Часть 1

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

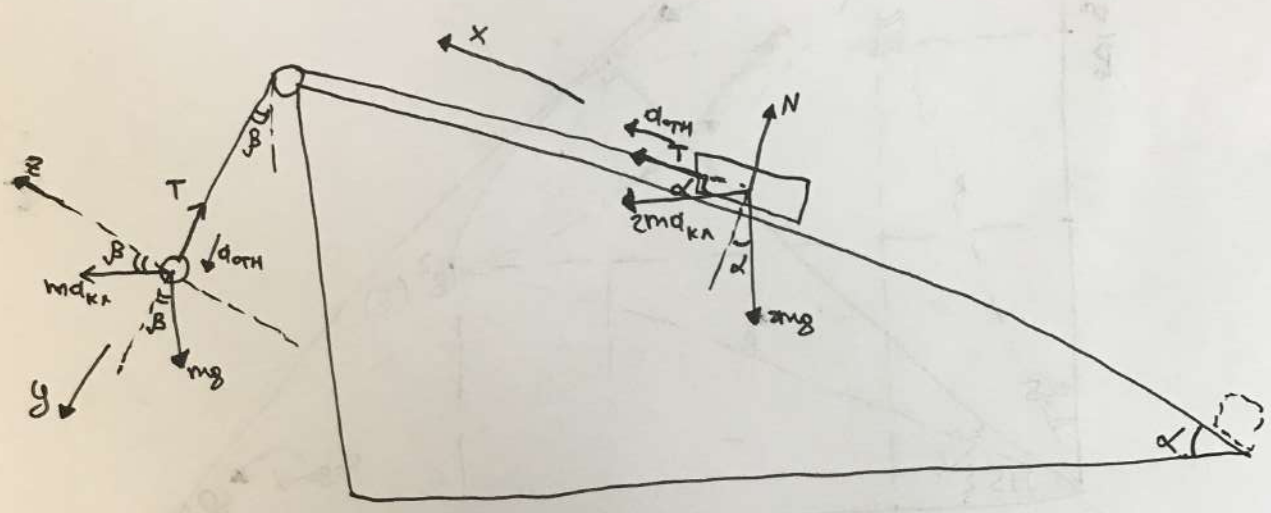
Шифр: **21203698**

ID профиля: **282872**

Вариант 6

Чистовик

№1



1) Перейдем в неинерциальную СО, связанную с клином, введя силу инерции (для шарика - $ma_{кл}$, для бруска - $2ma_{кл}$, где $a_{кл}$ - ускорение клина)

2) ~~В силу нерастяжимости нити~~ ускорения на напр. нити одинаково и равно $a_{отн}$.

3) II ЗН на $Oz \perp$ силе натяжения и $a_{отн}$:

$ma_{кл}\cos\beta - mg\sin\beta = 0 \Rightarrow$ $a_{кл} = g\operatorname{tg}\beta \approx 4{,}2\ \frac{м}{с^2}$

$a_{кл} = \frac{5}{12}g$

4) II ЗН на O_x и O_y для бруска и шарика соответственно:

$$\begin{cases} 2ma_{отн} = T + 2ma_{кл}\cos\alpha - 2mg\sin\alpha & (1) \\ ma_{отн} = ma_{кл}\sin\beta + mg\cos\beta - T & (2) \end{cases}$$

(1) + (2): $3ma_{отн} = ma_{кл}(2\cos\alpha + \sin\beta) + mg(\cos\beta - 2\sin\alpha)$

$$\Rightarrow a_{отн} = \frac{g\operatorname{tg}\beta(2\cos\alpha + \sin\beta) + g(\cos\beta - 2\sin\alpha)}{3} \approx \frac{1{,}8}{3}\ \frac{м}{с^2}$$

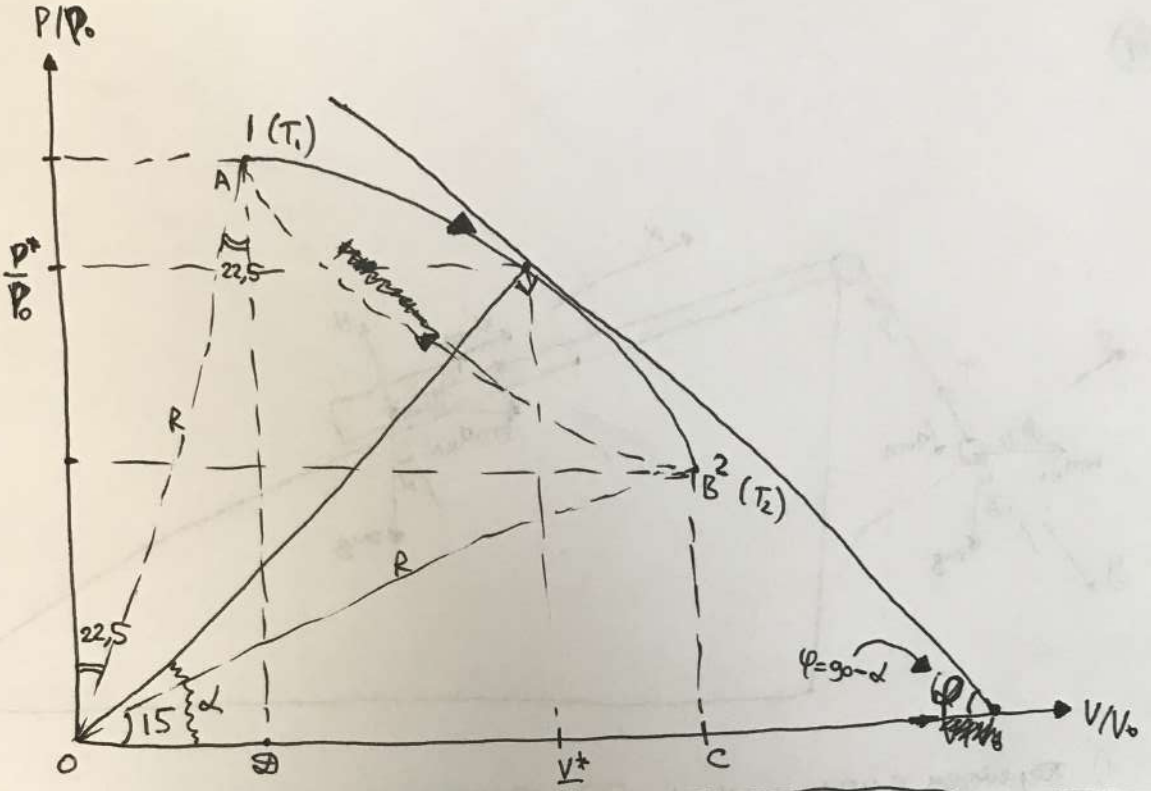
$a_{отн} = \frac{9}{50}g$

5) $H\operatorname{ctg}\alpha = \frac{a_{отн}\tau^2}{2} \Rightarrow$

$$\Rightarrow \tau = \sqrt{\frac{2H\operatorname{ctg}\alpha}{a_{отн}}} = \sqrt{\frac{400}{27}\frac{H}{g}} = \frac{20}{3}\sqrt{\frac{H}{3g}}$$

