Часть 1

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

Шифр: **21200103**

ID профиля: **208750**

Вариант 7

стр. 5 $\Delta U_{1x} = \frac{i}{2}\nu R \Delta T_{1x} = \frac{3}{2}\left(p(\varphi+\Delta\varphi)V(\varphi+\Delta\varphi) - p(\varphi)V(\varphi)\right)$

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$A = \frac{1}{2}\left(p(\varphi+\Delta\varphi) + p(\varphi)\right) \cdot \left(V(\varphi+\Delta\varphi) - V(\varphi)\right)$

(при малых изменениях угла φ, площадь под графиком будет равна площади соответствующей трапеции)

$C = \frac{Q}{\Delta T}$

$Q = \Delta U + A$

$$Q = \frac{3}{2}\left(p(\varphi+\Delta\varphi)V(\varphi+\Delta\varphi) - p(\varphi)V(\varphi)\right) + \frac{1}{2}\left(p(\varphi+\Delta\varphi) + p(\varphi)\right)\left(V(\varphi+\Delta\varphi) - V(\varphi)\right) =$$

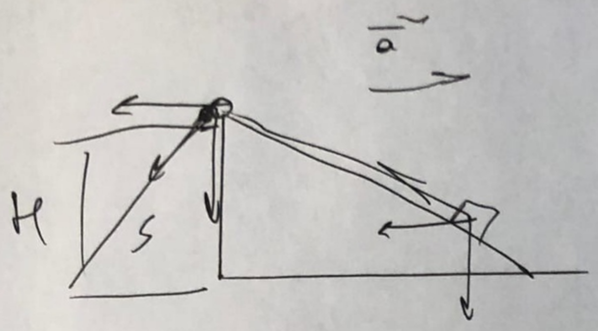
$$= \frac{3}{2}p_0V_0\left((\sin\varphi\cos\Delta\varphi + \cos\varphi\sin\Delta\varphi)(\cos\varphi\cos\Delta\varphi - \sin\varphi\sin\Delta\varphi) - \sin\varphi\cos\varphi\right) + \frac{1}{2}p_0V_0(\sin\varphi\cos\Delta\varphi + \cos\varphi\sin\Delta\varphi + \sin\varphi)(\cos\varphi\cos\Delta\varphi - \sin\varphi\sin\Delta\varphi)$$

$\Delta\varphi$ — малый угол

$$\Rightarrow Q = p_0V_0\left(\frac{3}{2}\Delta\varphi(\cos^2\varphi - \sin^2\varphi) - \Delta\varphi\sin^2\varphi\right) = 0$$

$$\frac{3}{2}\cos^2\varphi = \left(\frac{3}{2}+1\right)\sin^2\varphi$$

$$\Rightarrow tg^2\varphi = \frac{3}{5} \Rightarrow tg\varphi = \sqrt{\frac{3}{5}}$$



$$x^2+y^2=R^2$$

$$\int_{\text{m.}}^{x} x^2+y^2=\text{const}$$

$$A=S(1;x)=\frac{p_x+p_1}{2p_0}\cdot\left(\frac{V_x-V_1}{V_0}\right)$$

$$p_xV_x+p_1V_x-p_1V_1-p_x\cancel{V}_1 - \frac{3}{2}\nu R(T_x-T_1)$$

$$\left(\frac{p_1}{p_0}\right)^2+\left(\frac{V_1}{V_0}\right)^2=\left(\frac{p_x}{p_0}\right)^2+\left(\frac{V_x}{V_0}\right)^2 \quad p_xV_x=T_x\nu R=p_0\sin\varphi\, V_0\cos\varphi$$

$$T_1=\frac{p_0V_0\sin 60^\circ\cos 60^\circ}{\nu R}$$

$$\frac{p_x}{\cancel{p_0}\sin\varphi}=\frac{p_1}{\cancel{p_0}\sin 60^\circ}$$

$$p_xV_x+p_x\frac{\sin 60^\circ}{\sin\varphi}V_x-p_1V_1-p_1\frac{\sin\varphi}{\sin 60^\circ}V_1$$

$$-\frac{3}{2}\nu R$$

$$\Rightarrow 3\left(p(\varphi+\Delta\varphi)\cancel{V(\varphi+\Delta\varphi)}-p(\varphi)\cancel{V(\varphi)}\right)=$$

