Часть 1

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

Шифр: **21201644**

ID профиля: **370207**

Вариант 6

№ 1

Чистовик

Дано:

$\cos\alpha = \frac{4}{5}$

$\cos\beta = \frac{12}{13}$

$g = 10\ \frac{м}{с^2}$

Найти:

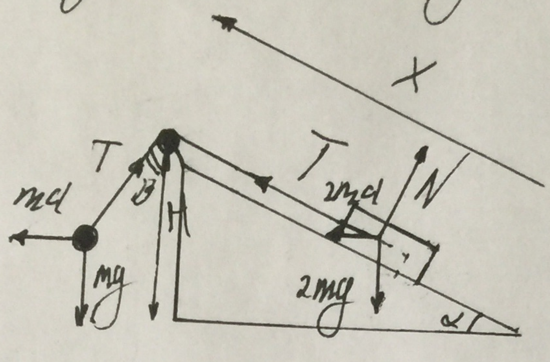
1) $a_{клина}$

2) $a_{отн.\ клина}$

3) τ

Решение

Пересядем в систему отсчёта клина.



1) $\frac{ma}{mg} = tg\beta = \frac{a}{g}$

$tg^2\beta + 1 = \frac{1}{\cos^2\beta}$

$tg\beta = \sqrt{-1 + \frac{1}{\cos^2\beta}}$

$a = g\sqrt{\frac{1}{\cos^2\beta} - 1}$

$a = 10\sqrt{\frac{13^2}{12^2} - 1} = \frac{10 \cdot 5}{12} \approx 4{,}17\ \frac{м}{с^2}$

2) $\begin{cases} ma_{отн.\ клина} = m\sqrt{a^2 + g^2} - T \\ 2ma_{отн.\ клина} = T + 2ma \cdot \cos\alpha - 2mg \cdot \sin\alpha \end{cases}$

$3\cancel{m} a_{отн.\ клина} = \cancel{m}\sqrt{a^2 + g^2} + 2\cancel{m}a \cdot \cos\alpha - 2\cancel{m}g \cdot \sin\alpha$

$a_{отн.\ клина} = \frac{\sqrt{a^2 + g^2} + 2a \cdot \cos\alpha - 2g\sqrt{1 - \cos^2\alpha}}{3}$

$a_{отн.\ клина} = \frac{10{,}83 + 6{,}672 - 12}{3} \approx 1{,}83\ \frac{м}{с^2}$

3) $\frac{a_{отн.\ клина} \cdot \tau^2}{2} = \frac{H}{\cos\beta}$

$\tau = \sqrt{\frac{2H}{a_{отн.\ клина} \cdot \cos\beta}}$

$\tau =$

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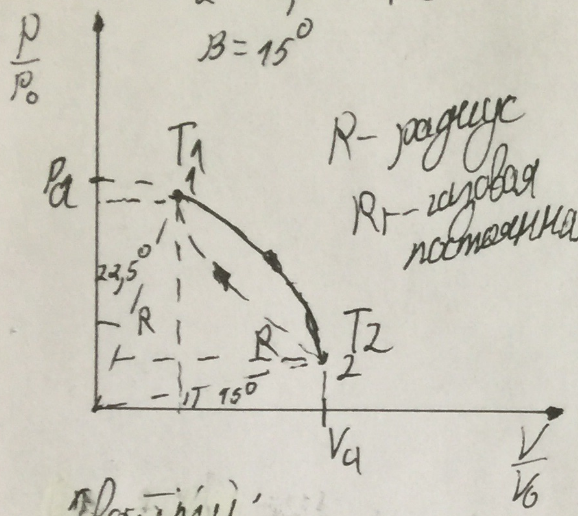
Чистовик

№ 2

Дано:

$\alpha = 22{,}5^0 \quad i = 5$

$\beta = 15^0$



R – радиус

$R_Г$ – газовая постоянная

Найти:

1) $\frac{T_1}{T_2}$

2) y

3) $\frac{A_Г}{A_{12}}$

Решение

1) $\nu R_Г T_1 = R \cdot \sin\alpha \cdot R \cdot \cos\alpha$

$\nu R_Г T_2 = R \cdot \sin\beta \cdot R \cdot \cos\beta$

$\frac{T_1}{T_2} = \frac{\sin 2\alpha}{\sin 2\beta}$

$\frac{T_1}{T_2} = \frac{\sin 45^0}{\sin 30^0} = \frac{\frac{\sqrt{2}}{2}}{\frac{1}{2}} = \sqrt{2} \approx 1{,}414$

2) Теплоёмкость равна 0 у адиабаты; процесс статия 12 можно считать адиабатическим, так как пренебрежимо малый теплообмен.