Чистовик

№2



1) Обозначим радиус окр-ти $2\sqrt{3}$ R

Тогда $BC = R\sin 15$ $AD = R\cos 22{,}5$

$OC = R\cos 15$ $OD = R\sin 22{,}5$

Из уравнения Менделеева - Клапейрона

$T \sim PV$

$$\Rightarrow \frac{T_2}{T_1} = \frac{BC \cdot OC}{AD \cdot OD} = \frac{\sin 15 \cos 15}{\sin 22{,}5 \cos 22{,}5} = \frac{\sin 30}{\sin 50}$$

$$\frac{T_2}{T_1} = \frac{\sin 30}{\sin 50} = \frac{1}{2\sin 50} \quad (1)$$

2) Когда $C = 0 \Rightarrow \delta Q = \delta A + dU = 0$

Пусть P^* и V^* - значения давл. и объема в точке, где $C = 0$

$$P^* dV + \frac{5}{2} P^* dV + \frac{5}{2} V dP = 0 \Rightarrow \frac{7}{2} P^* dV + \frac{5}{2} V dP = 0$$

Прямая, кас. в т. $C = 0$ окр-ти $\perp R$

Тогда α - искомый угол

$$\frac{dP}{dV} = \frac{7}{5}\frac{P^*}{V^*} \quad (2)$$

$$tg\alpha = \frac{P/P_0}{V/V_0} \quad (3)$$

$$tg\varphi = ctg\alpha = \frac{dP/P_0}{dV/V_0} \quad (4)$$

Из (2), (3) и (4): $tg\alpha = \sqrt{\frac{5}{7}}$

Листовик

№2 (продолжение)

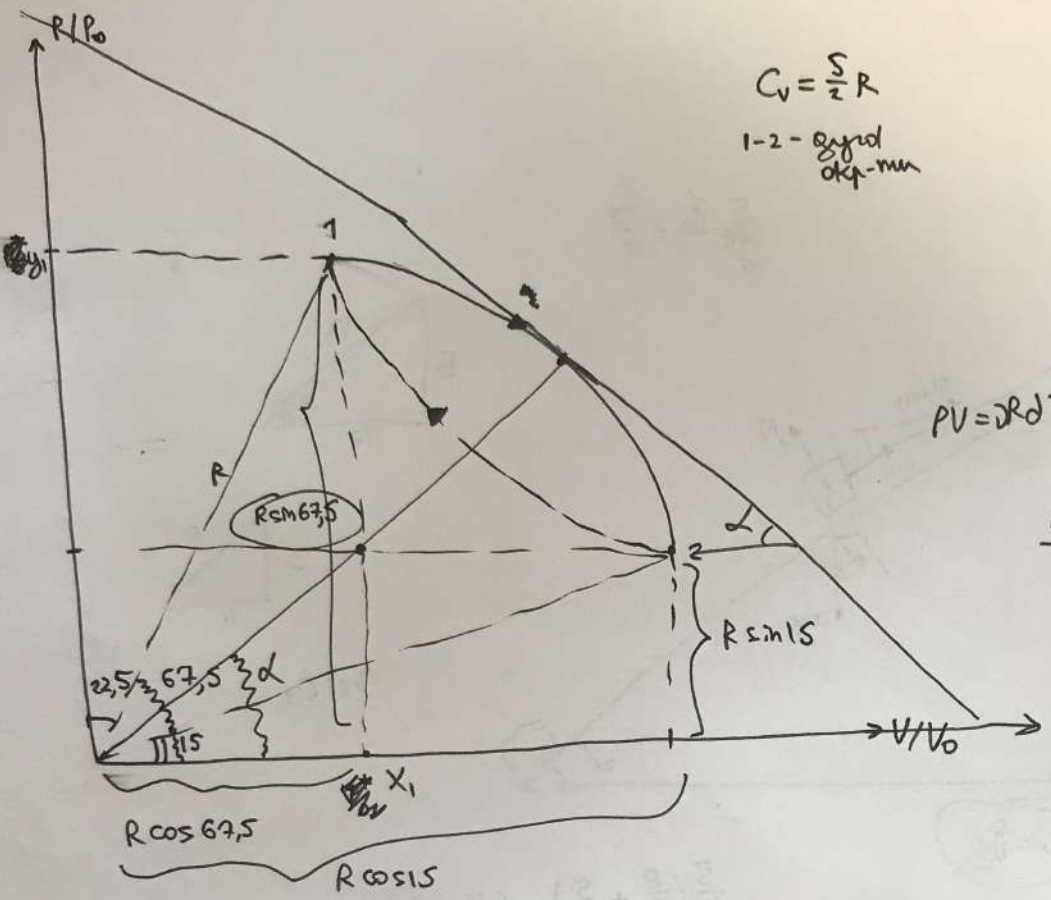
3) Из условия $Q_{21} = 0$

$Q_{12} = A_{цикл} = A_{12} + \Delta U_{12}$

$\Rightarrow$ $\frac{A_{цикл}}{A_{12}} = 1 + \frac{\Delta U_{12}}{A_{12}} = 1 + \frac{C_v \nu (T_2 - T_1)}{A_{12}}$

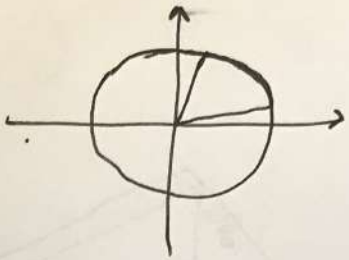
~~$A_{цикл} = A_{12}$~~ ~~$A_{цикл} = A_{12} + A_{21} = A_{12} + C_v \nu (T_1 - T_2)$~~