$$=p(\varphi+\Delta\varphi)\cancel{V(\varphi+\Delta\varphi)}+p(\varphi)V(\varphi+\Delta\varphi)$$

$$-p(\varphi+\Delta\varphi)V(\varphi)-p(\varphi)\cancel{V(\varphi)}$$

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стр. 3

задача 1. п. 2

$$\begin{cases} T + F_{иб}\cos\alpha - \frac{mg}{2}\sin\alpha = \frac{m}{2}a_б \\ F_{иш}\cdot\cos\left(\frac{\pi}{2}-\beta\right) + mg\cos\beta - T = ma_б \end{cases}$$

$$\vec{F_{иб}} = \frac{ma}{2}$$

$$\begin{cases} T + \frac{ma}{2}\cos\alpha - \frac{mg}{2}\sin\alpha = \frac{ma_б}{2} \\ ma\cos\left(\frac{\pi}{2}-\beta\right) + mg\cos\beta = ma_б + T \end{cases}$$

$$\Rightarrow \frac{\cancel{m}a_б}{2} + \frac{\cancel{m}g}{2}\sin\alpha - \frac{\cancel{m}a}{2}\cos\alpha =$$

$$= \cancel{m}a\sin\beta + \cancel{m}g\cos\beta - \cancel{m}a_б$$

$$a_б = \frac{2}{3}\left(g\cos\beta + a\sin\beta + \frac{a}{2}\cos\alpha - \frac{g}{2}\sin\alpha\right)$$

$$\sin\alpha = \frac{12}{13}; \quad \sin\beta = \frac{4}{5}$$

$$a_б = \frac{2}{3}g\left(\frac{3}{5} + \frac{3}{\cancel{4}}\cdot\frac{\cancel{4}}{5} + \frac{3}{8}\cdot\frac{5}{13} - \frac{1}{2}\cdot\frac{12}{13}\right) =$$

$$= g\frac{2}{3}\left(\frac{6}{5} - \frac{6}{13} + \frac{15}{104}\right) = 0{,}589g$$

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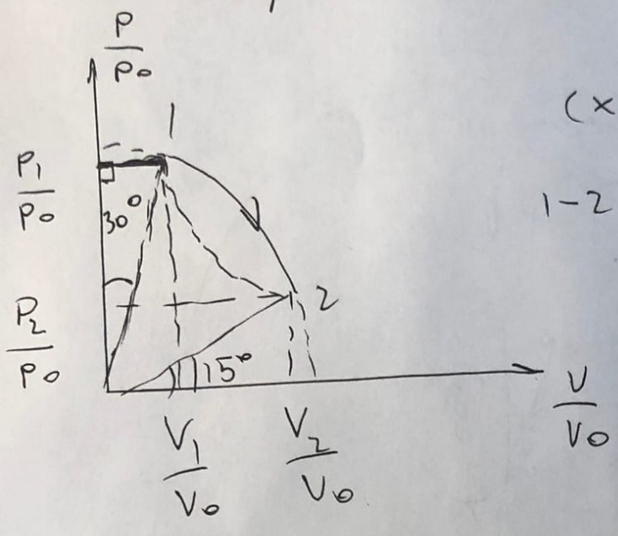


$$(x-a)^2+(y-b)^2=R^2$$

1–2:

$$①:\ \left(\frac{p_1}{p_0}\right)^2+\left(\frac{V_1}{V_0}\right)^2 = R^2$$

$$\cancel{R^2=\left(\frac{p_1}{p_0}\right)^2}$$

$$\cancel{\sqrt{\left(\frac{p_1}{p_0}\right)^2+\left(\frac{V_1}{V_0}\right)^2}}$$

$$R\cdot\cos 30^\circ = \frac{p_1}{p_0}$$

$$R=\frac{p_1}{p_0\cos 30^\circ}$$

$$Q_{12}=\Delta \underset{<0}{U_{12}}+\underset{>0}{A}$$

$$p_1V_1=\nu RT_1$$

$$\cancel{(\cos 15^\circ)^2\left(\left(\frac{V_2}{V_0}\right)^2+\left(\frac{p_2}{p_0}\right)^2\right)=\left(\frac{V_2}{V_0}\right)^2}$$

$$\left(\frac{p_1}{p_0}\right)^2+\left(\frac{V_1}{V_0}\right)^2=\frac{\left(\frac{p_1}{p_0}\right)^2}{(\cos 30^\circ)^2}$$

$$\cancel{p_2V_2=\nu RT_2}$$

$$\cancel{\left(\frac{p_2}{p_0}\right)^2=\frac{\left(\frac{V_2}{V_0}\right)^2(1-\cos^2 15^\circ)}{\cos^2 15^\circ}}$$

