Часть 1

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

Шифр: **21200044**

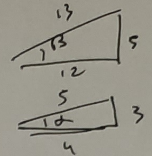
ID профиля: **207610**

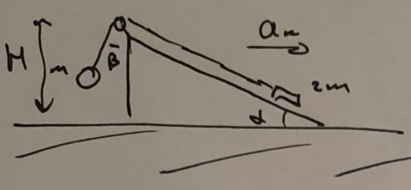
Вариант 6

Чистовик Вариант 11-06

Задача №1

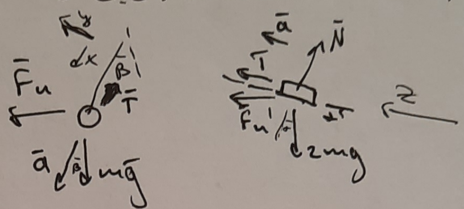
$\cos\alpha = \frac{4}{5}$, $\cos\beta = \frac{12}{13}$





1) $a_к$ — ?

В С.О. клина $|\bar{a}_{шарика}| = |\bar{a}_{бруска}| = a$



для шарика: $\bar{F}_и + \bar{T} + m\bar{g} = m\bar{a}$

y: $F_и \sin(90^\circ - \beta) - mg\sin\beta = 0 \Rightarrow m a_к = mg\,\mathrm{tg}\,\beta \Rightarrow a_к = g\,\mathrm{tg}\,\beta$

x: (1) ~~$F_и \cos(90-\beta) + mg\cos\beta - T = ma$~~

$a_к = g\,\mathrm{tg}\,\beta = 4{,}08\ \frac{м}{с^2} = g\frac{5}{12} = \frac{5}{12}g$

2) для бруска ускорение относительно клина равно a

для шарика (1) $m a_к \sin\beta + mg\cos\beta - T = ma$

$T = m(g\,\mathrm{tg}\,\beta \sin\beta + g\cos\beta - a)$

для бруска: z: $T + F_и' \cos\alpha - 2mg\sin\alpha = 2ma$

$-ma + mg\cos\beta + mg\,\mathrm{tg}\,\beta\sin\beta + 2ma_к\frac{4}{5} - 2mg\sin\alpha = 2ma$

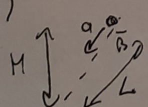
$3a = g(\cos\beta + \mathrm{tg}\,\beta\sin\beta + 2\,\mathrm{tg}\,\beta\,\frac{4}{5} - 2\sin\alpha)$

$a = \frac{g}{3}(\cos\beta + \mathrm{tg}\,\beta\sin\beta + 2\,\mathrm{tg}\,\beta\,\frac{4}{5} - 2\sin\alpha)$

$a = \frac{g}{3}\left(\frac{12}{13} + \frac{5}{12}\cdot\frac{5}{13} + 2\cdot\frac{5}{12}\cdot\frac{4}{5} - 2\cdot\frac{3}{5}\right) = \frac{g}{3}\left(\frac{720 + 125 + \cancel{650}\,520 - 936}{12\cdot 13\cdot 5}\right)$

~~$a = \frac{g\cdot 559}{3\cdot 12\cdot 13\cdot 5} = \frac{43}{3\cdot 12\cdot 5}g = \frac{43}{180}g$~~ $\quad a = \frac{429}{3\cdot 12\cdot 13\cdot 5}g = \frac{11}{60}g$

3)



$L = \frac{H}{\cos\beta}$

$\upsilon_0 = 0 \Rightarrow L = a\frac{\tau^2}{2} \Rightarrow \tau^2 = \frac{2L}{a} = \frac{2H}{\cos\beta\, a}$

$\tau^2 = \frac{2H}{\frac{12}{13}\cdot\frac{11}{60}g} = \frac{2\cdot 5\cdot 13}{11}\frac{H}{g}$ ~~$\tau^2 = \frac{2H}{\frac{12}{13}\cdot\frac{43}{180}g} = \frac{2H\cdot 13\cdot 15}{43g} = \frac{390}{43}\frac{H}{g}$~~

~~$\tau = \sqrt{\frac{390}{43}\frac{H}{g}}$~~

$\tau^2 = \frac{130}{11}\frac{H}{g}$

(1)

