# Часть 1

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

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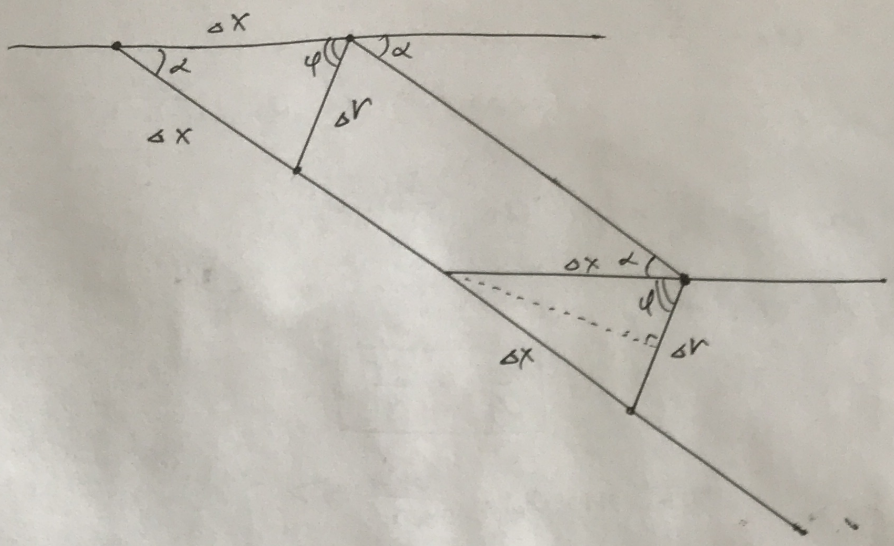
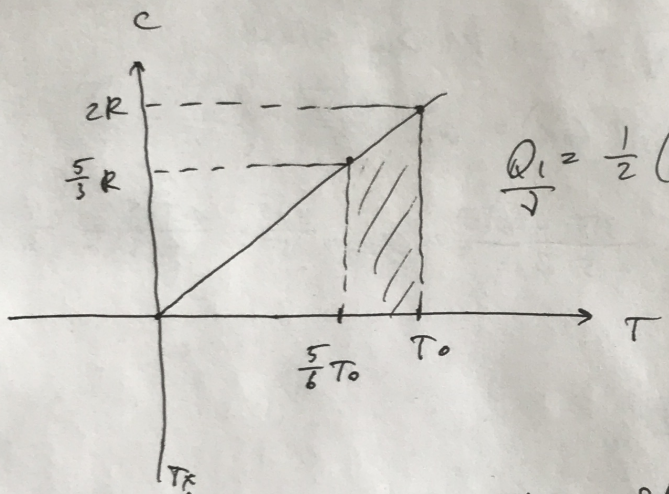
Вариант 1




$$\frac{Q_1}{\nu} = \frac{1}{2}\left(\frac{2}{3}R + \frac{5}{3}R\right)\cdot\frac{1}{6}T_0 = \frac{1}{2}\cdot\frac{11}{3}\cdot\frac{1}{6}RT_0 = \frac{11}{36}RT_0$$

$$Q_1 = \frac{11}{36}\nu RT_0$$

$$\nu\cdot\int_{T_0}^{T_x} c(T)\,dT = Q = A + \Delta U = A + \frac{3}{2}\nu R(T_x - T_0)$$

$$A = \nu\cdot\frac{2R}{T_0}\int_{T_0}^{T_x} T\,dT - \frac{3}{2}\nu RT_x + \frac{3}{2}\nu RT_0 =$$

$$= \frac{2\nu R}{T_0}\cdot\frac{T^2}{2}\Big|_{T_0}^{T_x} - \frac{3}{2}\nu RT_x + \frac{3}{2}\nu RT_0 =$$

$$= \frac{\nu R}{T_0}\cdot T_x^2 - \frac{\nu R}{T_0}\cdot T_0^2 - \frac{3}{2}\nu RT_x + \frac{3}{2}\nu RT_0 =$$

