Часть 1

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

Шифр: **21200084**

ID профиля: **359289**

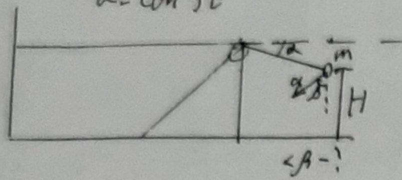
Вариант 4

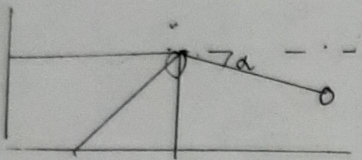
Чистовик

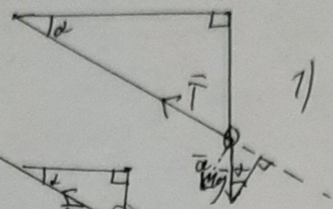
Физика 11

1. $\cos\alpha = \frac{8}{17}$ $\quad \alpha \in (0; \frac{\pi}{2})$

$\alpha = const$







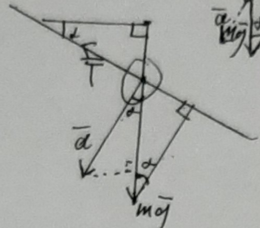
из нерастяж. нити

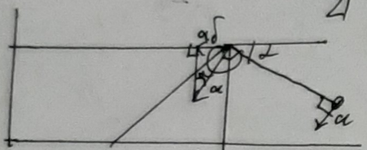
1) $\begin{cases} T = mg\sin\alpha \\ a = \frac{mg\cos\alpha}{m} = g\cos\alpha \end{cases}$

$\Downarrow$

$\angle\beta = \angle\alpha$

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

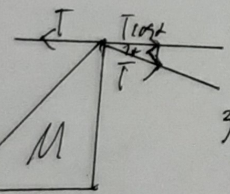




2) для сохранения угла α вся наклонённая нить движется с ускорением a, ~~но~~ блок имеет только горизонтальную составляющую a

$a_б = a\cos\alpha = g\cos^2\alpha$

$a_б = 10 \cdot \left(\frac{8}{17}\right)^2 = \frac{640}{289} \approx 2{,}2\ \frac{м}{с^2}$



3) $Ma_б = T - T\cos\alpha$

$a_б = \frac{T(1-\cos\alpha)}{M} = g\cos^2\alpha$

$T = \frac{g\cos^2\alpha\, M}{1-\cos\alpha} = mg\sin\alpha$

$\frac{m}{M} = \frac{\cos^2\alpha}{(1-\cos\alpha)\sin\alpha} = \frac{\cos^2\alpha}{(1-\cos\alpha)\sqrt{1-\cos^2\alpha}} = \frac{\cos^2\alpha}{(1-\cos\alpha)\sqrt{(1-\cos\alpha)(1+\cos\alpha)}} =$

$= \frac{8^2}{17^2\cdot\left(1-\frac{8}{17}\right)\sqrt{\left(1-\frac{8}{17}\right)\left(1+\frac{8}{17}\right)}} = \frac{8^2}{9\cdot 3\cdot 5} \approx$ ~~0,474~~ $=$

$= \frac{64}{135} \approx 0{,}474$

4) $\frac{a\cos\alpha\, t^2}{2} = H$

$t = \sqrt{\frac{2H}{g\cos^2\alpha}} = \frac{17}{8}\sqrt{\frac{H}{5}}$

Ответ: 1) $\cos = \frac{8}{17}$ 2) $a_б = \frac{640}{289} \approx 2{,}2\ \frac{м}{с^2}$ 3) $\frac{m}{M} = \frac{64}{135} \approx 0{,}474$

4) $t = \frac{17}{8}\sqrt{\frac{H}{5}}$

1

Чистовик Физика 11 11

2.