$\sin y = \sin 75^0$ или $\sin y = \sin 67{,}5^0$, так как таких точек две, это точка 1 и 2.

3) $A_Г = A_{12} + A_{21}$

$\frac{A_Г}{A_{12}} = 1 + \frac{A_{21}}{A_{12}}$

$\frac{A_Г}{A_{12}} = \frac{-\frac{5}{4}(1-\sqrt{2})\cdot\sin 30^0}{\frac{3\pi - 4\sin 45^0}{16}} = \frac{20(1-\sqrt{2})\cdot\sin 30^0}{3\pi - 4\sin 45^0}$

$A_{21} = -\Delta U_{12} = -\frac{5}{2}\nu R_Г \Delta T = -\frac{5}{2}\cdot 0{,}414 \cdot R \cdot \sin\beta \cdot R \cdot \cos\beta$

$A_{12} = \frac{\pi R^2}{4} - \frac{\pi R^2 \cdot 22{,}5^0}{360^0} - \frac{\nu R_Г T_1}{2} = \frac{\pi R^2}{4} - \frac{\pi R^2}{16} - \frac{R^2 \cdot \sin 2\alpha}{4}$

$\frac{A_Г}{A_{12}} = 1 - \frac{\frac{5}{4}\cdot 0{,}414 \cdot \sin 30^0}{\frac{\pi 3 - 4\sin 45^0}{16}} = 1 - \frac{4{,}14}{\pi 3 - 2\sqrt{2}} = 1 - \frac{4{,}14}{9{,}42 - 2{,}828} =$

$1 - \frac{4{,}14}{6{,}59} \approx 0{,}3718$

2

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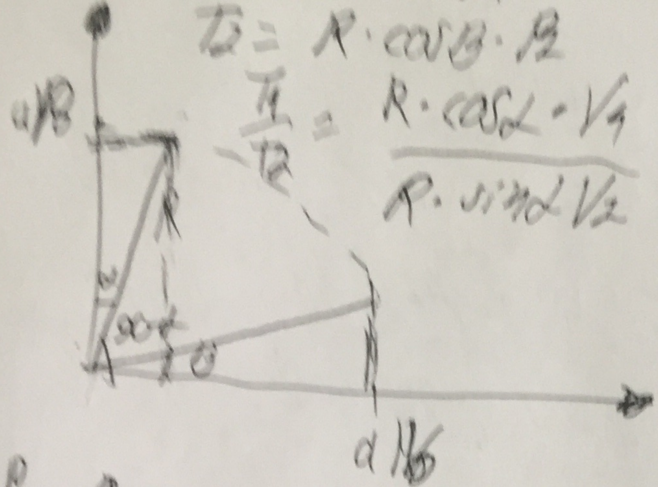
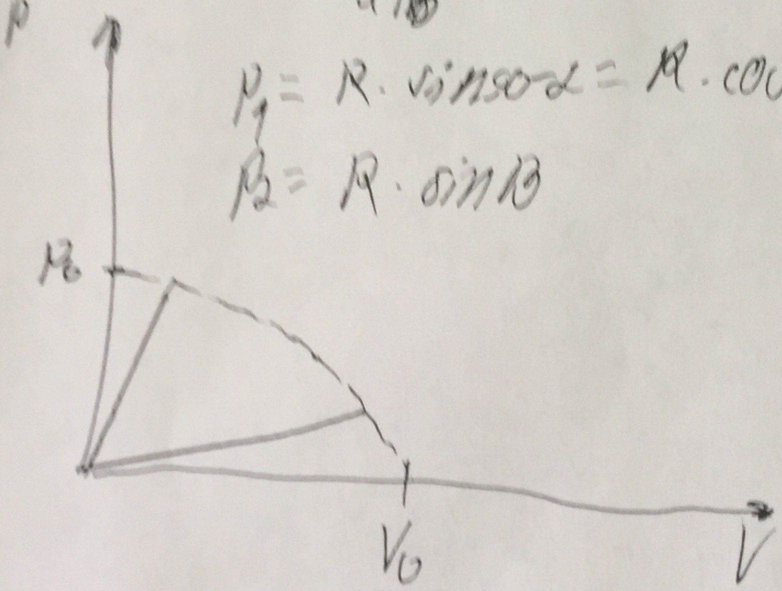
$R = aB = aV_0$