~~0,066844~~

~~0,033~~

$$\cos 30^\circ=\frac{\sqrt3}{2}$$

$$\cos 15^\circ = 0{,}966$$

0,066844

1,2 − 0,46 + 0,144

$$p_1V_1=\cancel{\nu R}\frac{V_1^2p_0}{V_0\cancel{\nu R}a}$$

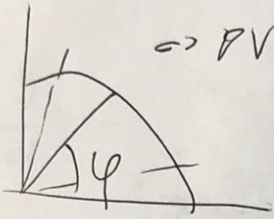
$$p_1=\frac{p_0V_1}{V_0a}$$

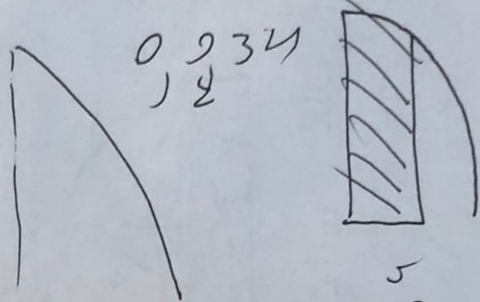
$0{,}45 + 0{,}8 + 0{,}144 - 0{,}46$

$P(\varphi) = P_0 \sin\varphi$

$V(\varphi) = V_0 \cos\varphi$

$\Rightarrow PV = \nu R T$





$0{,}934$

$\left(\frac{V_2^2 \alpha^2 \cos^2 30^\circ}{\cos^2 15^\circ}\right) P_0 b - V_2^2 P_0 a \Big) \cdot \frac{\cancel{V_0 \nu R b}}{V_2^2 P_0}$

$\cancel{V_0 \nu R a b}$

$\cancel{V_2^2}\left(\frac{\alpha^2 \cos^2 30^\circ}{\cos^2 15^\circ} \cancel{P_0} b - \cancel{P_0}\alpha\right)$

$\cancel{\alpha V_2^2 P_0}$

$= \frac{\cos^2 30^\circ}{\cos^2 15^\circ} \cdot ab - 1$

$\frac{\cancel{\cos^2 30^\circ}}{\cancel{\cos^2 15^\circ}} \cdot \frac{1-\cos^2 30^\circ}{\cancel{\cos^2 30^\circ}} \cdot \frac{\cancel{\cos^2 15^\circ}}{1-\cos^2 15^\circ}$

$\frac{0{,}866}{2} - \frac{1-0{,}75}{1-0{,}933} - 1 =$

$\frac{\sqrt{3}}{2} \cdot \frac{1}{2} - \frac{0{,}26 \cdot 0{,}966}{0{,}26 \cdot 0{,}966}$

$0{,}1817$

$0,$

$Q = \Delta U + A$ ($\Delta U < 0$, $A > 0$)

$A = -\Delta U$

$C_{\nu R} = 0$

$\frac{\pi R^2 \cdot \varphi}{360^\circ}$

$\frac{Q}{\Delta T}$

νR

$A_{1x} = -\frac{3}{2}\nu R \Delta T_{1x}$

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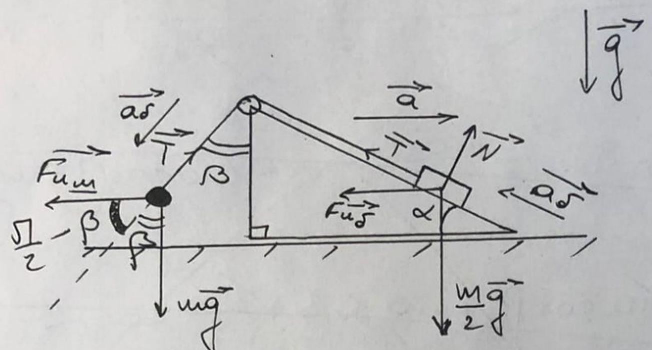
задача 1.