Ответ: 1) ускорение клина $a_к = \frac{5}{12}g$

2) ускорение бруска относ. клина $a = \cancel{\frac{43}{180}g} = \frac{11}{60}g$

3) шарик достигнет стола через время ~~$\tau = \sqrt{\frac{390}{43}\frac{H}{g}}$~~ $\tau = \sqrt{\frac{130}{11}\frac{H}{g}}$

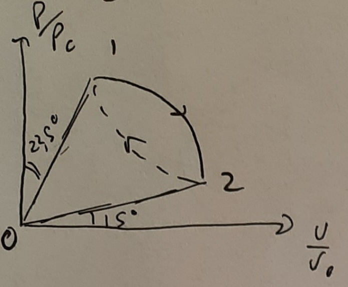
Чистовик Вариант 11-06

Задача №2 (1 лист из 2)

$C_V = \frac{5}{2}R$, $i = 5$

1-2 – окр.

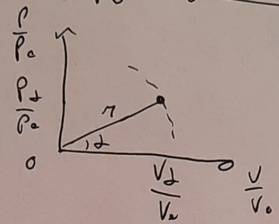
2-1: $Q = 0$



1) $\frac{T_1}{T_2}$ – ?, $T = \frac{pV}{\nu R} = \frac{p_0 V_0}{\nu R}\frac{p}{p_0}\cdot\frac{V}{V_0}$

$$\cancel{\left(\frac{p}{p_0}\right)^2 + \left(\frac{V}{V_0}\right)^2 = r^2}$$

$$\cancel{\frac{p}{p_0} = \sqrt{r^2 - \left(\frac{V}{V_0}\right)^2}}$$



$\frac{p_\alpha}{p_0} = r\sin\alpha$, $\frac{V_\alpha}{V_0} = r\cos\beta$

(1): $\frac{p_1}{p_0} = r\sin(90° - 22{,}5°)$

$\frac{V_1}{V_0} = r\cos(90° - 22{,}5°)$

$$T_1 = \frac{p_0 V_0}{\nu R} r^2 \sin 67{,}5° \cos 67{,}5° = \frac{p_0 V_0}{\nu R} r^2 \frac{1}{2} \sin 135°$$

(2): $\frac{p_2}{p_0} = r\sin 15°$, $\frac{V_2}{V_0} = r\cos 15°$, $T_2 = \frac{p_0 V_0}{\nu R} r^2 \sin 15 \cos 15 = \frac{p_0 V_0}{\nu R}\frac{r^2}{2}\sin 30°$

$$\frac{T_1}{T_2} = \frac{p_0 V_0}{\nu R}\frac{r^2}{2}\frac{\sin 135°}{p_0 V_0\, r^2} 2\nu R \frac{1}{\sin 30°} = \frac{\sin 135°}{\sin 30°} = \frac{\sin 45°}{\sin 30°} = \frac{\sqrt{2}}{2 \cdot \frac{1}{2}} = \sqrt{2}$$

2) $C = \frac{\delta Q}{dT}$, $C = 0 \Rightarrow Q = 0 \Rightarrow$ график в этой точке касается адиабаты

$$pV^\gamma = const \to dp\, V^\gamma + p\gamma V^{\gamma-1} dV = 0$$

$$\frac{dp}{dV} = -\frac{p\gamma V^\gamma}{V\, V^\gamma} = -\gamma\frac{p}{V} = -\frac{i+2}{i}\frac{p}{V} = -\frac{7}{5}\frac{p}{V}$$

$$\left(\frac{p}{p_0}\right)^2 + \left(\frac{V}{V_0}\right)^2 = r^2 \to 2\frac{p}{p_0}\frac{dp}{p_0} + 2\frac{V}{V_0}\frac{dV}{V_0} = 0$$

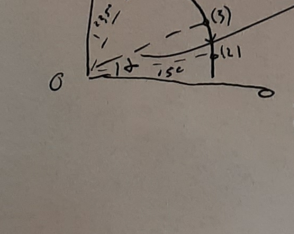
$$\frac{dp}{dV} = -\frac{V}{V_0^2}\frac{p_0^2}{p} = -\frac{p_0^2}{V_0^2}\frac{V}{p}$$