$$= \boxed{\frac{\nu R}{T_0}T_x^2 - \frac{3}{2}\nu RT_x + \frac{1}{2}\nu RT_0}$$

$$\frac{\nu R}{T_0}\cdot\frac{9}{16}T_0^2 - \frac{3}{2}\cdot\nu R\cdot\frac{3}{4}T_0 + \frac{1}{2}\nu RT_0 =$$

$$= \frac{9}{16}\nu RT_0 - \frac{18}{16}\nu RT_0 + \frac{8}{16}\nu RT_0 = -\frac{1}{16}\nu RT_0$$

$$\sin\varphi = \sin\left(\frac{\pi}{2} - \frac{\alpha}{2}\right) =$$

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

$$\cos\alpha = 2\cos^2\frac{\alpha}{2} - 1$$

$$\cos\frac{\alpha}{2} = \sqrt{\frac{\cos\alpha + 1}{2}}$$

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

Чистовик
Вар. 11-01
11 класс

① продолжение

т.о. $a_x = g \cdot \frac{3\sqrt{5}}{2\sqrt{5}+6} \approx g \cdot 0,67 \approx \boxed{0,64g}$

7) $a_{wy} = a_w \sin\varphi = g \cdot \frac{\sqrt{5}^3}{2 \cdot 4(\sqrt{5}+3)} \cdot \frac{8\sqrt{5}}{5} =$

Чистовик

11 класс
Вар. 11-01.

2.

$\nu$, $T_0$
$C(T) = 2R\frac{T}{T_0}$
$T_0 \to \frac{5}{6}T_0$
$Q_1 - ?$
$T_x - ?$
$A_{min} - ?$

1) $-Q_1 = \int_{T_0}^{\frac{5}{6}T_0} C(T)\cdot dT\cdot\nu =$

$= \nu\cdot 2R\cdot\frac{1}{T_0}\int_{T_0}^{\frac{5}{6}T_0} T\,dt = \frac{2R\cdot\nu}{T_0}\cdot\frac{T^2}{2}\Big|_{T_0}^{\frac{5}{6}T_0} =$

$= \frac{R\nu}{T_0}\left(\frac{25}{36}T_0^2 - T_0^2\right) = \frac{R\nu}{T_0}\cdot T_0^2\cdot\left(-\frac{11}{36}\right)$

$\boxed{Q_1 = \frac{11}{36}\nu R T_0}$

2) $-Q_2 = A + \frac{3}{2}\nu R\Delta T = \int C(T)\cdot\nu\cdot dT$ ($\Delta T = \Delta U$)

$A = \int C(T)\nu\,(\cancel{T_x - T_0}\,\cancel{dT}) - \frac{3}{2}\nu R(T_x - T_0)$

$A = \int_{T_0}^{T_x}\frac{2R\nu}{T_0}T\,dt - \frac{3}{2}\nu R(T_x - T_0) =$

$= \frac{2R\nu}{T_0}\cdot\frac{T^2}{2}\Big|_{T_0}^{T_x} - \frac{3}{2}\nu R(T_x - T_0) =$

$= \frac{R\nu}{T_0}(T_x^2 - T_0^2) - \frac{3}{2}\nu R(T_x - T_0) =$

$= \frac{\nu R}{T_0}T_x^2 - \nu R T_0 - \frac{3}{2}\nu R T_x + \frac{3}{2}\nu R T_0 =$

$= \frac{\nu R}{T_0}T_x^2 - \frac{3}{2}\nu R T_x + \frac{1}{2}\nu R T_0 = A$

$x_0 = \frac{-b}{2a} = \frac{\frac{3}{2}\nu R}{2\cdot\frac{\nu R}{T_0}}\cdot T_0 = \boxed{\frac{3}{4}T_0 = T_{min\,x}}$

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

$= \frac{9}{16}\nu R T_0 - \frac{18}{16}\nu R T_0 + \frac{8}{16}\nu R T_0 = \boxed{-\frac{1}{16}\nu R T_0}$

Ответ: $Q_1 = \frac{11}{36}\nu R T_0$

$T_x = \frac{3}{4}T_0$

$A_{min} = -\frac{1}{16}\nu R T_0$

стр. 3

Чистовик 1 (продолжение) 11 класс

Вариант 11-01.

