Часть 1

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

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Вариант 1

Чистовик

Задача №2

$$c(T) = 2R\frac{T}{T_0}$$

$$T_1 = \frac{5}{6}T_0$$

1)

$$dQ = c\nu\, dT$$

$$\int_0^Q dQ = \nu\int_{T_0}^{T_1} 2R\frac{T}{T_0}\, dT$$

$$Q = \frac{2\nu R}{T_0}\int_{T_0}^{T_1} T\, dT$$

$$Q = \frac{\cancel{2}\nu R}{T_0}\,\frac{T^2}{\cancel{2}}\Big|_{T_0}^{T_1}$$

$$Q = \frac{\nu R}{T_0}\cdot(T_1^2 - T_0^2)$$

$$Q_1 = -Q = \frac{\nu R}{T_0}(T_0^2 - T_1^2)$$

Подставим $T_1 = \frac{5}{6}T_0$:

$$Q_1 = \frac{\nu R}{\cancel{T_0}}\left(T_0^{\cancel{2}} - \frac{25}{36}T_0^{\cancel{2}}\right) = \nu R\left(T_0 - \frac{25}{36}T_0\right) = \nu R T_0\,\frac{36-25}{36}$$

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

2) $dQ = dA + dU$

$$c\nu\, dT = dA + C_V\nu\, dT$$

$$(c - C_V)\nu\, dT = dA.$$

$$\int_{T_0}^{T_2}(c - C_V)\nu\, dT = \int_0^A dA$$

Чистовик

Задача №2

$$A=\int_{T_0}^{T_2}(C-C_V)\,\nu\,dT$$

$$A=\int_{T_0}^{T_2}\left(2R\frac{T}{T_0}-\frac{3}{2}R\right)\nu\,dT$$

$$\cancel{A=\int_{T_0}^{T_2}2R\frac{T}{T_0}-\int_{T_0}}$$

$$A=\int_{T_0}^{T_2}2R\frac{T}{T_0}\cdot\nu\,dT-\int_{T_0}^{T_2}\frac{3}{2}R\,\nu\,dT$$

$$A=\frac{2R\nu}{T_0}\int_{T_0}^{T_2}T\,dT-\frac{3}{2}\nu R\int_{T_0}^{T_2}dT$$

$$A=\frac{\cancel{2}\nu R}{T_0}\left(\frac{T_2^2}{\cancel{2}}-\frac{T_0^2}{\cancel{2}}\right)-\frac{3}{2}\nu R(T_2-T_0)$$

$$A=\nu R\left(\frac{1}{T_0}(T_2^2-T_0^2)-\frac{3}{2}(T_2-T_0)\right)$$

$$A=\nu R\left(\frac{1}{T_0}\underbrace{(T_2-T_0)}(T_2+T_0)-\frac{3}{2}\underbrace{(T_2-T_0)}\right)$$

$$A=\nu R(T_2-T_0)\left(\frac{1}{T_0}(T_2+T_0)-\frac{3}{2}\right)$$

$$A(T)=\nu R(T-T_0)\left(\frac{T}{T_0}+1-\frac{3}{2}\right)$$

$$A(T)=\nu R(T-T_0)\left(\frac{T}{T_0}-\frac{1}{2}\right)$$

Чистовик

Задача №2

$$A(T) = \frac{\nu R}{T_0}(T - T_0)\left(T - \frac{1}{2}T_0\right)$$

$$\frac{dA}{dT} = \frac{\nu R}{T_0}\left((T-T_0)'\left(T - \frac{1}{2}T_0\right) + (T-T_0)\left(T - \frac{1}{2}T_0\right)'\right)$$

$$\frac{dA}{dT} = \frac{\nu R}{T_0}\left(\left(T - \frac{1}{2}T_0\right) + (T - T_0)\right)$$

$$\frac{dA}{dT} = \frac{\nu R}{T_0}\left(T - \frac{1}{2}T_0 + T - T_0\right)$$

$$\frac{dA}{dT} = \frac{\nu R}{T_0}\left(2T - \frac{3}{2}T_0\right)$$

Экстремум:

$$\frac{dA}{dT} = 0 \qquad \left(2T - \frac{3}{2}T_0\right) = 0$$

$$2T = \frac{3}{2}T_0$$

$$\boxed{T = \frac{3}{4}T_0}$$

$$\boxed{T_2 = \frac{3}{4}T_0}$$

$$A(T_2) = \frac{\nu R}{T_0}\left(\frac{3}{4}T_0 - T_0\right)\left(\frac{3}{4}T_0 - \frac{1}{2}T_0\right)$$

$$A(T_2) = \frac{\nu R}{T_0}\left(-\frac{1}{4}T_0\right)\left(\frac{3}{4}T_0 - \frac{2}{4}T_0\right)$$

$$A(T_2) = \frac{\nu R}{T_0}\left(-\frac{1}{4}T_0 \cdot \frac{1}{4}T_0\right)$$

$$A(T_2) = \frac{\nu R}{T_0}\left(-\frac{1}{16}T_0^2\right)$$

$$A(T_2) = -\frac{\nu R T_0}{16}$$

Чистовик

Задача №2

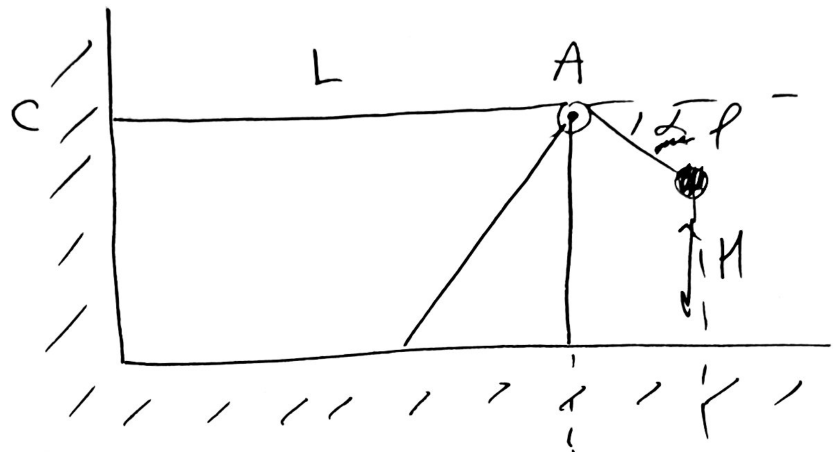
Ответ: 1) $Q_1 = \frac{11}{36} \nu R T_0$

2) $T_2 = \frac{3}{4} T_0$

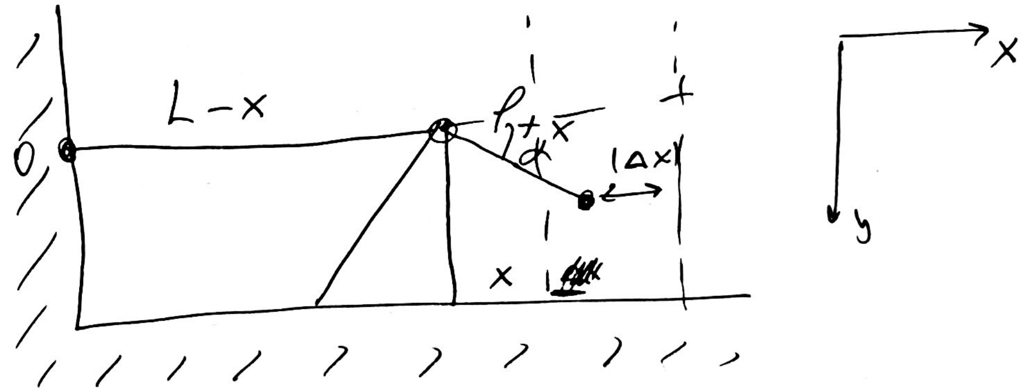
3) $A(T_2) = A_{min} = -\frac{\nu R T_0}{16}$