$A_{12} = \frac{1}{4}\pi R^2 - \frac{22,5}{360}\pi R^2 - \frac{15}{360}\pi R^2$



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

1-2 - адиабатическое расширение



$PV = \nu R T$

$R \sin 15 \; R \cos 15$

0,965

0,766

$\left(\frac{P}{P_0}\right)^2 + \left(\frac{V}{V_0}\right)^2 = \text{const}$

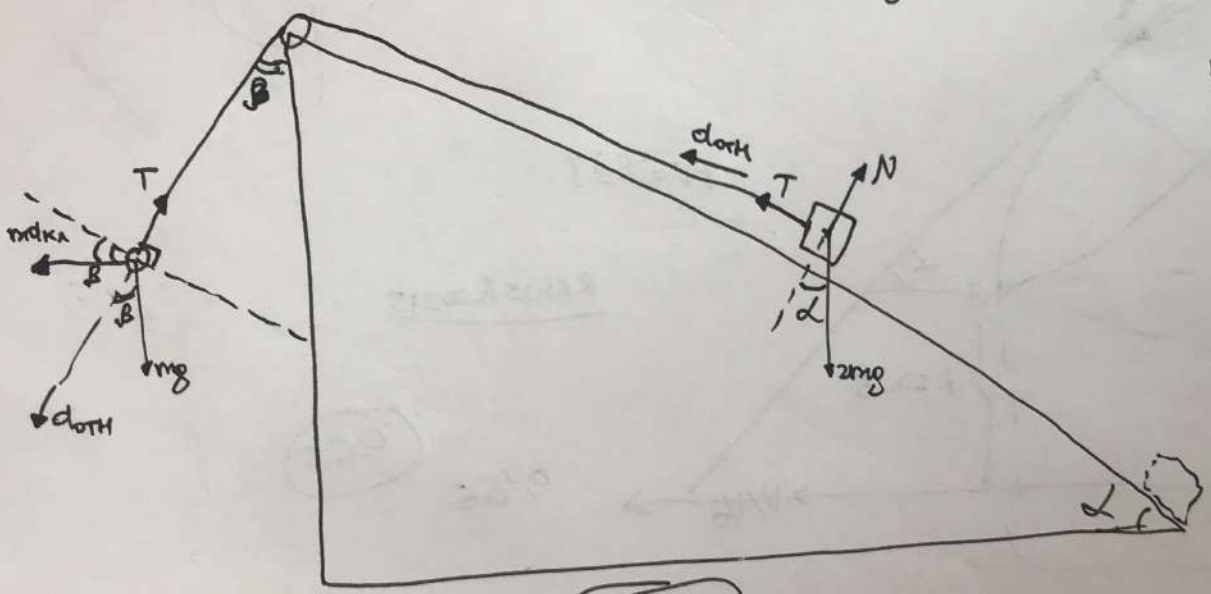
$2\frac{P}{P_0} dP + 2\frac{V}{V_0} dV = 0$

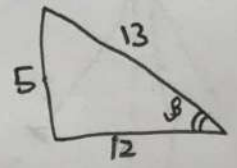
$\frac{P dP}{P_0} = -\frac{V}{V_0} dV$

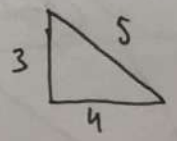
$\frac{P_2^2 - P_1^2}{P_0} + \frac{V_2^2 - V_1^2}{V_0} = 0$

$2x^2$

$\delta Q = PdV + \frac{5}{2} PdV + \frac{5}{2} VdP + dPV + \frac{7}{2} PdV + \frac{7}{2} VdP = 0$







$0{,}2269$

$\frac{5}{12}\left(\frac{8}{5}+\frac{5}{13}\right)+\left(\frac{12}{13}-\frac{3}{5}\right)$ / $3 \approx 0{,}388$

$mg\sin\beta = ma_{кл}\cos\beta \Rightarrow a_{кл} = \frac{5}{12}g$

$\operatorname{tg}\alpha = \frac{H}{x}$

$$\frac{A_y}{A_{12}}$$

$$\left(\frac{P}{P_0}\right)^2 + \left(\frac{V}{V_0}\right)^2 = \text{const}$$

$$Q_{12} = A_{12} + \Delta U_{12} = A_y$$

$$2\frac{P}{P_0}\frac{dP}{} + 2\frac{V}{V_0}dV = 0$$

$$\frac{A_y}{A_{12}} = 1 + \frac{\Delta U_{12}}{A_{12}} = 1 + C_v$$

$$\operatorname{tg}(90-\alpha) = \frac{7}{5}\operatorname{tg}\alpha$$

$$\operatorname{ctg}\alpha = \frac{7}{5}\operatorname{tg}\alpha \qquad \operatorname{tg}^2\alpha = \frac{5}{7}$$