5) $a_m = a_k \cdot \frac{2\sqrt{5}}{5}$

Из п. 1 и 3: $T\cos\alpha = M \cdot a_k \cdot \frac{\cos\alpha}{1-\cos\alpha} = m \cdot a_m \cdot \cos\varphi$

$M \cdot a_k \cdot \frac{3}{5} \cdot \frac{\sqrt{5}}{2} = m \cdot a_k \cdot \frac{2\sqrt{5}}{5} \cdot \frac{\sqrt{5}}{5}$

$\frac{3}{2}M = \frac{2}{5}m$; $\frac{m}{M} = \frac{3}{2} \cdot \frac{5}{2} = \frac{15}{4}$

$$\boxed{\frac{m}{M} = \frac{15}{4}}$$

6) Из п. 3: $T = m \cdot a_m \cdot \frac{\cos\varphi}{\cos\alpha} \Rightarrow$

$\Rightarrow mg - m \cdot a_m \cdot \cos\varphi \cdot \operatorname{tg}\alpha = m \cdot a_m \cdot \sin\varphi$

$g = a_m(\sin\varphi + \cos\varphi \operatorname{tg}\alpha) = a_k \cdot \frac{2\sqrt{5}}{5} \cdot \left(\frac{2\sqrt{5}}{5} + \frac{\sqrt{5}}{5} \cdot \frac{4}{3}\right) =$

$= a_k \cdot \frac{2\sqrt{5}}{5} \cdot \frac{4\sqrt{5} + 6\sqrt{5}}{5 \cdot 3} = a_k \cdot \frac{2\sqrt{5}}{5} \cdot \frac{10\sqrt{5}}{5 \cdot 3} = \frac{4}{3}a_k$

$$\boxed{a_k = \frac{3}{4}g}$$

7) $a_m = \frac{3}{4} \cdot \frac{2\sqrt{5}}{5}g = \frac{3\sqrt{5}}{10}g$

$a_{my} = a_m \cdot \sin\varphi = g \cdot \frac{3\sqrt{5}}{10} \cdot \frac{2\sqrt{5}}{5} = \frac{3}{5}g$

$H = \frac{a_{my} \cdot t^2}{2} \Rightarrow t = \sqrt{\frac{2H}{a_{my}}} = \sqrt{\frac{2H \cdot 5}{3g}} = \boxed{\sqrt{\frac{10}{3}\frac{H}{g}}}$

Ответ: $\cos\varphi = \frac{\sqrt{5}}{5}$

$a_k = \frac{3}{4}g$

$\frac{m}{M} = \frac{15}{4}$

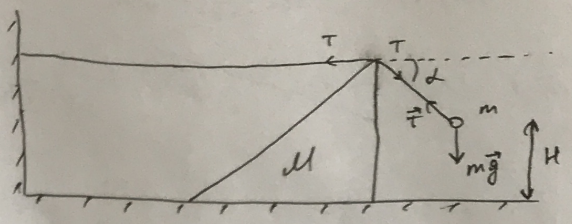
$t = \sqrt{\frac{10}{3}\frac{H}{g}}$

стр. 2

Чистовик 1. 11 класс Вариант 11-01

$\cos\alpha = \frac{3}{5}$

$\frac{H}{\sin\alpha} = \frac{4}{5}$

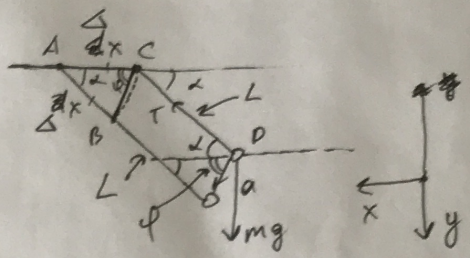



1) $Ma_x = T - T\cos\alpha = T(1-\cos\alpha)$

$T = \frac{Ma_x}{1-\cos\alpha}$

2) $\alpha + 2\varphi = \pi$ ($\Delta ABC$ – р/б)

