Часть 1

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

Шифр: **21201593**

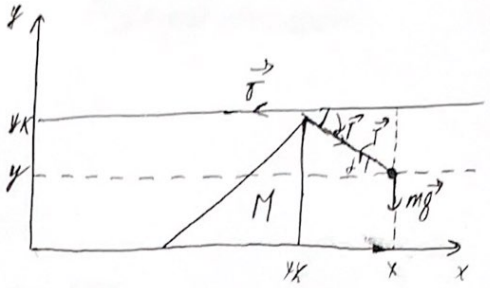
ID профиля: **316362**

Вариант 2

Чистовик

Физика 11 класс

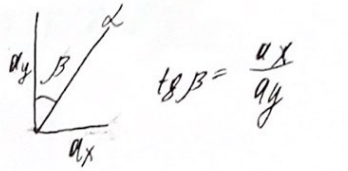
Задача №1



длина нити $l = const \Rightarrow \dot{l} = 0 \Rightarrow \ddot{l} = 0$

oy: $l = x_K - 0 + \frac{y_K - y}{\sin\alpha} \Rightarrow A_x + \frac{-a_y}{\sin\alpha} = 0$

Ox: $l = x_K - \frac{x_K - x}{\cos\alpha}$ $\quad A_x + \frac{a_x - A_x}{\cos\alpha} = 0$



$a_y = A_x \sin\alpha$

$a_x - A_x + A_x \cos\alpha = 0$

$\begin{cases} a_x = A_x(1-\cos\alpha) \\ a_y = A_x \sin\alpha \end{cases}$ | связь ускорений

$$tg\beta = \frac{A_x(1-\cos\alpha)}{A_x \sin\alpha} = \frac{1-\cos\alpha}{\sin\alpha} \quad (1)$$

по 2 закону Ньютона:

M: $-T + T\cos\alpha = MA_x$

m: Ox: $-T\cos\alpha = ma_x = mA_x(1-\cos\alpha)$

Oy: $T\sin\alpha - mg = ma_y = mA_x \sin\alpha$

$\begin{cases} -T\cos\alpha = mA_x(1-\cos\alpha) \quad | \cdot \sin\alpha \\ T\sin\alpha - mg = mA_x \sin\alpha \quad | \cdot \cos\alpha \end{cases}$

сложим: $-mg\cos\alpha = mA_x \sin\alpha(1-\cos\alpha) + mA_x \sin\alpha\cos\alpha$

$-mg\cos\alpha = mA_x \sin\alpha - mA_x \sin\alpha\cos\alpha + mA_x \sin\alpha\cos\alpha$

$-mg\cos\alpha = mA_x \sin\alpha$

$$A_x = -\frac{mg\cos\alpha}{m\sin\alpha} = -g\,ctg\alpha \quad (2)$$

отн. масс:

$-T(1-\cos\alpha) = MA_x = -Mg\,ctg\alpha$

$$T = \frac{Mg\,ctg\alpha}{1-\cos\alpha}$$

но $T\cos\alpha = -mA_x(1-\cos\alpha) = mg\,ctg\alpha(1-\cos\alpha)$

$\frac{Mg\,ctg\alpha\cos\alpha}{1-\cos\alpha} = mg\,ctg\alpha(1-\cos\alpha)$

$$\frac{m}{M} = \frac{\cos\alpha}{(1-\cos\alpha)^2} \quad (3)$$

(1)

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t - ? $a_y = A_x \sin\alpha = -g\,ctg\alpha \sin\alpha = -g\cos\alpha$

$y(t) = H - \frac{a_y t^2}{2} = H - \frac{g\cos\alpha\, t^2}{2}$

$y(t) = 0 \quad t = \sqrt{\frac{2H}{g\cos\alpha}}$ (4)

Ответ: 1) $tg\beta = \frac{1-\cos\alpha}{\sin\alpha}$ 2) $A_x = -g\,ctg\alpha$ 3) $\frac{n}{H} = \frac{\cos\alpha}{(1+\cos\alpha)^2}$ 4) $t = \sqrt{\frac{2H}{g\cos\alpha}}$

