Часть 1

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

Шифр: **21203478**

ID профиля: **382099**

Вариант 1

Чистовик

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

$$Q_1 = \int\limits_{5/6 T_0}^{T_0} 2R\nu \frac{T\,dT}{T_0} = \frac{R\nu}{T_0} T^2 \Big|_{5/6 T_0}^{T_0} = R\nu T_0 \left(1 - \frac{25}{36}\right) = 11 R\nu T_0$$

$\boxed{\text{ответ: } Q_1 = 11 R\nu T_0}$

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

$$\frac{2R\nu}{T_0} \int\limits_{T_0}^{T'} T\,dT = A + \frac{3}{2}\nu R \Delta T$$

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

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

$$\frac{R\nu}{T_0}\left(T'^2 - T_0^2 - \frac{3}{2}T_0 T' + \frac{3}{2}T_0^2\right) = A$$

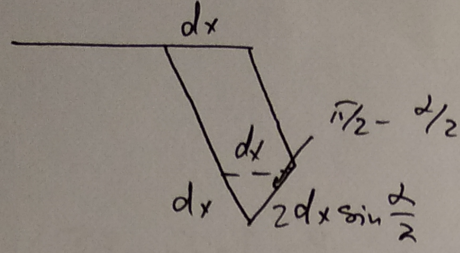
$$A = \frac{R\nu}{T_0}\left(T'^2 - \frac{3}{2}T_0 T' + \frac{1}{2}T_0^2\right)$$

$A_{min} \Rightarrow \quad T' = \frac{\frac{3}{2}T_0}{2} = \frac{3}{4}T_0$ $\boxed{\text{ответ: } \frac{3}{4}T_0}$

3) $$A_{min} = \frac{R\nu}{T_0}\left(\frac{9}{16}T_0^2 - \frac{3}{2}T_0^2 \cdot \frac{3}{4} + \frac{1}{2}T_0^2\right) =$$

$$= R\nu T_0 \left(\frac{9}{16} - \frac{18}{16} + \frac{8}{16}\right) = \frac{-1}{16} R\nu T_0$$ $\boxed{\text{ответ: } \frac{-1}{16} R\nu T_0}$

① 1)



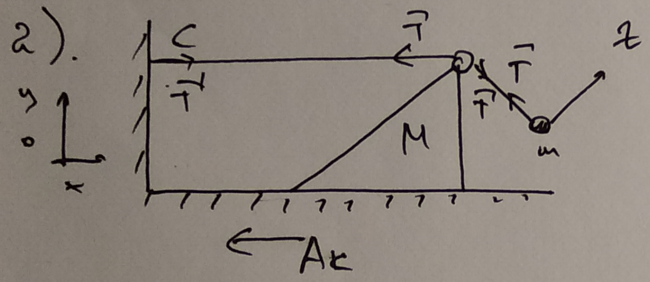
Диск - под углом φ к горизонту, где

$$\varphi = \frac{\pi}{2} - \frac{\alpha}{2}$$

$$\sin\varphi = \cos\frac{\alpha}{2} = \sqrt{\frac{1+\cos\alpha}{2}} = \sqrt{\frac{4}{5}} = \frac{2\sqrt{5}}{5}$$

Ответ: $\sin\varphi = \frac{2\sqrt{5}}{5}$

2).



2ЗН для клина:

$$Ox: \begin{cases} T(1-\cos\alpha) = MA_к \\ A_m = 2A_к \sin\frac{\alpha}{2} \end{cases}$$

условие неразрывности

Oz:

$$\begin{cases} mg\cos\frac{\alpha}{2} - T\sin\frac{\alpha}{2} = m2A_к\sin\frac{\alpha}{2} \\ T(1-\cos\alpha) = MA_к \\ T\cos\frac{\alpha}{2} = mg\sin\frac{\alpha}{2} \end{cases}$$

$$T = mg\,\mathrm{tg}\,\frac{\alpha}{2}$$

$$mg\cos\frac{\alpha}{2} - T\sin\frac{\alpha}{2} = m2A_к\sin\frac{\alpha}{2}$$

$$g\cos\frac{\alpha}{2} - g\frac{\sin^2\frac{\alpha}{2}}{\cos\frac{\alpha}{2}} = 2A_к\sin\frac{\alpha}{2}$$

$$A_к\sin\frac{\alpha}{2} = g\left(\cos^2\frac{\alpha}{2} - \sin^2\frac{\alpha}{2}\right)$$

$$A_к = g\frac{\cos\alpha}{\sin\alpha} = \frac{3}{4}g$$

Ответ: $A_к = \frac{3}{4}g$

Чистовик   лист 2 стр 3.