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




$\cos\varphi = \cos\left(\frac{\pi}{2} - \frac{\alpha}{2}\right) = \sin\frac{\alpha}{2}$

$\cos\alpha = 1 - 2\sin^2\frac{\alpha}{2} \Rightarrow \sin\frac{\alpha}{2} = \sqrt{\frac{1-\cos\alpha}{2}}$

$\cos\varphi = \sqrt{\frac{1-\frac{3}{5}}{2}} = \boxed{\frac{\sqrt{5}}{5} = \cos\varphi}$ ; $\sin\varphi = \frac{2\sqrt{5}}{5}$

3) $Ox: \begin{cases} T\cdot\cos\alpha = m a_m \cdot \cos\varphi \\ Oy: \quad mg - T\cdot\sin\alpha = m a_m \sin\varphi \end{cases}$

4) Пусть $AC = \Delta x = AB$. $BC^2 = 2\Delta x^2 - 2\Delta x^2\cdot\cos\alpha =$

$= 2\Delta x^2(1-\cos\alpha)$

$BC = \Delta r_{\text{модуль}} = \Delta x \cdot \sqrt{2(1-\cos\alpha)}$

$\Delta r = \Delta x \cdot \frac{2\sqrt{5}}{5}$

$a_m = \Delta\ddot{r} = \Delta\ddot{x}\cdot\frac{2\sqrt{5}}{5} = a_к \cdot \frac{2\sqrt{5}}{5}$

стр. 1

(из п. 1)

5) $T\cdot\cos\alpha = Ma_x \frac{\cos\alpha}{1-\cos\alpha} = m\cdot a_m\cdot\cos\varphi$

$M\cdot a_m \cdot \frac{2\sqrt{5}}{5}\cdot\frac{3}{5}\cdot\frac{5}{2} = m a_m \cdot \frac{\sqrt{5}}{5}$

$3M = m$ ; $\boxed{\frac{m}{M} = 3}$

стр. 2

(из п. 3)

6) $T = \frac{m a_m\cdot\cos\varphi}{\cos\alpha}$ (из п. 3) $\Rightarrow mg - m\cdot a_m\cos\varphi\cdot\operatorname{tg}\alpha = m\cdot a_m\cdot\sin\varphi$

$g = a_m(\cos\varphi\operatorname{tg}\alpha + \sin\varphi)$ ; $a_m = g\cdot\frac{1}{\cos\varphi\operatorname{tg}\alpha + \sin\varphi} = g\cdot\frac{5\cdot 3}{4(\sqrt{5}+3)}$

$a_к = a_m\cdot\frac{2\sqrt{5}}{5} = g\cdot\frac{2\sqrt{5}}{5}\cdot\frac{1}{\frac{4}{3}\cdot\frac{\sqrt{5}}{5} + \frac{4}{5\cdot 3}} = g\cdot\frac{2\sqrt{5}}{5}\cdot\frac{5\cdot 3}{2(4(\sqrt{5}+3))} = \boxed{g\cdot\frac{3\sqrt{5}}{2\sqrt{5}+6}}$