Чистовик

Задача №1



1) Пусть клин сдвинули на расстояние x. Длина нити при этом не изменилась, в силу нерастяжимости



Смещение шарика по y:

$$\Delta y = y_1 - y_0 \qquad y_1 = (l + x)\sin\alpha$$

$$y_0 = l\sin\alpha$$

$$\Delta y = l\sin\alpha + x\sin\alpha - l\sin\alpha = x\sin\alpha$$

$$\Delta x = x_1 - x_0 \qquad \Delta x = \cancel{L} - x + \cancel{l\cos\alpha} + x\cos\alpha - \cancel{L} - \cancel{l\cos\alpha}$$

$$= x\cos\alpha - x < 0.$$

$$x_0 = L + l\cos\alpha$$

$$x_1 = (L - x) + (l + x)\cos\alpha \qquad |\Delta x| = x(1 - \cos\alpha)$$

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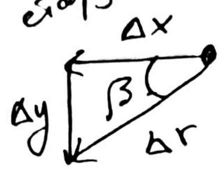
Чистовик

Задача №1

т.к тело стартует из состояния покоя

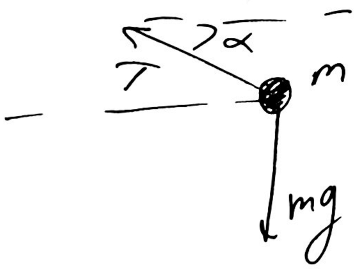


$$\frac{\Delta x}{\Delta y} = \frac{a_x}{a_y}$$

$$\boxed{tg\beta = \frac{\Delta y}{\Delta x} = \frac{\cancel{x}\sin\alpha}{\cancel{x}(1-\cos\alpha)} = \frac{\sin\alpha}{1-\cos\alpha}}$$

2) Найдем ускорение шара

$$\boxed{\frac{a_y}{a_x} = tg\beta}$$



$$\begin{cases} ma_x = T\cos\alpha \\ ma_y = mg - T\sin\alpha \end{cases} \qquad \begin{cases} T = \dfrac{ma_x}{\cos\alpha} \\ m(a_y - g) = -T\sin\alpha \end{cases}$$

$$\begin{cases} T = \dfrac{ma_x}{\cos\alpha} \\ T = \dfrac{m(g-a_y)}{\sin\alpha} \end{cases} \qquad \frac{\cancel{m}a_x}{\cos\alpha} = \frac{\cancel{m}(g-a_y)}{\sin\alpha}$$

$$a_x = \frac{\cos\alpha}{\sin\alpha}(g - a_y)$$

$$a_x = \frac{\cos\alpha}{\sin\alpha}(g - a_x tg\beta)$$

$$a_x = \frac{\cos\alpha}{\sin\alpha}\left(g - a_x \cdot \frac{\sin\alpha}{1-\cos\alpha}\right)$$

Чистовик

Задача №1

$$a_x = \frac{\cos\alpha}{\sin\alpha} g - a_x \cdot \frac{\cancel{\sin\alpha}}{1-\cos\alpha} \cdot \frac{\cos\alpha}{\cancel{\sin\alpha}}$$

$$a_x + a_x \frac{\cos\alpha}{1-\cos\alpha} = \frac{\cos\alpha}{\sin\alpha} g$$

$$a_x \frac{1 \cancel{-\cos\alpha + \cos\alpha}}{1-\cos\alpha} = \frac{\cos\alpha}{\sin\alpha} g$$

$$a_x = \frac{\cos\alpha}{\sin\alpha}(1-\cos\alpha) g$$

$$a_y = a_x \cdot \frac{\sin\alpha}{1-\cos\alpha} = \frac{\cos\alpha}{\cancel{\sin\alpha}} \cdot \cancel{(1-\cos\alpha)} g \cdot \frac{\cancel{\sin\alpha}}{\cancel{(1-\cos\alpha)}} =$$

$$= \boxed{g\cos\alpha}$$

2) Найдем связь ускорений клина и шара:

$$\Delta h = x$$

$$\frac{a_{кл}}{a_x} = \frac{x}{\Delta x} = \frac{\cancel{x}}{\cancel{x}(1-\cos\alpha)}$$