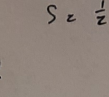
$$: -\frac{7}{5}\frac{p}{V} = -\frac{p_0^2}{V_0^2}\frac{V}{p} \Rightarrow \frac{p^2}{p_0^2} = \frac{V^2}{V_0^2}\frac{5}{7} \Rightarrow \frac{p}{p_0} = \sqrt{\frac{5}{7}}\frac{V}{V_0} \Rightarrow$$

$$\Rightarrow r\sin\alpha = \sqrt{\frac{5}{7}} r\cos\alpha \Rightarrow \operatorname{tg}\alpha = \sqrt{\frac{5}{7}} \Rightarrow \alpha = \operatorname{arctg}\sqrt{\frac{5}{7}}$$

3) $\frac{A}{A_{расш}}$, $A_{12} = \frac{1}{2} r^2 (\arcsin \cos 15° - \arcsin \sin 22{,}5°) = \frac{1}{2} r^2 \frac{75° - 22{,}5°}{180°} 2\pi =$

$= \pi r^2 \frac{52{,}5}{180} =$





$s = \frac{1}{2} r^2 (\arcsin\cos\alpha_2 - \arcsin\cos\alpha_1)$

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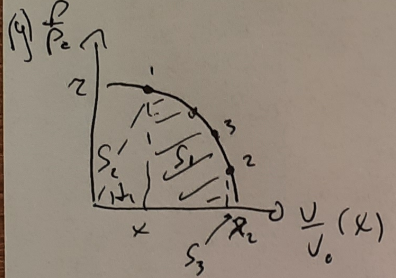
Задача №2   Чистовик (2 лист из 2)   Вариант 11-06

3) $\frac{A_{цикл}}{A_{расш}} = \frac{A_{расш} + A}{A_{расш}} = 1 + \frac{A}{A_{расш}}$, где A - работа в процессе 2-1

$$A_{расш} = \int_{(1)}^{(2)} p\,dV = p_0V_0 \int_{(1)}^{(2)} \frac{p}{p_0}\, d\frac{V}{V_0} = p_0V_0 S_1$$



$$S_1 = \int_{(1)}^{(2)} \sqrt{r^2 - x^2}\,dx = r^2 \int_{(1)}^{(2)} \sqrt{1 - \left(\frac{x}{r}\right)^2}\, d\frac{x}{r} =$$

$$= \cancel{r^2 \int_{x_1}^{x_2} d \sin \frac{x}{r} = r^2 \arcsin \frac{x}{r} \Big|_{x_1}^{x_2}}$$

2-1: $Q = 0 \Rightarrow A = -\Delta U = A = -\frac{5}{2}\nu R(T_1 - T_2)$

$$A = +\frac{5}{2}\nu R(T_2 - T_1) = \frac{5}{2}\nu R T_2(1 - \sqrt{2})$$

$$S_1 \approx \frac{\pi r^2}{4} - S_2 - S_3 \approx \frac{\pi r^2}{4} - \frac{r + r\sin\alpha_1}{2} r\cos\alpha_1 - \frac{1}{2} r \sin\alpha_2 (r - r\cos\alpha_2)$$

$$S_1 = r^2\left(\frac{\pi}{4} - \frac{\sin\alpha_1 + 1}{2}\cos\alpha_1 - \frac{1 - \cos\alpha_2}{2}\sin\alpha_2\right) =$$

$\alpha_1 = 67{,}5°$, $\alpha_2 = 15°$

$$S_1 = r^2(0{,}785398 - 0{,}961939 \cdot 0{,}382683 - 0{,}017037 \cdot 0{,}258819)$$

$$S_1 = r^2(0{,}417280 - 0{,}004409) = 0{,}412870 \cdot r^2 = kr^2$$

$A_{расш} = p_0V_0S_1$, $A = \frac{5}{2}\nu R(1 - \sqrt{2}) \frac{p_0V_0}{\nu R} \frac{r^2}{2}\sin 30°$

$$\frac{A_{цикл}}{A_{расш}} = 1 + \frac{\frac{5}{4}\cancel{p_0V_0} \cancel{r^2} \sin 30° (1 - \sqrt{2})}{\cancel{p_0V_0}\, k \cancel{r^2}} = 1 - \frac{1}{2}\frac{5}{4}\frac{\sqrt{2} - 1}{k} = 1 - \frac{0{,}517767}{2 \cdot 0{,}412870} =$$

$$= 1 - 0{,}627034 = 0{,}372966 \approx 0{,}373$$

Ответ: 1) $\frac{T_1}{T_2} = \sqrt{2}$

2) $\operatorname{tg}\alpha = \sqrt{\frac{5}{7}}$, $\alpha = \operatorname{arctg}\sqrt{\frac{5}{7}}$