$$\operatorname{tg}\alpha = \sqrt{\frac{5}{7}}$$

$$\int_{R\sin 23{,}5}^{R} \sqrt{R^2 - (x^2)}\, dx$$

$$A_{12} = A_{y} + A_{21}$$

$$\operatorname{tg}\alpha = \frac{P/P_0}{V/V_0} = \frac{PV_0}{VP_0}$$

$$Q_{21} = A_{12} + \Delta U_{12}$$

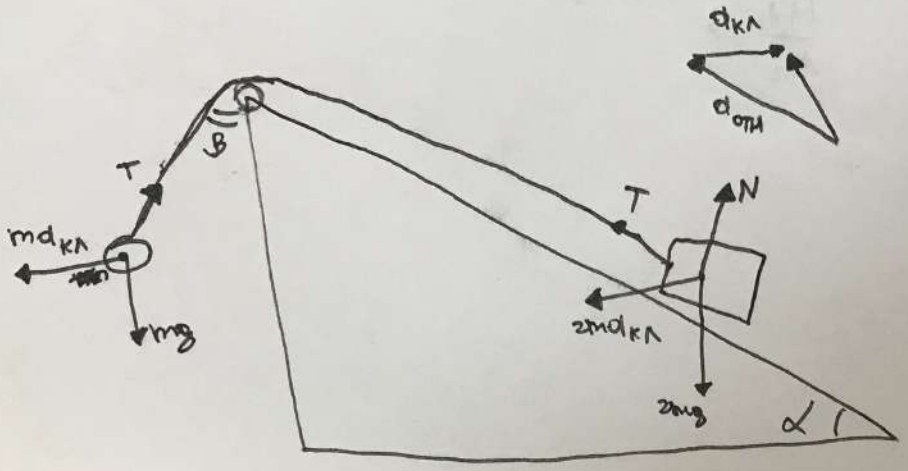
$$\operatorname{tg}(90-\alpha)$$

$$1 + \frac{C_v D(T_2 - T_1)}{}$$

$$\frac{\alpha}{360} \cdot 2\pi R^2$$

$$\operatorname{ctg}\alpha = \frac{7}{5}\operatorname{tg}\alpha$$

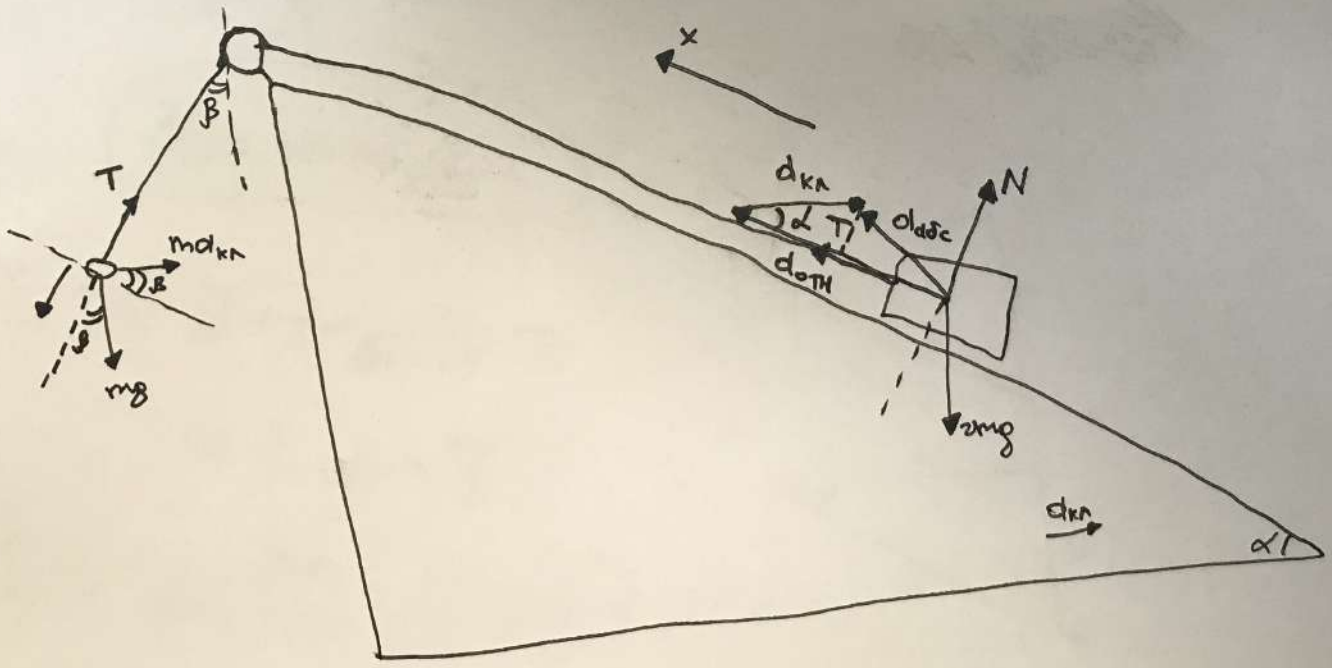
$$A_{\text{укр}} =$$

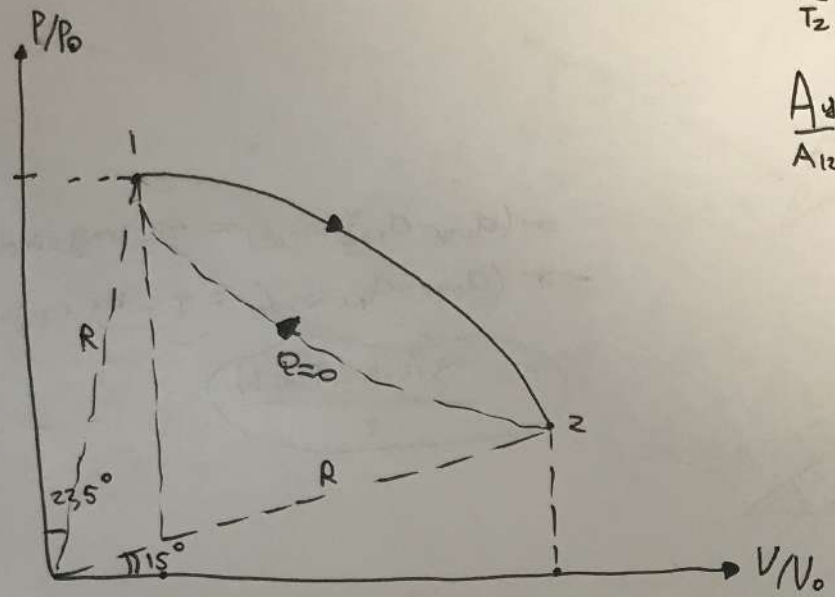


$$2m(a_{OTH} - a_{KA}\cos\alpha) = T - 2mg\sin\alpha$$

$$-2m(a_{OTH} - a_{KA}\cos\alpha) = T - mg\cos\beta$$

$$T = \frac{mg(2\sin\alpha + \cos\beta)}{2}$$

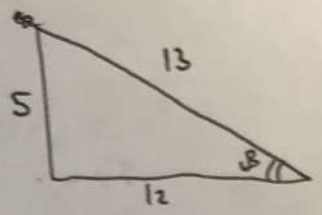


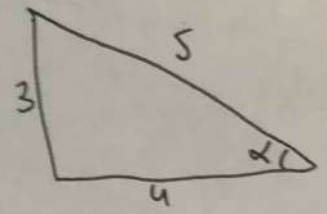


$\frac{T_1}{T_2} = ?$ $\alpha = ?$ $(c=0)$

$\frac{A_{cl}}{A_{12}} = ?$

$Q_{12} = A_{12} + \Delta U_{12}$





$$\frac{5}{12}\left(\frac{8}{5}+\frac{5}{13}\right) = \frac{5(104+25)}{12\cdot 65} = \frac{8\cdot 129}{12\cdot \frac{65}{13}} = \frac{129}{156} = \frac{43}{52}$$

