Часть 1

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

Шифр: **21202524**

ID профиля: **319163**

Вариант 4

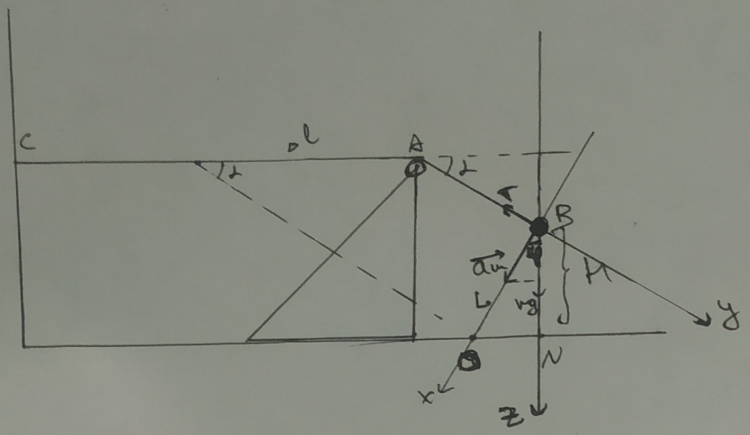
Вариант 11-04 Числовик Физика 11 класс

№1

$\cos\alpha = \frac{8}{17}$

M

1) φ - ?
2) $a_{кл}$ - ?
3) $\frac{m}{M}$ - ?
4) t - ?



1) т.к. $L = const$, т.е. ускорение шара не выйет на L, то $\overrightarrow{a_{кл}} \perp$ нити, т.е. $\varphi = \alpha$ и $\cos\varphi = \cos\alpha = \frac{8}{17}$

2) Пусть $OB = L$, тогда перемещение шара: Δl и $\sin\alpha = \frac{L}{\Delta l}$

тогда $L = \Delta l \sin\alpha$, т.е $a_{кл} = a_{кл} \cdot \sin\alpha$

$a_{кл} = \frac{a_{кл}}{\sin\alpha}$

∑ 3. Ньютона на оси: OX: $Ma_{кл} = Mg\cos\alpha$ } ⇒
(оси, как показано на рис.) OY: $T = mg\sin\alpha$ }

⇒ $a_{кл} = g\cos\alpha$ тогда $a_{кл} = \frac{g\cos\alpha}{\sin\alpha} = g \cdot \frac{1}{tg\alpha} = g \cdot \frac{8}{15} \approx 5{,}3\ м/с^2$

$\sin\alpha = \sqrt{1 - \frac{64}{17^2}} = \frac{15}{17}$

$tg\alpha = \frac{15}{8}$;

3)

4) $H = \frac{a_{кл} t^2}{2}$, где $a_{кл} = a_{кл} \cdot \cos\alpha = g\cos^2\alpha$

$\frac{2H}{g\cos^2\alpha} = t^2$ $t = \sqrt{\frac{2H}{g\cos^2\alpha}} = \frac{\sqrt{2}}{\sqrt{g}\cos\alpha} \cdot \sqrt{H} = \frac{17}{8} \cdot \frac{1}{\sqrt{10}}\sqrt{H} \approx 0{,}95\sqrt{H}$

Ответ: 1) $\cos\varphi = \frac{8}{17}$; 2) $a_{кл} = \frac{8}{15}g \approx 5{,}3\ м/с^2$; 3) —; 4) $t = \sqrt{\frac{2H}{g\cos^2\alpha}} \approx 0{,}95\sqrt{H}$

№2

ν
T_0
$C(T) = \frac{9}{5}R\frac{T}{T_0}$

1) Q_1-?
2) T-?
3) A_{min}-?

