a_0$

$$a_0 = \frac{v_0 B^2 l^2}{mR}$$ ~~$= const$~~ !

2) ~~$F_a = 2 m a_1 = B y_i l$~~ $= \frac{v_0 B^2 l^2}{2R}$

$$a_1 = \frac{v_0 B^2 l^2}{2mR}$$

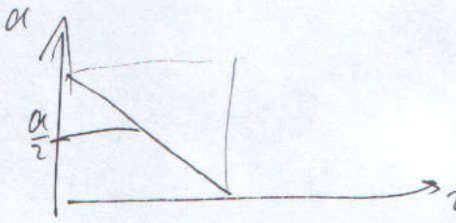
3) $v_0 - a_0 t = v a_1 t$

$v_0 - \frac{a_0}{2} t = \frac{a_1 t}{2}$

$2 v_0 = (a_0 + a_1) t$

$t = \frac{2 v_0}{a_0 + a_1}$

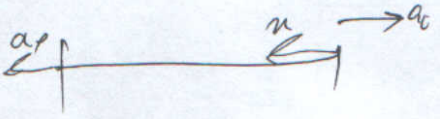
$a \sim v$



$v = v_0 - \frac{a_0}{2} t = v_0 - \frac{v_0 B^2 l^2}{2mR} \cdot \frac{2 v_0}{(a_0 + a_1)} = \frac{v_0 (v_0 B l)^2}{mR \left(\frac{v_0 B^2 l^2}{mR} + \frac{v_0 B^2 l^2}{2mR} \right)} =$

$= v_0 - \frac{v_0 B^2 l^2}{\frac{3}{2} v_0 B^2 l^2} = \frac{2 v_0}{3}$

3) $S =$ $\quad S = S_0 - v_0 t + \frac{a_1 t^2}{2} - \frac{a_0 t^2}{2}$



$S = S_0 - v_0 \cdot \frac{4mR}{3B^2 l^2} + \frac{v_0 B^2 l^2}{2 \cdot 2mR} \cdot \frac{16 m^2 R^2}{9 B^4 l^4} -$

$- \frac{4}{2} \frac{v_0 B^2 l^2}{mR} \cdot \frac{16 (mR)^2}{9 B^4 l^4} = S_0 - \frac{4 v_0 mR}{3 B^2 l^2} +$

$+ \frac{4 v_0 \cdot mR}{9 B^2 l^2} - \frac{8 v_0 mR}{9 B^2 l^2} =$

$= S_0 - \frac{4 v_0 mR}{3 B^2 l^2} - \frac{4}{9} \frac{v_0 mR}{B^2 l^2} = S_0 - \frac{16 v_0 mR}{9 B^2 l^2}$

$t = \frac{2 v_0}{\frac{v_0 B^2 l^2}{mR} + \frac{v_0 B^2 l^2}{2mR}} = \frac{2}{\frac{3}{2} \frac{B^2 l^2}{mR}} = \frac{4 mR}{3 B^2 l^2}$

(1)

Чистяков

№3

Дано:

$C_1 = C$

$C_2 = 2C$

E

1) γ_0 - ?

2) Q - ?

3) γ_1 - ?

Решение:

1) В установившем. режиме: $C = \frac{q}{U}$

$q_1 = q_2 = C_1 U_1 = C_2 U_2$

$U_2 + U_1 = E$; $U_1 = \frac{C_2 U_2}{C_1}$

$U_2 = E - U_1 = E - \frac{C_2 U_2}{C_1}$

$U_2 \left(1 + \frac{C_2}{C_1}\right) = E$

$U_2 = \frac{E}{1 + \frac{C_2}{C_1}}$

$\gamma_0 = \frac{U_2}{k} = \frac{E}{\left(1 + \frac{C_2}{C_1}\right)k} = \frac{E}{\frac{3}{2}k} = \boxed{\frac{2E}{3k}}$

2) $\frac{C_2 U_2^2}{2} = Q = \frac{C_2 E^2}{\left(1 + \frac{C_2}{C_1}\right)^2} = \boxed{2 C_2 E^2}$

Ответ: 1) $\gamma_0 = \frac{2E}{3k}$; 2) $Q = 2 C_2 E^2$

(2)

Чистовик.

N 4.

Дано:

$m, 2m, k, 2k, B, l, \rho_0$

1) a_0 - ?

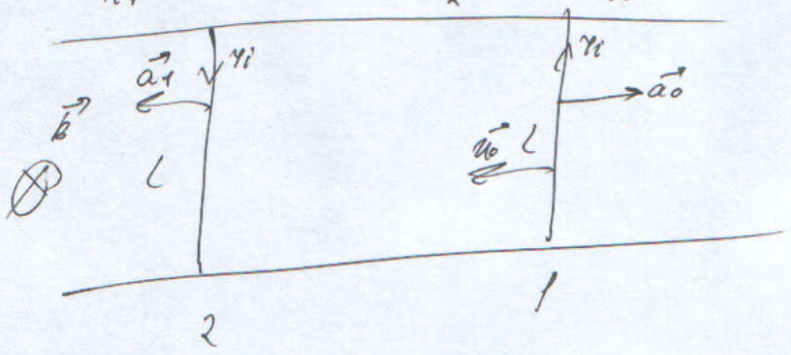
2) u - ?