стр. 1



1) Перейдём в с.о., св. с клином

$\vec{F_{\text{инерции шарика}}} = -m\vec{a}$, т.к. $\angle\beta = const$, то $\sum(\vec{F_{иш}}$ и $m\vec{g})$ коллинеарна $\vec{T}$

$\Rightarrow \frac{mg}{ma} = tg\beta$

$\cos\beta = \frac{3}{5} \Rightarrow \sin\beta = \frac{4}{5}$

$\Rightarrow tg\beta = \frac{4}{3}$

$\Rightarrow a = \frac{3}{4}g = 7{,}5\ м/с^2$

2) ~~$\begin{cases} T + F_{иб}\cdot\cos\alpha - \frac{mg}{2}\sin\alpha = \frac{m}{2}a_б \\ F_{иш}\cdot\cos\beta + mg\cos(\frac{\pi}{2}-\beta) - T = ma_б \end{cases}$~~

~~$\vec{F_{иб}} = \frac{m}{2}a$~~

~~$\begin{cases} T + \frac{ma}{2}\cos\alpha - \frac{mg}{2}\sin\alpha = \frac{m}{2}a_б \\ ma\cos\beta + mg\sin\beta - T = ma_б \end{cases}$~~

$$\Big(\underbrace{\left(\frac{P_1}{P_0}\right)^2}_{a} + \underbrace{\left(\frac{V_1}{V_0}\right)^2}_{b}\Big)\cdot \cos^2 30^\circ = \underbrace{\left(\frac{P_1}{P_0}\right)^2}_{a}$$

$$(a+b)\cos^2 30^\circ = a \qquad a(1-\cos^2 30^\circ) = b\cos^2 30^\circ$$

$$a\,\frac{1-\cos^2 30^\circ}{\cos^2 30^\circ} = b$$

$$\frac{\frac{P_1}{P_0}}{\cos 30^\circ} = \frac{\frac{V_2}{V_0}}{\cos 15^\circ} \qquad \left(\frac{P_1}{P_0}\right)^2\overbrace{\left(\frac{1-\cos^2 30^\circ}{\cos^2 30^\circ}\right)}^{a} = \left(\frac{V_1}{V_0}\right)^2$$

$$\frac{\frac{V_1}{\cancel{V_0}}}{\cos 30^\circ a} = \frac{\frac{V_2}{\cancel{V_0}}}{\cos 15^\circ} \qquad \left(\frac{P_2}{P_0}\right)^2\overbrace{\left(\frac{\cos^2 15^\circ}{1-\cos^2 15^\circ}\right)}^{b} = \left(\frac{V_2}{V_0}\right)^2$$

$$V_1 = \frac{V_2\cdot a\cdot \cos 30^\circ}{\cos 15^\circ} \qquad P_1V_1 = \nu RT_1$$

$$T_1^2 = \frac{\left(\frac{V_1}{V_0}\right)^2 \cdot \frac{V_1^2 P_0^2}{\nu^2 R^2}}{a} \qquad P_2V_2 = \nu RT_2$$

$$P_1 = \frac{\nu RT_1}{V_1}$$

$$T_2^2 = \frac{\left(\frac{V_2}{V_0}\right)^2 \cdot \frac{V_2^2 P_0^2}{\nu^2 R^2}}{b} \qquad \left(\frac{\nu RT_1}{V_1 P_0}\right)^2\cdot a = \left(\frac{V_1}{V_0}\right)^2$$

$$T_1 = \frac{V_1^2 P_0}{V_0 \nu R a} \qquad \left(\frac{\nu RT_2}{V_2 P_0}\right)^2\cdot b = \left(\frac{V_2}{V_0}\right)^2$$

$$T_2 = \frac{V_2^2 P_0}{V_0 \nu R b} \qquad \frac{T_2 - T_1}{T_2}$$

$$\frac{\dfrac{b\left(\frac{V_2\cdot a\cdot \cos 30^\circ}{\cos 15^\circ}\right)^2 P_0}{V_0 \nu R a b} - \dfrac{V_2^2 P_0 a}{V_0 \nu R b a}}{\dfrac{V_2^2 P_0}{V_0 \nu R b}}$$

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стр. 2 чистовик физика, 11 кл

$$\begin{cases} T = \dfrac{ma_б}{2} + \dfrac{mg}{2}\sin\alpha - \dfrac{ma}{2}\cos\alpha \\ T = ma\cos\beta + mg\sin\beta - ma_б \end{cases}$$