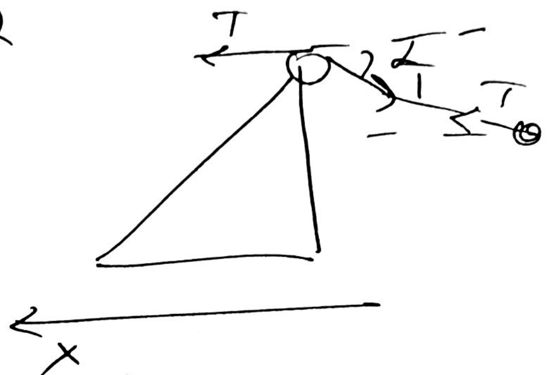
$$\boxed{a_{кл} = a_x \cdot \frac{1}{1-\cos\alpha}} = \frac{\cos\alpha}{\sin\alpha} g$$

Чистовик

Задача № 1

3) Пусть масса клина M, шара — m.

$$\begin{cases} Ma_{кл} = T - T\cos\alpha \\ ma_x = T\cos\alpha \end{cases}$$

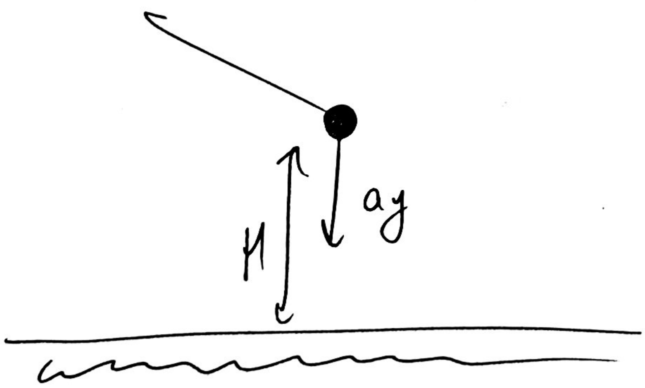


$$\frac{M}{m} \cdot \frac{a_{кл}}{a_x} = \frac{\cancel{T}(1-\cos\alpha)}{\cancel{T}\cos\alpha}$$

$$\frac{M}{m} \cdot \frac{1}{1-\cos\alpha} = \frac{1-\cos\alpha}{\cos\alpha}$$

$$\boxed{\frac{M}{m} = \frac{(1-\cos\alpha)^2}{\cos\alpha}}$$

4)



$$H = \frac{a_y \cdot t^2}{2} \qquad t^2 = \frac{2H}{a_y} = \frac{2H}{g\cos\alpha}$$

$$\boxed{t = \sqrt{\frac{2H}{g\cos\alpha}}}$$

Чистовик

Задача №1

Ответ: 1) $tg\beta = \frac{\sin\alpha}{1-\cos\alpha} = 2$

2) $a_{кл} = \frac{\cos\alpha}{\sin\alpha} g = \frac{\frac{3}{\cancel{5}}}{\frac{4}{\cancel{5}}} g = \frac{3}{4} g$

(M - масса клина

m - масса шара)

3) $\frac{m}{M} = \left(\frac{M}{m}\right)^{-1} = \frac{\cos\alpha}{(1-\cos\alpha)^2} = \frac{15}{4}$

