Часть 1

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

Шифр: **21200366**

ID профиля: **177367**

Вариант 4

Физика 11кл

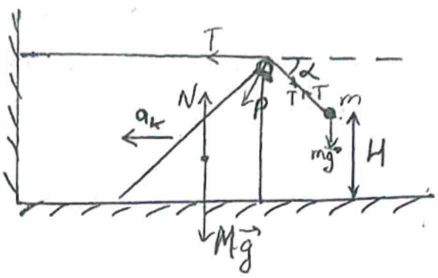
(Билет)

Вариант 11-04 Чистовик.

№1 Дано:

α, $\cos\alpha = \frac{8}{17}$, H

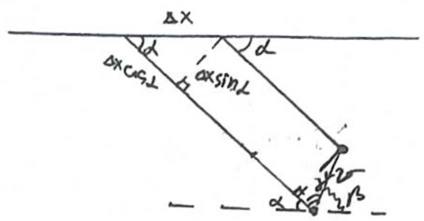
1) $tg\beta$ — ?
2) $a_к$ — ?
3) $\frac{m}{M}$ — ?
4) τ — ?



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

$\sin\alpha = \sqrt{1-\cos^2\alpha} = \sqrt{1-\frac{64}{289}} = \sqrt{\frac{225}{289}} = \frac{15}{17}$

$tg\alpha = \frac{\sin\alpha}{\cos\alpha} = \frac{15 \cdot 17}{17 \cdot 8} = \frac{15}{8}$



$a \uparrow\uparrow v \Rightarrow \beta$ - искомый

1) $tg\gamma = \frac{\Delta x \sin\alpha}{\Delta x(1-\cos\alpha)} = \frac{\sin\alpha}{1-\cos\alpha} = \frac{15}{17\cdot(1-\frac{8}{17})} = \frac{15\cdot 17}{17\cdot 9} = \frac{15}{9}$

$tg(\alpha+\gamma) = \frac{tg\alpha + tg\gamma}{1 - tg\alpha \cdot tg\gamma} = \frac{\frac{15}{8}+\frac{15}{9}}{1-\frac{225}{72}} = -\frac{15\cdot 72}{72\cdot 153} = -\frac{15}{153}$

$tg\beta = tg(180-(\alpha+\gamma)) = -tg(\alpha+\gamma) = \frac{15}{153}$

2)

Ответ: 1) $tg\beta = \frac{15}{153}$

Физика 11кл

Билет 11-04 Чистовик.

№2 Дано:

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

1) $Q_1 (Q_1>0)$ - ? $T_1=\frac{3}{4}T_0$

2) A_{min} T_k - ?

3) A_{min} - ?

Решение:

Гелий - одноатомн. ид. газ $\Rightarrow C_V=\frac{3}{2}R$, $C_p=\frac{5}{2}R$

По 1^ому началу т/д:

$$Q_+=\Delta U+A_г$$

1) $\Delta U = C_V\nu(T_1-T_0)=\frac{3}{2}\nu R(T_1-T_0)=\frac{3}{2}\nu R(\frac{3}{4}T_0-T_0)=-\frac{3\nu RT_0}{8}$

$$\nu CdT=\nu C_V dT+dA$$

$$dA=\nu(C-C_V)dT$$

$$\int_0^A dA=\int_{T_0}^{T_1}\nu\left(\frac{9R}{5T_0}T-\frac{3}{2}R\right)dT$$

$$A=\int_{T_0}^{T_1}\left(\frac{9\nu R}{5T_0}TdT-\frac{3}{2}\nu RdT\right)$$

$$A=\frac{9\nu R}{10T_0}(T_1^2-T_0^2)-\frac{3}{2}\nu R(T_1-T_0)=\frac{9\nu R}{10T_0}\left(\frac{9}{16}T_0^2-T_0^2\right)-$$

$$-\frac{3}{2}\nu R\left(\frac{3}{4}T_0-T_0\right)=-\frac{9\cdot7\nu RT_0^{\cancel{2}}}{10\cdot16\cancel{T_0}}+\frac{3\nu RT_0}{8}=-\frac{63}{160}\nu RT_0+\frac{3}{8}\nu RT_0=\frac{-63+60}{160}\nu RT_0=-\frac{3}{160}\nu RT_0$$