Задача №2

$C(T) = \frac{5}{2} R \frac{T}{T_0}$

1) $\delta Q = C(T)\,\partial\,dT = \frac{5}{2}\partial R \frac{T\,dT}{T_0}$

$Q = \frac{5}{2}\partial R \int_{T_0}^{\frac{T_0}{2}} \frac{T\,dT}{T_0} = \frac{5}{2}\frac{\partial R}{T_0}\frac{T^2}{2}\Big|_{T_0}^{\frac{T_0}{2}} = \frac{5\partial R}{2T_0}\cdot\frac{1}{2}\left(\frac{T_0^2}{4} - T_0^2\right) = \frac{5\partial R}{4T_0}\cdot\left(-\frac{3}{4}T_0^2\right) =$

$= -\frac{15\partial R T_0^2}{16 T_0} = -\frac{15}{16}\partial R T_0 = -Q_1$

$Q_1 = \frac{15}{16}\partial R T_0$

2) $\delta Q = \delta U + \delta A$

$\delta A = \delta Q - \delta U = \frac{5}{2}\frac{\partial R}{T_0} T\,dT - \frac{3}{2}\partial R\,dT$

$\delta U = C\,\partial\,dT = \frac{3}{2}\partial R\,dT$

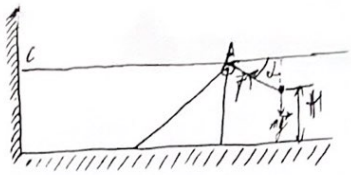
$A = \sum \delta A \int_{T_0}^{T_x} \frac{5\partial R T\,dT}{2T_0} - \int_{T_0}^{T_x} \frac{3}{2}\partial R\,dT = \frac{5}{2}\partial R \frac{1}{T_0}\int_{T_0}^{T_x} T\,dT - \frac{3}{2}\partial R \int_{T_0}^{T_x} \delta T$

Ответ: 1) $Q_1 = \frac{15}{16}\partial R T_0$

№1

Чертовщина

Дано:
$\cos\alpha = \frac{4}{5}$



$m\vec{g} = \vec{T}\sin\alpha$

по 3. Н

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

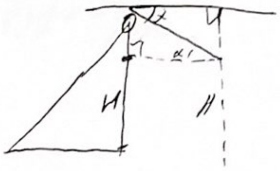
$ma = T - mg\cos\beta$

$ma - T = -mg\cos\beta$

$\cos\beta = \frac{T - mg}{mg} = \frac{T}{mg} - \frac{g}{g}$

$\beta = 90 - \alpha = 90 - \arccos(\cos\alpha) \approx 53^\circ$

$\cos\beta = 0{,}6$



$a = \frac{T - mg\cos\beta}{m} = \frac{T}{m} - g\cos\beta = \frac{T}{m} - 10 \cdot 0{,}6 = \frac{T}{m} - 6$

1-Н

$F = ma$

$T = (a+6)m$

$(a+6)m = Ma$

$ma + 6m = Ma$

$6m = Ma - ma$

$6m = a(M-m)$

$a = \frac{6m}{M-m}$

№2

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$t - ?$ $\quad a_y = A_x \sin\alpha = -g\,ctg\,\alpha \sin\alpha = -g\cos\alpha$

$$y(t) = H - \frac{a_y t^2}{2} = H - \frac{g\cos\alpha\, t^2}{2}$$

$$y(t) = 0 \qquad t = \sqrt{\frac{2H}{g\cos\alpha}} \ (4)$$

Ответ: 1.) $tg\beta = \frac{1-\cos\alpha}{\sin\alpha}$ 2.) $A_x = -g\,ctg\,\alpha$ 3.) $\frac{m}{M} = \frac{\cos\alpha}{(1-\cos\alpha)^2}$ 4.) $t = \sqrt{\frac{2H}{g\cos\alpha}}$.