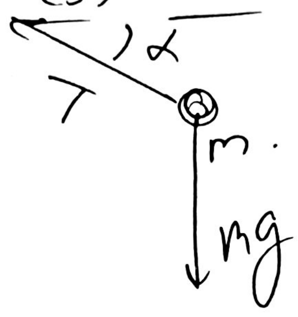
4) $t = \sqrt{\frac{2H}{g\cos\alpha}} = \sqrt{\frac{2H}{g\cdot\frac{3}{5}}} = \sqrt{\frac{10H}{3g}}$

$$\frac{a_{nzn}}{a_x} = \frac{x}{x(1-\cos\alpha)} = \frac{1}{1-\cos\alpha}$$

$$\frac{\rho\,\partial R}{T_0}\left(\frac{T_1^2}{\cancel{7}} - \frac{T_0^2}{\cancel{7}}\right)$$

$$\frac{3/5}{\left(1-\frac{3}{5}\right)^2} = \frac{3/5}{\left(\frac{2}{5}\right)^2} = \frac{3}{\cancel{5}_1}\cdot\frac{\cancel{25}^{5}}{4} = \frac{15}{4}$$

$$\frac{\partial R}{T_0}\left(T_0^2 - T_1^2\right)$$



$$\frac{\partial R}{\cancel{T_0}}\left(T_0^{\cancel{2}} - \frac{25}{36}T_0^{\cancel{2}}\right) =$$

$$\partial R T_0 \left(\frac{36-25}{36}\right) =$$

$$= \frac{11\,\partial R T_0}{36}$$

$$m a_x = T\cos\alpha \qquad T = \frac{m a_x}{\cos\alpha}$$

$$m a_y = mg - T\sin\alpha$$

$$T\sin\alpha = mg - m a_y$$

$$T = \frac{m(g-a_y)}{\sin\alpha}$$

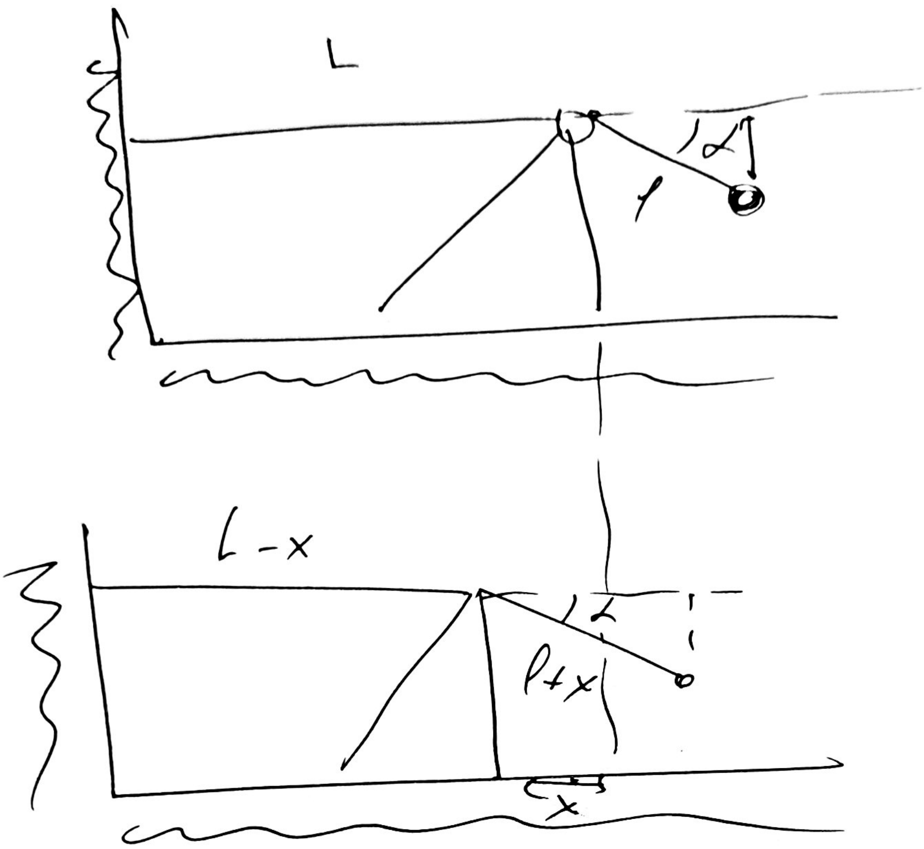
$$\frac{\cancel{m}a_x}{\cos\alpha} = \frac{\cancel{m}(g-a_y)}{\sin\alpha}$$