$Q=\Delta U+A=-\frac{3\nu RT_0}{8}-\frac{3}{160}\nu RT_0=-\frac{63\nu RT_0}{160}$ - тепло, переданное газу $\Rightarrow$

$$\Rightarrow Q_1=-Q=\frac{63\nu RT_0}{160}$$

2) $A=\frac{9\nu R}{10T_0}(T_k^2-T_0^2)-\frac{3}{2}\nu R(T_k-T_0)=\frac{3}{2}\nu R(T_k-T_0)\left(\frac{3(T_k+T_0)}{5T_0}-1\right)=\frac{3}{2}\nu R(T_k-T_0)\left(\frac{3T_k-2T_0}{5T_0}\right)=$

$$=\frac{3}{2}\nu R\cdot\frac{3T_k^2-2T_kT_0-3T_0T_k+2T_0^2}{5T_0}=\frac{3}{2}\nu R\,\frac{3T_k^2-5T_kT_0+2T_0^2}{5T_0}$$

$$A(T_k)=\frac{3\nu R}{10T_0}(3T_k^2-5T_kT_0+2T_0^2)$$

$$A_{min}\rightarrow T_k=-\frac{(-5T_0)}{2\cdot3}=\frac{5T_0}{6}$$

3) $A_{min}=\frac{3\nu R}{10T_0}\left(3\cdot\frac{25T_0^2}{36}-\frac{25T_0^2}{6}+2T_0^2\right)=\frac{3\nu R}{10T_0}\left(\frac{25T_0^2}{12}-\frac{50T_0^2}{12}+\frac{24T_0^2}{12}\right)=\frac{3\nu R}{10T_0}\cdot\left(-\frac{T_0^2}{12}\right)=$

$$=-\frac{\nu RT_0}{40}$$

Ответ: 1) $Q_1=\frac{63\nu RT_0}{160}$

2) $T_k=\frac{5T_0}{6}$

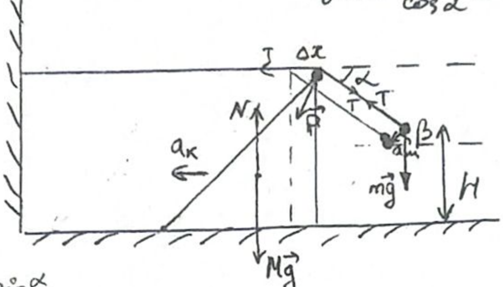
3) $A_{min}=-\frac{\nu RT_0}{40}$

2

Черновик.

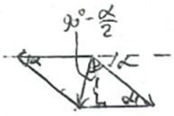
$$\sin\alpha = \sqrt{1-\cos^2\alpha} = \sqrt{1-\frac{64}{289}} = \sqrt{\frac{225}{289}} = \frac{15}{17}$$

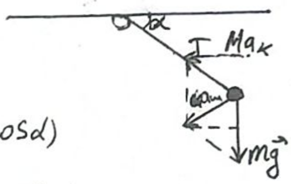
$$tg\alpha = \frac{\sin\alpha}{\cos\alpha} = \frac{15\cdot 17}{17\cdot 8} = \frac{15}{8}$$



$tg\alpha = \frac{h-H}{\ldots}$ h_1 $\frac{h_1+\Delta h}{l+\Delta l}$

$$tg\gamma = \frac{\Delta x\sin\alpha}{\Delta x(1-\cos\alpha)} = \frac{\frac{15}{17}}{1-\frac{8}{17}} = \frac{15\cdot 17}{17\cdot 9} = \frac{15}{9} \approx 1{,}03$$





$$T\sin\alpha - mg = ma_y$$

$$T\cos\alpha = ma_x$$

$$T\sin\alpha = m(g+a_x)$$

$$tg\alpha = \frac{g+a_x}{a_y}$$

$$a_y\, tg\alpha = g+a_x$$

$$P_y = T\sin\alpha$$

$$P_x = T - T\cos\alpha = T(1-\cos\alpha)$$

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

$90^\circ - \frac{\alpha}{2} - 90^\circ + \alpha = \frac{\alpha}{2}$ $\quad P_x = T(1-\cos\alpha) = Ma_x$

~~$T\cos\alpha = M$~~ ~~$T\cos\alpha = Ma_x$~~

~~$T\sin\alpha - mg$~~

~~$T = ma_x = Ma_x$~~

$$T\cos\alpha = ma_{mx}$$

$$tg(180^\circ-\alpha) = -tg\alpha$$

sin, tg, cos

$$P\cos\frac{\alpha}{2} = Ma_x$$

$$tg(\alpha+\gamma) = \frac{\sin(\alpha+\gamma)}{\cos(\alpha+\gamma)} = \frac{\sin\alpha\cos\gamma + \cos\alpha\sin\gamma}{\cos\alpha\cos\gamma - \sin\alpha\sin\gamma} = \frac{tg\alpha + tg\gamma}{1 - tg\alpha\, tg\gamma} =$$

$$= \frac{\frac{15}{8}+\frac{15}{9}}{1-\frac{225}{72}} = \frac{15\cdot 72}{72\cdot(72-225)} = -\frac{15}{153}$$

$$tg\beta = -tg(\alpha+\gamma) = \frac{15}{153}$$

$$\nu C\Delta T = \frac{3}{2}\nu R\Delta T + p\Delta V$$

$$\nu\left(C - \frac{3}{2}R\right)\Delta T = p\Delta V = A$$

$$\nu\left(C - \frac{3}{2}R\right)dT = dA$$

$$\nu\left(\frac{9}{5}R\frac{T}{T_0} - \frac{3}{2}R\right)dT = dA$$

$$\int_0^A dA = \int_{T_0}^{T_1}\left(\frac{9}{5}\frac{R\nu}{T_0}T\,dT - \frac{3}{2}\nu R\,dT\right)$$

$$A = \frac{9}{5}\frac{R\nu T^2}{2T_0}\Big|_{T_0}^{T_1} - \frac{3}{2}\nu RT\Big|_{T_0}^{T_1} = \frac{9\nu R}{10\,T_0}(T_1^2 - T_0^2) - \frac{3}{2}\nu R(T_1-T_0) = \frac{3}{2}\nu R(T_1-T_0)\left(\frac{3(T_1+T_0)}{5T_0} - 1\right) =$$

$$= \frac{3}{2}\nu R(T_1-T_0)\left(\frac{3T_1+3T_0-5T_0}{5T_0}\right) = \frac{3}{2}\nu R(T_1-T_0)\left(\frac{3T_1-2T_0}{5T_0}\right) = \frac{3}{2}\nu R\left(\frac{3T_1^2-2T_1T_0-3T_1T_0+2T_0^2}{5T_0}\right) =$$

$$= \frac{3}{2}\nu R\left(\frac{3T_1^2-5T_1T_0+2T_0^2}{5T_0}\right) \qquad -\frac{b}{2a} = \frac{5T_0}{6}$$

$$A_{min} = \frac{3}{2}\nu R\left(\frac{3\cdot\frac{25}{36}T_0^2 - \frac{25}{6}T_0^2 + 2T_0^2}{5T_0}\right) = \frac{3\nu R}{2\cdot 5T_0}\left(\frac{25}{12}T_0^2 - \frac{25}{6}T_0 + 2T_0^2\right) =$$

$$= \frac{3\nu R}{2\cdot 5T_0}\left(25T_0^2 - 50T_0^2 + 24T_0^2\right) = \frac{3\nu R}{10T_0}\cdot(-T_0^2) = -\frac{3\nu RT_0}{10}$$

$$-\frac{3\nu RT_0^2}{10\,T_0\cdot 12_4} = -\frac{\nu RT_0}{40}$$

$$MV_x + mV_{mx} = 0$$

Часть 2

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

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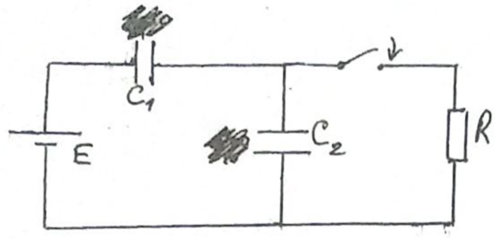
Вариант 4

Вариант 11-04 Часть 2 Чистовик

№3



Дано: $q_{c0} = q_{2c0} = 0$, C, R (предварительно не заряжены)
$C_2 = C$, $C_1 = 5C$

Найти: 1) I_{R0} – ?
2) Q – ?
3) I_R – ? $I_{c2} = I_0$

1) До замыкания ключа режим установился ⇒ тока нет

II з-н Кирхгофа: $E = \frac{q_{10}}{C_1} + \frac{q_{20}}{C_2}$ $q_0 = q_{10} = q_{20}$ (послед. соединение)

$$E = \frac{q_0}{5C} + \frac{q_0}{C} = \frac{q_0}{5C} + \frac{5q_0}{5C} = \frac{6q_0}{5C} \Rightarrow \frac{q_0}{C} = \frac{5E}{6}, \quad q_0 = \frac{5}{6}EC$$

Сразу после замыкания ключа напряжение на конденсаторах будет такое же, как и до размыкания $\Rightarrow U_{c2} = \frac{q_{20}}{C_2} = \frac{q_0}{C} = \frac{5E}{6}$

$$U_{c2} = I_{R0} \cdot R \Rightarrow I_{R0} = \frac{U_{c2}}{R} = \frac{5E}{6R}$$

2) После замыкания ключа, когда режим установился, тока нет ⇒
$\Rightarrow IR = 0 \Rightarrow U_{c2} = IR = 0$

$$E = U_{c1} = \frac{q_1}{C_1} \Rightarrow q_1 = 5EC$$

По ЗСЭ: $E\Delta q = \Delta W_{c1} + \Delta W_{c2} + Q$

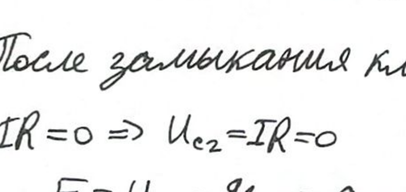
$$\Delta q = q_1 - q_0 = 5EC - \frac{5}{6}EC = \frac{25}{6}EC \quad \Delta W_{c1} = \frac{q_1^2}{2C_1} - \frac{q_0^2}{2C_1} = \frac{25E^2C^2 - \frac{25}{36}E^2C^2}{10C} =$$

$$= \frac{25E^2\cancel{C^2}\cdot \cancel{35}^{7}}{\cancel{10C}_{2}\cdot 36} = \frac{175E^2C}{72} \qquad \Delta W_{c2} = 0 - \frac{q_0^2}{2C_2} = -\frac{25E^2\cancel{C^2}}{36\cdot 2\cancel{C}} = -\frac{25E^2C}{72}$$

$$Q = E\Delta q - \Delta W_{c1} - \Delta W_{c2} = \frac{25}{6}E^2C - \frac{175E^2C}{72} + \frac{25E^2C}{72} = \frac{300E^2C - 175E^2C + 25E^2C}{72} = \frac{150E^2C}{72} =$$

$$= \frac{50E^2C}{24} = \frac{25E^2C}{12}$$

3)



По 2 правилу Кирхгофа:
$E = U_{c1} + U_{c2}$

По 1 правилу Кирхгофа:
$I = I_R - I_0$

$$\dot{q}_1 = I = I_R - I_0 \quad \dot{q}_2 = -I_0$$

$$E = U_{c1} + U_{c2} = \frac{q_1}{C_1} + \frac{q_2}{C_2}$$

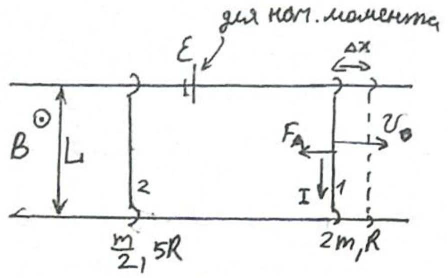
Продифференцируем: $\dot{E} = \frac{\dot{q}_1}{5C} + \frac{\dot{q}_2}{C} \Rightarrow 0 = \frac{I_R - I_0}{5C} - \frac{I_0}{C} = \frac{I_R - 6I_0}{5C} \Rightarrow I_R = 6I_0$

Ответ: 1) $I_{R0} = \frac{5E}{6R}$, 2) $Q = \frac{25}{12}CE^2$, 3) $I_R = 6I_0$

Физика 11кл

Билет 11-04 Часть 2
(Вариант) Чистовик.

№4



Дано: $B, L, m_1 = 2m$, $R_1 = R$, v_0
$m_2 = \frac{m}{2}$, $R_2 = 5R$,

Найти: 1) a_{10} – ?
2) v_1, v_2 – ?
3) ΔL – ?

~~1) В начальн. момент на перемычку~~ (на ~~положит. заряды в ней действует~~ $F_Л$ сила ~~Лоренца => возникает эл. ток~~)

1) по з-ну Фарадея: $-\frac{d\Phi}{dt} = \mathcal{E} = -\frac{BL\,dx}{dt} = -BLv_0$

$$\mathcal{E} = I(R_{\cancel{?}} + 5R) = 6IR \Rightarrow I = \frac{BLv_0}{6R}$$

$$F_A = BIL = \frac{(BL)^2 v_0}{6R} = 2ma_{10} \Rightarrow a_{10} = \frac{(BL)^2 v_0}{12mR}$$

2)

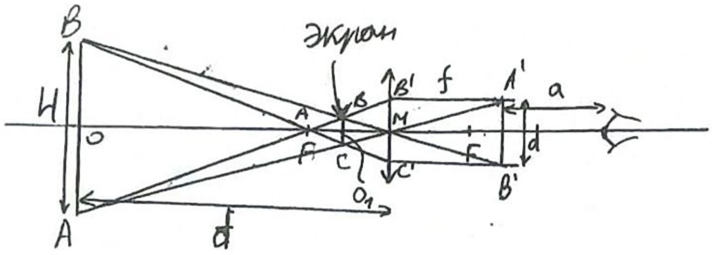
Ответ: 1) $a_{10} = \frac{(BL)^2 v_0}{12mR}$

Физика 11кл

Вариант 11-04 Часть 2

Чистовик.

№5



Дано:

$F = 24$ см

$H = 9$ см

$d = 96$ см

$a = 24$ см

1) x – ?

2) $D_м$ – ?

3) l – ?

1) По ф-ле тонкой линзы:

$$\frac{1}{d}+\frac{1}{f}=\frac{1}{F} \Rightarrow \frac{1}{f}=\frac{d-F}{Fd} \Rightarrow f=\frac{Fd}{d-F}=\frac{24\cdot 96}{96-24}=\frac{24\cdot 96}{72}=32\text{ см}$$ – расстояние от линзы до изображения

$x = f + a = 32 + 24 = 56$ см

2) $\Gamma=\frac{d}{D}=\frac{f}{d} \Rightarrow d = D\frac{f}{d} = 9\cdot\frac{32}{96}=9\cdot\frac{1}{3}=3$ см

При $D_м = d = 3$ см наблюдатель сможет увидеть целиком всё изображение циферблата

3) Из подобия ~~$\triangle ABC \sim \triangle AB'C'$~~ $\Rightarrow$

$$\left.\begin{aligned}\triangle OBM \sim \triangle O_1BM \Rightarrow \frac{H}{2b}=\frac{d}{l}\\ \triangle AB'M \sim \triangle ABO_1 \Rightarrow \frac{d}{2b}=\frac{F}{F-l}\end{aligned}\right\} \Rightarrow \frac{H}{d}=\frac{d(F-l)}{lF} \Rightarrow$$

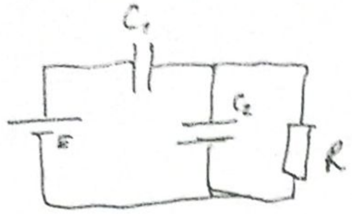
$$\Rightarrow HlF = d^2F - d^2l \Rightarrow (HlF + d^2l) = d^2F \Rightarrow l = \frac{d^2F}{HF+d^2}=\frac{9\cdot 24}{9\cdot 24+9}=\frac{9\cdot 24}{9\cdot 25}=\frac{24}{25}\text{ см}$$

Ответ: 1) $x = 56$ см

2) $D_м = 3$ см

3) $l = \frac{24}{25}$ см

Черновик.



$\cancel{E = U_{c_1} + U_{c_2} \quad U_{c_2} = IR}$

$\cancel{E = \frac{q}{C_1} + \frac{q}{C_2} = \frac{q}{5C} + \frac{q}{C} = \frac{6q}{5C}}$

$\cancel{\frac{q}{C} = IR}$

$E = U_{c1} + U_{c2}$

$U_{c2} = I_R R$

$U_{c_2} = 0 \qquad E = \frac{q_1}{C_1} = \frac{q_1}{5C} \Rightarrow q_1 = 5CE$

$\cancel{EI = U_{c_1} I + U_{c_2} I_0}$

$EI = U_{c1} I + U_{c2} I$

$U_{c2} I_0 = I_R^2 R$

$EI = U_{c1} I + U_{c2} I_0 + I_R^2 R$

$U_{c2} I = U_{c2} I_0 + I_R^2 R$

$\cancel{E(I_R + I_0) = U_{c_1}(I_R + I_0) + U_{c_2} I_0}$

$U_{c2}(I - I_0) = I_R^2 R$

$U_{c2} I_R = I_R^2 R$

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

$\dot q_2 = I_0$

$\dot q_1 = I_0 + I_R$

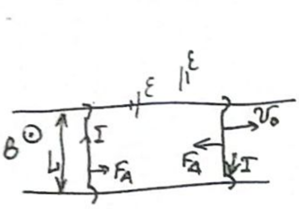
$\dot E = \frac{\dot q_1}{C_1} + \frac{\dot q_2}{C_2}$

$0 = \frac{I_0 + I_R}{5C} + \frac{I_0}{C} = \frac{6I_0 + I_R}{5C} = 0 \Rightarrow I_R = 6I_0$

$\dot q_2 = -I_0$

q_1

$\frac{I_R - I_0}{5C} - \frac{I_0}{C} = \frac{I_R - I_0 - 5I_0}{5C} = \frac{I_R - 6I_0}{5C} = 0$

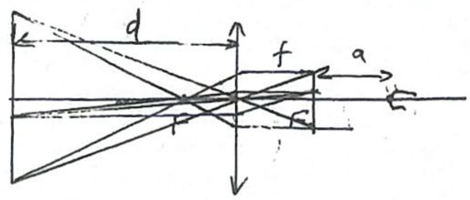


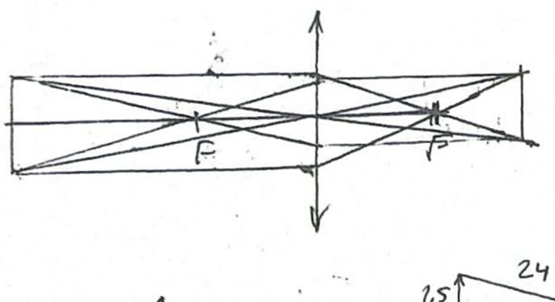
$F_A = IBL = ma$

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

$-\frac{BL\,dx}{dt} = \mathcal{E} \Rightarrow \mathcal{E} = BLv_0$

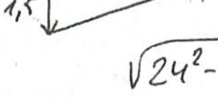
$\mathcal{E} = I(R + 5R$

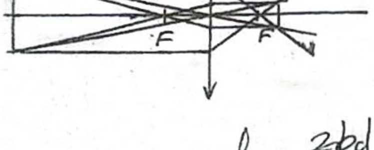




$\frac{d}{D} = \frac{f}{d}$

$d = D\frac{f}{d} = \frac{32}{96} D = \frac{D}{3}$





$\sqrt{24^2 - 1,5^2} = \sqrt{576 - 2,25} = \sqrt{573,75} = 23,95$

5см

$l = \frac{2bd}{4H} \qquad \frac{H}{d} = \frac{d(F-l)}{lF}$

$\frac{b2}{d} = \frac{F-l}{l}$