3) $\begin{cases} A_x = g\,\mathrm{ctg}\,\alpha \\ T = mg\,\mathrm{tg}\,\frac{\alpha}{2} \\ T(1-\cos\alpha) = MA_x \end{cases}$

$$mg\,\mathrm{tg}\,\frac{\alpha}{2}(1-\cos\alpha) = Mg\,\mathrm{ctg}\,\alpha$$

$$m\,\mathrm{tg}\,\frac{\alpha}{2}(1-\cos\alpha) = M\,\mathrm{ctg}\,\alpha$$

$$\frac{m\,\mathrm{tg}\,\frac{\alpha}{2}(1-\cos\alpha)}{M\,\mathrm{ctg}\,\alpha} = 1 \qquad \frac{m}{M} = \frac{\mathrm{ctg}\,\alpha}{\mathrm{tg}\,\frac{\alpha}{2}(1-\cos\alpha)} =$$

$$\mathrm{tg}\,\frac{\alpha}{2}) = \frac{\sin\alpha}{1-\cos\alpha}$$

$$= \frac{\mathrm{ctg}\,\alpha\cdot\sin\alpha}{(1-\cos\alpha)^2} = \frac{\frac{\cos\alpha}{\sin\alpha}\cdot\sin\alpha}{(1-\cos\alpha)^2} = \frac{\cos\alpha}{(1-\cos\alpha)^2} =$$

$$= \frac{\frac{3}{5}}{(1-\frac{3}{5})^2} = \frac{\frac{3}{5}}{\frac{4}{25}} = \frac{3}{5} : \frac{4}{25} = \frac{3\cdot\cancel{25}^{5}}{\cancel{5}\cdot 4} = \frac{15}{4}$$

$\boxed{\underline{\text{ОТВЕТ:}}\ \frac{m}{M} = \frac{15}{4}}$

Черновик

(1) Дано: ν моль, He, $T_0 \to$ охлаждение

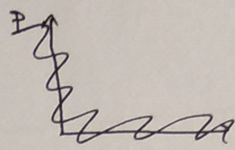
$C(T) = 2R\frac{T}{T_0}$, $R = 8{,}31$

$T_1 = \frac{5}{6}T_0$

1) $Q_1 = ?$
2) $A_{min} \Rightarrow T' = ?$
3) $A_{min} = ?$

He – 3/2

Решение:



$P_1V_1 = \nu R T_0$ $\qquad$ $P_2V_2 = \frac{5}{6}\nu R T_0$

$36 - 25 = 11$

1) $\delta Q = 2R\nu\frac{T}{T_0}dT$

$$Q_1 = \int_{5/6 T_0}^{T_0} 2R\nu\frac{T\,dT}{T_0} = \frac{R\nu}{T_0}T^2\Big|_{5/6T_0}^{T_0} = R\nu T_0\left(1 - \frac{25}{36}\right) = \frac{11}{36}R\nu T_0$$

$$\boxed{Q_1 = 11R\nu T_0}$$

A_{min}

$T' = ?$

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

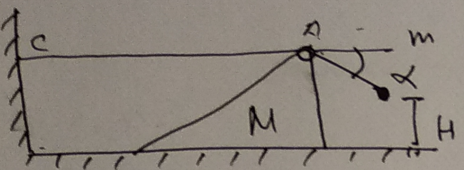
$$\frac{2R\nu}{T_0}\int_{T_0}^{T'} T\,dT = A + \frac{3}{2}\nu R\Delta T$$