$T_1 = R \cdot \sin\alpha \cdot P_1$

$T_2 = R \cdot \cos\beta \cdot P_2$

$\frac{T_1}{T_2} = \frac{R \cdot \cos\alpha \cdot V_1}{R \cdot \sin\alpha V_2}$





$P_1 = R \cdot \sin(90-\alpha) = R \cdot \cos\alpha$

$P_2 = R \cdot \sin\beta$

$T_1 = R \cdot \sin\alpha \cdot R \cdot \cos\alpha$

$T_2 = R \cdot \sin\beta \cdot R \cdot \cos\beta$

$\frac{T_1}{T_2} = \frac{\sin\alpha \cdot \cos\alpha}{\sin\beta \cdot \cos}$

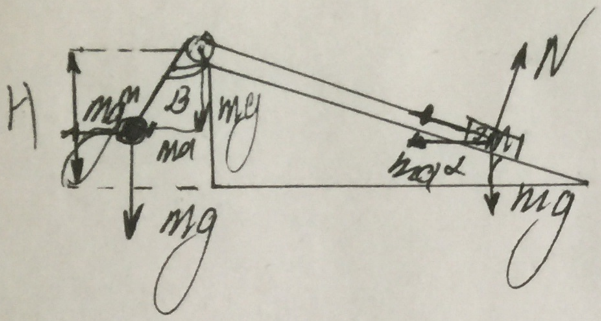
$\Delta Q = 0$

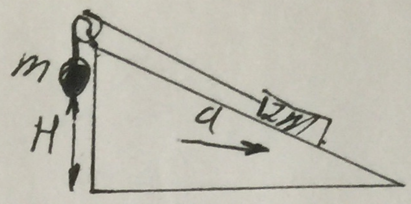
$90 - 22{,}5 = 67{,}5$

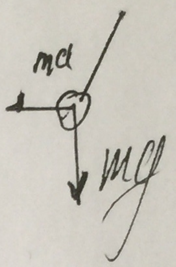
$\frac{4}{16} - \frac{1}{16} = \frac{3}{16}$

$\cos\alpha = \frac{4}{5}$

$\cos\beta = \frac{12}{13}$







$\frac{\pi R^2}{4}$

1) $\frac{ma}{mg} = tg\beta = \sqrt{\frac{1}{\cos^2\beta} - 1}$

$a = g\sqrt{\frac{1}{\cos^2\beta} - 1}$

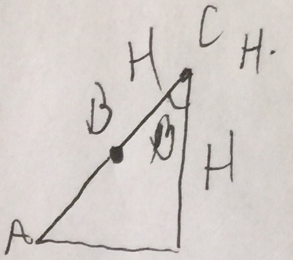
$\sqrt{m^2a^2 + m^2g^2} = m\sqrt{a^2+g^2} - T = ma_{\text{отн. клина}}$

$A_{n2} = \cancel{R \cdot R}$

$\frac{20 \cdot 3}{5} = 4 \cdot 3 = 12$

$A_{B2} =$

$1 - \frac{16}{25} = \frac{9}{25} = \frac{3}{5}$



$\sqrt{\frac{2AB}{a_{\text{отн. клина}}}} = t$

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

$AB = \frac{H}{\cos\beta} - H = H\left(\frac{1}{\cos\beta} - 1\right)$

$AB = \frac{a_{\text{отн клина}} t^2}{2}$

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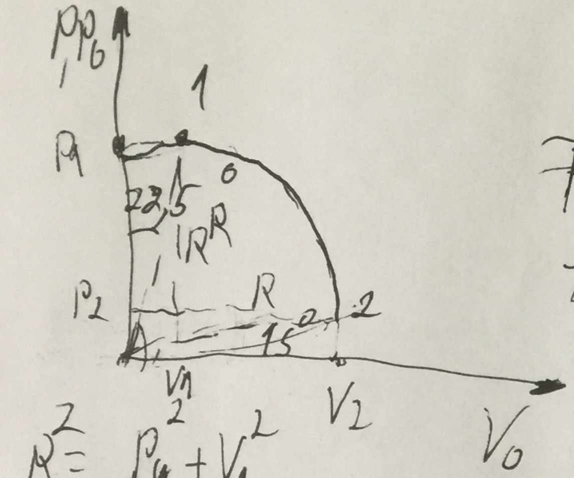
$i=5$