3) $\frac{A_{цикл}}{A_{расш}} \approx 0{,}373$

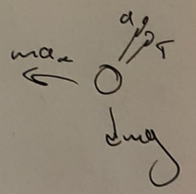
Черновик

$u = \sqrt{1-\left(\frac{x}{r}\right)^2}$

$v = d\frac{x}{r}$

$du = \frac{v}{2\sqrt{1-\left(\frac{x}{r}\right)^2}}$

$v = \frac{x^2}{r}$



$A_{13} = Q_{13}$

$F_n \cancel{\cos}\beta = mg \sin\beta$

$a_n \cos\beta = mg \sin\beta$

$a_n = mg \, tg\beta$

$dT + \delta U$

$\delta \quad \delta \quad \delta \quad \delta$

$\gamma = \frac{i+2}{i} \quad x^2 = 2x$

$Q = 0 \Rightarrow A = -\Delta U$

$\frac{5}{3}$

$C_v = \frac{5}{2} R$

газ расширяется $(x^3)' = 3x^2$ $\quad dx^3 = 3dx$

$\cancel{A \geq pV}$ $\quad$ ат $\quad$ 1, 3 $\quad dx^3 = 3x^2 dx$

$p dV + \frac{i}{2} \nu R dT = 0$ $\quad pV^\gamma = const$

$\cancel{A_{12} = Q}$ $\quad \cancel{p dV}$ $\quad p = const / V^\gamma$

$(\Pi r^2) \quad \frac{const}{V^\gamma} dV + \frac{i}{2} \nu R dT = 0$

$+ d(\gamma+1) \, d V^{(\gamma+1)} = + \frac{i}{2} d\left(\frac{const}{V^{\gamma-1}}\right)$

$dS = y dx = r \sin\alpha \, r d\cos\alpha$ $\quad (\gamma+1) \, dV^{\gamma-(\gamma+1)} = \frac{i}{2} const \, \cancel{d(V^{\gamma-1})}$

$\cancel{r^2 \sin\alpha \, d\alpha}$ $\quad 0 - \left(\frac{\Pi}{2}\right)$

$\gamma = \frac{i}{2} - 1 = \frac{i-2}{2} \qquad \frac{5-2}{2} = \frac{3}{2}$

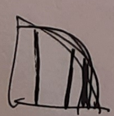
$= r^2 \sqrt{1-\cos^2\alpha} \, d\cos\alpha$

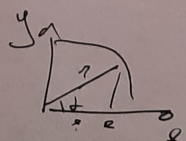
$\frac{i+2}{i} = \frac{i+2}{2}$

$pV^\gamma = const$

$\frac{5}{2} \nu R dT + pV \qquad i=2$

$\frac{i-2}{4} = \frac{1}{3}$





$y^2 + x^2 = r^2 \qquad \frac{5}{3} \quad \frac{7}{5} \quad \frac{7}{5} \quad \frac{5}{3}$

$y^2 = r^2 - x^2$

$y = r\sqrt{1-\left(\frac{x}{r}\right)^2} \qquad \frac{7}{5} \quad \frac{3}{5}$

$S = \int y dx = r^2 \sqrt{1-\left(\frac{x}{r}\right)^2} d\left(\frac{x}{r}\right) \qquad \frac{5}{7} \quad \frac{5}{3}$

$-\frac{\Pi}{2} - \frac{\Pi}{2} = -\Pi$

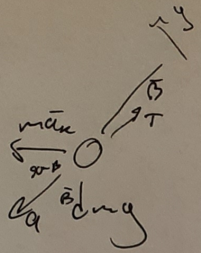
$= \frac{1}{2} r^2 \arcsin\frac{x}{r}\Big|_{x_1}^{x_2} = r^2 \arcsin \cancel{\cos}\alpha \Big|_{\alpha_1}^{\alpha_2}$