$$\frac{2R\nu}{T_0}\int_{T_0}^{T_1} T\,dT = A + \frac{3}{2}\nu R(T' - T_0)$$

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

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

1) Черновик



$\cos\alpha = 3/5$

1) sin/cos/tg/ctg

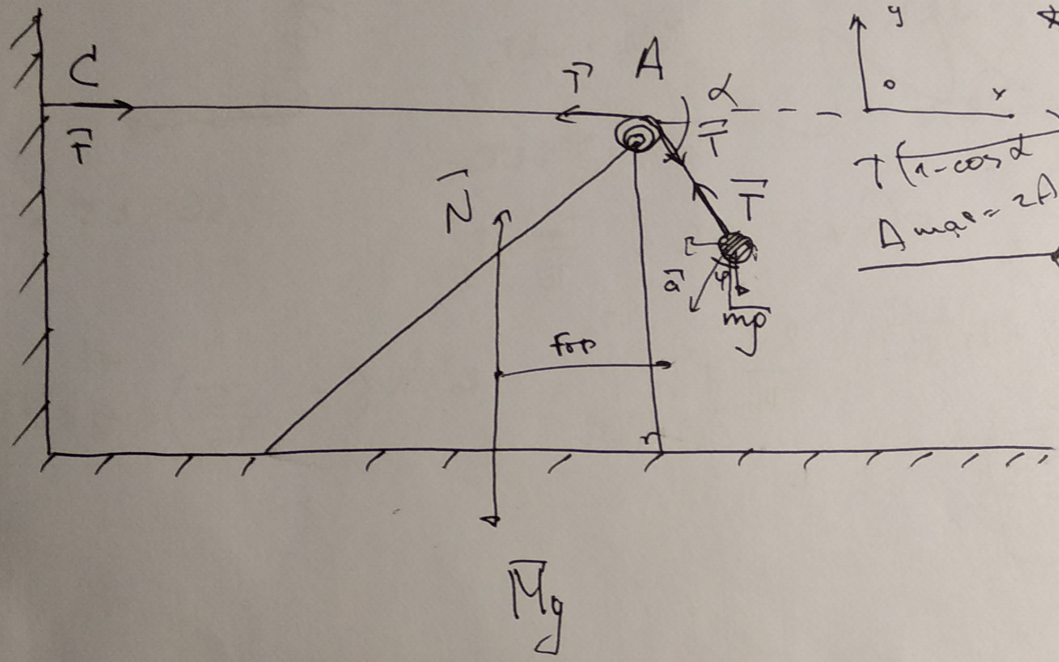
1) $\varphi_a = ?$

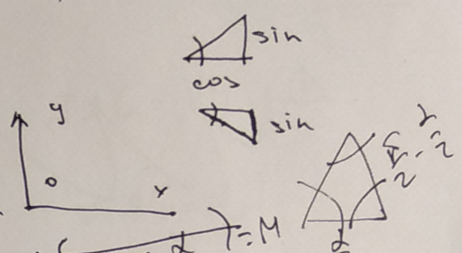
2) $\frac{m}{M}$

3) $t = ?$

Пусть масса шара — m и масса клина M

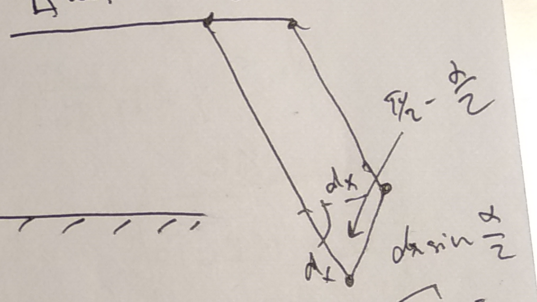
~~1 до начала движения~~





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

Δ шара $= 2A$кл $\sin\frac{\alpha}{2}$



$\sin = \cos\frac{\alpha}{2} = \sqrt{\frac{1+\cos\alpha}{2}} = \sqrt{\frac{4}{5}} = \frac{2\sqrt{5}}{5}$!!! =

Законы Ньютона д после начала движения:

~~oy: $-mg + T\sin\alpha = 0$~~

~~ox: $-T\cos\alpha$~~

oy: $-mg + T\sin\alpha$

ЗЗИ:

~~ллл~~

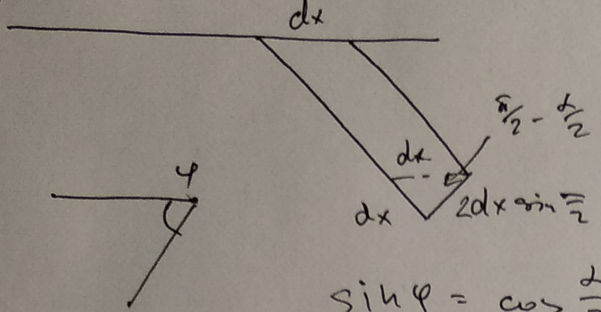
$A_k \sin\frac{\alpha}{2} = g\left(\cos^2\frac{\alpha}{2} - \sin^2\frac{\alpha}{2}\right)$

~~A_k~~

$A_k = g\frac{\cos\alpha}{\sin\alpha} = \frac{3}{4}g$

Черновик   лист 3 стр 5

1).

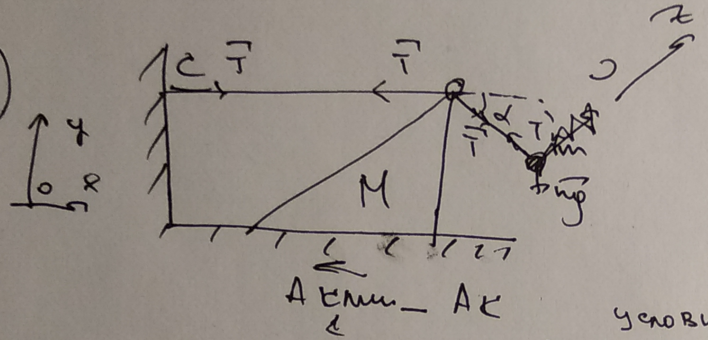


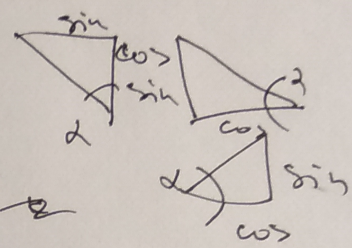
Лист под углом φ

$\varphi = \frac{\pi}{2} - \frac{\alpha}{2}$ к горизонту

$$\sin\varphi = \cos\frac{\alpha}{2} = \sqrt{\frac{1+\cos\alpha}{2}} = \sqrt{\frac{4}{5}} = \frac{2\sqrt{5}}{5}$$

2)





2 ЗН:

для клина

Ox: $\begin{cases} T(1-\cos\alpha) = MA_к \\ A_{шар} = 2A_к\sin\frac{\alpha}{2} \end{cases}$ условие неразрывности

Oz.

$$\begin{cases} mg\cos\frac{\alpha}{2} - T\sin\frac{\alpha}{2} = m\,2A_к\sin\frac{\alpha}{2} \quad ?? \\ T(1-\cos\alpha) = MA_к \\ T\cos\frac{\alpha}{2} = mg\sin\frac{\alpha}{2} \end{cases}$$

$T = mg\,\mathrm{tg}\frac{\alpha}{2}$

$$mg\cos\frac{\alpha}{2} - T\sin\frac{\alpha}{2} = m\,2A_к\sin\frac{\alpha}{2}$$

$$\cancel{A_к = \frac{mg\cos\frac{\alpha}{2} - T\sin\frac{\alpha}{2}}{2m\sin\frac{\alpha}{2}}}$$

$$g\cos\frac{\alpha}{2} - g\frac{\sin^2\frac{\alpha}{2}}{\cos\frac{\alpha}{2}} = 2A_к\sin\frac{\alpha}{2} \Rightarrow$$

$$\cancel{2A_к = g\left[\frac{\cos\frac{\alpha}{2}}{\sin\frac{\alpha}{2}} - \frac{\sin^2\frac{\alpha}{2}}{\cos\frac{\alpha}{2}}\right]}$$

Черновик лист 2 стр 4.

Проверка

$$\frac{2R\nu}{T_0}\left(T'^2 - T_0^2\right) = A + 3/2\,\nu R\left(T' - T_0\right)$$

$$\frac{2R\nu}{T_0}\left(T'^2 - T_0^2\right) - \frac{3}{2}\nu R\left(T' - T_0\right) = A$$

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

$$\frac{\nu R}{T_0}\left(2T'^2 - 2T_0^2 - \frac{3}{2}\frac{T'T_0}{\cancel{T_0}} - \frac{3}{2}T_0\right)$$

$$\frac{R\nu}{T_0}\left(T'^2 - T_0^2 - \frac{3}{2}T_0T' + \frac{3}{2}T_0^2\right) = A.$$

$$A = \frac{R\nu}{T_0}\left(T'^2 - \frac{3}{2}T_0 \cdot T' + \frac{1}{2}T_0^2\right)$$

Если A min, то $T' = \frac{\frac{3}{2}T_0}{2} = \boxed{\frac{3}{4}T_0} \Rightarrow$

3) $A_{min} = ?$

$$A_{min} = \frac{R\nu}{T_0}\left(\frac{9}{16}T_0^2 - \frac{3}{2}T_0^2 \cdot \frac{3}{4} + \frac{1}{2} \cdot T_0^2\right) =$$

$$= \frac{R\nu}{T_0}\left(\frac{9}{16}T_0^2 - \frac{9}{8}T_0^2 + \frac{1}{2}T_0^2\right) = R\nu T_0\left(\frac{9}{16} - \frac{18}{16} + \frac{8}{16}\right) =$$

$$= \left(\frac{17}{16} - \frac{18}{16}\right)R\nu T_0 = \frac{-1}{16}R\nu T_0.$$

Часть 2

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

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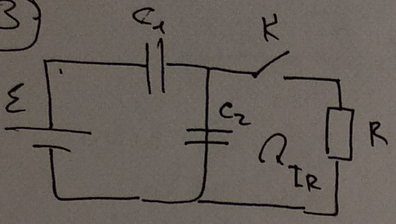
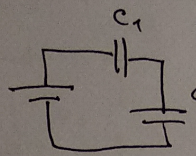
Вариант 1

3



1) 

Заряд на C_1 и C_2 одинаковый т.к ток ~~на~~ через C_1 тот же ток ~~на~~ через C_2.

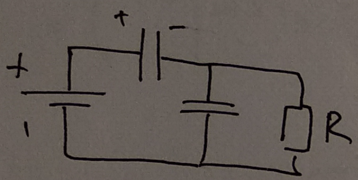
~ После замыкания (сразу)

$$E = \frac{q}{2C} + \frac{q}{C} = \frac{3}{2}\cdot\frac{q}{C} \Rightarrow q = \frac{3}{2}CE$$

$$U_R = \frac{q}{C} = \frac{2}{3}CE : C = \frac{2}{3}E \Rightarrow I_R = \frac{2}{3}\cdot\frac{E}{R}$$

$\boxed{\text{Ответ: } I_R = \frac{2}{3}\frac{E}{R}}$

2) После установки токов на C_1 и C_2 будет



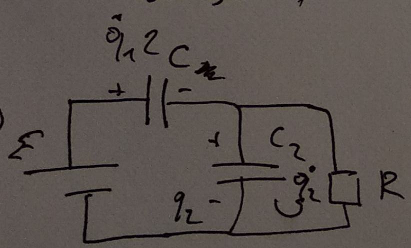
$$q_k = 2EC, \quad q_0 = \frac{2}{3}EC \Rightarrow \Delta q = \frac{4}{3}EC$$

З.С.Э: $A + W_1 = W_2 + Q$

$$\Delta q E + \frac{q^2}{2C} + \frac{q^2}{4C} = \frac{\cancel{2}E^2C}{\cancel{2}} + Q \qquad Q_1$$

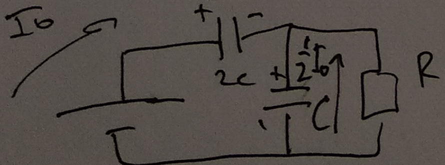
$$\frac{4}{3}E^2C + \frac{\cancel{4}}{3\cancel{8}}C^{\cancel{2}}E^2\cdot\frac{\cancel{8}}{\cancel{4C}} = E^2C + Q \qquad E^2C\left(\frac{4}{3}+\frac{1}{3}-1\right) = \frac{2}{3}E^2C$$