1) $dQ = \nu C dT$

$dQ = \nu \cdot \frac{9}{5}R\frac{T}{T_0}dT \Rightarrow$ ~~$Q_1 = \nu\frac{9}{5}R\cdot\frac{1}{T_0}\left(\frac{T^2}{2}\right)$~~

$\Rightarrow |Q_1| = \left|\frac{9}{5}\frac{\nu R}{T_0}\cdot\frac{T^2}{2}\right|_{T_0}^{\frac{7}{4}T_0}| \Rightarrow Q_1 = \frac{9}{5}\frac{\nu R}{T_0}\left(\frac{T_0^2 - \frac{9}{16}T_0^2}{2}\right)$

$Q_1 = \frac{9}{10}\frac{\nu R}{T_0}\cdot T_0^2\left(\frac{7}{16}\right)$; $Q_1 = \frac{63}{160}\nu R T_0$

2) $dA = dQ - dU$ (из I начала термодинамики) ; $dU = \frac{3}{2}\nu R dT$

$dA = \frac{9}{5}\frac{\nu R}{T_0}T dT - \frac{3}{2}\nu R dT \Rightarrow A = \frac{9}{10}\frac{\nu R}{T_0}(T^2 - T_0^2) - \frac{3}{2}\nu R(T - T_0)$

$A = \frac{9}{10}\frac{\nu R}{T_0}\cdot T^2 - \frac{3}{2}\nu R T - \frac{9}{10}\nu R T_0 + \frac{3}{2}\nu R T_0$

$A(T) = \frac{9}{10}\frac{\nu R}{T_0}T^2 - \frac{3}{2}\nu R T + \frac{6}{10}\nu R T_0$

$A'(T) = \frac{9}{10}\frac{\nu R}{T_0}\cdot 2T - \frac{3}{2}\nu R$; при A_{min} $A'(T) = 0$, т.е:

$\frac{18}{10}\frac{\nu R}{T_0}\cdot T - \frac{3}{2}\nu R = 0 \Leftrightarrow \frac{18}{10}\frac{T}{T_0} = \frac{3}{2} \Rightarrow T = \frac{1}{3}\cdot\frac{10}{18}\cdot 6\, T_0 = \frac{5}{6}T_0$

$T = \frac{5}{6}T_0$

3) $A_{min} = A\left(T = \frac{5}{6}T_0\right) = \frac{9}{10}\frac{\nu R}{T_0}\cdot\frac{25}{36}T_0^2 - \frac{3}{2}\nu R\cdot\frac{5}{6}T_0 + \frac{6}{10}\nu R T_0 =$

$= 0{,}625\nu R T_0 - 1{,}25\nu R T_0 + 0{,}6\nu R T_0 = -0{,}025\nu R T_0$

Ответ: 1) $Q_1 = \frac{63}{160}\nu R T_0 \approx 0{,}4\nu R T_0$; 2) $T = \frac{5}{6}T_0 \approx 0{,}83T_0$; 3) $A_{min} = -0{,}025\nu R T_0$

Вариант 11-04 Черновик Фунина 11 класс

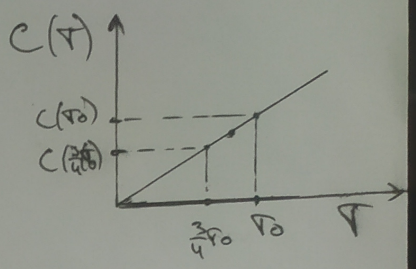
N2

$C(T) = \frac{9}{5}R\frac{T}{T_0}$

1) $T_0 \to \frac{3}{4}T_0$
$Q_1 - ?$
2) $T - ?$ A_{min}
3) $A_{min} - ?$

1) $Q = \nu C \Delta T$ $\quad C(T) = \frac{9}{5}R\frac{T}{T_0}$

~~$Q = \nu\frac{5}{2}R$~~ $C_{ср}(T_0;\frac{3}{4}T_0) = \frac{9}{5}R\,\frac{T_0+\frac{3}{4}T_0}{2}\cdot\frac{1}{T_0}$



$C_{ср}$

$dQ = \nu\cdot\frac{9}{5}R\frac{T}{T_0}dT$

$dQ = \frac{9}{5}\frac{\nu R}{T_0}\cdot T\,dT$

$Q = \frac{9}{5}\frac{\nu R}{T_0}\frac{T^2}{2}$; $Q_1 = \frac{9}{5}\frac{\nu R}{T_0}\frac{T^2}{2}\Big|_{\frac{3}{4}T_0}^{T_0}$

$Q_1 = \frac{9}{5}\frac{\nu R}{T_0}\cdot\frac{(T_0^2-\frac{9}{16}T_0^2)}{2}$; $Q_1 = \frac{9}{5}\frac{\nu R}{T_0}\frac{7T_0^2}{32}$; $Q_1 = \frac{63}{160}\nu R T_0$