$He \Rightarrow i=3$ $\quad PV=\nu RT$

$C(T)=\frac{9}{5}R\frac{T}{T_0}$ $\quad Q=\int_{T_1}^{T_2} C\nu dT$

$$1)\ Q=-\int_{T_0}^{\frac{3}{4}T_0} C(T)\nu dT=\int_{\frac{3}{4}T_0}^{T_0}\frac{9}{5}R\frac{T}{T_0}\nu dT=\frac{9R\nu}{5T_0}\int_{\frac{3}{4}T_0}^{T_0} TdT =$$

$$=\frac{9R\nu}{5T_0}\frac{T^2}{2}\Big|_{\frac{3}{4}T_0}^{T_0}=\frac{9R\nu}{5T_0}\left(\frac{T_0^2}{2}-\frac{9}{16\cdot 2}T_0^2\right)=\frac{9R\nu}{5T_0}\cdot\frac{7T_0^2}{32}=\frac{63\nu RT_0}{160}$$

$$2)\ Q=\Delta U+A \quad A=Q-\Delta U=\int_{T_0}^{T}\frac{9RT\nu dT}{5T_0}-\frac{i}{2}\nu R(T-T_0)=$$

$$=\frac{9\nu R}{5T_0}\left(\frac{T^2}{2}-\frac{T_0^2}{2}\right)-\frac{3}{2}\nu RT+\frac{3}{2}\nu RT_0=\frac{9\nu RT^2}{10T_0}-\frac{9\nu RT_0}{10}-\frac{3}{2}\nu RT+\frac{3}{2}\nu RT_0$$

$$A'=\frac{9\nu RT}{5T_0}-\frac{3}{2}\nu R=0$$

$T=\frac{15}{18}T_0$ - минимум, т. к. $A'(T+\varepsilon)>0$, $A'(T-\varepsilon)<0$

$$3)\ A=\frac{9\nu R}{10T_0}\left(\frac{15}{18}T_0\right)^2-\frac{9\nu RT_0}{10}-\frac{3}{2}\nu R\frac{15}{18}T_0+\frac{3}{2}\nu RT_0=$$

$$=\nu RT_0\left(\frac{9\cdot 3}{2\cdot 18}-\frac{9}{10}-\cancel{\frac{3\cdot 15}{2\cdot 18}}\frac{5}{4}+\frac{3}{2}\right)=\frac{\nu RT_0}{180}\left(27\cdot 5-18\cdot 9-5\cdot 45+3\cdot 90\right)=$$

$$=\frac{\nu RT_0}{10}$$

Ответ: 1) $Q=\frac{63\nu RT_0}{160}$, 2) $T=\frac{15}{18}T_0$, 3) $A=\frac{\nu RT_0}{10}$

2

Физика 11

Черновик

$$\frac{9R\nu T^2}{10T_0} - \frac{\nu R\nu T_0^2}{10\cancel{T_0}} - \frac{3}{2}\nu RT + \frac{3}{2}\nu RT_0 = A$$

$$A' = 0 = \frac{9R\nu T}{5T_0} - \frac{3}{2}\nu R$$

$$\frac{3}{2}\cancel{\nu R} = \frac{9\cancel{\nu R}T}{5T_0}$$

$$T = \cancel{\frac{3\cdot 5}{2}}\ \frac{3\cdot 5}{2\cdot 9}T_0 = \frac{15}{18}T_0$$

$$\frac{9\cdot 15\,\nu RT_0}{10\cdot 18} - \frac{9}{10}\nu RT_0 - \frac{3\cdot 15}{2\cdot 18}\nu RT_0 + \frac{3}{2}\nu RT_0 =$$

$$= \cancel{R}\,\nu RT_0\left(\frac{9\cdot \cancel{15}^{3}}{\cancel{10}_{2}\cdot 18} - \frac{9}{10} - \frac{\cancel{3}^{2}\cdot 5}{2^2\cdot\cancel{9}} + \frac{3}{2}\right) = \nu RT_0$$

$$\frac{27}{36} - \frac{9}{10} + \frac{5}{4} + \frac{3}{2} = \frac{27\cdot 5 - 18\cdot 9 + 5\cdot 45 + 3\cdot 90}{180}$$

135 162 225 270

$$\frac{\cancel{360} - 405 - 387}{180} \qquad \frac{7}{10}$$

$$\begin{array}{r} 405 \\ -\,387 \\ \hline 18 \end{array}$$

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Черновик

$$\frac{8^2}{17^2\left(1-\frac{8}{17}\right)\cdot\sqrt{1-\frac{8^2}{17^2}}} = \frac{64}{17\cdot 9\cdot\sqrt{\frac{1}{17}\cdot\frac{25}{17}}} = \frac{64\cdot 8^2}{3^2\cdot 3\cdot 5} = \frac{64}{27\cdot 5}$$

135

$17 \times 17 = 119 + 17$

$$\frac{2R\alpha T}{T}$$

$640 : 135 = 0{,}4740$

$$\cos\alpha = \frac{a\sin t^2}{2}$$

$6\cdot 49 = 284$

$$\frac{a\cos\alpha\, t^2}{2} = H$$

$$t = \sqrt{\frac{2H}{g\cos^2\alpha}} = \sqrt{\frac{2H\cdot 17^2}{10\cdot 64}} = \frac{17}{8}\sqrt{\frac{H}{5}}$$

$$Q = \int_{\frac{3}{4}T_0}^{T_0} \frac{9}{5}R\frac{T}{T_0}\nu\, dT = \frac{9}{5}\frac{R}{T_0}\nu\int_{\frac{3}{4}T_0}^{T_0} T\,dT = \frac{9R\nu}{5T_0}\left.\frac{T^2}{2}\right|_{\frac{3}{4}T_0}^{T_0} =$$

$$= \frac{9R\nu}{5T_0}\left(\frac{16T_0^2}{32} - \frac{9}{32}T_0^2\right) = \frac{9R\nu\cdot 7T_0^2}{5T_0\cdot 32} = \frac{63}{160}\nu RT_0$$

63

160

$$\frac{9RT}{5T_0}.$$

$$Q = \Delta U + A$$

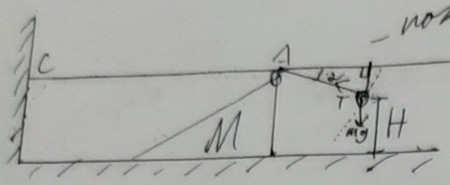
$$A = Q - \Delta U = \int_{T_0}^{T}\frac{9RT\nu\,dT}{5T_0} - \frac{i}{2}\nu R\Delta T$$

$$A = \int P\Delta V$$

$$\frac{9R\nu}{5T_0}\left.\frac{T^2}{2}\right|_{T_0}^{T} - \frac{3}{2}\nu R(T - T_0) =$$

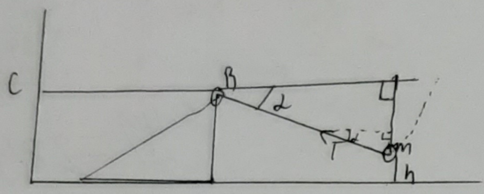
$$= \frac{9R\nu}{5T_0}\left(\frac{T^2}{2} - \frac{T_0^2}{2}\right) - \frac{3}{2}\nu RT + \frac{3}{2}\nu RT_0$$

Черновик Физика 11

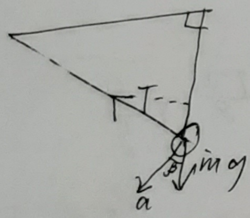


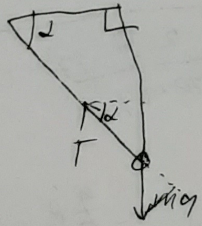
$$\cos\alpha = \frac{8}{17} = \cancel{const}$$

$$\alpha = const$$



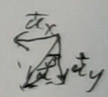
$$\vec{a} = \frac{\vec{T} + m\vec{g}}{m}$$





$\cancel{T\sin\alpha = mg}$

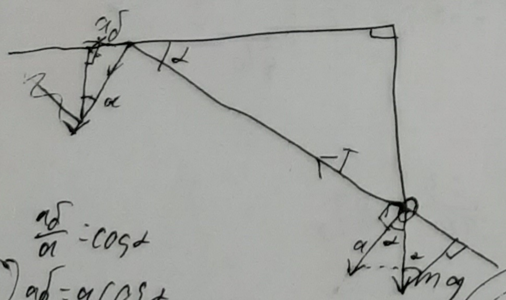
$\cancel{a = \frac{T\cos\alpha}{m}}$



$$Ox: a_x = \frac{T\cos\alpha}{m}$$

$$Oy: a_y = \frac{mg - T\sin\alpha}{m}$$

$$tg\,\beta = \frac{a_x}{a_y} = \frac{T\cos\alpha\, m}{m(mg - T\sin\alpha)} = \frac{T\cos\alpha}{mg - T\sin\alpha}$$

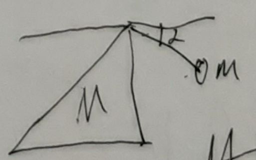


$$\frac{a_б}{a} = \cos\alpha$$

(1) $a_б = a\cos\alpha$

(1) $T = mg\sin\alpha$

$$a = \frac{mg\cos\alpha}{m}$$



$\cancel{MV^2 + m}$

$\frac{m}{M}$ − ?

$$\frac{\cancel{g}\cos^2\alpha\, M}{1-\cos\alpha} = m\cancel{g}\sin\alpha$$

$$\frac{m}{M} = \frac{\cos^2\alpha}{(1-\cos\alpha)\sin\alpha}$$

$$a_б = \frac{T - T\cos\alpha}{M} = \frac{T(1-\cos\alpha)}{M}$$

$$T = \frac{g\cos^2\alpha\, M}{1-\cos\alpha}$$

Часть 2

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

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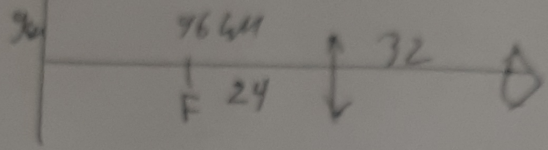
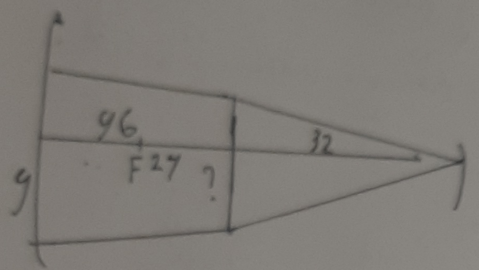
Вариант 4

Черновик

5.



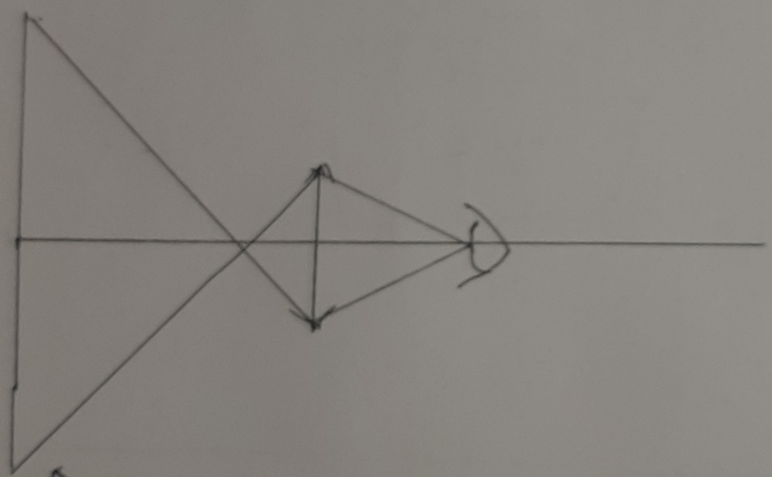


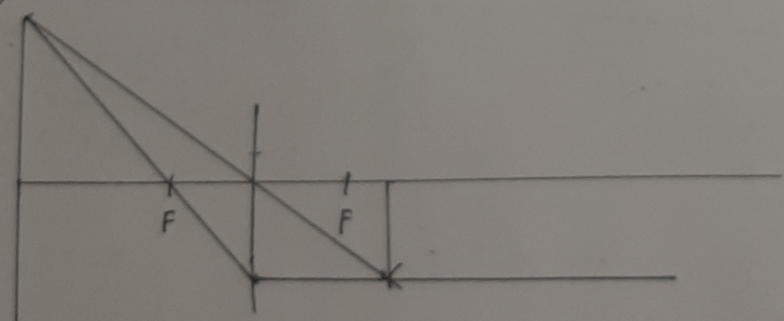
$$\frac{1}{F} = \frac{1}{a} + \frac{1}{b}$$

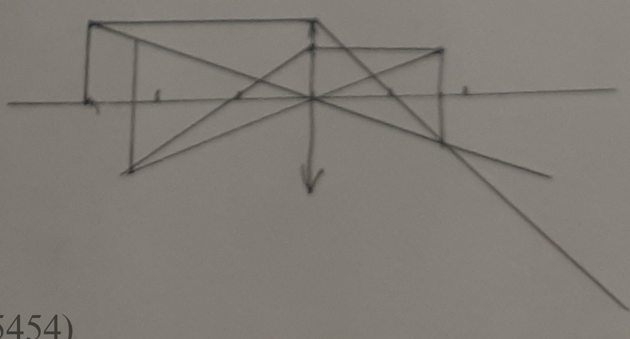
$$\frac{1}{b} = \frac{1}{F} - \frac{1}{a} = \frac{a-F}{aF}$$

$$b = \frac{aF}{a-F} = \frac{96 \cdot 24}{96-24} = \frac{96 \cdot 24}{72} = $$

$$= 32 \text{ см}$$



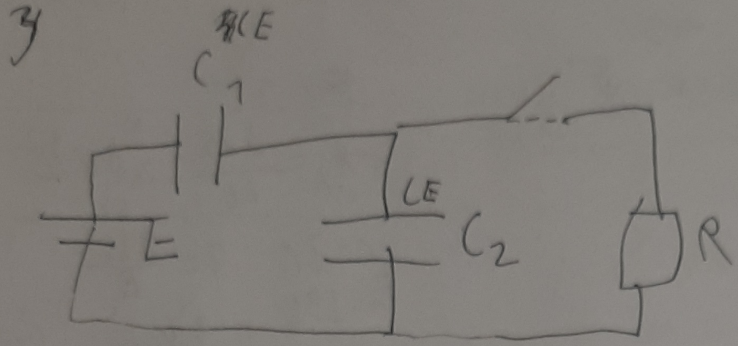




Черновик

$4\varphi - \frac{C^{2}\varepsilon^{2}}{2(C_1+C_2)}$

3)



$C_2 = C \quad C_1 = 5C$

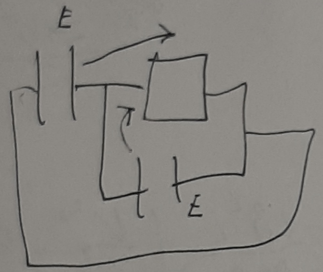
$q = CU$

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

$U = IR$

1) $I = \frac{U}{R} = \frac{2CE + CE}{R} = \frac{3CE}{R}$

2)



$-C_1(E - \varphi) + C_2(\varphi - 0) = 0$

$-5CE + 5C\varphi + C\varphi = 0$

$\varphi = \frac{5}{6}E$

$\varphi_1 = \varphi = \frac{5}{6}E$

$\int_0^\infty \frac{B^2 L V^2}{12 Rm} dt = V_0 \int_0^\infty$

$BLV_1 = BLV_2$

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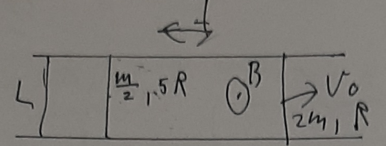
Черновик

4.



$$\mathcal{E}_i = \frac{B\,dS}{dt} = BVL$$

$$\mathcal{E} = IR \qquad I = \frac{BV_0L}{R}$$

$$F_A = IBL = \frac{B^2V_0L^2}{R}$$

1) $a_1 = \frac{B^2V_0L^2}{2mR}$

2) $V_1 = V_2$

$$\frac{2mV_0^2}{2} = \frac{(2m+0,5m)V^2}{2} + \int I^2R\,dt$$

$$F_m = \frac{B^2VL^2}{R}$$

$$\int a_1\,dt = \int a_2\,dt$$

$$\int_0^\infty \frac{B^2VL}{2mR}\,dt = \int_0^\infty \frac{2B^2VL}{mR}\,dt$$

$$-\frac{B^2V_0L}{2mR} = \frac{B^2L}{2mR}\left(\frac{V^2}{2}-\frac{V_0^2}{2}\right) = \frac{2B^2L}{mR}\left(\frac{V^2}{2}-\frac{V_0^2}{2}\right)$$

$$\frac{B^2L}{4mR}V^2 - \frac{B^2L}{mR}V^2 = \frac{B^2LV_0^2}{4mR} - \frac{B^2LV_0^2}{mR}$$

$$V^2 = \frac{\frac{B^2LV_0^2}{mR}\left(\frac14 - 1\right)}{\frac{B^2L}{mR}\left(\frac14 - 1\right)} = V_0^2\left(\frac{-\frac34}{-\frac34}\right.$$

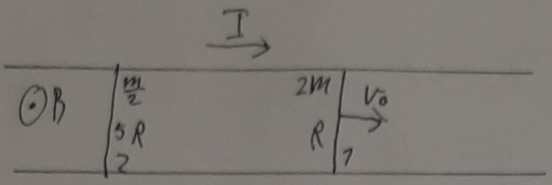
$$\frac{2mV_0^2}{2} = \frac{2,5mV^2}{2} + \int_0^\infty \frac{V^2}{R}\,dt$$

$$mV_0^2 - \frac{2,5}{2}mV^2 = \int_0^\infty \frac{B^2L^2\Delta V^2}{R}\,dt = \frac{B^2L^2}{R}\,\frac{\Delta V^3}{3}\Bigg|_0^\infty = \frac{B^2L^2}{mR}\left(0 - \frac{V_0^3}{3}\right)$$

$$V^2 = \frac{2}{2,5}\left(V_0^2 + \frac{B^2L^2V_0^3}{mR\cdot 27}\right)$$

Чистовик

4.



1) $\mathcal{E}_i = \frac{-B\,dS}{dt} = -BLV$

$F_A = IBV \qquad I = \frac{\mathcal{E}}{R_0} = \frac{BLV}{6R}$

$a_1 = \frac{F}{m} = \frac{B^2LV^2}{6R\cdot 2m}$

2) $V_1 = V_2$

$\cancel{ЗСЭ: \frac{2mV_0^2}{2} = \frac{2,5mV^2}{2} + Q}$

$\cancel{\frac{2,5mV^2}{2} = \frac{2mV_0^2}{2}} - \int_0^\infty \frac{B^2L^2\Delta V^2}{R}dt$

$\cancel{Q = \int_0^\infty \frac{V^2}{R}dt = \int_0^\infty \frac{B^2L^2\Delta V^2}{R}dt}$ $\quad \Delta V = V_1 - V_2$

ЗСЭ: $\frac{2mV_0^2}{2} = \frac{2,5mV^3}{2} + Q$

$\frac{2,5mV^2}{2} = \frac{2mV_0^2}{2} - \int_0^\infty \frac{B^2L^2(V_1-V_2)^2}{R}dt$

$V_1 = V_2$

$\cancel{\int_0^\infty \frac{B^2LV^2}{3\cdot 2Rm}dt = V_0 - \int_0^\infty \frac{B^2LV^2}{12Rm}}$

$\cancel{\frac{B^2LV^2}{3Rm} = -\frac{B^2LV^2}{12Rm}}$

$\frac{2,5mV^2}{2} = mV_0^2 - \frac{B^2L}{R}\left(0 - \frac{V_0^3}{3}\right)$

$V^2 = \frac{2V_0^2}{2,5} + \frac{B^2L\,2V_0^3}{R\,2,5m\,3}$

$V^2 = \frac{4}{5}V_0^2 + \frac{4B^2LV_0^3}{15Rm}$

$V = V_0\sqrt{\frac{4}{5} + \frac{4B^2LV_0}{15Rm}}$

Ответ: 1) $\frac{B^2LV^2}{6R2m}$ 2) $V = V_0\sqrt{\frac{4}{5} + \frac{4B^2LV_0}{15Rm}}$

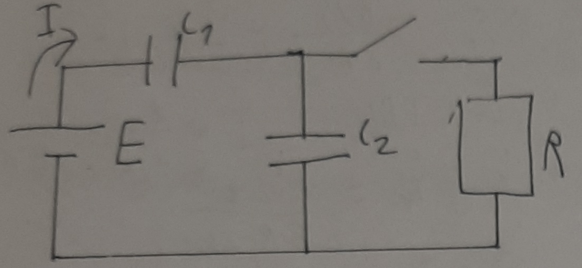
2

Чистовик

3

~~Чистовик~~ Черновик

1.



$C_1 = 5C$ $C_2 = C$

$q = CU$

~~1) Конденсаторы заряжены до CE не заряжаются => $I_R = 0$~~

~~C_2 зарядится до~~

~~1) Конденсаторы заряжены до q = CE~~

~~$I = \frac{2E}{R}$~~

$A = Eq^*$

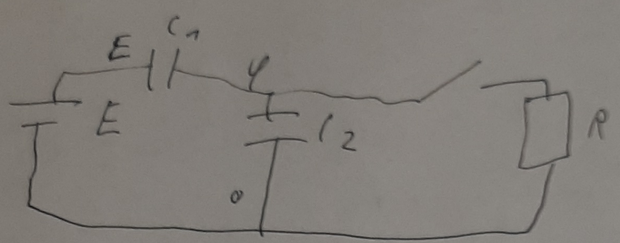
Было

~~2)~~

$\cancel{\frac{30}{61}}$ $\frac{\overset{30}{\cancel{5}}}{18}$ + $\frac{1}{18}$

Чистовик $C_1 = 5C$ $C_2 = C$

3.



1) $-C_1(E-\varphi)+C_2(\varphi-0)=0$

$-5CE+5C\varphi+C\varphi=0$

$\varphi = \frac{5}{6}E$

Т. к. U на конденсаторе меняется не мгновенно, то

$I = \frac{5}{6}\frac{E}{R}$

2) ~~ЗСЭ~~: $W'_{C_1} = \frac{C_1E^2}{2}$ $W'_{C_2} = 0$

$W_{C_1} = \frac{C_1E^2}{72}$ $W_{C_2} = \frac{25C_2E^2}{72}$

$A_1 = W'_{C_1}+W'_{C_2}-W_{C_1}-W_{C_2}+Q = \frac{C_1E^2}{2} - \frac{C_1E^2+25C_2E^2}{72}+Q$

$A = Eq^*$ $q^* = C_1E - \frac{1}{6}C_1E = \frac{5}{6}C_1E$

$E^2\frac{5}{6}C_1 = \frac{C_1E^2}{2} - \frac{E^2}{72}(C_1-C_2)+Q$

$Q = E^2C_1\cdot\frac{10}{6}+\frac{E^2}{72}\cdot 4C = E^2C\left(\frac{10}{6}+\frac{4}{72}\right) = \frac{CE^2\cdot 31}{18}$

Ответ: 1) $\frac{5}{6}E$ 2) $\frac{31CE^2}{18}$

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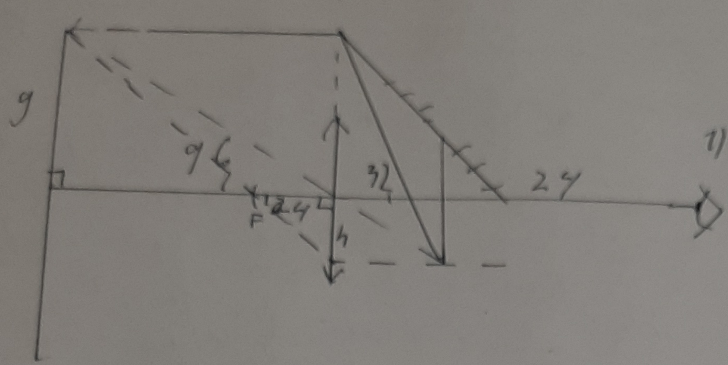
Чистовик

5.



$$\frac{1}{F}=\frac{1}{a}+\frac{1}{b}$$

1) $b=\frac{aF}{a-F}=\frac{96\cdot 24}{96-24}=32$ см

$x=b+24=32+24=56$ см

2) $\frac{9}{h}=\frac{96-24}{24}$. $h=\cancel{\frac{72}{24}\cdot 9}=\frac{9\cdot 24}{72}=3$ см

3)

Ответ: 1) 56 см 2) 3 см

3