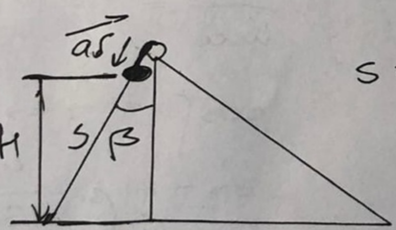
$$\frac{ma_б}{2} + \frac{mg}{2}\sin\alpha - \frac{ma}{2}\cos\alpha = ma\cos\beta + mg\sin\beta - ma_б$$

$$\frac{3}{2}ma_б = ma\cos\beta + mg\sin\beta + \frac{ma}{2}\cos\alpha - \frac{mg}{2}\sin\alpha$$

$$a_б = \frac{2}{3}\left(\frac{3}{4}g\cdot\frac{3}{5} + g\cdot\frac{4}{5} + \frac{3}{8}g\cdot\frac{5}{13} - \frac{g}{2}\cdot\frac{12}{13}\right)$$

$$a_б = \frac{2}{3}g\left(\frac{9}{20} + \frac{4}{5} + \frac{15}{104} - \frac{12}{26}\right) = 6{,}23\ м/с^2$$

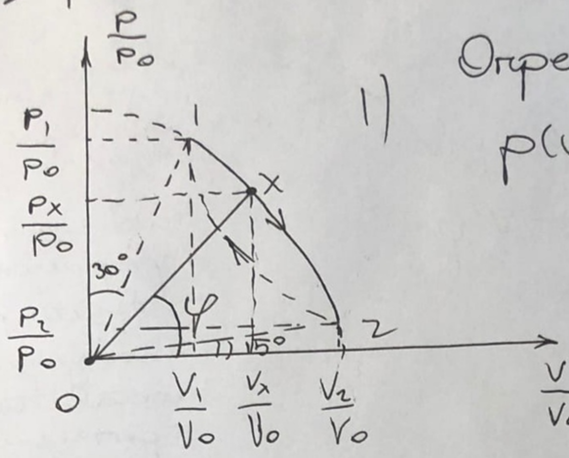
3)



$$s = \frac{H}{\cos\beta} = \frac{a_б t^2}{2}$$

$$\Rightarrow t = \sqrt{\frac{2H}{a_б\cos\beta}}$$

стр. 4



1) Определим зависимость $p(\varphi)$ и $V(\varphi)$

$$\frac{p}{p_0} = \sin\varphi$$

$$\frac{V}{V_0} = \cos\varphi$$

$$\Rightarrow p(\varphi) = p_0 \sin\varphi$$

$$V(\varphi) = V_0 \cos\varphi$$

$$p_1 V_1 = \nu R T_1 = p_0 \sin(90° - 30°) \cdot V_0 \cos(90° - 30°)$$

$$p_2 V_2 = \nu R T_2 = p_0 \sin(15°) \cdot V_0 \cdot \cos(15°)$$

$$\Rightarrow T_1 = \frac{p_0 \sin 60° \, V_0 \cos 60°}{\nu R}$$

$$T_2 = \frac{p_0 \sin(15°) \cdot V_0 \cos(15°)}{\nu R}$$

$$\Rightarrow \frac{T_1 - T_2}{T_2} = \frac{p_0 V_0 \left(\sin 60° \cos 60° - \sin 15° \cos 15° \right)}{p_0 V_0 \sin 15° \cos 15°} =$$

$$= 0{,}724$$

2) $$\overset{???}{Q_{12}} = \overset{<0}{\Delta U_{12}} + \overset{>0}{A_{12}}$$ $\Rightarrow$ Q_{12} в теории может быть равно 0 в некоторой т. x

$$\Rightarrow -\Delta U_{1x} = A_{1x}$$ $\Rightarrow$ меняем угол φ ищем, где $Q = 0$

$$A_{1x} = -\frac{3}{2} \nu R \Delta T_{1x}$$

Часть 2

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

Шифр: **21200103**

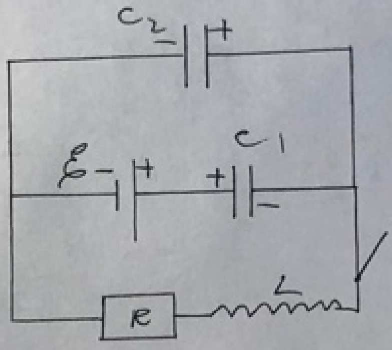
ID профиля: **208750**

Вариант 7

чистовик физика, 11 кл

стр. 1.