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

$dA = dQ - dU$; $dA = \frac{9}{5}\frac{\nu R}{T_0}\cdot T\,dT - \frac{3}{2}\nu R\,dT$

$A = \frac{9}{5}\frac{\nu R}{T_0}\cdot\frac{T^2}{2}\Big|_{T_0}^{T} - \frac{3}{2}\nu R T\Big|_{T_0}^{T}$

$A = \frac{9}{10}\frac{\nu R}{T_0}(T^2-T_0^2) - \frac{3}{2}\nu R(T-T_0)$

$A(T) = \frac{9}{10}\frac{\nu R}{T_0}(T^2-T_0^2) - \frac{3}{2}\nu R(T-T_0)$; $A(T) = \frac{9}{10}\frac{\nu R}{T_0}T^2 - \frac{9}{10}\nu R T_0^2 - \frac{3}{2}\nu R T + \frac{3}{2}\nu R T_0$

$A(T) = \frac{9}{10}\frac{\nu R}{T_0}T^2 - \frac{3}{2}\nu R T + \frac{6}{10}\nu R T_0$ $\quad x_0 = \frac{\frac{3}{2}\nu R T}{2\cdot\frac{9}{10}\frac{\nu R}{T_0}} = \frac{3\cdot 10^5}{2\cdot 7\cdot 8}T_0 = \frac{15}{18}T_0$

$A'(T) = \frac{9}{10}\frac{\nu R}{T_0}2T - \frac{3}{2}\nu R$ $\quad A'(T)=0$: $\frac{18}{10}\frac{\nu R T}{T_0} - \frac{15}{10}\nu R = 0$

$\frac{18\nu R T}{T_0} = 15\nu R$ $\quad T = \frac{15}{18}T_0$

3) A_{min} $\quad A_{min} = A(T=\frac{15}{18}T_0) = \frac{9}{10}\frac{\nu R}{T_0}\left(\frac{15^2}{18^2}T_0^2 - T_0^2\right) - \frac{3}{2}\nu R\left(\frac{15}{18}T_0 - T_0\right) =$

Часть 2

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

Шифр: **21202524**

ID профиля: **319163**

Вариант 4

Чистовик Физика 11-04 ①

№3

$C_2 = C$

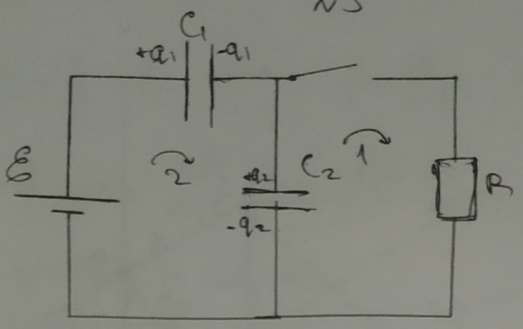
$C_1 = 5C$

1) Σ_{R_1} - ?

2) Q - ?

3) ~~C_2~~

Σ_0 ; Σ_{R_2} - ?



1) Сразу после замыкания ↑ $U_R - U_{C_2} = 0$ по правилу Кирхгофа

$\Sigma_{R_1} R = U_{C_2}$

↻ $\varepsilon = U_{C_1} + U_{C_2}$

Закон сохранения заряда (ключ ~~2~~, разомкнут):

$q_2 - q_1 = 0 \qquad q_2 = q_1$; $U_{C_1} = \frac{q_1}{C_1}$, $U_{C_2} = \frac{q_2}{C_2} = \frac{q_1}{C_2}$

$\varepsilon = q_1\left(\frac{1}{C_1} + \frac{1}{C_2}\right) = q_1 \frac{6}{5} \frac{1}{C}$; $q_1 = \frac{5}{6}\frac{\varepsilon}{C}C$; $U_{C_2} = \frac{5}{6}\frac{\varepsilon C}{C} = \frac{5}{6}\varepsilon$

$\Sigma_{R_1} = \frac{U_{C_2}}{R} = \frac{5}{6}\frac{\varepsilon}{R}$ $\qquad U_{C_1} = \frac{1}{6}\varepsilon$

2) $A_{ист} - Q = W_2 - W_1$

$W_1 = \frac{C_1 U_1^2}{2} + \frac{C_2 U_2^2}{2}$; $W_2 = \frac{C_1 U_3^2}{2} + \frac{C_2 U_4^2}{2}$