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



$pV=\vartheta RT$

$\cancel{T_1 = R\cdot V_1}\sin$

$T_1 = R\cdot\sin 67{,}5^0\cdot V_1$

$T_2 = \cancel{R\cdot\cos 15^0}\ R\cdot\sin$

$R^2 = p_1^2+V_1^2$

$R^2 = p_2^2+V_2^2$

$p^2+V^2=R^2$

$\cancel{\frac{p_1}{V_1}}$ ~

$\frac{V_1}{p_1} = tg\,22{,}5^0$

$\frac{p_2}{V_2} = tg\,15^0$

$\frac{T_1}{T_2} = \frac{p_1V_1}{p_2V_2}$

$\frac{p_1}{V_1}$ $\frac{p_1}{V_1}$

$p_1^2+V_1^2=R^2$

$p_2^2+V_2^2=R^2$

$p_1^2+V_1^2=p_2^2+V_2^2$

$p_1^2\cdot V_1^2+V_1^4=p_2^2\cdot V_1^2+V_2^2\cdot V_1^2$

$\frac{T_1^2}{T_2^2}+\frac{V_1^4}{p_2^2\cdot V_2^2}=\frac{V_1^2}{V_2^2}+\frac{V_1^2}{p_2^2}$

$\cancel{p_1=V_2}$

$C\cdot\Delta T=\Delta U+A_r$

$C=0$ $C=0$

$\frac{\Delta Q}{\Delta T}=0$

Часть 2

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

Шифр: **21201644**

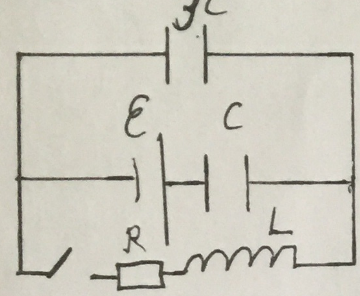
ID профиля: **370207**

Вариант 6

Чистовик

№3

Дано:

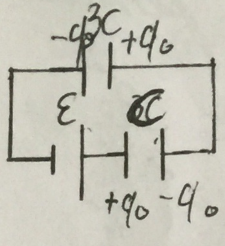


1) $\frac{\Delta I}{\Delta t}$ при $t =$ сразу после замыкания ключа

2) Q_2

3) Если ток через 3C равен I_0, найти $^R I_R$

Решение



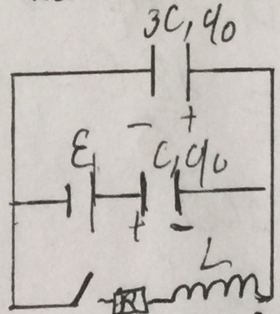
$$\mathcal{E} = \frac{q_0}{C} + \frac{q_0}{3C}$$

$$\mathcal{E} = \frac{4q_0}{3C}$$

$$q_0 = \frac{3\mathcal{E}C}{4}$$

$$I_L(0) = 0$$

Сразу после замыкания ток на катушке индуктивности и заряд на обкладках конденсатора скачком не меняется



1) $$\mathcal{E} = \frac{q_0}{C} + L\cdot\frac{\Delta I}{\Delta t} = \frac{q_0}{C} + L\dot{I}$$

$$\mathcal{E} - \frac{3}{4}\mathcal{E} = L\dot{I}$$

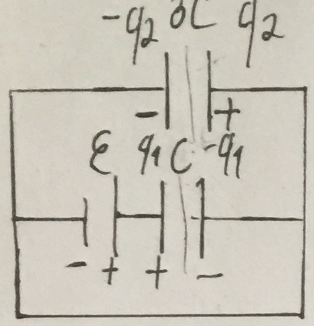
$$\frac{\mathcal{E}}{4} = L\dot{I}$$

$$\dot{I} = \frac{\mathcal{E}}{4L}$$

Чистовик

№3

2) В установившемся режиме ток в цепи отсутствует



$W_0 = \frac{q_0^2}{2\cdot 3C} + \frac{q_0^2}{2C}$

$W' = \frac{q_1^2}{2C}$

$A_{ист} = \varepsilon \cdot \Delta q$

$W_0 = \frac{9\varepsilon^2 \cdot C^2}{16\cdot 2\cdot 3C} + \frac{9\varepsilon^2\cdot C^2}{16\cdot 2C} =$

$\frac{3\varepsilon^2\cdot C}{32C} + \frac{9\varepsilon^2\cdot C}{32C} = \frac{12\varepsilon^2 C}{32} = \frac{3\varepsilon^2 C}{8}$

$\varepsilon = \frac{q_1}{C}$

$q_1 = q_0 + \Delta q$

$\Delta q = \varepsilon C - \frac{3}{4}\varepsilon C = \frac{\varepsilon C}{4}$

$W' = \frac{\varepsilon^2 C^2}{2C} = \frac{\varepsilon^2 C}{2}$

$A_{ист} = \frac{\varepsilon^2 C}{4}$

$\varepsilon = \frac{q_1}{C} + \frac{q_2}{3C}$

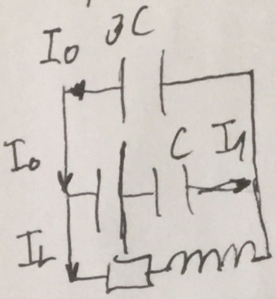
$\varepsilon = \varepsilon + \frac{q_2}{3C}$