$$\frac{a_x}{\cos\alpha} = \frac{(g-a_y)}{\sin\alpha}$$

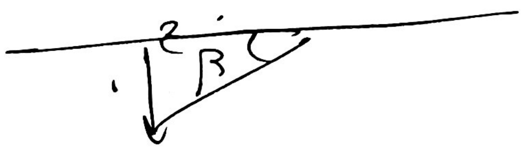
$$a_x = \frac{\cos\alpha}{\sin\alpha}\left(g - \frac{\sin\alpha}{1-\cos\alpha}a_x\right) = \frac{\cos\alpha}{\sin\alpha}g - \frac{\cos\alpha}{1-\cos\alpha}a_x$$

$$a_x + \frac{\cos\alpha}{1-\cos\alpha}a_x = \frac{\cos\alpha}{\sin\alpha}g$$

$$a_x\,\frac{1\cancel{-\cos\alpha+\cos\alpha}}{1-\cos\alpha} = \frac{\cos\alpha}{\sin\alpha}g \qquad a_x = \frac{\cos\alpha}{\sin\alpha}(1-\cos\alpha)$$



$y_1 = (l+x)\sin\alpha$



$y_0 = l\sin\alpha$

$\Delta y = x\sin\alpha$

$\cancel{\Delta x}\quad x_0 = L + l\cos\alpha$

$x_1 = L - x + (l+x)\cos\alpha$

$\cancel{L} + \cancel{l\cos\alpha} - \cancel{L} + x - \cancel{l\cos\alpha} - x\cos\alpha = \Delta x$

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

$$\boxed{\frac{\Delta y}{\Delta x} = \frac{\cancel{x}\sin\alpha}{\cancel{x}(1-\cos\alpha)} = \frac{\sin\alpha}{1-\cos\alpha}}$$

$$\begin{cases} T(1-\cos\alpha) = Ma_{kn.x} \\ T\cos\alpha = ma_x \end{cases}$$

$$\frac{\cos\alpha}{1-\cos\alpha} = \frac{m}{M}\cdot(1-\cos\alpha).$$

$$\frac{m}{M} = \frac{\cos\alpha}{(1-\cos\alpha)^2} = \frac{\frac{3}{5}}{\left(\frac{2}{5}\right)^2} = \frac{\cancel{\frac{3}{5}}}{\frac{4}{25}}$$

$$a_y = a_x \cdot tg\beta$$

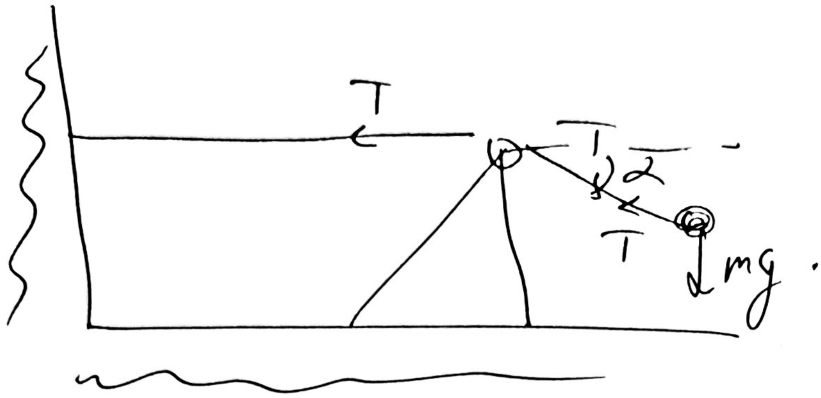
$$a_y = g\frac{\cos\alpha}{\cancel{\sin\alpha}}\cancel{(1-\cos\alpha)}\cdot\frac{\cancel{\sin\alpha}}{\cancel{1-\cos\alpha}}$$