3) ρ - ?

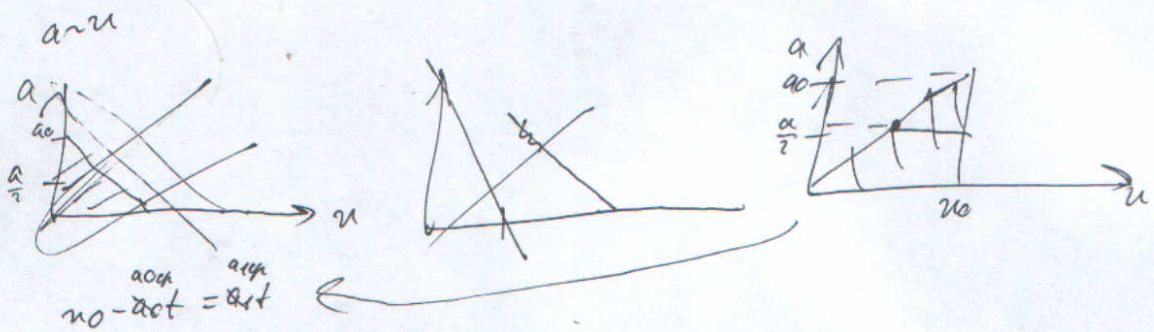
Решение:

1) $\mathcal{E}_i = u_0 B l$ $\quad F_A = IBl$

$q_i = \gamma_{ik} \Rightarrow R_A = \frac{B u_0 B l^2}{k} = \frac{u_0 B^2 l^2}{k} = m a_0 \Rightarrow \boxed{a_0 = \frac{u_0 B^2 l^2}{mk}}$



2) $2m a_1 = BI_i l = \frac{u_0 B^2 l^2}{2k} \Rightarrow a_1 = \frac{u_0 B^2 l^2}{2k}$



$u_0 - a_{0ср} t = a_{1ср} t$

$u_0 - \frac{a_0}{2} t = \frac{a_1}{2} t$

$2u_0 = (a_0 + a_1) t$

$t = \frac{2u_0}{a_0 + a_1} \Rightarrow u = u_0 - \frac{a_0}{2} t = u_0 - \frac{u_0 B^2 l^2 \cdot 2k}{2mk (a_0 + a_1)} = \frac{u_0 u_0 (u_0 B l)^2}{mR \left(\frac{u_0 B^2 l^2}{mR} + \frac{u_0 B^2 l^2}{2mk}\right)} =$

$= u_0 - \frac{u_0^2 B^2 l^2}{\frac{3}{2} u_0 B^2 l^2} = \boxed{\frac{u_0}{3}}$

3) 

$\rho = \rho_0 - u_0 t + \frac{a_1 t^2}{2} - \frac{a_0 t^2}{2}$;

$\rho t = \frac{2u_0}{\frac{u_0 B^2 l^2}{mR} + \frac{u_0 B^2 l^2}{2mk}} = \frac{4mk}{3B^2 l^2}$;

$\rho = \rho_0 - u_0 \frac{4mk}{3B^2 l^2} + \frac{u_0 B^2 l^2}{2 \cdot 2mk} \cdot \frac{16 m^2 k^2}{9 B^4 l^4} -$

$- \frac{u_0 B^2 l^2}{4mk} \cdot \frac{4 (mk)^2}{9 B^4 l^4} = \boxed{\rho_0 - \frac{4 u_0 mk}{9 B^2 l^2}}$

Ответ: 1) $a_0 = \frac{u_0 B^2 l^2}{mk}$; 2) $u = \frac{u_0}{3}$; 3) $\rho = \rho_0 - \frac{4 u_0 mk}{9 B^2 l^2}$

(3) чистовик

№5.

Дано:

$F = 0{,}09$ м

$H = 0{,}09$ м

$d = 0{,}36$ м

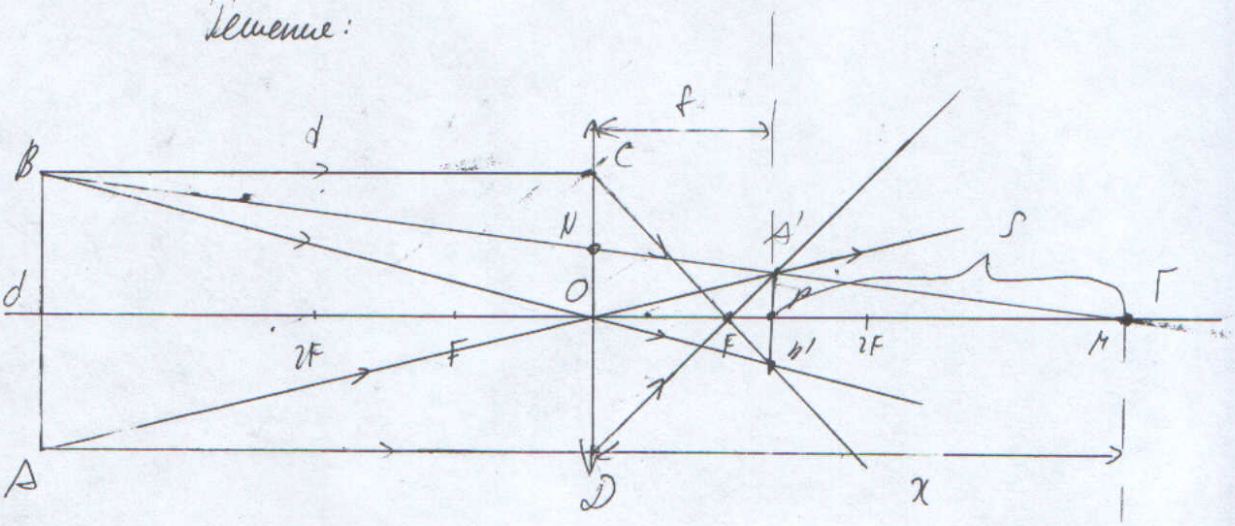
$f = 0{,}24$ м

1) x – ?

2) Δm – ?

3) f_1 – ?

Решение:



1) $\frac{1}{F} = \frac{1}{d} + \frac{1}{f} \Rightarrow f = \frac{F}{\frac{1}{F} - \frac{1}{d}} = 0{,}12$ м

2) $\Rightarrow x = f + f = 0{,}12 + 0{,}24 = 0{,}36$ (м)

2) $\frac{O'M}{BO'} = \frac{OM}{NO}$ $NO = \frac{OM \cdot BO'}{O'M} = \Delta m = 0{,}048$ м

3) Экран нужно поместить в точке фокуса справа от линзы, так как лучи не пересекутся и изображение не получится. $f = F$

ΔCFD и $\Delta FA'B'$:

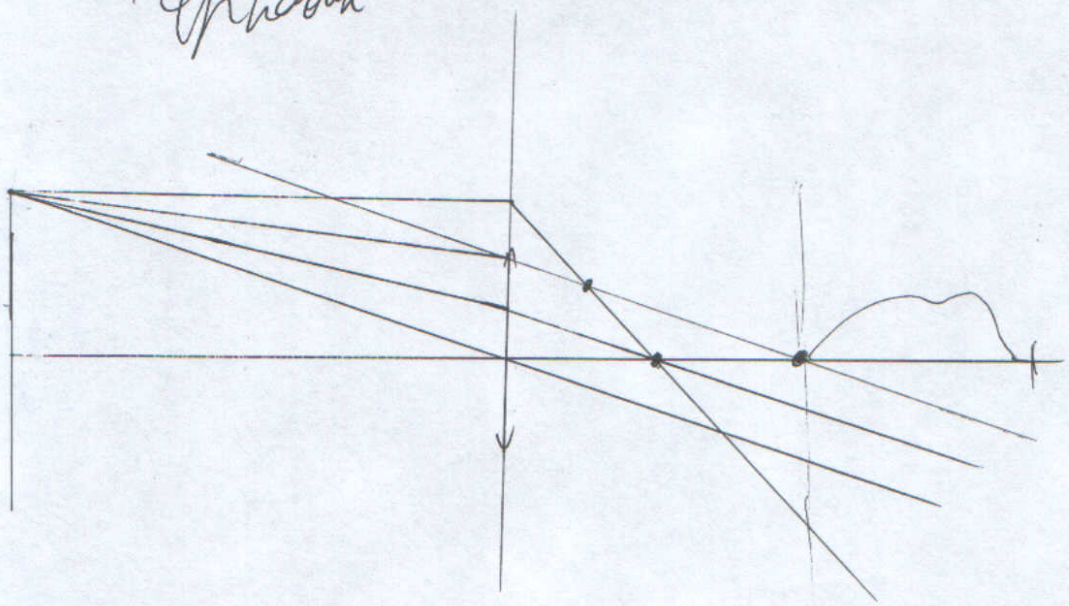
$OP = 0{,}12$ м $\quad CD = H \quad A'B' = H' \quad \Gamma = \frac{f}{d} = \frac{1}{3} = \frac{H'}{H} \Rightarrow H' = 0{,}03$ м

$\frac{H}{OF} = \frac{H'}{f - F} \quad \frac{0{,}09}{0{,}09} = \frac{0{,}03}{0{,}03}$

$1 = 1$

Ответ: 1) $x = 0{,}36$ м; 2) $\Delta m = 0{,}048$ м $= 4{,}8$ см; 3) $f_1 = F = 0{,}09$ м со стороны изображения (справа от линзы)

Чертеж



$$\frac{0{,}36 + 0{,}36}{9} = \frac{0{,}36}{D_л} \qquad D_л = 4{,}5\ см$$