задача 3.



1) скорость возрастания тока в катушке — $\frac{dI_L}{dt}$

(2-ое правило Кирхгоффа) $\Rightarrow \mathcal{E} - \underbrace{U_1}_{?} = L\frac{dI_L}{dt} + R\cdot I_R \Leftrightarrow$

до замыкания ключа:
правые обкладки конденсаторов в сумме электронейтральны $\Rightarrow q_1 = q_2 = q$

(2-ое правило Кирхгоффа) $\mathcal{E} = U_1 + U_2$

$$U_1 = \frac{q}{C_1};\ U_2 = \frac{q}{C_2}$$

$$\Rightarrow \frac{q}{C_1} + \frac{q}{C_2} = \mathcal{E} \Rightarrow q = \frac{\mathcal{E}}{\frac{1}{C_1} + \frac{1}{C_2}}$$

$$\Rightarrow U_1 = \frac{\mathcal{E}C_2}{C_1 + C_2}$$

$$U_2 = \frac{\mathcal{E}C_1}{C_1 + C_2}$$

$$\Leftrightarrow \mathcal{E} - \frac{\mathcal{E}C_2}{C_1 + C_2} = L\frac{dI_L}{dt} + R\cdot I_R$$

$I_R = I_L$ (последовательное соед.)

и в момент замыкания ключа $I_L = 0 \Rightarrow I_R = 0$

$$\Rightarrow \frac{dI_L}{dt} = \frac{\mathcal{E} - \mathcal{E}\frac{C_2}{C_1 + C_2}}{L} = \frac{\mathcal{E}}{L}\left(1 - \frac{4C}{5C}\right) = \frac{1\cdot\mathcal{E}}{5\cdot L}$$

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задача 5.

D_0 – глаз

D_2 – очки для удаленных предметов

D_1 – очки для чтения

$$\begin{cases} \dfrac{1}{0{,}25} + \dfrac{1}{f} = -|D_1| + D_0 \\ \underbrace{\dfrac{1}{d}}_{\to 0}\ (d \to \infty) + \dfrac{1}{f} = -|D_2| + D_0 \\ \dfrac{D_2}{D_1} = 3 \end{cases}$$

1) $\dfrac{1}{x} + \dfrac{1}{f} = D_{глаза} = D_0$

$$\frac{1}{f} = D_0 - D_2$$

$$\frac{1}{0{,}25} + \cancel{D_0} - D_2 = \cancel{D_0} - D_1$$

$$\begin{cases} D_2 - D_1 = 4 \\ \dfrac{D_2}{D_1} = 3 \end{cases} \Rightarrow \begin{matrix} D_1 = 2 \\ D_2 = 6 \end{matrix}$$

$$\frac{1}{x} + D_0 - D_2 = D_0$$

$$\Rightarrow \frac{1}{x} = 6 \Rightarrow x = \frac{1}{6} = 0{,}167\ м$$

3) $\dfrac{1}{0{,}5} + \dfrac{1}{f} = D_0 - D_3$

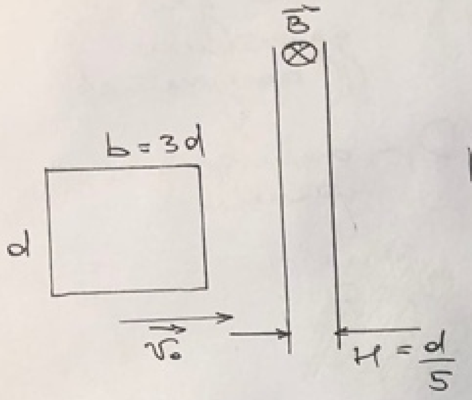
$$2 + D_0 - 6 = D_0 - D_3 \Rightarrow D_3 = 4$$

чистовик физика 11 кл

для узла 1: $I_0 + I_0 \frac{C_2}{C_1} = I_k$

$\Rightarrow I_k = 5 I_0$

задача 4.