$\Pi r^2 \qquad 0 : \frac{\Pi}{2}$

1

Черновик

169 − 144 = 25

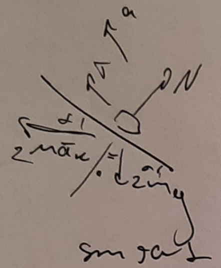


$y: \; ma_n\cos\beta = mg\sin\beta$

$a_n = g\,tg\beta = \frac{5}{12}g$

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

$T = \frac{5}{12}mg\frac{5}{13} + mg\frac{12}{13} - ma$



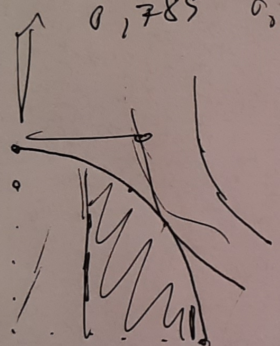
$\frac{3}{5}$

$2ma = T + 2m\frac{5}{12}g\frac{4}{5} - 2mg\cancel{\sin\alpha}$

$3ma = \frac{25}{12\cdot13}mg + \frac{12}{13}mg + \frac{8}{12}mg - \frac{2\cdot3}{5}mg$

0,785   0,4128

$a = \frac{g}{3}\left(\frac{25}{12\cdot13} + \frac{12}{13} + \frac{40}{12} - \frac{6}{5}\right)$



t ≈ 49203°

Часть 2

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

Шифр: **21200044**

ID профиля: **207610**

Вариант 6

Черновик

$\frac{1}{F} = -7 + D_2$ $\quad \frac{1}{0{,}25} = 4$

$\frac{1}{F} + 4 = -3 + D_2$ $\quad Q = A + W_1 - W_2 = C\mathcal{E}^2\left(\frac{3}{4} + \frac{3}{8} - \frac{3}{2}\right) =$

$= C\mathcal{E}^2 \frac{-6+3-12}{8}$

$D_2 = \frac{1}{F}$

$A = (W_2 + Q) - W_1$

$D_2 = 7$ $\quad Q = A + W_1 - W_2$

$A = \Delta W = W_2 - (W_1 + Q) = W_2 - W_1 - Q \quad \frac{2}{8} + \frac{3}{8} - \frac{4}{8}$

$Q = W_2 - W_1 - A$

$C = \frac{q}{U}$ $\quad \cancel{Q = A + W_1 - W_2 =}$ $Q = C\mathcal{E}^2\left(\frac{4}{8} - \frac{3}{8} - \frac{2}{8}\right)$

$v = v_0 - at$

$UC = q$ $\quad S = v_0 t - \frac{at^2}{2}$ $\quad = C\mathcal{E}^2\left(\frac{3}{4} + \frac{3}{8} - \frac{3}{2}\right) = C\mathcal{E}^2 \frac{6+3-12}{8}$

$\frac{dU}{dt} C = \frac{dq}{dt}$ $\quad t = \frac{v_0 - v}{a}$ $\quad \frac{3}{2} > \frac{3}{4}$

$Q = C\mathcal{E}^2\left(\frac{3}{2} - \frac{3}{8} - \frac{3}{4}\right) =$

$-b + v_0 \frac{v_0 - v}{a} - \frac{a(v_0 - v)^2}{2a^2} = 0$ $\quad = C\mathcal{E}^2 \frac{3\cdot 4 - 3 - 3\cdot 2}{8} = \frac{12-3-6}{8} = 3$

$U_2 = U_R + Lv$

$-2ab + v_0^2 + v^2 =$

$2ba = v_0^2 + v^2 - 2vv_0$

$v^2 = v_0^2 + 2ab$

$U_R = U_2 - Lv$ $\quad q\, L\, I \quad C\, dI = d$

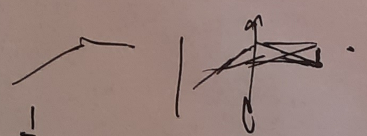
$S = vt - \frac{at^2}{2}$

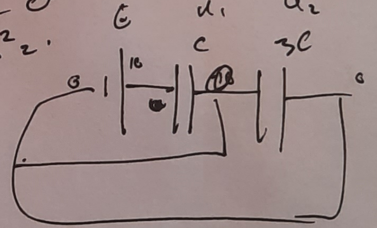
$v_0^2 = v^2 - 2ab$

$D_0 + D_g = 2D_2 = \frac{2}{F} + \frac{1}{d}$ $\quad U_1 = \mathcal{E}$

$v^2 = v$

$v_0^2 =$





$\frac{1}{d}$

I_L

$\frac{I_C}{3} = C\frac{dU}{dt}$ $\quad I_0 + I_1 = I_L$ $\quad I_0 = 3C\frac{dU_2}{dt}$