$q_2 = 0$

$Q = W_0 - W' + A_{ист}$

$Q = \frac{3\varepsilon^2 C}{8} - \frac{\varepsilon^2 C}{2} + \frac{\varepsilon^2 C}{4} = \frac{\varepsilon^2 C}{8}$

3)



По 3С

$I_0 = I_1 + I_L$

$I_0 = \frac{I_0}{3} + I_L$

$I_L = \frac{2I_0}{3}$

$U = RI_R = RI_L = R\cdot\frac{2}{3}I_0 = \frac{2}{3}RI_0$

$I_0 = 3C\cdot\frac{\Delta U_{3C}}{\Delta t}$

$\Delta U_{3C} = \Delta U_C$

$I_1 = C\cdot\frac{\Delta U_{3C}}{\Delta t}$

$I_0 = 3I_1$

$I_1 = \frac{I_0}{3}$

Чистовик

№4

Решение

Дано:

$b = \frac{d}{4}$,

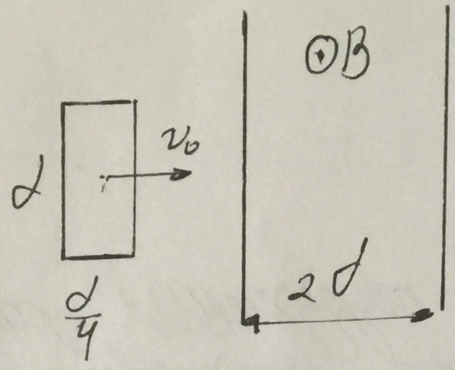
v_0, m, R, B, $H = 2d$

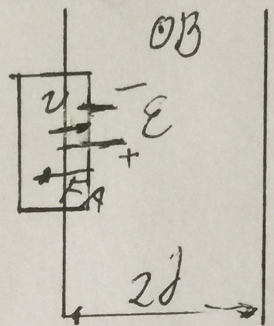
Найти:

1) a_0

2) v_1

3) v_2





$$\mathcal{E} = Bvd$$

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

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

$$F_0 = B^2 d^2 \frac{v_0}{R}$$

1) $ma_0 = B^2 d^2 \frac{v_0}{R}$

$$a_0 = \frac{B^2 d^2 v_0}{R \cdot m}$$

$$a(v) = \frac{B^2 d^2 v}{Rm}$$

$$\frac{\Delta v}{\Delta t} = \frac{B^2 \cdot d^2 \Delta x}{Rm \cdot \Delta t}$$

$$\Delta v = \frac{B^2 \cdot d^2 \Delta x}{Rm}$$

$$\Delta v = \frac{B^2 \cdot d^3}{4Rm}$$

Просуммируем выражение от $t=0$ до τ

2) $v_0 - \frac{B^2 d^2 \cdot \frac{d}{4}}{Rm} = v_1$

$$v_1 = v_0 - \frac{B^2 d^3}{4Rm}$$

3

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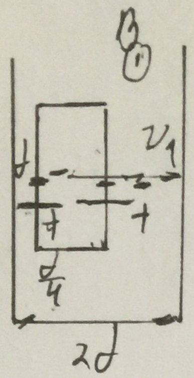
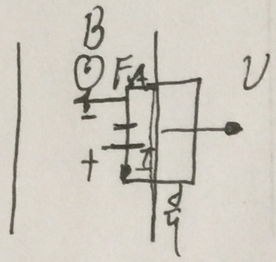
Чистовик

№4

3)



После полного погружения рамки в магнитное поле сила тока отсутствует, скорость становится постоянной



Но возникает сила Ампера сразу же после начала выхода из магнитного поля

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

$a = \frac{B^2 d^2 \cdot v}{Rm}$

$\frac{\Delta v}{\Delta t} = \frac{B^2 d^2 \cdot \Delta x}{R \cdot m \cdot \Delta t}$

$\Delta v = \frac{B^2 d^2 \cdot d}{4Rm} = \frac{B^2 d^3}{4Rm}$

$v_2 = v_1 - \Delta v$

$v_2 = v_0 - \frac{B^2 d^3}{2Rm}$

Чистовик

№5

Дано:

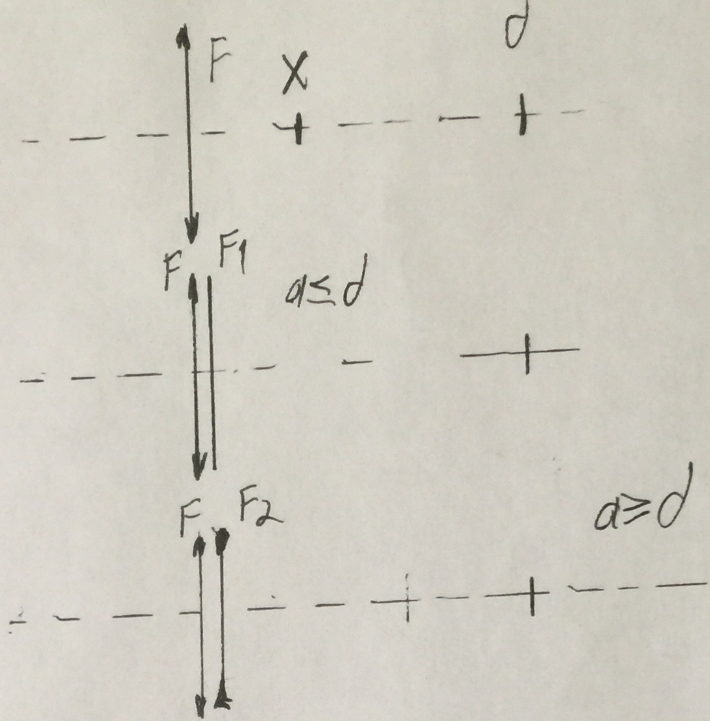
$d = 25$ см

$\frac{D_1}{D_2} = \frac{F_2}{F_1} = \frac{7}{3}$

1) $x - ?$

2) $d' = 50$ см, $F - ?$

Решение



1) $\frac{1}{F} = \frac{1}{d} + \frac{1}{f}$

$\frac{1}{f} = \frac{d-F}{Fd}$

$f = \frac{Fd}{d-F}$

$\Gamma = \frac{f}{d} = \frac{F}{d-F}$

$\frac{1}{F} = \frac{1}{x} - \frac{1}{f}$

$\frac{1}{f} = \frac{1}{x} - \frac{1}{F}$

$\frac{1}{f} = \frac{F-x}{xF}$

$f = \frac{xF}{F-x}$

$\frac{f}{x} = \Gamma = \frac{F}{F-x}$

$\frac{F}{F-x} = \frac{F}{d-F}$ $\quad 2F - d = x$

5

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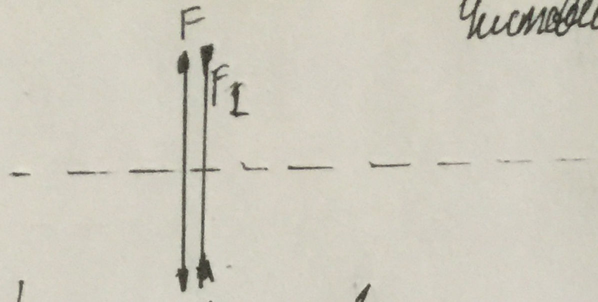
Чистовик



$D' = \frac{1}{F} + \frac{1}{F_1} = \frac{1}{F'}$

$\frac{1}{F'} = \frac{1}{d'} + \frac{1}{f'}$

$\frac{\cancel{f'}}{d'} = \cancel{\frac{1}{f}} > \frac{f}{d}$

$f' > f$ $\qquad \frac{1}{f'} < \frac{1}{f}$

$\frac{1}{F} + \frac{1}{F_1} = \frac{1}{d} + \frac{1}{f'}$

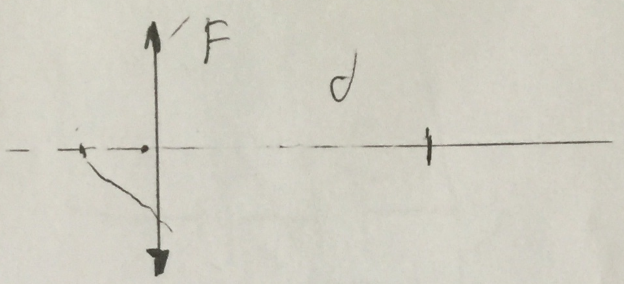
$\frac{1}{F} + \frac{1}{F_1} - \frac{1}{F} = \frac{1}{f'} - \frac{1}{f}$

$\frac{1}{F_1} < 0$

F_1 – рассеивающая

Тогда F_1 – собирающая

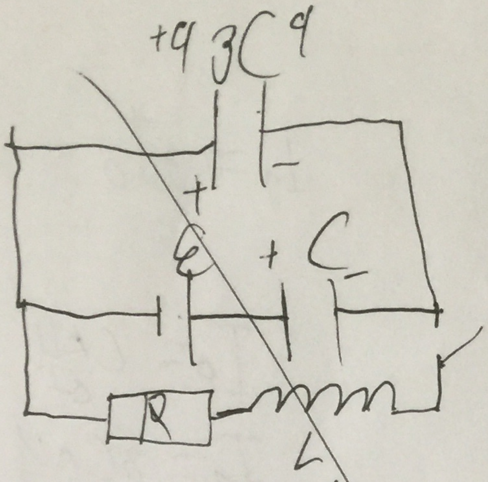
№5



$$\frac{1}{F_1} + \frac{1}{F_2} = \frac{7}{3}$$

$$\frac{F_2}{F_1} = \frac{7}{3}$$

№3

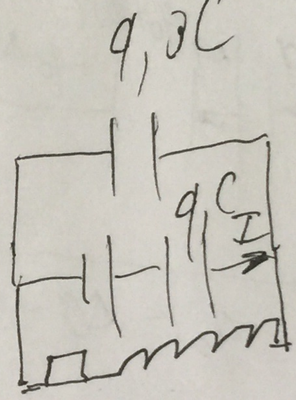


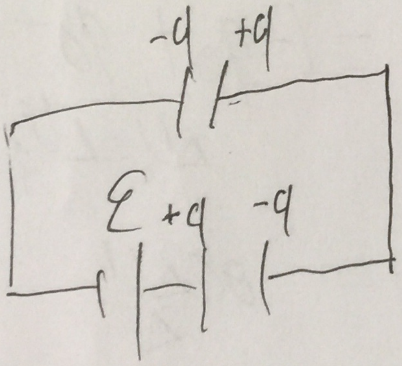
$$\mathcal{E} = \frac{q}{C} - \frac{q}{3C}$$

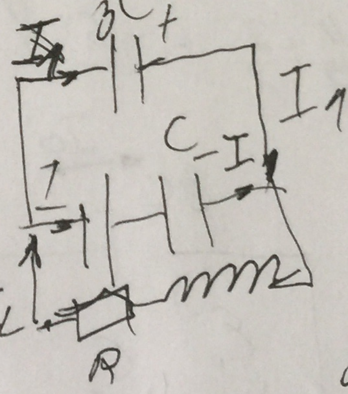
$$\mathcal{E} = \frac{2q}{3C}$$

ε

q_1



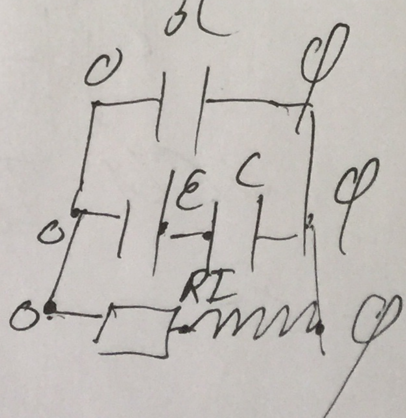


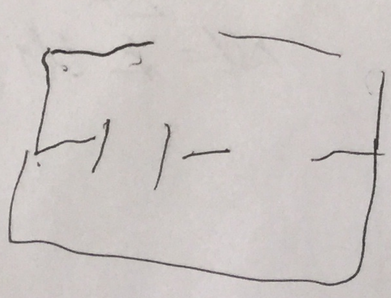


$$q - q = 0$$

$$\mathcal{E} = \frac{q}{C} + \frac{q}{3C} = \frac{4q}{3C}$$

$$I_L = I_1$$





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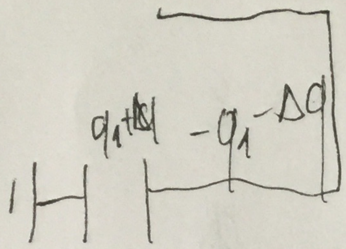
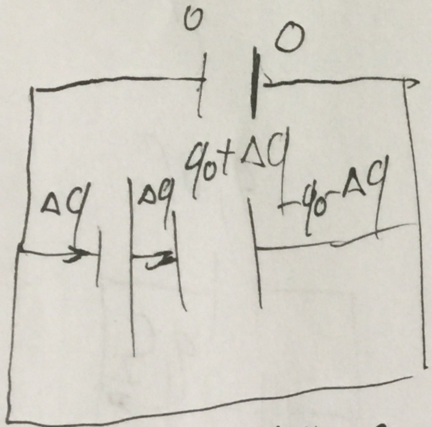
$I_1 = 3I_0$