Задача №2

$$C(T) = \frac{5}{2} R \frac{T}{T_0}$$

1.) $\delta Q = C(T)\,\nu\, dT = \frac{5}{2}\nu R \frac{T\,dT}{T_0}$

$$Q = \frac{5}{2}\nu R \int_{T_0}^{\frac{T_0}{2}} \frac{T\,dT}{T_0} = \frac{5}{2}\frac{\nu R}{T_0}\frac{T^2}{2}\Big|_{T_0}^{\frac{T_0}{2}} = \frac{5\nu R}{2T_0}\cdot\frac{1}{2}\left(\frac{T_0^2}{4} - T_0^2\right) = \frac{5\nu R}{4T_0}\cdot\left(-\frac{3}{4}T_0^2\right) =$$

$$= -\frac{15\nu R T_0^2}{16 T_0} = -\frac{15}{16}\nu R T_0 = -Q_1$$

[illegible]

$$Q_1 = \frac{15}{16}\nu R T_0$$

2.) $\delta Q = \delta U + \delta A$

$$\delta A = \delta Q - \delta U = \frac{5}{2}\frac{\nu R}{T_0} T\,dT - \frac{3}{2}\nu R\, dT$$

$$\delta U = C_V \nu\, dT = \frac{3}{2}\nu R\, dT$$

~~$A = \int \delta A = \int_{T_0}^{T_x} \frac{5\nu R T\,dT}{2T_0} - \int_{T_0}^{T_x}\frac{3}{2}\nu R\,dT = \frac{5}{2}\nu R\frac{1}{T_0}\int_{T_0}^{T_x} T\,dT - \frac{3}{2}\nu R\int_{T_0}^{T_x} dT$~~

[illegible]

Часть 2

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

Шифр: **21201593**

ID профиля: **316362**

Вариант 2

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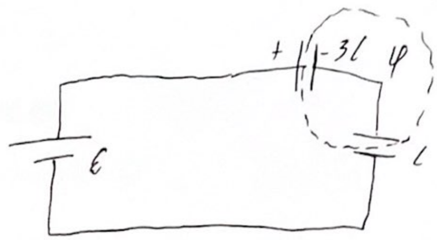
Физика 11 класс.

Задача №3

до замыкания:



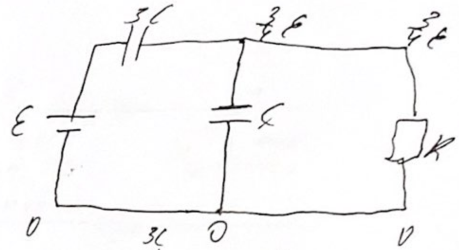
$0 = -q_{3C} + q_C$

$q_{3C} = q_C \Rightarrow C(\varphi - 0) = 3C(\mathcal{E} - \varphi)$

$\varphi = 3\mathcal{E} - 3\varphi \quad \varphi = \frac{3}{4}\mathcal{E}$

после замык. заряд сразу не меняется на C и 3C => сохр. распр. потенц.

$I = \frac{\frac{3}{4}\mathcal{E}_0}{R} = \frac{3\mathcal{E}_0}{4R}$ – ток через R сразу после замык.

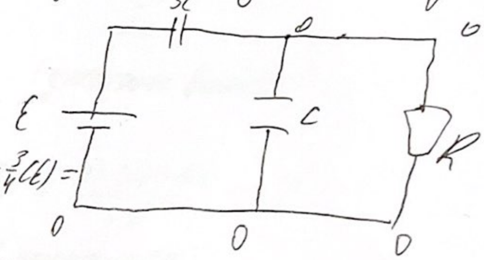


нов. устан. реж.:

$I_C = \frac{d\,q_C}{dt} = 0$

т.к. $I_C = 0 \Rightarrow I_R = 0 \Rightarrow U_R = 0$ (1)

т.к. $U_R = 0 \Rightarrow U_C = 0 \Rightarrow U_{3C} = \mathcal{E}$



по ЗСЭ:

$A_{ист} = \Delta W_{эл} + Q$. $A_{ист} = \mathcal{E} q_{прот} = \mathcal{E}\cdot(q_2 - q_1) = \mathcal{E}(3C\mathcal{E} - \frac{3}{4}C\mathcal{E}) = \frac{9}{4}C\mathcal{E}^2$

было: $q_1 = 3C(\mathcal{E} - \frac{3}{4}\mathcal{E}) = \frac{3}{4}C\mathcal{E}$

стало: $q_2 = 3C(\mathcal{E} - 0) = 3C\mathcal{E}$

$\Delta W_{эл} = \frac{3C\mathcal{E}^2}{2} + \frac{C0^2}{2} - \frac{3C\cdot(\frac{1}{4}\mathcal{E})^2}{2} - \frac{C(\frac{3}{4}\mathcal{E})^2}{2} = \frac{36}{32}C\mathcal{E}^2 = \frac{9}{8}C\mathcal{E}^2$

$Q = A_{ист} - \Delta W_{эл} = \frac{9}{4}C\mathcal{E}^2 - \frac{9}{8}C\mathcal{E}^2 = \frac{9}{8}C\mathcal{E}^2$ (2)

по ЗСЗ:

$I_1 = I_0 + I_R$

$I_0 = \frac{dq_2}{dt} = \frac{d(CU_2)}{dt} = \{C = const\} = C\frac{dU_2}{dt}$

$I_1 = \frac{dq_3 C}{dt} = 3C\frac{dU_1}{dt}$

$\mathcal{E} = U_1 + U_2 \Rightarrow \frac{I_0}{I_1} = \frac{C\frac{dU_1}{dt_1}}{3C\frac{dU_1}{dt}} = \frac{1}{3}$

$U_2 = \mathcal{E} - U_1$

$(I_0) = C\frac{d(\mathcal{E} - U_1)}{dt} = |-C\frac{dU_1}{dt}| = C\frac{dU_1}{dt}$

то есть $I_1 = 3I_0$

$I_R = 3I_0 - I_0 = 2I_0$

$U_R = 2I_0 R$ (3)

Ответ: 1) $U_R = 0$; 2) $\frac{9}{8}C\mathcal{E}^2$; 3) $2I_0R$

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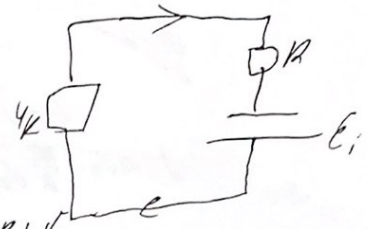
Задача № 4

Эквивалентная схема:



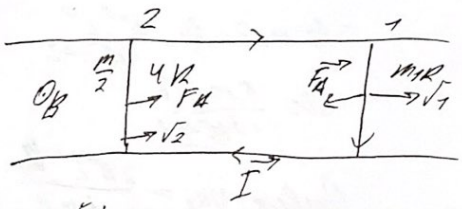
$I_0 = \frac{\varepsilon_i}{5R} = \frac{BV_0L}{5R}$

$\Rightarrow F_A = \frac{m}{2}a_2 = I_0BL = BL\frac{BLV_0}{5R}$

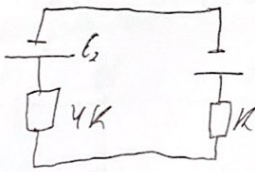
$\frac{1}{2}ma_2 = \frac{B^2L^2V_0}{R}$

$a_2 = \frac{2B^2L^2V_0}{5mR}$ (1)

2.1



Экв. схема:



$\varepsilon_1 = BV_1L$

$\varepsilon_2 = BV_2l$ (докажем выше)

$\Rightarrow I = \frac{\varepsilon_1 - \varepsilon_2}{5R} = \frac{BL(V_1 - V_2)}{5R} \Rightarrow$

$\Rightarrow F_{A1} = BIL_0 = F_{A2} = BIL$ (силы ампера одинаковы)