$I_0 = I_1 + I_L$ $\quad U_R = U_2$ $\quad I_1 = C\frac{dU_1}{dt}$

$I_L - I_0 - I_C = \frac{C}{dt}\left(\frac{3dU_2 - dU_1}{4}\right)$ $\quad U_R = \mathcal{E} - U_1$ $\quad I_L = I_0 + I_1 = C\frac{dU_1 + 2dU_2}{dt}$

$= \frac{C}{dt} = \frac{4dU_2}{} = \frac{C}{dt}(dU_2 - dU_1)$ $\quad I_L = C\frac{2dU_2}{dt}$

$= \frac{C}{dt} 4U_1 = \frac{4U}{3} =$ $\quad I_L = 2C\frac{dU_1}{dt} = 2C$

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Чистовик   Вариант 11-06

Задача №5

$F_г = F + \Delta F$, $\Delta F \to 0$ $\Rightarrow F_г = F$, $D_г = D$, $d = 25$ см

$\frac{D_д}{D_б} = \frac{7}{3}$, f - расстояние от хрусталика до сетчатки

1) $D_б + D_г = \frac{1}{f} + \frac{1}{d}$
$D_д + D_г = \frac{1}{f} + \frac{1}{d_\infty} = \frac{1}{f}$ $\Big| \Rightarrow D_б - D_д = \frac{1}{d}$
$D_д = \frac{7}{3} D_б$ $\Big/ \Rightarrow D_б - \frac{7}{3} D_б = \frac{1}{d}$

$\frac{1}{d} = -\frac{4}{3} D_б$

$D_б = -\frac{3}{4d}$

$D_б = -\frac{3}{4 \cdot 25 см} = -\frac{3}{1 м} = -3$ дптр

$D_д = \frac{7}{3} \cdot (-3)$ дптр $= -7$ дптр

$D_г = \frac{1}{f} + \frac{1}{x}$
$D_г = \frac{1}{f} - D_д$ $\Big| \Rightarrow \frac{1}{\cancel{f}} + \frac{1}{x} = \frac{1}{\cancel{f}} - D_д$

$x = -\frac{1}{D_д} = -\frac{1}{-7} = \frac{1}{7}$ м

$x = 14,3$ см

2) $D_о - ?$ $d_1 = 50 см = 0,5 м$

$D_г + D_о = \frac{1}{f} + \frac{1}{d_1}$
$D_г + D_д = \frac{1}{f}$ $\Big| \Rightarrow D_о - D_д = \frac{1}{d_1}$

$D_о = \frac{1}{d_1} + D_д = \frac{1}{0,5 м} - 7$ дптр $= -5$ дптр

Ответ: 1) $x = 14,3$ см, $D_д = -7$ дптр
2) $D_о = -5$ дптр

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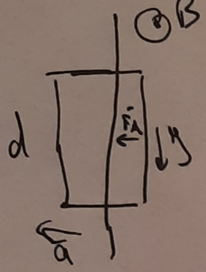
21200044 (U207610 M1263326)

Чистовик Вариант 11-06

Задача №4

$b = d/4$, m, R, $H = 2d = 8b$

m, d, v_0, R, B $H > b$

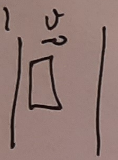


1) $\mathcal{E} = \frac{d\Phi}{dt} = B\frac{dS}{dt} = B\frac{d\,v\,dt}{dt} = Bdv_0$

$J = \frac{\mathcal{E}}{R} = \frac{Bdv_0}{R}$, $F_A = BJd = Bd\frac{Bdv_0}{R}$

$F_A = \frac{B^2d^2v_0}{R}$

$a = \frac{F_A}{m} = \frac{B^2d^2v_0}{mR}$

2) 