# Часть 2

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

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Вариант 1

$$\mathcal{E} = \frac{q_1}{C_1} + I_R \cdot R$$

$$0 = \frac{I_0}{C_1} - \dot{I}_R \cdot R \quad ; \quad \dot{I}_R = \frac{I_0}{RC_1}$$

$$\frac{dI_R}{dt} = \frac{I_0}{RC_1}$$

$$dW_1 = \frac{q_1^2}{2C_1}$$

$$I_0 = I_R + I_C$$

$$dW_1 = \frac{2q_1 dq_1}{2C_1} = \frac{q_1}{C_1} \cdot dq_1$$

$$dq_2 = I_C \cdot dt \quad ; \quad dq_1 = I_0 \cdot dt$$

$$dW_2 = -\frac{q_2}{C_2} \cdot dq_2$$

$$I_R^2 \cdot dt = \frac{dQ}{R}$$

$$dA = \mathcal{E} \cdot dq_1 = dW_2 + dW_1 + dQ$$

$$\mathcal{E} \cdot I_0 \cdot dt = \frac{q_1}{C_1} \cdot I_0 \cdot dt - \frac{q_2}{C_2} \cdot I_C dt + I_R^2 \cdot R \cdot dt$$

$$\mathcal{E} \cdot I_0 = \frac{q_1}{C_1} \cdot I_0 - \frac{q_2}{C_2} \cdot I_C + I_R^2 \cdot R \qquad \frac{q_1}{C_1} = \mathcal{E} - I_R \cdot R$$

$$I_C = I_0 - I_R$$

$$\mathcal{E} \cdot I_0 = \frac{q_1}{C_1} \cdot I_0 - I_R \cdot R (I_0 - I_R) + I_R^2 \cdot R$$

$$\mathcal{E} \cdot I_0 = \frac{q_1}{C_1} I_0 - I_R I_0 \cdot R + I_R^2 \cdot R + I_R^2 \cdot R$$

$$\mathcal{E} I_0 = \mathcal{E} I_0 - I_R \cdot I_0 \cdot R - I_R \cdot I_0 \cdot R + 2 I_R^2 \cdot R$$

$$2 I_R \cdot I_0 \cdot R = 2 I_R^2 \cdot R \qquad I_0 = I_R$$

$$W_1 = \frac{q_1^2}{2C_1} \quad ; \quad dW_1 = \frac{2q_1 \cdot dq_1}{2C_1} = \frac{q_1}{C_1} \cdot I_0 \cdot dt$$

$$W_2 = \frac{q_2^2}{2C_2} + \quad ; \quad dW_2 = \frac{2q_2 \cdot dq_2}{2C_2} = -\frac{q_2}{C_2} \cdot I_C \cdot dt$$

$$\mathcal{E} \cdot \Delta q = \mathcal{E} \cdot I_0 \cdot dt \quad ; \quad dQ = I_R^2 \cdot R \cdot dt$$

$$\mathcal{E} \cdot I_0 \cdot dt = \frac{q_1}{C_1} I_0 dt - \frac{q_2}{C_2} I_C \cdot dt + I_R^2 \cdot R \cdot dt$$

$$\mathcal{E} \cdot I_0 = (\mathcal{E} - I_R \cdot R) I_0 - I_R \cdot R (I_0 - I_R) + I_R^2 \cdot R$$

$$0 = -I_R \cdot I_0 \cdot R - I_R \cdot I_0 \cdot R + I_R^2 \cdot R + I_R^2 R$$

Числовик

5.

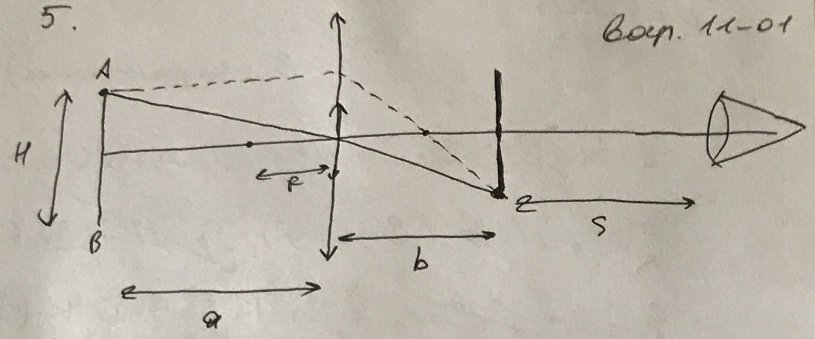
$F = 9$ см.

$H = 9$ см

$a = 36$ см

$S = 24$ см

$X$, $D_м$




1) $\frac{1}{F} = \frac{1}{a} + \frac{1}{b} \Rightarrow \frac{1}{b} = \frac{1}{F} - \frac{1}{a} = \frac{a-F}{F \cdot a} = \frac{36-9}{36 \cdot 9} = \frac{27^{3}}{36 \cdot 9} = \frac{1}{12}$

$b = 12$ см

$X = S + b = 12 + 24 = \boxed{36 \text{ см}}$

стр. 5

Числовик

4 (продолжение)

$a_2 = \frac{dv_2}{dt}$ ; $a_1 = \frac{dv_1}{dt}$

$2\frac{dv_2}{dt} = -\frac{dv_1}{dt}$

$2\int_0^{v_x} dv_2 = -\int_{v_0}^{v_x} dv_1$

$2v_x = -v_x + v_0$ ; $3v_x = v_0$ ; $\boxed{v_x = \frac{v_0}{3}}$

~~$2a_2 = -a_1$~~

~~$2\frac{dv_2}{dt} = -\frac{dv_1}{dt}$~~

~~$2\int_0^{v_x} dv_2 = -\int_{v_0}^{v_x} dv_1$~~

~~$\frac{dv_m}{dt} = 2(v_2 - v_x)$~~

$2a_2 = -a_1$

$\frac{dv_2}{dt} = \frac{(v_1 - v_2)\cdot L^2 B^2}{6Rm}$

$2dv_2 = dv_1$

$dv_1 = \frac{(v_1 - v_2)L^2B^2}{3Rm}$

Ответ: $a = \frac{L^2 v_0 B^2}{6mR}$

$v_1 = v_2 = \frac{v_0}{3}$

Чистовик

11 класс

Вар. 11-01

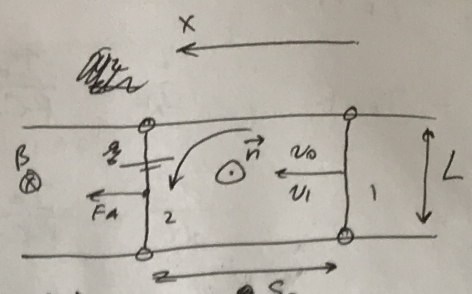
$m_2 = 2m$

$m_1 = m$

$B, L, m, R$

$2m, 2R, v_0, S_0$

4.




$\Phi_1 = L \cdot S_0 \cdot B \cdot (-1) = -LBS_0$

1) $\mathcal{E}_i = -\frac{d\Phi}{dt}$

$\Phi_2 = -L \cdot (S_0 - v_0 dt) \cdot B$

$d\Phi = \Phi_2 - \Phi_1 = -LBS_0 + LBv_0 dt + LBS_0 =$

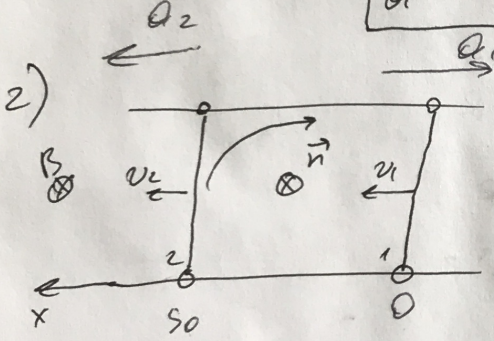
$= LB \cdot v_0 dt$

$\mathcal{E}_i = -\frac{LBv_0 dt}{dt} = -LB \cdot v_0$

$\mathcal{E}_i = I_0 \cdot 3R \Rightarrow I_0 = \frac{\mathcal{E}_i}{3R} = \frac{LBv_0}{3R}$