Ox: $m\frac{dV_1}{dt} = -F_A$

Oy: $\frac{m}{2}\frac{dV_2}{dt} = F_A$ $\Rightarrow$ можно сложить

$\frac{m}{2}\frac{dV_2}{dt} + m\frac{dV_1}{dt} = F_A - F_A = 0$

$\frac{d}{dt}\left(\frac{m}{2}V_2 + mV_1\right) = 0$

$\Rightarrow mV_1 + \frac{1}{2}mV_2 = const.$

в конце они перестанут сближаться

$V_1 - V_2 = U \Rightarrow mV_0 = mU + \frac{m}{2}U \Rightarrow \frac{3}{2}mU = V_0m$

$U = \frac{2}{3}V_0m$

2

с другой стороны:

$\begin{cases} m\frac{dV_1}{dt} = -F_A \\ \frac{m}{2}\frac{dV_2}{dt} = F_A \end{cases}$ (вычтем из верхнего нижнее):

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$$\frac{m\,\Delta v_1}{\Delta t} - \frac{m}{2}\frac{\Delta v_2}{\Delta t} = -2F_A = -\frac{2}{5}\frac{(BL)^2(v_1 - v_2)}{R}$$

$v_1 - v_2 = v_{отн} = \frac{\Delta L}{\Delta t}$ где L расстояние между перемычками

$$\Delta\left(mv_1 - \frac{m}{2}v_2\right) = -\frac{2}{5}\frac{B^2L^2}{R}\Delta t$$

$$\sum \Delta\left(mv_1 - \frac{m}{2}v_2\right) = -\frac{2}{5}\frac{B^2L^2}{R}\sum \Delta L$$

$$\Delta\left(mv_1 - \frac{m}{2}v_2\right) = mu - \frac{m}{2}u - mv_0 = \frac{m}{2}u - mv_0 = \frac{m}{2}\cdot\frac{2}{3}v_0 - mv_0 =$$

$$= \frac{mv_0}{3} - mv_0 = -\frac{2}{3}v_0$$

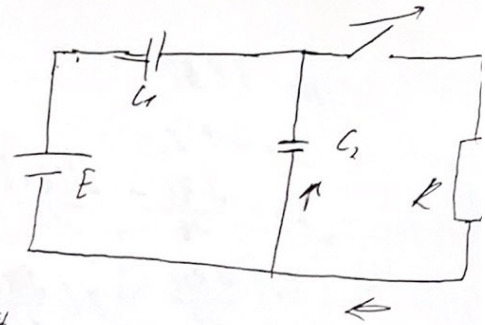
$$-\frac{2}{3}mv_0 = \frac{2}{5}\frac{B^2L^2}{R}\Delta L$$

$$\Delta L = \frac{5mRv_0}{3B^2L^2}$$

Ответ: 1) $a_2 = \frac{2B^2L^2v_0}{5mR}$ 2) $v_1 = v_2 = \frac{2}{3}v_0$ 3) $\Delta L = \frac{5mRv_0}{3B^2L^2}$

Куликовских

$C_2 = C$; $C_1 = 3C$



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

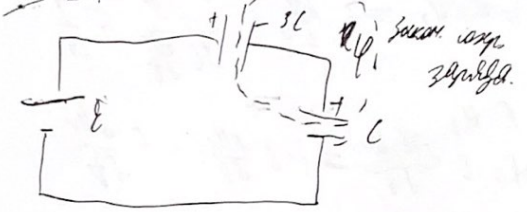
$I = q't$

$q = \frac{C}{4}$

$I = \frac{U}{R} = \frac{q}{CR}$

$I = \frac{\mathcal{E}}{R}$

где заряд.



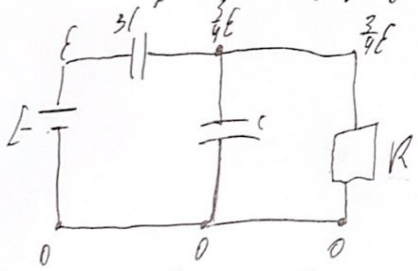
закон сохр. заряда.