Конденсатор 1 зарядится до $U_3 = \varepsilon$, а конденсатор 2 разрядится через резистор

$A_{ист} = \Delta q_1 \varepsilon = (q_3 - q_1)\varepsilon = (\varepsilon C_1 - U_1 C_1)\varepsilon = \varepsilon^2(5C - \frac{5}{6}C) = \frac{25}{6}\varepsilon^2 C$

$U_4 = 0$

$Q = W_2 - W_1 + A_{ист}$ ~~$\frac{5C(\frac{1}{6}\varepsilon)^2}{2} + \frac{C(\frac{5}{6}\varepsilon)^2}{2}$~~

$Q = \frac{5C\varepsilon^2}{2} + 0 - \frac{5C(\frac{1}{6}\varepsilon)^2}{2} - \frac{C(\frac{5}{6}\varepsilon)^2}{2} + \frac{25}{6}\varepsilon^2 C = \frac{5}{2}C\varepsilon^2 - \frac{5}{72}C\varepsilon^2 - \frac{25}{72}C\varepsilon^2 + \frac{25}{6}C\varepsilon^2 =$

$= C\varepsilon^2\left(\frac{100}{72} + \frac{25}{6}\right) = 6{,}25\,C\varepsilon^2$

Ответ: 1) $\Sigma_{R_1} = \frac{5}{6}\frac{\varepsilon}{R}$; 2) $Q = 6{,}25\,C\varepsilon^2$

Чистовик Физика И-04 (2)

$B; L; v_0$

$m_1, 2m$

$m_2 = \frac{m}{2}$

$R_1 = R$

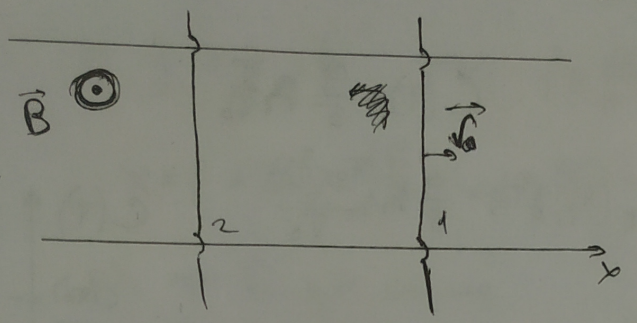
$R_2 = 5R$

1) a_1 - ?

2) $v_1; v_2$ - ?

3) ΔL - ?

N4



1) $\mathcal{E}_0 = \frac{d\Phi_B}{dt} = \frac{BdS}{dt} = \frac{BLdx}{dt} = BLv_0$

по контуру начнёт течь ток I_0

$\mathcal{E}_0 = I_0 R_2 + I_0 R_1$; $I_0 = \frac{\mathcal{E}_0}{R_1 + R_2}$

$I_0 = \frac{\mathcal{E}}{6R}$

2 з. Ньютона на Ob: $m_1 a_1 = F_A$; $F_A = I_0 L B$

$m_1 a_1 = \frac{\mathcal{E}_0}{6R} L \cdot B$; $a_1 = \frac{BLv_0}{6Rm_1} \cdot LB$; $a_1 = \frac{B^2 L^2 v_0}{12Rm}$

2) перемычки будут отталкиваться, т.к. по ним течёт ток противоположного направления

Ответ: 1) $a_1 = \frac{B^2 L^2 v_0}{12Rm}$

Вариант 4 Чистовик Физика 11 класс

№5

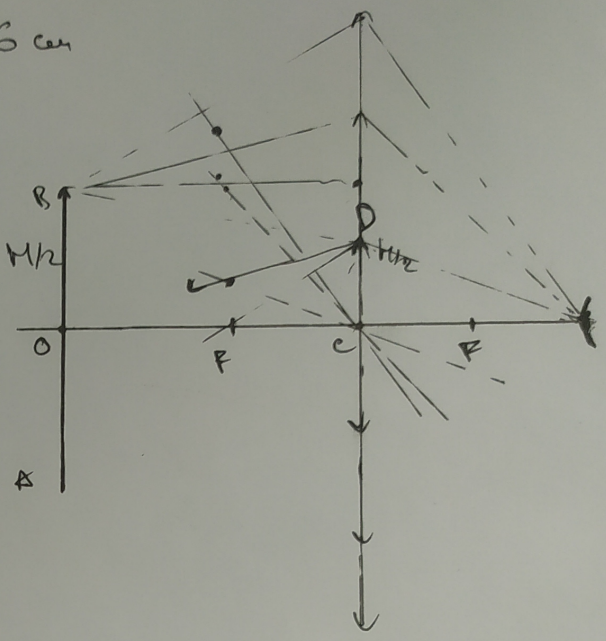
$R = 24$ см
$H = 9$ см
$d = L_1 = 32$ см
$L_2 = 24$ см

$x - ?$
$D_M - ?$
$L_3 - ?$

1) $\frac{1}{d} + \frac{1}{f} = \frac{1}{F} \Rightarrow f = \frac{dF}{d-F} = 32$ см

$x = f + L_2 = \frac{dF}{d-F} + L_2 = 56$ см

2) при $D_M \leq H$ мы не увидем изобр.



Ответ: 1) $x = \frac{dF}{d-F} + L_2 = 56$ см

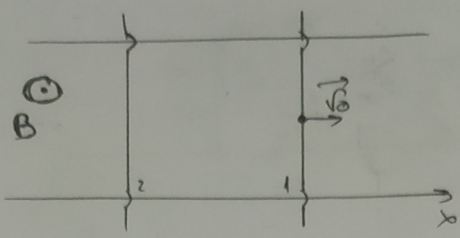
Вариант 4-ая

Черновик

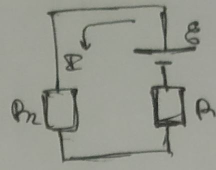
№5

(1)

L, R $m_1 = 2m$, $R_1 = R$ $m_2 = m/2$, $R_2 = 5R$ v_0, B
1) a_1
2) v_1, v_2 – ?
3) Q



1) $\mathcal{E} = \frac{d\Phi_B}{dt} = \frac{B\,dS}{dt} = \frac{BL\,dx_1}{dt} = BLv_0$



; $\mathcal{E} = I_0 R_2 + I_0 R_1$

$I_0 = \frac{\mathcal{E}}{R_1 + R_2} = \frac{\mathcal{E}}{6R}$

$F_A = I_0 v_0 B = \frac{\mathcal{E}}{6R} v_0 B$

$m a_1 = F_A$; $a_1 = \frac{F_A}{m_1} = \frac{\mathcal{E} v_0 B}{6R \cdot 2m} = \frac{1}{2} \mathcal{E} v_0 B$

2) ЗСЭ: $\frac{m_1 v_0^2}{2} = \frac{m_2 v_2^2}{2} + \frac{m_1 v_1^2}{2}$

ЗСИ: $m_1 v_0 = m_1 v_1 - v_2 v_2$

$\Leftrightarrow \begin{cases} \frac{2m v_0^2}{2} = \frac{m v_2^2}{4} + \frac{2m v_1^2}{2} \\ 2m v_0 = 2m v_1 - \frac{m}{2} v_2 \end{cases}$

$\begin{cases} 4v_0^2 = 4v_1^2 + v_2^2 \\ 4v_0 = 4v_1 - v_2 \end{cases} \Leftrightarrow \begin{cases} v_2 = 4(v_1 - v_0) \\ v_2^2 = 4(v_0^2 - v_1^2) \end{cases}$

$v_2 = \frac{(v_0 - v_1)(v_0 + v_1)}{(v_1 - v_0)} = -v_0 - v_1$

$4v_0^2 = 4v_1^2 + 16(v_1 - v_0)^2$

$4v_0^2 = 4v_1^2 + 16v_1^2 - 32 v_1 v_0 + v_0^2$

$-v_0 - v_1 = 4v_1 - 4v_0$; $3v_0 = 5v_1$; $v_1 = \frac{3}{5} v_0$

~~$v_2 = 4 \cdot \frac{3}{5} v_0 =$~~ $v_2 = 4\left(\frac{3}{5} v_0 - v_0\right) = -\frac{8}{5} v_0$

$4 \cdot v_0^2 = 4 \cdot \frac{9}{25} v_0^2 + \frac{64}{25} v_0^2$;