$$\frac{43}{52} + \frac{12}{13} - \frac{6}{5} \in$$

$$\in \frac{43+48}{52} - \frac{6}{5} = \frac{91}{52} - \frac{6}{5} = \frac{455-312}{260} = \frac{143}{260} = 0{,}55$$

$$\frac{0{,}55}{3} \approx 0{,}188$$

$$\frac{2\cdot\frac{4}{3}}{9/508} = \frac{8}{27}\cdot 50$$

$$\frac{400}{27}$$

$$d_{orH} = 0{,}188 = \frac{18}{100} = \frac{9}{50}$$

$$\frac{dP}{dV} = -\frac{7}{5}\frac{P}{V}$$

x^2

$2x$

$$\frac{P\,dP}{dV} = \frac{-P_0}{V_0} V$$

$$\frac{7}{5}\frac{P^2}{P_0} = \frac{V^2}{V_0}$$

$$\left(\frac{P}{P_0}\right)^2 + \left(\frac{V}{V_0}\right)^2 = 0$$

$$2\frac{P}{P_0}dP + 2\frac{V}{V_0}dV = 0$$

$PdV = \ldots$

$PdV + VdP$

$$-\frac{P}{P_0}\cdot\frac{dP}{dV} = \frac{V}{V_0}$$

$$\frac{7}{5}\frac{P^2}{P_0} = \frac{V^2}{V_0}$$

$$\frac{P}{V} = \sqrt{\frac{5P_0}{7V_0}}$$

Часть 2

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

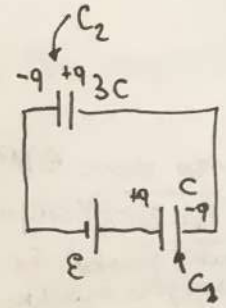
Шифр: **21203698**

ID профиля: **282872**

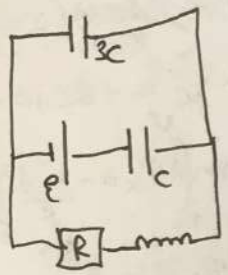
Вариант 6

Чистовик

№3

1) 

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

2) 

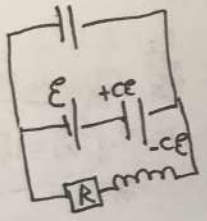
Сразу после замыкания заряд на конд. не изм., так $2/3$ катушку не пометем

$\Rightarrow$ $U_R = 0$

Потом

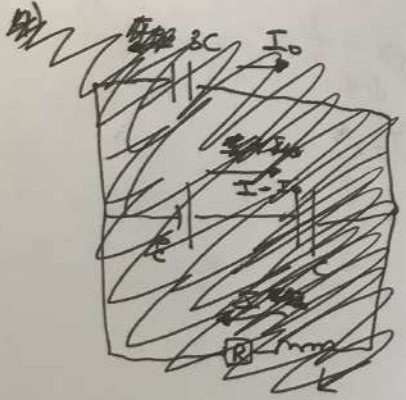
$L\frac{dI_L}{dt} = \frac{q}{3C} = \frac{\mathcal{E}}{4} \Rightarrow$ $\frac{dI_L}{dt} = \frac{\mathcal{E}}{4L}$

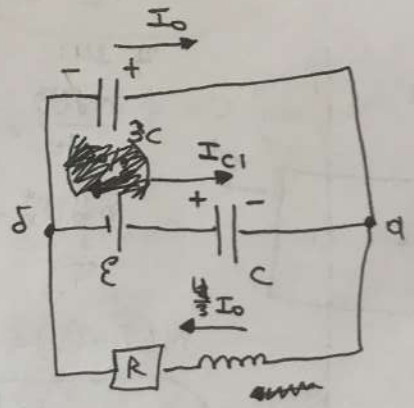
3) После замыкания ток перестанет выделяться, когда $I_R = 0 \Rightarrow$ $U_{C_2} = 0$



ЗСЭ: $\mathcal{E}\left(\frac{3}{4}C\mathcal{E} - \frac{3}{4}C\mathcal{E}\right) + \frac{q^2}{2C} + \frac{q^2}{6C} = Q + \frac{C\mathcal{E}^2}{2}$

$\Rightarrow$ $Q = \frac{C\mathcal{E}^2}{8}$

4) 



$\varphi_a - \varphi_b = \frac{q_{C_2}}{3C} = \mathcal{E} - \frac{q_{C_1}}{C} \Rightarrow q_{C_2} = 3C\mathcal{E} - 3q_{C_1}$

$-\frac{dq_{C_2}}{dt} = -3\frac{dq_{C_1}}{dt}$

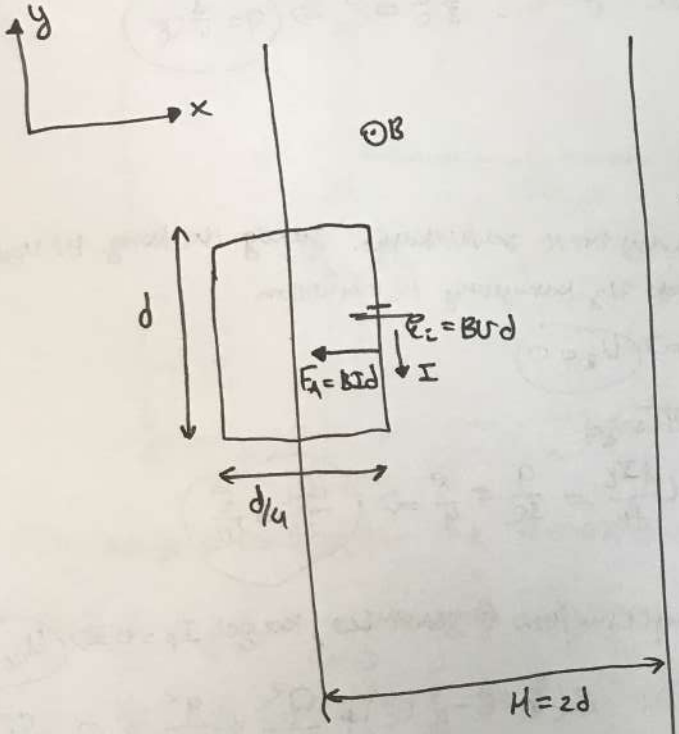
$\Rightarrow$ $I_0 = +3I_{C_1}$

$\Rightarrow I_R = I_0 + \frac{I_0}{3} = \frac{4}{3}I_0$

$\Rightarrow$ $U_R = \frac{4}{3}I_0R$

Ответ: 1) $\frac{\mathcal{E}}{4L} = \frac{dI_L}{dt}$ 2) $\frac{C\mathcal{E}^2}{8}$ 3) $U_R = \frac{4}{3}I_0R$