$q_2 =$



$I_0 = C\frac{\Delta U}{\Delta t}$

$I_1 = 3C\frac{\Delta U}{\Delta t}$

$\frac{q}{3C} = \varepsilon$

$q = \varepsilon \cdot 3C$

$I = U \cdot 3C$

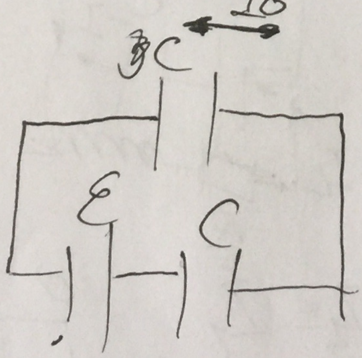
$\Delta q = -q_0 - \Delta q + 0 - 0 - (-q_0 + q_0 - q_0$

$\Delta U = \Delta U_1$

$\frac{3}{8} - \frac{4}{8} + \frac{2}{8} = \frac{5-4}{}$

$I_0 = 3C\frac{\Delta U}{\Delta}$

$\cancel{3C\frac{\Delta U}{\Delta t} = C\Delta U}$



$3CU = I_0$

$\varepsilon -$

$3C\frac{\Delta U}{\Delta t} = I_0$

$\Delta U = \Delta U_1$

$F = \frac{f}{d}$

$\frac{1}{F} = \frac{1}{x} + 1$

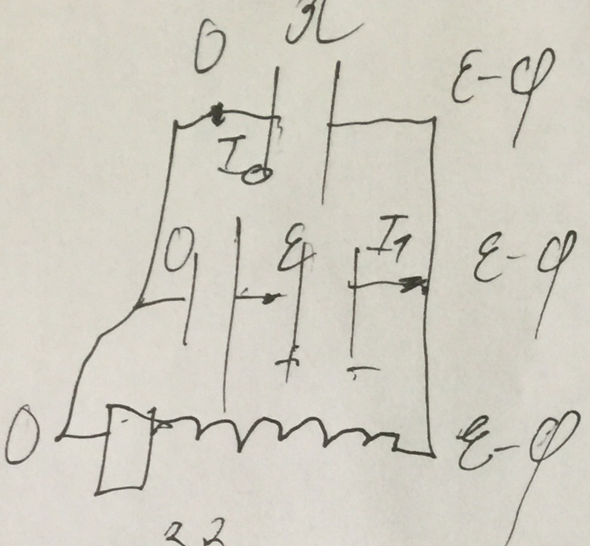
$F = \cancel{\frac{x}{x}}$

$\frac{1}{F} =$

F

$F - x = d - F$

$2F = d = x$



$$F=\frac{B^2 d^2}{R}\cdot v \qquad F(v)=\frac{B^2 d^2}{R}\cdot v$$

$$\cancel{F\cdot \frac{d}{4}}$$

$$\Delta A = F\cdot \Delta x$$

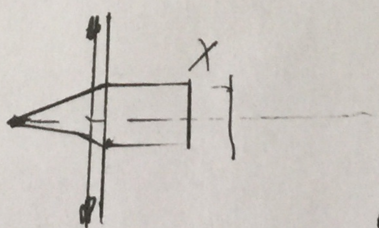
$$\Delta A = \frac{B^2 d^2}{R}\cdot\frac{\Delta x}{\Delta t}\cdot \Delta x$$

$$\cancel{\frac{mv^2}{}}$$

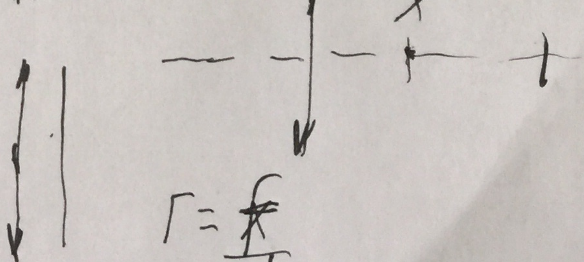
$$mv\cdot\Delta v = \frac{B^2 d^2}{R}\cdot v\cdot \Delta x$$

$$a(t)=\frac{B^2 d^2\cdot v}{R\cdot m}$$

$$\frac{\Delta v}{\Delta t}=\frac{B^2 d^2}{R\cdot m}\cdot\frac{\Delta x}{\Delta t}$$



$$\frac{1}{F}=\frac{1}{d}+\frac{1}{f}$$



$$\Gamma=\frac{f}{d}$$