$\boxed{\text{Ответ: } \frac{2}{3}E^2C}$

3) 

$\downarrow \dot{q}_1$

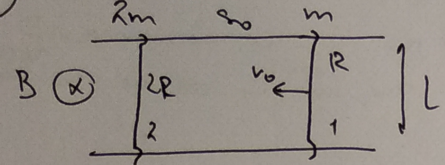
$$\begin{cases} E = \frac{q_1}{2C} + \frac{q_2}{C} \\ \frac{q_2}{C} = (\dot{q}_1 - \dot{q}_2)R \end{cases} \Rightarrow \dot{q}_1 = -2\dot{q}_2 \Rightarrow \dot{q}_2 = -\frac{1}{2}\dot{q}_1$$



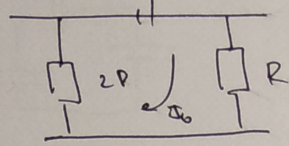
$\downarrow \frac{3}{2}I_0$

$\boxed{I_R = \frac{3}{2}I_0}$

4



1) a_0 — ускорение 2^{го} в начальный момент



$\mathcal{E} = -\dot{\Phi} = -BLv_0$

$BLv_0 = 3RI_0$

$I_0 = \dfrac{BLv_0}{3R}$

2ЗН: $2ma_0 = \dfrac{B^2L^2v_0}{3R} \Rightarrow a_0 = \dfrac{B^2L^2v_0}{6mR}$

$\boxed{\text{Ответ: } \dfrac{B^2L^2v_0}{6mR} = a_0}$

3) $S_\infty = S - \int_0^\infty v_0 t\,dt = S - \int_0^\infty v_0 e^{-\frac{2}{3}\psi t}\,dt = S - \left[-\dfrac{2v_0}{3\psi}\cdot e^{-\frac{3}{2}\psi t}\Big|_0^\infty\right] =$

$= S - \dfrac{2v_0}{3\psi} \Rightarrow$

$\Delta S = S - \dfrac{2v_0}{\cancel{3}}\cdot\dfrac{\cancel{3}Rm}{B^2L^2} = S - \dfrac{2v_0Rm}{B^2L^2}$

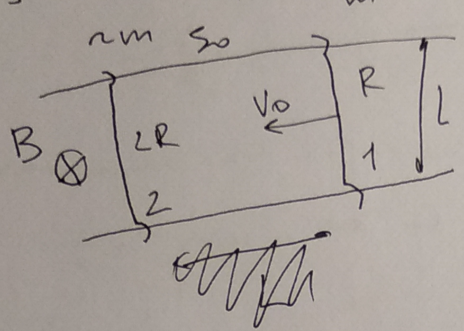
$\boxed{\text{Ответ: } S - \dfrac{2v_0Rm}{B^2L^2}}$

Черновик лист 1 стр 2.

написать проктору

$\frac{4}{3}E^2C + \frac{1}{3}C^2E^2 \cdot \frac{3}{4C} = E^2C + Q$

$\frac{4}{3} + \frac{1}{3} - 1 =$



$1 \rightarrow V_0$

~~индукция~~

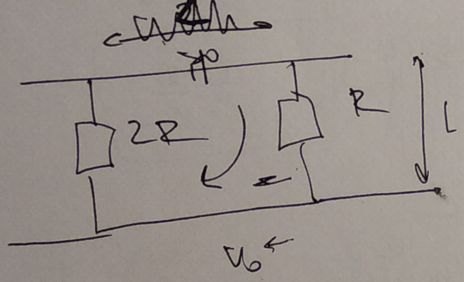
1) $a_{20} = ?$

2) $t = ?$

3) $S_0, S' = ?$

БрЕд или не бред

Решение:



$\mathcal{E} = -\dot{\Phi} = -BLV_0$ $\quad BLV_0 = 3RI_0$

$I_0 = \frac{BLV_0}{3R}$

23Н

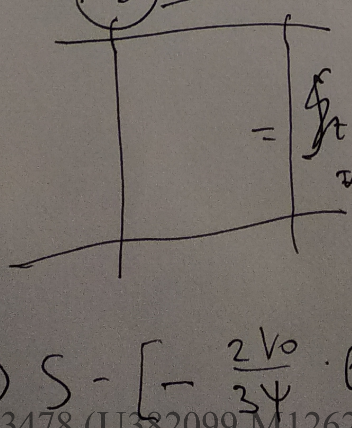
Сила Ампера =

$= \frac{B^2L^2V_0}{3R}$ $\quad \frac{B^2L^2V_0}{3 \cdot R}$ 2)????

$2ma_0 = \frac{B^2L^2V_0}{3R}$

$a_0 = \frac{B^2L^2V_0}{3 \cdot 2 \cdot m \cdot R} = \frac{B^2L^2V_0}{6mR}$

3 $\rightarrow$ $S_\infty = S - \int_0^\infty V_0 \, dt =$



$= S - \int_0^\infty V_0 e^{-\frac{2}{3}\psi t} dt = $ ⊜

$\Delta S = S - \frac{2V_0}{3} Rm \cdot 3$

(2) $S - \left[-\frac{2V_0}{3\psi} \cdot e^{-\frac{3}{2}\psi t} \Big|_0^\infty \right]$

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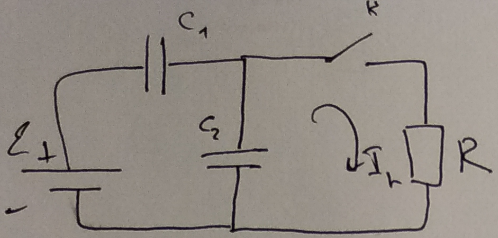
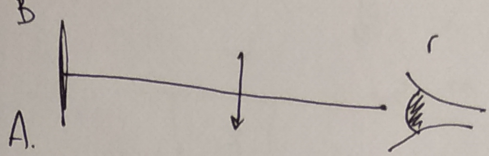
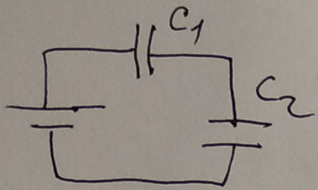
Черновик лист 1 стр 1



~~по правилу~~ Кирхгофа





Заряд на C_1 и C_2 одинаковый!
(т.к. что через C_1 ток и через C_2)

— после замыкания

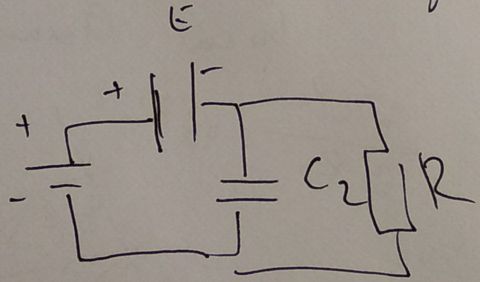
$$E = \frac{q}{2C} + \frac{q}{C} = \frac{3}{2}\frac{q}{C} \quad \text{от} \quad q = \frac{2}{3}CE$$

$$U_r = \frac{q}{C} = \frac{2}{3C}\mathcal{E} : C = \frac{2}{3}\mathcal{E} \Rightarrow \boxed{I_R = \frac{2}{3}\frac{\mathcal{E}}{R}}$$

$$q_k = 2EC \qquad EC \qquad \frac{6-2}{3} = \frac{4}{3}$$

$$q_0 = \frac{2}{3}$$

$$\Delta q = \frac{4}{3}EC$$



$$\Delta q E + \frac{q^2}{2C} + \frac{q^2}{4C} = \cancel{2}\frac{E^2C}{\cancel{2}} + Q$$

$$\Delta q E + \frac{q^2}{2C} + \frac{q^2}{4C} = E^2C + Q$$

$$\frac{4}{3}E^2C + \frac{\cancel{4}}{3\cancel{9}}C^2E^2 \cdot \frac{\cancel{3}}{4\cancel{C}} = E^2C + Q$$

$$\frac{4}{3}E^2C + \frac{1}{3}E^2C - E^2C = Q$$