$0 = -q_{3C} + q_C$

$q_{3C} = q_C \Rightarrow C(\varphi - 0) = 3C(\mathcal{E} - \varphi)$

$\varphi = 3\mathcal{E} - 3\varphi \qquad \varphi = \frac{3}{4}\mathcal{E}$

после размык. заряд. сразу не меняется $\Rightarrow$ на C и 3C $\Rightarrow$ сохр. разн. п



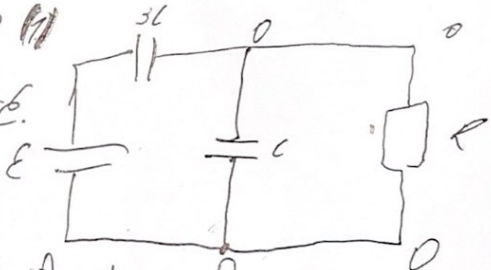
$I = \frac{\frac{3}{4}\mathcal{E}_0}{R} = \frac{3\mathcal{E}_0}{4R}$ – так ток R сразу после замык.

пов. устан. реж.:

$I_C = \frac{dq_C}{dt} = 0$

т.к. $I_C = 0 \Rightarrow I_R = 0 \Rightarrow U_R = 0$

т.к. $U_R = 0 \Rightarrow U_C = 0 \Rightarrow U_{3C} = \mathcal{E}$.



по 3C:

$A_{ист.} = \Delta W_{эл} + Q$

$A_{ист.} = \mathcal{E} \cdot q_{прош} = \mathcal{E}(q_2 - q_1) = \mathcal{E}\left(3C\mathcal{E} - \frac{3}{4}C\mathcal{E}\right) = \frac{9}{4}C\mathcal{E}^2$

было: $q_1 = 3C\left(\mathcal{E} - \frac{3}{4}\mathcal{E}\right) = \frac{3}{4}C\mathcal{E}$

стало: $q_2 = 3C(\mathcal{E} - 0) = 3C\mathcal{E}$

$\Delta W_{эл} = \frac{3C\mathcal{E}^2}{2} + \frac{C_0^2}{2} - \frac{3C \cdot (\frac{3}{4}\mathcal{E})^2}{2} - \frac{C(\frac{3}{4}\mathcal{E})^2}{2} = \frac{36}{32}C\mathcal{E}^2 = \frac{9}{8}C\mathcal{E}^2$

$Q = A_{ист} - \Delta W_{эл} = \frac{9}{4}C\mathcal{E}^2 - \frac{9}{8}C\mathcal{E}^2 = \frac{9}{8}C\mathcal{E}^2$ (2)

8.4
6.6
2.2-33

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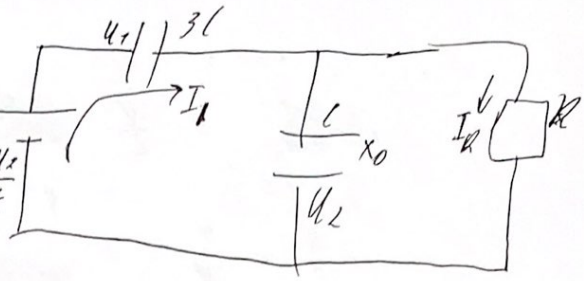

по 3 СЗ:

$I_1 = I_0 + I_R$

$I_0 = \frac{dq_C}{dt} = \frac{d(CU_2)}{dt} = \{C = const\} = C\frac{dU_2}{dt}$

$I_1 = \frac{dq_{3C}}{dt} = 3C\frac{dU_1}{dt}$

по ЗСЗ $\mathcal{E} = U_1 + U_2 \Rightarrow \frac{I_0}{I_1} = \frac{C\frac{dU_1}{dt}}{3C\frac{dU_1}{dt}} = \frac{1}{3}$

$U_2 = \mathcal{E} - U_1$

$|I_0| = C\frac{d(\mathcal{E} - U_1)}{dt} = |-C\frac{dU_1}{dt}| = C\frac{dU_1}{dt}$

по если $I_1 = 3I_0$

$I_R = 3I_0 - I_0 = 2I_0$

$U_R = 2I_0 R$ (3)

Черновик

Задача №7

Дано: