Часть 1

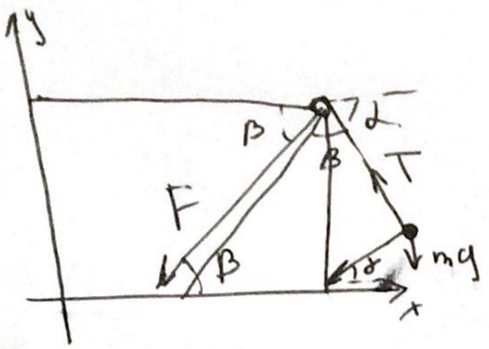
Олимпиада: **Физика, 11 класс (1 часть)**

Шифр: **21202988**

ID профиля: **144226**

Вариант 3

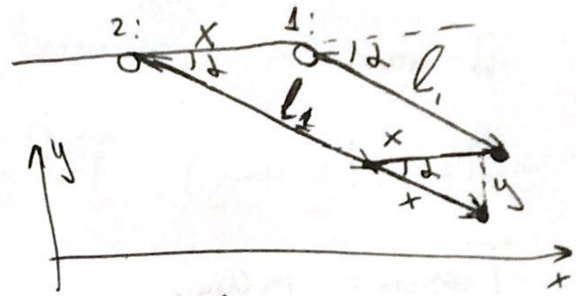
Чистовик Ф11-4-0406



Клин: M; $a_к$:

Шар: m; $a_ш$.

1) Рассмотрим перемещение



По оси Ox система сместилась на x

Тогда $l_2 = l_1 + x$; перемещение по Oy, тогда $y = \sin\alpha \cdot x$

Т.к изначально система покоится, то

$$\frac{a_{шy}}{a_{шx}} = \frac{y}{x} = \sin\alpha \quad ; \; a_{шy} = a_ш \cdot \sin\gamma \; ; \; a_{шx} = a_ш \cdot \cos\gamma$$

$$\operatorname{tg}\gamma = \sin\alpha$$

$$\gamma = \operatorname{arctg}(\sin\alpha) \Rightarrow \operatorname{tg}\gamma = \frac{12}{13}$$

2) Кинемат связь: $a_к = a_{шx}$

Из второго закона Ньютона для шара

Ox: $T\cos\alpha = m a_ш \cos\gamma$

Oy: $T\sin\alpha - mg = -m a_ш \sin\gamma$

№2 ~~Чистовик~~ Черновик Ф11-Y-0406

1) $Q(T) = C(T)\nu T$

Рассмотрим dT, тогда $\delta Q = 3\nu R \frac{T}{T_0} dT$

Интегрируем: $\int_Q^0 \delta Q = \int_{T_0}^{T} \frac{3\nu RT}{T_0} dT$

$$-Q_1 = \frac{3}{2}\frac{\nu R}{T_0}\left(T^2 - T_0^2\right)$$

$T = \frac{3}{5}T_0$; $-Q_1 = \frac{3}{2}\nu RT_0\left(\frac{9}{25} - 1\right)$

$$Q_1 = \frac{3\cdot 16}{2\cdot 25}\nu RT_0 = \frac{24}{25}\nu RT_0$$

2)

$Q = A + \Delta U$

$Q = \frac{3}{2}\frac{\nu R}{T_0}(T^2 - T_0^2)$ – кол-во теплоты отданное газом при уменьшении температуры до T.

$\Delta U = \frac{3}{2}\nu R(T - T_0)$

$A = Q - \Delta U$

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

$A_{min} \Rightarrow A'(T) = 0$;

$A'(T) = \frac{3\nu RT}{T_0} - \frac{3}{2}\nu R = 0$; $\frac{T}{T_0} = \frac{1}{2}$

$T' = \frac{T_0}{2}$

3) $A(T) = A\left(\frac{T_0}{2}\right) = A_{min} = -\frac{3}{2}\nu RT_0\cdot\frac{3}{4} + \frac{3}{2}\nu RT_0\cdot\frac{1}{2} = -\frac{3}{8}\nu RT_0$

Ответ: 1) $Q_1 = \frac{24}{25}\nu RT_0$; 2) $T = \frac{T_0}{2}$; 3) $A_{min} = -\frac{3}{8}\nu RT_0$

3

$A(T) = 3$? Черновик ФП11-Y-04а

$Q = A + \Delta U$

$A = Q - \Delta U$

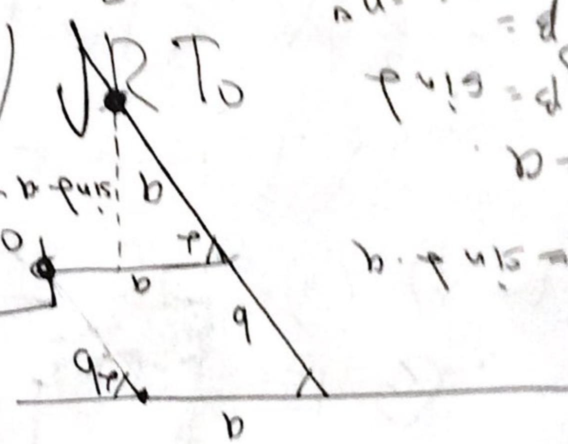
$A = 3\nu R \frac{T\,dT}{T_0} - \frac{3}{2}\nu R \Delta T$

$T = \frac{T_0}{4}$ - Правда?

$A(T) = 3\nu R T_0 \frac{1}{16} + \frac{3}{2}\nu R T_0 \cdot \frac{3}{4}$ $\Delta U = \frac{3}{2}\nu R(T - T_0)$

$\left(\frac{3}{16} + \frac{18}{16}\right)\nu R T_0$

$\frac{21}{16}\nu R T_0$

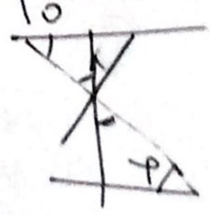


2) $Q = A + \Delta U$

$3\nu R \frac{T\,dT}{T_0} = A + \frac{3}{2}\nu R(T - T_0)$

$A = 3\frac{\nu R (T\,dT)}{T_0} - \frac{3}{2}\nu R(T - T_0)$

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



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

$$A(T)' = \cancel{\frac{3}{2}\nu R}\frac{2T}{T_0} - \cancel{\frac{3}{2}\nu R} = 0$$

$$\frac{2T}{T_0} = 1$$

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

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

$$-\frac{3}{2}\nu R \cdot \frac{3}{4}T_0 + \frac{3}{2}\nu R\frac{T_0}{2}$$

$$\nu R T_0\left(\frac{3}{4} - \frac{9}{8}\right) \qquad \frac{6-9}{8} = -\frac{3}{8}\nu R T_0$$

$\cos\alpha$

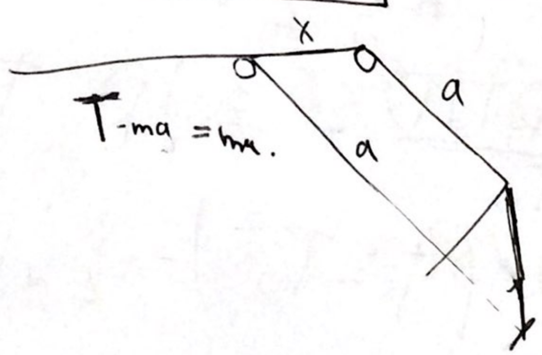
$\frac{3}{4}\left(1 - \frac{1}{2}\right)$ 9 - ?

$F = m\vec{a}$

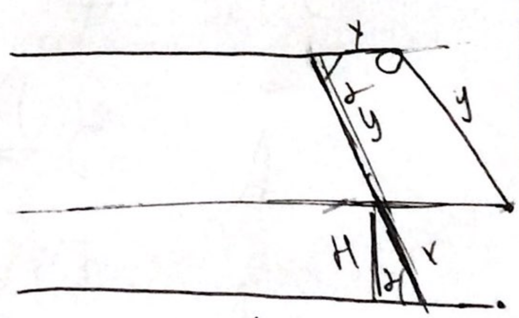
время?

$\cos\beta = dy$

$\downarrow g \quad \beta = \arccos dg.$



cos



$\sin\alpha = \frac{x}{H}$

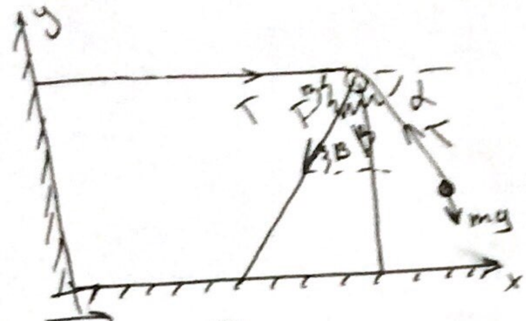
$t = \sqrt{\frac{144\cdot 2H}{5\cdot 13 g}}$

$$\frac{12}{13} = \frac{g\frac{5}{12}t^2}{H\cdot 2}$$

№1 Ф11-Y-0406

Клин: M; $a_к$

Шар: m; $a_ш$



1) $\vec{F} = m\vec{a}$ для m:

На O_y: $T\sin\alpha - mg = -ma_{шy}$

O_x: $-T\cos\alpha = -ma_{шx}$

$$T = \frac{ma_{шx}}{\cos\alpha}$$

$$ma_{шx}\,tg\,\alpha - mg = -ma_{шy}$$

$a_{шx}\,tg\,\alpha + a_{шy} = g$; Пусть $a_{шx} = a_ш \cdot \cos\gamma \Rightarrow a_{шy} = a_ш \cdot \sin\gamma$

$$a_ш(\cos\gamma \cdot \sin\alpha + \cos\alpha \cdot \sin\gamma) = g\cos\alpha$$

$$a_ш \sin(\alpha + \gamma) = g\cos\alpha$$

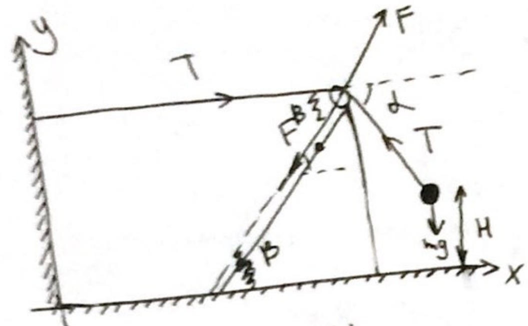
$$\sin(\alpha + \gamma) = \frac{g}{a_ш}\cos\alpha$$

№1

Ф11-7-0406

~~Чистовик~~

№1



Клин: M ; $a_к$

Шар: m ; $a_ш$

1) Второй закон Ньютона для шара

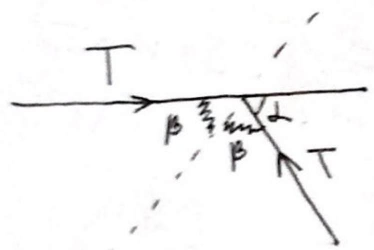
Oy: $T\sin\alpha - mg = m a_{шy}$; $T = \dfrac{m(g + a_{шy})}{\sin\alpha}$

Ox: $-T\cos\alpha = -a_{шx}\cdot m$

$$a_{шx} = \frac{T}{m}\cos\alpha = g\,\mathrm{ctg}\,\alpha, \quad \mathrm{ctg}\,\alpha = \frac{5}{12};\ \mathrm{arctg}\left(\frac{5}{12}\right)$$

2) $a_{шx} = a_к = g\,\mathrm{ctg}\,\alpha = \dfrac{\cancel{50}\ 25}{\cancel{12}\ 6}\ \dfrac{м}{с^2} = \dfrac{25}{6}\ \dfrac{м}{с^2}$ (Кинемат связь)

3) Сила F, с которой блок действует на клин равна:



$\beta = 90 - \dfrac{\alpha}{2}$

$$F = 2T\cos\beta = 2T\sin\frac{\alpha}{2}$$

Второй закон Ньютона для клина:

Ox: $F\cdot\cos\beta = M a_к$

$2T\sin^2\dfrac{\alpha}{2} = M\cdot a_к$; $a_к = a_{шx} = g\,\mathrm{ctg}\,\alpha$; $T = \dfrac{mg}{\sin\alpha}$

$\dfrac{2mg}{\sin\alpha}\sin^2\dfrac{\alpha}{2} = M\cdot g\dfrac{\cos\alpha}{\sin\alpha}$; $\dfrac{m}{M} = \dfrac{\cos\alpha}{2\sin^2\alpha/2} = \dfrac{\cos\alpha}{1-\cos\alpha}$

$$\frac{m}{M} = \frac{5}{8}$$

Продолжение на 2

4) Продолжение №1 ~~Чистовик~~

Ф11-У-0406

шар падает с g вниз, значит

$H = \frac{gt^2}{2}$; $t = \sqrt{\frac{2H}{g}}$

Ответ: 1) $\operatorname{arctg}\left(\frac{5}{12}\right)$

2) $a_к = \frac{5}{12}g = \frac{25}{6}$ м/с²

3) $\frac{m}{M} = \frac{5}{8}$

4) $t = \sqrt{\frac{2H}{g}}$

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

$\frac{\sin^2\alpha}{1-\sin^2\alpha} = \frac{144}{169}$ $\sin^2 =$

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

$\frac{1}{\sin^2\alpha} = \frac{169+144}{144}$ $\frac{\sin^2\alpha}{1-\sin^2\alpha} = \frac{144}{169}$