№4 Чистовик



1) Из-за движ. в МП появится $\mathcal{E}_i = BVd$ (см. рис.) на правой стороне рамки. F_A будет сообщ. импульс только по Ox (по Oy F_A компенсируют друг друга)

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

II ЗН:

2) $m\frac{dV_x}{dt} = -BId = -\frac{B^2d^2V}{R}$ | $\cdot dt$

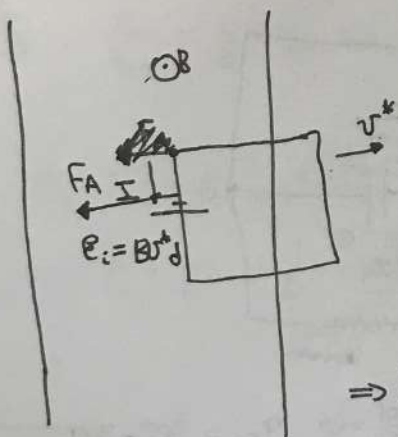
$\Rightarrow m\int_{V_0}^{V} dV_x = -\frac{B^2d^2}{R}\int_0^{d/4} dx$

$m(V_0 - V) = \frac{B^2d^3}{4R}$

$\Rightarrow V = V_0 - \frac{B^2d^3}{4mR}$

2) Когда рамка полностью войдет в область с МП $\mathcal{E}_i$ будут компенсироваться и рамка будет двигаться с $V = const$, т.е. $V_1 = V = V_0 - \frac{B^2d^3}{4mR}$ (т.к. тока не будет)

3)



II ЗН:

$m\frac{dV_x^*}{dt} = -\frac{B^2d^2}{R}V^*$

$m\int_{V_1}^{V_2} dV_x^* = -\frac{B^2d^2}{R}\int_0^{d} dx^*$

$m(V_1 - V_2) = \frac{B^2d3}{4R}$

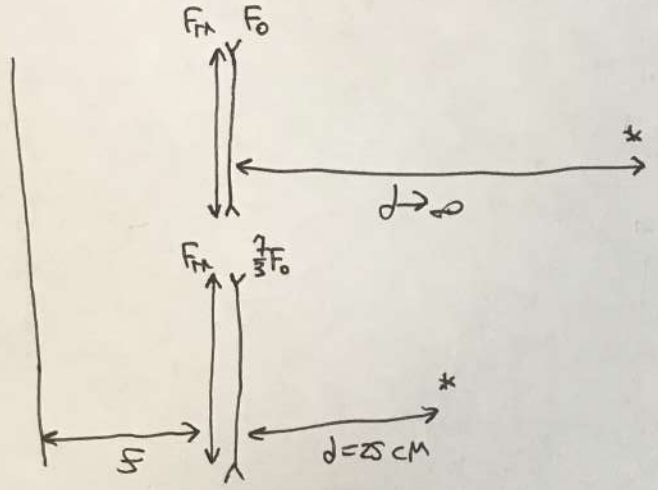
$\Rightarrow V_2 = V_0 - \frac{B^2d^3}{2mR}$

Ответ: $V = V_0 - \frac{B^2d^3}{4mR} = V_1$, $V_2 = V_0 - \frac{B^2d^3}{2mR}$

№5 Чистовик

1) Изображение формируется в глазу на одном и том же расстоянии f

2)



Т.к. линзы вплотную, то их оптические силы складываются

$$\begin{cases} \frac{1}{F_{гл}} - \frac{1}{F_0} = \frac{1}{f} \\ \frac{1}{F_{гл}} - \frac{1}{\frac{7}{3}F_0} = \frac{1}{f} + \frac{1}{d} \end{cases} \Rightarrow \begin{cases} \frac{1}{f} = \frac{F_0 - F_{гл}}{F_{гл} F_0} \quad (1) \\ \frac{1}{f} + \frac{1}{d} = \frac{7F_0 - 3F_{гл}}{7F_{гл} F_0} \quad (2) \end{cases}$$

$(2) - (1)$: $\frac{1}{d} = \frac{4F_{гл}}{7F_{гл}F_0} \Rightarrow F_0 = \frac{4}{7} d \approx 14$ см (рассеив.)

Без очков:

3) $\frac{1}{F_{гл}} = \frac{1}{f} + \frac{1}{x} \Rightarrow \frac{1}{x} = \frac{1}{F_{гл}} - \frac{1}{f} \Rightarrow x = F_0 \approx 14$ см

4) $\frac{1}{F_{гл}} - \frac{1}{F^*} = \frac{1}{f} + \frac{1}{L}$ ($L = 50$ см)

$\Rightarrow \frac{1}{F_0} - \frac{1}{F^*} = \frac{1}{L} \Rightarrow$

$\Rightarrow F^* = \frac{LF_0}{L - F_0} = \frac{50 \cdot 14}{36} \approx 19{,}5$ см (рассеивающ.)

Ответ: 1) $F_0 = x \approx 14$ см

2) $F^* = \frac{LF_0}{L - F_0} \approx 19{,}5$ см

$\frac{F_2}{F_1} = \frac{4}{3}$

$\frac{1}{f} = \frac{F_0 - F_{FA}}{F_{FA} F_0}$

$\frac{1}{f} + \frac{1}{d} = \frac{\frac{7}{3}F_0 - F_{FA}}{\frac{7}{3}F_{FA}F_0} = \frac{7F_0 - 3F_{FA}}{7F_{FA}F_0}$

$\frac{1}{d} = \frac{4F_{FA}}{7F_{FA}F_0}$

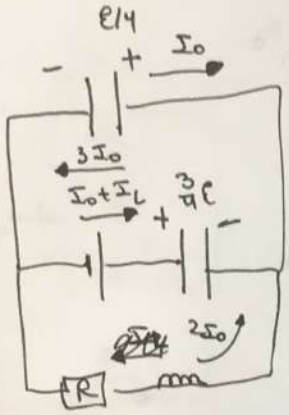
$\frac{D_1}{D_2} = \frac{F_2}{F_1} = \frac{4}{3}$

$\frac{1}{f} = \frac{F_0 + F_{FA}}{F_{FA}F_0}$ (1)

$\frac{1}{f} + \frac{1}{d} = \frac{3F_0 - 7F_{FA}}{3F_{FA}F_0}$ (2)

$\frac{1}{d} = \frac{\quad}{3F_{FA}F_0}$

$\frac{1}{F_{FA}} = \frac{1}{f} + \frac{1}{x}$



$$I_{C1}=\frac{dq_{C1}}{dt}=\frac{d(C_1+I_0)}{dt}=\frac{dI_L}{dt}+\frac{dI_0}{dt}$$

$$I_{C2}=\frac{dq_{C2}}{dt}=\frac{C\,dU}{dt}=I_0$$

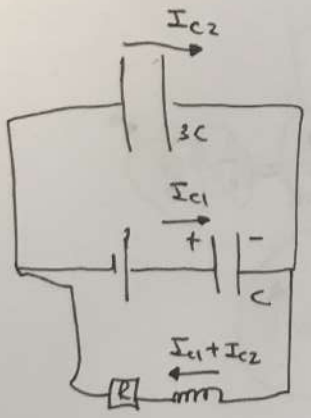
$$L\frac{dI_L}{dt}+U_R=U$$

$$I_{C2}+I_{C1}=\frac{dq_{C1}}{dt}+\frac{dq_{C2}}{dt} \qquad I=\frac{dq}{dt}$$

$$\begin{cases}\dfrac{q_{C2}}{3C}=L\dfrac{dI_L}{dt}+I_LR\\ \mathcal{E}-\dfrac{q_{C1}}{C}=L\dfrac{dI_L}{dt}+I_LR\end{cases}$$

$$\frac{dq_{C1}}{dt}=I_0+I_L$$

$$\frac{dq_{C2}}{dt}=I_0$$



$$\frac{q_{C2}}{3C}=L\frac{dI_{C1}+dI_{C2}}{dt}+(I_{C1}+I_{C2})R$$

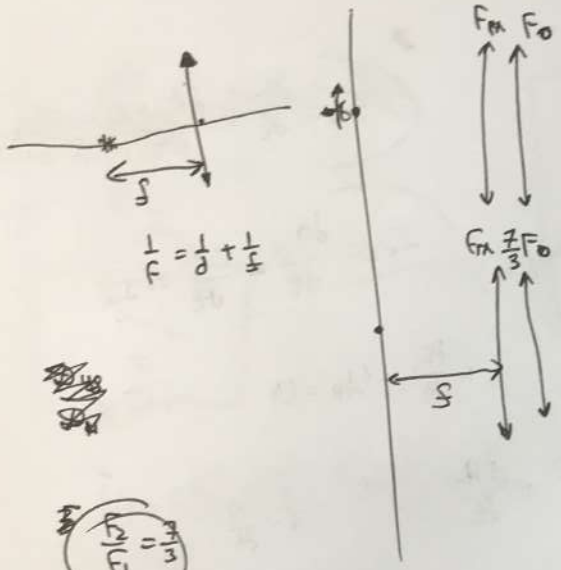
$$\mathcal{E}-\frac{q_{C1}}{C}=L\frac{dI_{C1}+dI_{C2}}{dt}+(I_{C1}+I_{C2})R$$

$$\frac{q_{C2}}{3C}=\mathcal{E}-\frac{q_{C1}}{C}$$

$$q_{C2}=(\mathcal{E}-q_{C1})3$$

$$dq_{C2}=-3dq_{C1}$$

$$I_{C2}=-3I_{C1}$$



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

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

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

F_o

$\frac{1}{F_{rm}} = \frac{1}{x} + \frac{1}{f}$

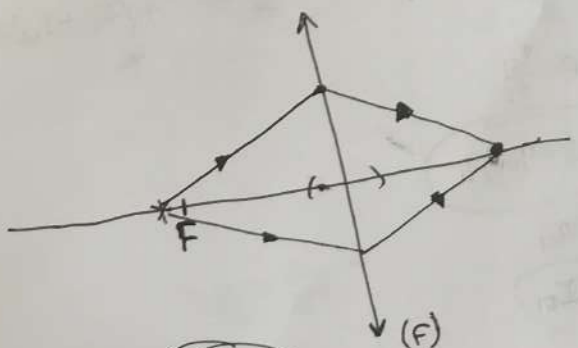
$\frac{1}{f} = \frac{F_o + F_{rm}}{F_{rm} F_o}$

$\frac{1}{f} + \frac{1}{d} = \frac{\frac{7}{3}F_o + F_{rm}}{F_{rm} F_o \frac{7}{3}}$

$+ F_{rm} F_o$

$\frac{1}{F_{rm}} = \frac{1}{d} + \frac{1}{f_1}$

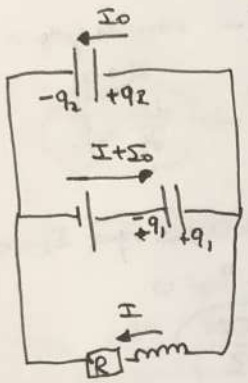
D_{cyMM}



$\frac{1}{F_{rm}} - \frac{1}{F_\lambda} = \frac{F_\lambda F_{rm}}{F_\lambda - F_{rm}}$

$f_o = \frac{F_1 F_2}{F_1 + F_2}$

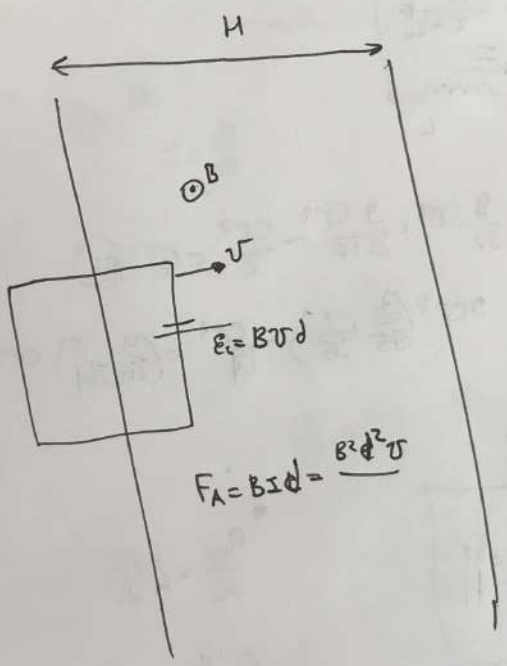
$f_o = \frac{F_1 F_2}{F_1 - F_2}$



$q_{C2} = 3CU$ $\quad \frac{dq_{C2}}{dt} = 3C\frac{dU}{dt} = I_0$

$U_R + L\frac{dI}{dt} = \frac{q_{C2}}{3C} + \frac{q_{C1}}{3C}$

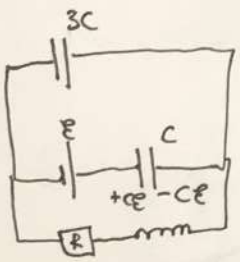
$= \frac{q_C}{3C}$



$m\frac{dv}{dt} = \frac{B^2L^2}{R}$

Черновик

№3



1) сразу после — напр. на катуш-х равно нулю, $I_L = 0$

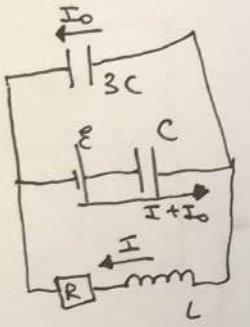
$\Rightarrow U_L = \mathcal{E} = L\frac{dI_L}{dt} \Rightarrow \boxed{\frac{dI_L}{dt} = \frac{\mathcal{E}}{L}}$

2) много последствие ветви тока $I_R = 0$

$\Rightarrow \boxed{q_{C1} = C\mathcal{E}}$, $q_{C2} = 0$

ЗСЭ: $C\mathcal{E}^2 = \frac{C\mathcal{E}^2}{2} + Q \Rightarrow \boxed{Q = \frac{C\mathcal{E}^2}{2}}$

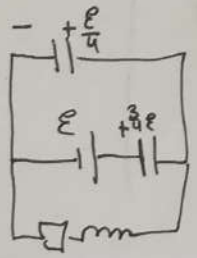
3)



96
64
32

$\frac{C\mathcal{E}^2}{4} + \frac{9}{32}C\mathcal{E}^2 + \frac{9}{6\cdot16}C\mathcal{E}^2 - \frac{C\mathcal{E}^2}{2} = Q$ (=)

(=) $9C\mathcal{E}^2\left(\frac{3}{96} + \frac{1}{96}\right) - \frac{C\mathcal{E}^2}{4} = \left(\frac{9}{32} - \frac{8}{24}\right)C\mathcal{E}^2 = \frac{3}{24}C\mathcal{E}^2 = \frac{C\mathcal{E}^2}{8}$

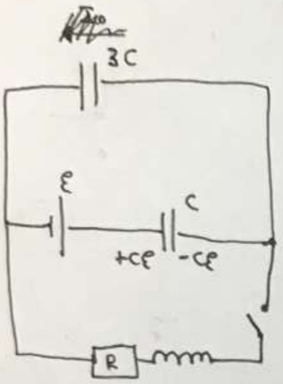


$\frac{q_{C2}}{3C} = L\frac{dI}{dt}$

6·16

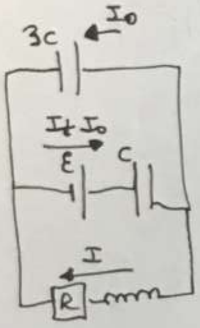
$Q = \left(\frac{1}{4} + \frac{9}{32} + \frac{9}{96} - \frac{1}{2}\right)C\mathcal{E}^2$

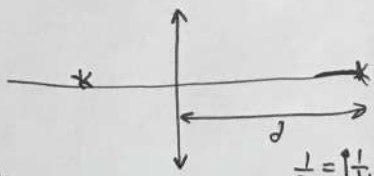
$\frac{9 + 27 - 24}{96} = \frac{12}{96}$



$U_L = L\frac{dI_L}{dt} \Rightarrow \frac{dI_L}{dt} = \frac{\mathcal{E}}{L}$

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





$L\frac{dI}{dt} + IR =$

$I = \frac{dq}{dt}$

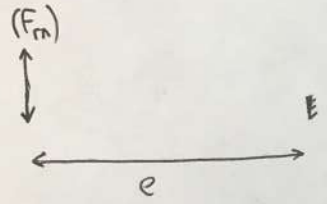
$\frac{1}{F} = \frac{1}{d} + \frac{1}{f}$

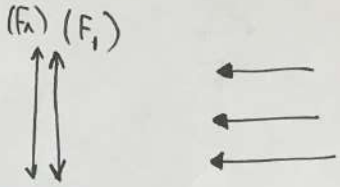
$L\frac{dI_L}{dt} = \frac{q_{c2}}{3C}$

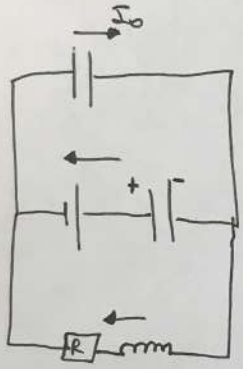
$L\,dI_L =$

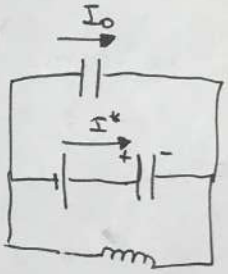
$\frac{1}{D_1^*} = \frac{1}{F_{\Lambda\Gamma}} + \frac{1}{F_1} = \frac{1}{F_1^*}$

$F_1^* = \frac{F_{\Gamma\Lambda} F_1}{F_{\Lambda\Lambda} + F_1}$


(F_E)
E
e


(F_A)
(F_1)


I_0
+
−
R


I_0
I'
+
−