$\Delta\Phi > 0 \quad \vec{B_p} \downarrow\uparrow \vec{B}$

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

$$\frac{d\Phi}{dt} = \frac{B d v_0 dt}{dt} = \mathcal{E}$$

$$\Rightarrow I = \frac{B d v}{R}$$

$$F_A = B I d = ma$$

$$\Rightarrow a = \frac{B^2 d^2 v_0}{Rm}$$

2) $S = \frac{d}{5}$

$$\Rightarrow \frac{d}{5} = \frac{v_1^2 - v_0^2}{2a} \Rightarrow \frac{2ad}{5} + v_0^2 = v_1^2$$

$$\Rightarrow v_1 = \sqrt{\frac{2B^2d^3v_0}{5Rm} + v_0^2}$$

3) $S = 3d \cancel{+\frac{d}{5} = \frac{16}{5}d}$

$$\Rightarrow \cancel{\frac{16}{5}d = v_2^2 - v} \qquad 3d = \frac{v_2^2 - \frac{2B^2d^3v_0}{5Rm} + v_0^2}{2a}$$

$$6\frac{B^2d^3v_0}{Rm} + \frac{2}{5}\frac{B^2d^3v_0}{Rm} + v_0^2 = v_2^2$$

$$\frac{32}{5}\frac{B^2d^3v_0}{Rm} + v_0^2 = v_2^2$$

2) через источник протечет такой заряд, благодаря которому U_{C_1} станет равно $\mathcal{E}$

$$\Rightarrow \Delta q = \frac{\mathcal{E}-U_1}{C_1}$$

$q = C\cdot U$

$$\Rightarrow \frac{C_1U_1^2}{2}+\frac{C_2U_2^2}{2}+\frac{\mathcal{E}-U_1}{C_1}\cdot\mathcal{E} = \frac{C_1}{2}\cdot\mathcal{E}^2+Q$$

$$\Rightarrow Q = \frac{C_1}{2}\cdot\frac{\mathcal{E}^2C_2^2}{(C_1+C_2)^2}+\frac{C_2}{2}\frac{\mathcal{E}^2C_1^2}{(C_1+C_2)^2}+$$

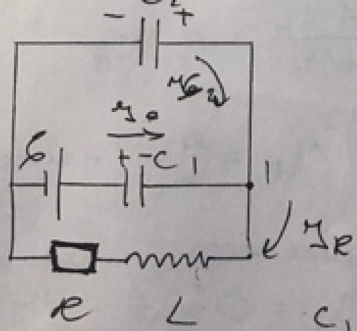
$$+\left(\frac{\mathcal{E}-\frac{\mathcal{E}C_2}{C_1+C_2}}{C_1}\right)\mathcal{E}-\frac{C_1}{2}\mathcal{E}^2 =$$

$$= \frac{C}{2}\cdot\frac{\mathcal{E}^2\cdot16C^2}{25C^2}+\frac{4C}{2}\cdot\frac{\mathcal{E}^2\cdot C^2}{25C^2}+\left(\frac{\mathcal{E}-\frac{4}{5}\mathcal{E}}{C}\right)\mathcal{E}-\frac{C}{2}\mathcal{E}^2=$$

$$= \frac{16\mathcal{E}^2C^{\cancel{3}}}{50\cancel{C^2}}+\frac{4C^{\cancel{3}}\mathcal{E}^2}{50\cancel{C^2}}+\frac{10\mathcal{E}^2}{50C}-\frac{C\mathcal{E}^2}{2}=$$

$$= \frac{30C\mathcal{E}^2}{50}-\frac{25}{50}C\mathcal{E}^2+\frac{10\mathcal{E}^2}{50C} = \frac{C\mathcal{E}^2}{10}+\frac{\mathcal{E}^2}{5C}$$

3)



C_1 заряжается
$\Rightarrow$ C_2 разряжается
I_0 = ток разрядки C_2!

$$C\frac{dU_C}{dt} = I_C$$ и

C_1 и C_2 подключены параллельно

$$\Rightarrow \left|\frac{dU_1}{dt}\right| = \left|\frac{dU_2}{dt}\right| \Rightarrow \frac{I_{C_1}}{C_1} = \frac{I_{C_2}}{C_2}$$

$$\Rightarrow I_{C_2} = \frac{C_2}{C_1}I_{C_1} = I_0\frac{C_2}{C_1}$$