$\sin\alpha = \frac{12}{\sqrt{169+144}}$ $\frac{1}{\sin^2\alpha} - 1 = \frac{169}{144}$

$\frac{1}{\sin^2\alpha} = \frac{169+14}{144} = \frac{16}{14}$

Часть 2

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

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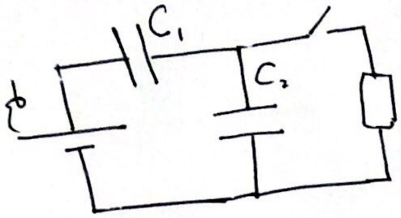
ID профиля: **144226**

Вариант 3

№3 Чистовик Ф11-Ч-0406



1) До замыкания

$$\begin{cases} U_{C_1}+U_{C_2}=\mathcal{E} & \text{– Кирхгоф} \\ C_1U_{C_1}=C_2U_{C_2} & \text{– равенство зарядов} \end{cases}$$

$U_{C_1}=\frac{1}{5}\mathcal{E}$

$U_{C_2}=\frac{4}{5}\mathcal{E}$

Напряжение на конденсаторе до замыкания равно напряжению после: Кирхгоф: $U_{C_2}=IR$

$$I=\frac{U_{C_2}}{R}=\frac{4\mathcal{E}}{5R}$$

2) Установившийся режим

$U'_{C_1}=\mathcal{E};\ U'_{C_2}=0$

ЗСЭ: $A_{ист}=Q+\Delta W_C$; $A_{ист}=\Delta q\,\mathcal{E}=\mathcal{E}(C_1\mathcal{E}-C_1U_{C_1}-C_2U_{C_2})$

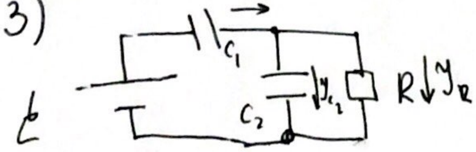
$A_{ист}=\frac{12}{5}C\mathcal{E}^2$

$$\Delta W_C=\frac{C_1\mathcal{E}^2}{2}-\frac{C_1U_{C_1}^2}{2}-\frac{C_2U_{C_2}^2}{2}$$

$\Delta W_C=\frac{8}{5}C\mathcal{E}^2 \Rightarrow Q=A_{ист}-\Delta W_C=\frac{12}{5}C\mathcal{E}^2-\frac{8}{5}C\mathcal{E}^2$

$Q=\frac{4}{5}C\mathcal{E}^2$

3)



Кирхгоф: $I_R=I_0+I_{C_2}$

$U_R=R\cdot I_R=RI_0-RI_{C_2}$

$U_{C_1}+U_{C_2}=\mathcal{E}$ и $U_{C_2}=I_R\cdot R$

Пусть через R протек dq

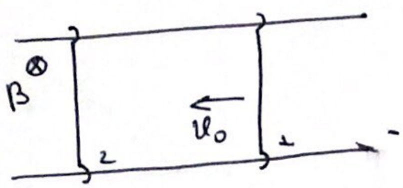
$$dq=C_1U_{C_1}-C_2U_{C_2}=C_1U_{C_1}+C_2U_{C_1}-C_2\mathcal{E}$$

$$\frac{dq}{dt}=I_R=\frac{C_1U_{C_1}}{dt}+\frac{C_2U_{C_1}}{dt}-\frac{C_2\mathcal{E}}{dt}=I_0+\frac{I_0}{4};\ -I_0=\frac{I_0}{4} \Rightarrow U_R=\frac{RI_0}{4}$$

$$\boxed{U_R=\frac{RI_0}{4}}$$

1

№4 Чистовик ФП-У-0406



1) $\vec{F} = m\vec{a}$

1: $F = BIL = 2m a_1$

$I = \frac{\mathcal{E}_i}{R_0} = \frac{\mathcal{E}_i}{4R}$

$\mathcal{E}_i = \frac{d\Phi}{dt} = \frac{d(BS)}{dt} = B\frac{dS}{dt} = B v_0 \cdot L$

$a_1 = \frac{BIL}{2m}$

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

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

и $v_1 = v_2$, чтобы $|\mathcal{E}_{i1}| = |\mathcal{E}_{i2}|$

$v_1 = v_2 = v_0\sqrt{\frac{2}{3}}$

$v_1 = v_2 = 0$

3) Тормозящая сила $F = IBL = \frac{\mathcal{E}_{инд}}{4R} BL = 2\frac{(BL)^2 v}{4R}$

Движутся две перемычки

$\vec{F} = m\vec{a}$

$\frac{dv}{dt} 2m = 2\frac{(BL)^2 v}{4R}$

$dv\, m = \frac{(BL)^2}{4R} v\, dt$ – перемещение

$v_0 m = \frac{(BL)^2}{4R} S_1$

$S_1 = \cancel{v_0 m (BL)^2}\ \frac{v_0 m 4R}{(BL)^2}$; $S_2 = \frac{v_0 m 2R}{(BL)^2}$

$S = S_0 + (S_1 + S_2)$

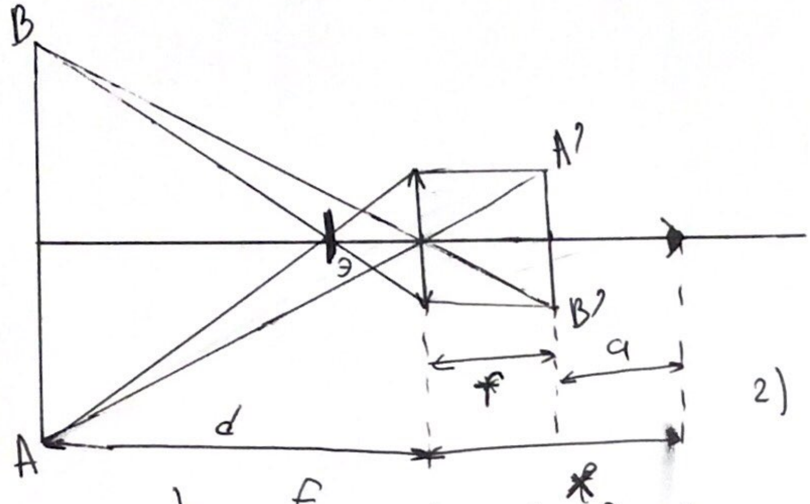
$S = S_0 + \frac{6R v_0 m}{(BL)^2}$

2

Чистовик

ФП-Y-0406

N5



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

$f=\frac{Fd}{d-F}=24см$

$x=f+a$

$x=24см+24см=48см$

2) $D_м=h$; где h - диаметр $A'B'$

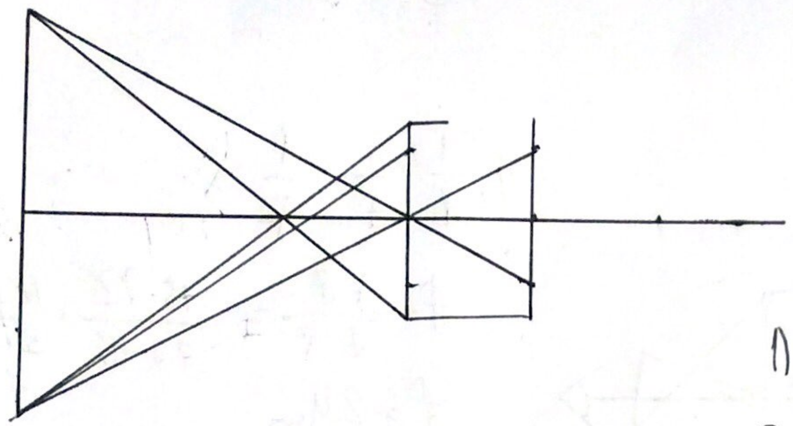
$\Gamma=\frac{h}{H}=\frac{f}{d}$; $h=H\frac{f}{d}$; $h=9см\frac{24см}{72см}=3см$

$D_м=3см$

3) Обратный ход лучей:

Если $A'B'$ испускает параллельный пучок, то все лучи будут проходит через F, туда и поставим Э, чтобы не видеть деталей.

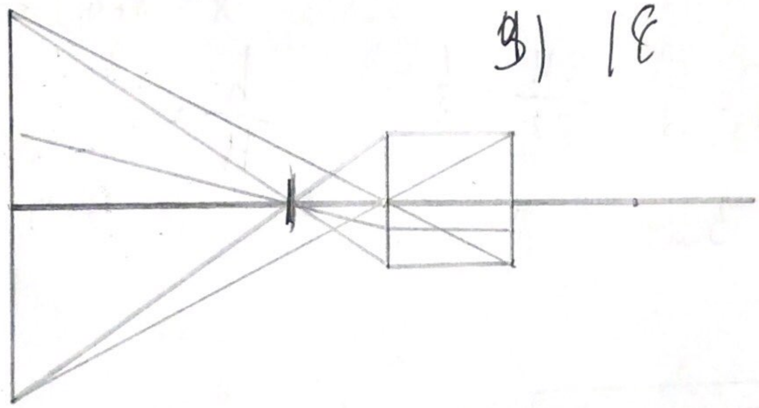
То есть. $l=F=18см$ слева от линзы



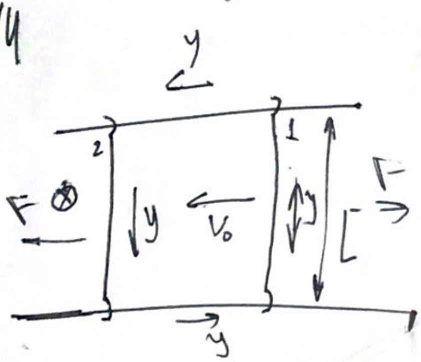
1) 48

2) 3

3) 18



№4



$1: 2m \quad R$

$2: m \quad 3R$

$ma = BYL$

$Y = \frac{\varepsilon}{4R}; \quad \varepsilon_i = \frac{d\Phi}{dt} = \frac{d(BS)}{dt} = Bv_0 \cdot L$

$a = \frac{BYL}{m}$

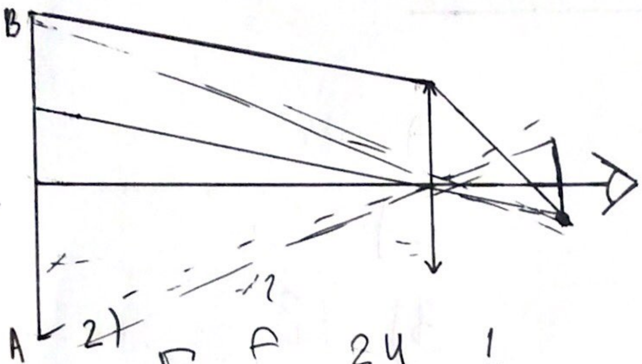
$Y = \frac{Bv_0L}{4R}$

1) $a = \frac{(BL)^2 v_0}{4Rm}$

BCIA? $\cancel{\frac{mv_0^2}{2}}$

Вд

Задача 5



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

$f = \frac{Fd}{d-F} = \frac{18 \cdot 72}{72-18} = \frac{18 \cdot 72}{54}$

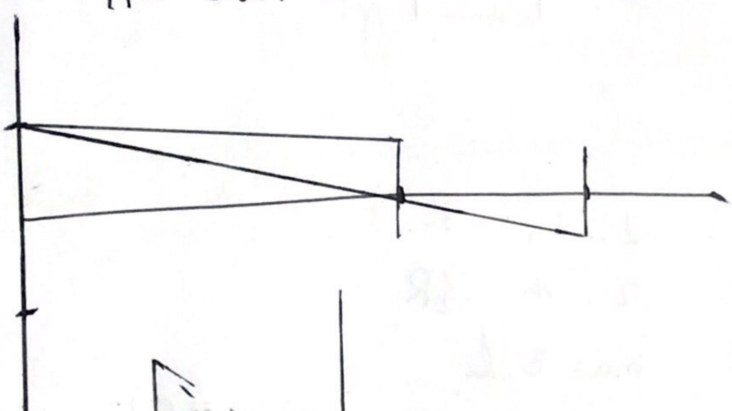
$f = 24$ см.

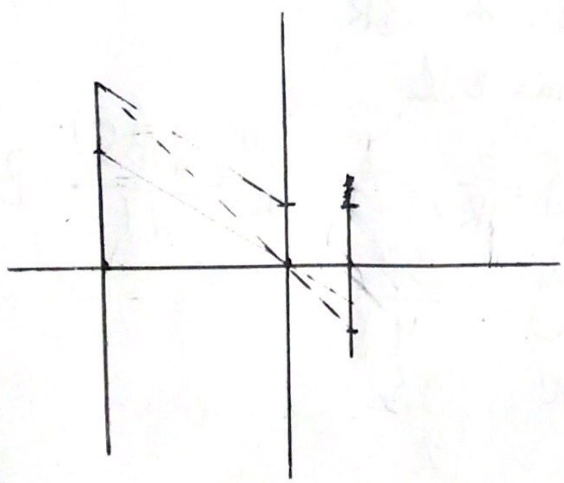
$x = f + a$; $x = 48$ см

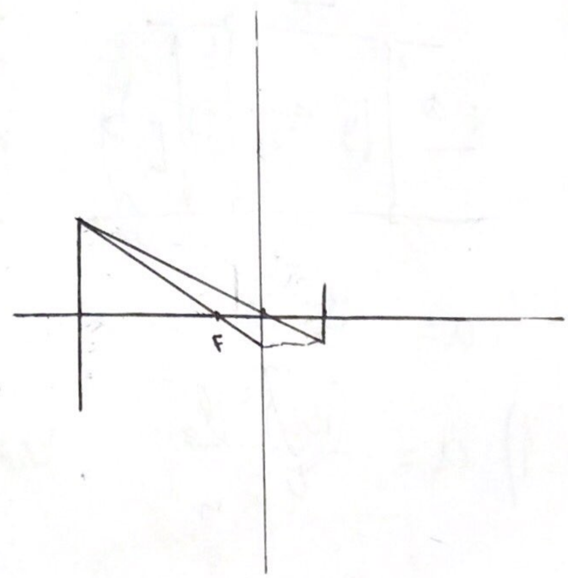
$\Gamma = \frac{f}{d} = \frac{24}{72} = \frac{1}{3}$

$\frac{h}{H} =$

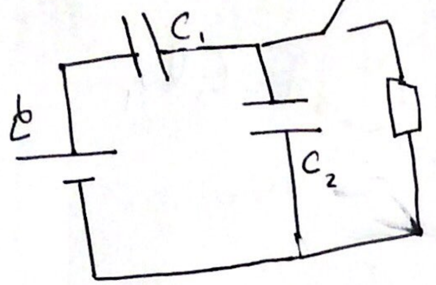
$h = 3$ см.







№3



1) $U_{c_1}+U_{c_2}=\mathcal{E}$ - до.

$C_1U_{c_1}=C_2U_{c_2} \Rightarrow$

$U_{c_1}=\frac{C_2}{C_1}U_{c_2}$

$U_{c_2}\left(1+\frac{C_2}{C_1}\right)=\mathcal{E}$

$U_{c_2}=\frac{\mathcal{E}}{1+\frac{C_2}{C_1}}=\frac{\mathcal{E}}{1+\frac{C}{4C}}=\frac{4}{5}\mathcal{E}$

$U_{c_1}=\frac{1}{5}\mathcal{E}$

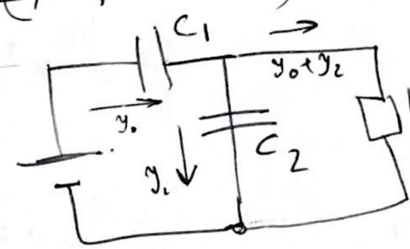
$U_{c_2}=U_{c_2\,до}$

$U_{c_2}=IR$, $I=\frac{U_{c_2}}{R}=\frac{4}{5}\frac{\mathcal{E}}{R}$

2) ~~$A_{ист}=Q+\Delta W_c$~~

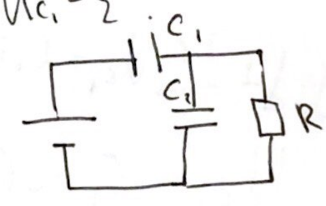
~~$A_{ист}=(C_1U_{c_1}+C_2U_{c_2})\mathcal{E}=\frac{4C\mathcal{E}^2}{5}+\frac{4C\mathcal{E}^2}{5}=\frac{8C\mathcal{E}^2}{5}$~~

$\Delta W_c=$



$U_{c_1}+U_{c_2}=\mathcal{E}$

$U_{c_1}=\mathcal{E}$



$I_0=\frac{\Delta q}{\Delta t}$

$I_0=\frac{C\,dU_{c_1}}{dt}$ $I_2=\frac{C\,dU_{c_2}}{dt}$

$\frac{4C\mathcal{E}^2}{2}$

$4C\mathcal{E}^2-\frac{8C\mathcal{E}^2}{5}=\frac{12}{5}C\mathcal{E}^2$

$\frac{20-8}{5}$

$\frac{4C\cdot\mathcal{E}^2}{2\cdot 25}$ $\frac{16C\cdot\mathcal{E}^2}{2\cdot 25}$ $\frac{10}{25}=\frac{2}{5}$

$2C\mathcal{E}^2-\frac{2C\cdot\mathcal{E}^2}{25}-\frac{8C\mathcal{E}^2}{25}$

$\frac{2}{5}C\mathcal{E}^2$

$\frac{10-2}{5}C\mathcal{E}^2$

$\frac{8}{5}C\mathcal{E}^2$

$$y_{c_2} = \frac{dq_{c_2}}{dt} = \frac{C_2 dU_{c_2}}{dt}$$

$$y_0 dt = C_1 U_{c_1}$$

$$y_{c_2} = y_0 - y_R$$

$$\frac{C_2 dU_{c_2}}{dt} = y_0 - y_R$$

$$y_R = \frac{U_{c_2}}{R} \qquad U_{c_2} = y_R \cdot R$$

$$dU_{c_2} = dy_R \cdot R$$

$$\frac{C_2 dU_{c_2}}{dt} = y_0 - \frac{U_{c_2}}{R} \qquad \frac{C_2 dy_R}{R\, dt} = y_0 - y_R$$

$$C_2 dU_{c_2} = y_0 dt - \frac{U_{c_2}}{R} dt.$$

$$C_2 dU_{c_2} = \left(y_0 - \frac{U_{c_2}}{R}\right) dt. \qquad \frac{C_2}{R}\frac{dy_R}{dt} + y_R = y_0$$

$$\frac{C_2}{R} dy_R + y_R dt = y_0 dt.$$

$$C_2 U_{c_2} = y_0 t - y_R t$$

$$C_1 U$$

$$\frac{C_2}{R} y_R + \Delta q_R = C_1 U_{c_1}$$

$$y_0 dt = C_1 U_{c_1} = C_1 (E - U_{c_2}$$

$$\cancel{\Delta q_R = C_1 U_{c_1}} - C_2 U_{c_2}.$$

$$C_2 U_{c_2} = C_1 E - C_1 U_{c_2} - \frac{U_{c_2} t}{R}$$

$$\cancel{\Delta q_R = C_1 (E - U_{c_2})} - C_2 U_{c_2}$$

$$\frac{\Delta q_R}{dt} = \frac{C_1 U_{c_1} - C_2 (E - U_{c_1})}{dt}$$

$$\cancel{\Delta q_R = C_1 E - U_{c_1}(C_1 + C_2)}$$

$$\frac{4C U_{c_1} + C U_{c_1} + CE}{dt} \quad \cancel{R} \quad \frac{\Delta q_R}{\Delta t} =$$

$$\frac{C_1 U_{c_1} - C_2 U_{c_2}}{dt} = \cancel{C_1 U_c}\ y_0 -$$

$q = q \sin Wt$

$U = U \sin Wt$

$U = \frac{q}{c} \sin Wt$

$y = qW \cos Wt$

$y_0 = q_0 W \cos Wt$

$y = \frac{\varepsilon_i}{R_0}$ $\frac{B v_0 L}{4R}$ $\frac{m v_0 4R}{B^2 L^2}$

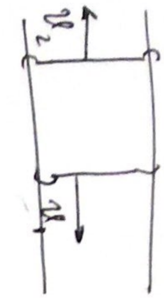
$y = \frac{BL \cdot a}{4R}$

$(R+3R)$

$2 v_0^2 = 2 v^2$

$2 v_0^2 = 3 v^2$

$v = v_0 \sqrt{\frac{2}{3}}$



$F = ma$

$$2m \frac{\Delta U}{\Delta t} = -2 \frac{B^2 L^2}{4R}$$