$v = v_0 - at \Rightarrow v_0 = v + at$

$b = v_0 t - \frac{at^2}{2}$

$b = vt + at^2 - \frac{at^2}{2} \Rightarrow b = vt + \frac{at^2}{2}$

$\frac{at^2}{2} + vt - b = 0$

$D = v^2 + 4b\frac{a}{2} = v^2 + 2ab$

$t = \frac{-v + \sqrt{v^2+2ab}}{a}$

$v = v_0 - at$

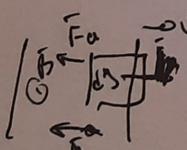
$v = v_0 + v - \sqrt{v^2+2ab}$

$v_0 = \sqrt{v^2+2ab}$

① $v^2 = v_0^2 - 2ab$

$v = \sqrt{v_0^2 - 2\frac{d}{4}\frac{B^2d^2v_0}{mR}}$

$v = \sqrt{v_0^2 - \frac{d^3B^2v_0}{2mR}}$



$v_1 = v = \sqrt{v_0^2 - \frac{d^3B^2v_0}{2mR}}$

3) аналогично ① $v_2^2 = v_1^2 - 2ab = v^2 - 2ab \overset{(1)}{=} (v_0^2 - 2ab) - 2ab = v_0^2 - 4ab$

~~по ... равно ...~~

$v_2 = \sqrt{v_0^2 - 4\frac{d}{4}\frac{B^2d^2v_0}{mR}}$

Ответ: 1) $a = \frac{B^2d^2v_0}{mR}$

2) $v_1 = \sqrt{v_0^2 - \frac{d^3B^2v_0}{2mR}} = \sqrt{v_0^2 - \frac{d^3B^2v_0}{2mR}}$

3) $v_2 = \sqrt{v_0^2 - \frac{d^3B^2v_0}{mR}}$

3

Чистовик Вариант 11-06

Задача №3 (2 лист из 2)

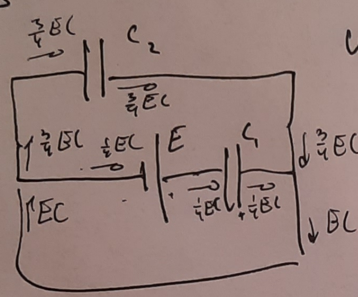
3) $I_2 = I_0$, U_R - ?

$CU_2 = q_2 \Rightarrow C\,dU_2 = dq_2 \Rightarrow C\frac{dU_2}{dt} = \frac{dq_2}{dt} = I_2$

$U_2 = U_R + Lv$

$E - U_1 = Lv + U_R$

2) через длительный промежуток времени токи всех перестанут, $v = 0$, напряжения установятся



$U_2' = 0$, $U_1' = E$, $q_2' = 0$ $q_1' = EC$

C_2 ~~отдал~~ $\Delta q_2 = \frac34 EC$

C_1 ~~отдал~~ получил $\Delta q_1 = \frac14 EC$

через E ?C прошел $\Delta q = \frac14 EC = \Delta q_1$

$A = E\Delta q = \frac14 CE^2$

$W_1 = \frac{CU_1^2}{2} + \frac{3CU_2^2}{2} = \frac{C}{2}E^2\left(\frac{9}{16} + \frac{3}{16}\right) = \frac38 CE^2$

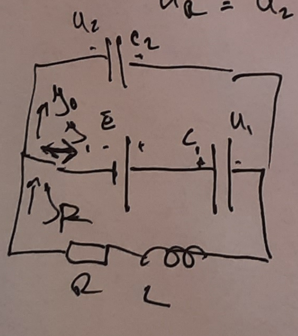
$W_2 = \frac{CU_1'^2}{2} = \frac12 CE^2$

$A = (W_2 + Q) - W_1 \Rightarrow Q = A + W_1 - W_2 = CE^2\left(\frac28 + \frac38 - \frac48\right) = \frac{CE^2}{8}$

3) ~~I_2~~ $= I_0$, U_R - ?