$F_A = I_0 \cdot L \cdot B = \frac{LBv_0}{3R} \cdot LB = \frac{v_0 L^2 B^2}{3R} = 2m \cdot a$

$\boxed{a = \frac{L^2 v_0 B^2}{6mR}}$, напр. влево




$d\Phi = (v_2 - v_1) \cdot L \cdot B \cdot dt$

$-\frac{d\Phi}{dt} = (v_1 - v_2) LB = \mathcal{E}_i$

$I = \frac{(v_1 - v_2) LB}{3R}$

$F_A = ILB = \frac{(v_1 - v_2) L^2 B^2}{3R}$

$$\begin{cases} 2m \frac{dv_2}{dt} = \frac{(v_1 - v_2) L^2 B^2}{3R} \\ -m \frac{dv_1}{dt} = -\frac{(v_1 - v_2) L^2 B^2}{3R} \end{cases} \Rightarrow 2m \frac{dv_2}{dt} = m \frac{dv_1}{dt}$$

$2m a_2 = m \cdot a_1$

$2a_2 = a_1$

$\int_0^{v_x} dv_2 = -\int_{v_0}^{v_x} dv_1$

$2v_x = v_0 - v_x$

$3v_x = v_0$, $\boxed{v_x = \frac{v_0}{3}}$ – установившаяся скорость обеих частей, направ. влево.

Когда скорости сравняются, ускорение = 0 $\Rightarrow$ продолжат двигаться с постоянными скоростями.

стр. 3

Чистовик

3 (продолжение)

11 класс

Вар. 11-01

$\mathcal{E} \cdot dq_1 = \mathcal{E} \cdot I_0 \cdot dt = dW_1 + dW_2 + dQ$

$\mathcal{E} \cdot I_0 \cdot dt = (\mathcal{E} - I_R R) \cdot I_0 \cdot dt - I_R \cdot R \cdot I_C \cdot dt + I_R^2 R dt$

$\mathcal{E} \cdot I_0 = \mathcal{E} I_0 - \mathcal{E} \cdot I_R \cdot R \, I_0 - I_R \cdot R \cdot (-I_0 + I_R) + I_R^2 \cdot R$

$0 = -I_0 I_R \cdot R + I_0 \cdot I_R \cdot R + I_0^2 \cdot R + I_R^2 \cdot R$

$2 I_0 I_R R = 2 I_R^2 R \quad 0 = 0$

$I_R = I_0$

3) $I_0 + I_C = I_R \qquad I_C = I_R - I_0 = \frac{dq_2}{dt}$

$I_R \cdot R = \frac{q_2}{C_2}$

$\mathcal{E} = \frac{q_1}{C_1} + I_R \cdot R$

$dq_1 = I_0 \cdot dt \; ; \; dq_2 = -I_C \cdot dt \; ; \; dW_1 = \frac{q_1}{C_1} I_0 \cdot dt \; ; \; dW_2 = -\frac{q_2}{C_2} I_C dt$

$\mathcal{E} \cdot I_0 \cdot dt = \frac{q_1}{C_1} I_0 dt - \frac{q_2}{C_2} I_C dt + I_R^2 \cdot R \cdot dt$

$\mathcal{E} \cdot I_0 = \mathcal{E} \cdot I_0 - I_0 I_R \cdot R - I_R \cdot R \cdot I_R + I_R R \cdot I_0 + I_R^2 \cdot R$

$0 = 0$

3) $I_0 + \frac{dq_2}{dt} = I_R = I_0 + I_C$

$\frac{q_2}{C_1} = I_R \cdot R = \mathcal{E} - \frac{q_1}{C_2} \; ; \qquad \mathcal{E} = \frac{q_2}{C_2} + \frac{q_1}{C_1}$