3)

Вариант 11-04 Черновик (2)

№4

$C_1 = 5C$

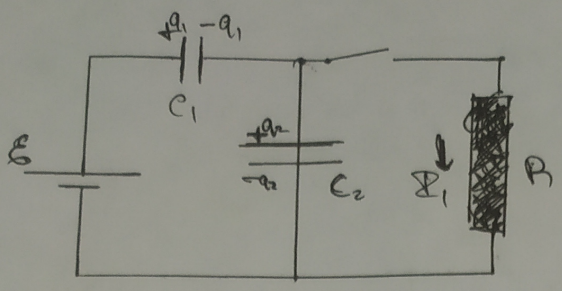
$C_2 = C$

1) $\mathcal{E}_1$ - ?

2) Q - ?

3) ~~$\mathcal{E}$~~

$\mathcal{E}_A$ - ?



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

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

$q_1 = q_2 = q_0$

$\mathcal{E} = \frac{q_0}{5C} + \frac{q_0}{C}$; $\mathcal{E} = \frac{6}{5}\frac{q_0}{C}$

~~$U_1 = \frac{q_0}{C_1} = \frac{\mathcal{E}_1}{6} = \frac{5}{6}$~~

$\frac{U_1}{U_2} = \frac{C_2}{C_1} = \frac{1}{5}$

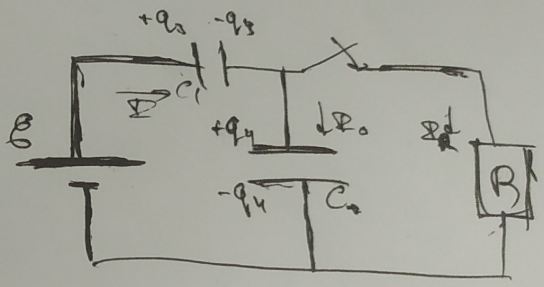
$U_1 = \frac{q_0}{C_1} = \frac{5}{6}\mathcal{E}\,C/5C = \frac{1}{6}\mathcal{E}$; $q_0 = \mathcal{E}C\frac{5}{6}$

$U_2 = \frac{5}{6}\mathcal{E}$

$\mathcal{E}_1 R = U_2$; $\mathcal{E}_1 = \frac{U_2}{R} = \frac{5}{6}\frac{\mathcal{E}}{R}$

2) $A_{ист} - Q = W_2 - W_1$

$W_1 = \frac{C_1 U_1^2}{2} + \frac{C_2 U_2^2}{2}$;



3) $\mathcal{E} = U_1 + \mathcal{E}_A R$

$\mathcal{E}_A R = ~~\frac{5}{6}~~ U_2$; $U_2 = \frac{q_4}{C_2}$

Черновик Ч-04

(3)

№5

$F = 24$ см

$H = 9$ см

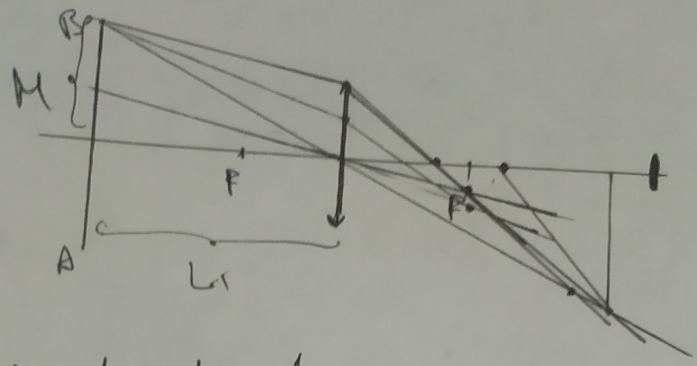
$d = L_1 = 96$ см

$L_2 = 24$ см

1) X – ?

2) D_M – ?

3) L_3)



1) $\frac{1}{d} + \frac{1}{f} = \frac{1}{F}$ $\quad f = \frac{dF}{d-F} = \frac{96 \cdot 24}{96-24} = 32$ см

$X = f + L_2 = 32 + 24 = 56$ см

$\Gamma = \frac{f}{d} = \frac{32}{96} = \frac{1}{3}$

2) $f_2 = 56$ см

$\Gamma_2 = \frac{56}{32} =$