$U_R = E - U_1 - Lv$

$U_R = U_2 - Lv$ $\Rightarrow$ ~~$2U_R = E - U_1 + U_2 - 2L0$~~ $\Rightarrow 0 = E - U_1 - U_2 \Rightarrow U_2 + U_1 = E$, $U_2 = E - U_1$



$3C\,dU_2 = dq_2 \Rightarrow 3C\frac{dU_2}{dt} = I_0$, $C\frac{dU_1}{dt} = I_1$

$I_R = I_1 + I_0 = I_1 + I_0 = \frac{C}{dt}(dU_2 + dU_1 + 2dU_2)$

$I_R = \frac{C}{dt}(dE + 2dU_2) = 2\frac{C\,dU_2}{dt}$, $C\frac{dU_2}{dt} = \frac{I_0}{3}$ (т.к. $3C\frac{dU_2}{dt} = I_0$)

$I_R = \frac23 I_0 \Rightarrow U_R = I_R R = \frac23 I_0 R$

Ответ: 1) скорость тока в катушке $v = \frac{E}{4L}$

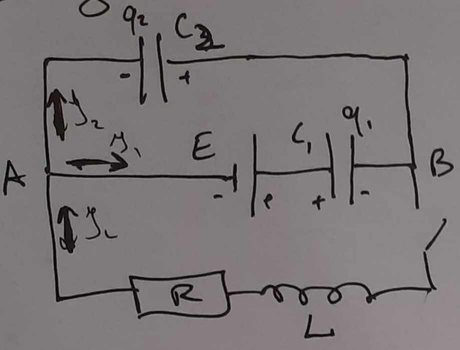
2) $Q = \frac{CE^2}{8}$

3) $U_R = \frac23 I_0 R$

2

Чистовик   Вариант 11-06

Задача N 3 (1 лист из 2)



$C_1 = C$, $C_2 = 3C$ $C = \frac{q}{U}$

1) до замыкания

$-q_1 + q_2 = 0 \Rightarrow q_1 = q_2 = q$

$U_2 = \frac{q_2}{C_2} = \frac{q_2}{3C}$, $U_1 = \frac{q_1}{C_1} = \frac{q_1}{C}$

$E = U_1 + U_2 \Rightarrow E = \frac{q}{C} + \frac{q}{3C} = \frac{q}{C}\frac{4}{3}$

$q = \frac{3}{4}EC \Rightarrow U_2 = \frac{\frac{3}{4}EC}{3C} = \frac{E}{4}$

$U_1 = \frac{3}{4}E$

$U_{BA} = U_2 = \frac{E}{4}$, сразу после замыкания: $J_L = 0$

$U_2 = \cancel{+}J_L R + L\frac{dJ_L}{dt}$

$U_2 = +J_L R + Lv \Rightarrow U_2 = Lv \Rightarrow v = \frac{U_2}{L} = \frac{E}{4L}$

2) Q — ? через длительный промежуток времени $v = 0 \Rightarrow U_2' = J_L R$

также ток через конденсаторы не течёт ⇒ они ~~з~~ будут иметь постоянное напряжение

$E - U_1' = +J_L R + Lv \Rightarrow E - U_1' = +J_L R$ ⇒

$U_2' = +J_L R$

$\Rightarrow E + U_2' - U_1' = 0 \Rightarrow U_1' = E + U_2'$

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

$U_1' = \frac{q'}{C_1} = \frac{3}{2}E$, $U_2' = \frac{q'}{3C} = \frac{1}{2}E$

$W_1 = \frac{CU_1^2}{2} + \frac{3CU_2^2}{2} = \frac{C}{2}\left(E^2\cdot\frac{9}{16} + E^2\cdot\frac{3}{16}\right) = CE^2\frac{1}{2}\cdot\frac{\cancel{12}^3}{\cancel{16}_4} = \frac{3}{8}CE^2$

$W_2 = \frac{CU_1'^2}{2} + \frac{3CU_2'^2}{2} = \frac{C}{2}\left(\frac{9}{4}E^2 + \frac{3}{4}E^2\right) = CE^2\frac{1}{2}\cdot\frac{12}{4} = \frac{3}{2}CE^2$

$A = (q' - q)E = CE^2\left(\frac{3}{2} - \frac{3}{4}\right) = \frac{3}{4}CE^2$

$\cancel{A = W_2 - W_1 + Q} \Rightarrow A = W_2 - (W_1 + Q) = W_2 - W_1 - Q$

$Q = W_2 - W_1 - A = CE^2\left(\frac{3}{2} - \frac{3}{8} - \frac{3}{4}\right) = CE^2\frac{12 - 3 - 6}{8} = \frac{3}{8}CE^2$