$0 = -\frac{1}{C_2} \cdot I_C + \frac{1}{C_1} \cdot I_0$

$\frac{I_C}{C_2} = \frac{I_0}{C_1} \; ; \; I_C = \frac{C_2}{C_1} I_0$

$I_R = I_0 + \frac{C_2}{C_1} I_0 = I_0 \left(1 + \frac{2C}{C}\right) = 3 I_0$

Ответ: $I = \frac{2}{3} \frac{\mathcal{E}}{R}$

$Q = \frac{2}{3} C \mathcal{E}^2$

$I_R = 3 I_0$

стр. 2

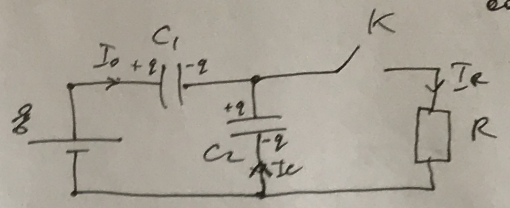
Чистовик

3.

11 класс
вар. 11-01.

$I_0$
$C_1 = 2C$
$C_2 = C$
$\mathcal{E}, C, R$

$I, Q, I_R - ?$




1) $\mathcal{E} = \frac{q}{C_1} + \frac{q}{C_2} = q \cdot \frac{C_1 + C_2}{C_1 C_2} \Rightarrow q = \mathcal{E} \cdot \frac{C_1 C_2}{C_1 + C_2} = \frac{2}{3}\mathcal{E}C$

$U_2 = \frac{q}{C_2} = \mathcal{E} \cdot \frac{C_1}{C_1 + C_2} = \mathcal{E} \cdot \frac{2C}{3C} = \frac{2}{3}\mathcal{E}$; $U_1 = \frac{1}{3}\mathcal{E}$

Сразу после замыкания: $I_R = U_2$

$$\boxed{I = \frac{2}{3}\frac{\mathcal{E}}{R}}$$

2) Через большой промеж. времени на $C_1$ зарядится до напряж. $\mathcal{E}$, $C_2$ разрядится и тока в цепи не будет.

$\frac{q'}{C_1} = \mathcal{E}$; $q' = 2C\mathcal{E} \Rightarrow \Delta q = q' - q = \frac{4}{3}\mathcal{E}C$

$A_{\mathcal{E}} = \Delta W + Q = W_2 - W_1 + Q$

$W_1 = \frac{C_1 U_1^2}{2} + \frac{C_2 U_2^2}{2} = \frac{2C}{2} \cdot \frac{1}{9}\mathcal{E}^2 + \frac{C}{2} \cdot \frac{4}{9}\mathcal{E}^2 = \frac{C\mathcal{E}^2}{9} + \frac{2C\mathcal{E}^2}{9} =$

$= \frac{1}{3}C\mathcal{E}^2$

$W_2 = \frac{C_1 \mathcal{E}^2}{2} = C\mathcal{E}^2$; $A_{\mathcal{E}} = \mathcal{E} \cdot \Delta q$

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

$$\boxed{Q = \frac{2}{3}C\mathcal{E}^2}$$

3)
$$\begin{cases} I_0 = I_R + I_C \\ I_R \cdot R = \frac{q_2}{C_2} \\ \mathcal{E} = \frac{q_1}{C_1} + \frac{q_2}{C_2} = \frac{q_1}{C_1} + I_R \cdot R \end{cases} \Rightarrow \frac{q_1}{C_1} = \mathcal{E} - I_R \cdot R$$

стр. 1.

$dq_2 = -I_C \cdot dt$; $dq_1 = I_0 \cdot dt$

$dQ = I_R^2 \cdot R \cdot dt$

$dW_1 = \frac{2q_1 \cdot dq_1}{2C_1} = \frac{q_1}{C_1} \cdot I_0 \cdot dt$; $dW_2 = -\frac{q_2}{C_2} \cdot I_C \cdot dt$