$$\underline{a_y = g\cos\alpha}$$

$$H = \frac{a_y t^2}{2}$$

$$H = g\frac{\cos\alpha \cdot t^2}{2}$$

Черновик



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

$\frac{\Delta x}{x} = 1-\cos\alpha$

$\frac{a_x}{a_{\kappa\Lambda x}} = 1-\cos\alpha$

$\frac{a_y}{a_x} = tg\beta$

$a_{\kappa\Lambda x} = \frac{a_x}{1-\cos\alpha}$

$a_{\kappa\Lambda x} = g\frac{\cos\alpha}{\sin\alpha} = ctg\,\alpha\, g$

$T\cos\alpha = ma_x$

$\cancel{T}mg - T\sin\alpha = ma_y$

$T = \frac{ma_x}{\cos\alpha}$

$T\sin\alpha = mg - ma_y$

$T = \frac{m(g-a_y)}{\sin\alpha}$

$\frac{\cancel{m}a_x}{\cos\alpha} = \frac{\cancel{m}(g-a_y)}{\sin\alpha}$

$T\cos\alpha$

$\frac{a_x}{\cos\alpha} = \frac{g-a_y}{\sin\alpha}$

$\begin{cases} T - T\cos\alpha = Ma_{\kappa\Lambda x} \\ T\cos\alpha = ma_x \end{cases}$

$a_x = (g-a_y)\cdot\frac{\cos\alpha}{\sin\alpha}$

$a_x = \left(g - a_x\cdot\frac{\sin\alpha}{1-\cos\alpha}\right)\cdot\frac{\cos\alpha}{\sin\alpha}$

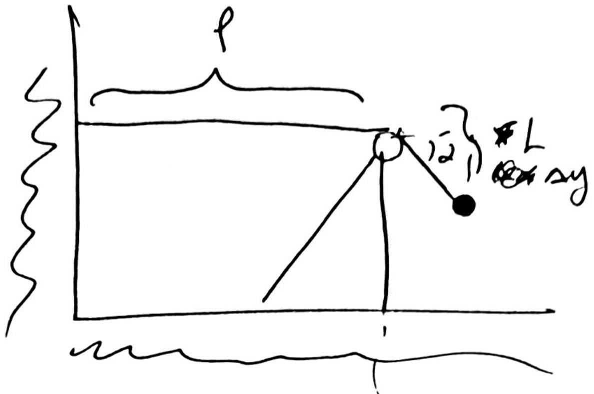
$a_x\left(\frac{1}{1-\cos\alpha}\right) = g\frac{\cos\alpha}{\sin\alpha}$

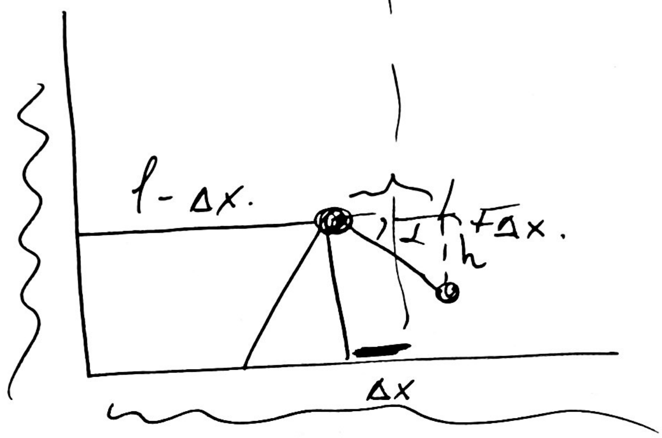
$a_x = g\frac{\cos\alpha}{\sin\alpha} - a_x\frac{\cancel{\sin\alpha}}{1-\cos\alpha}\cdot\frac{\cos\alpha}{\cancel{\sin\alpha}}$

$a_x\left(\frac{1\cancel{-\cos\alpha}\cancel{+\cos\alpha}}{1-\cos\alpha}\right) = g\frac{\cos}{\sin}$

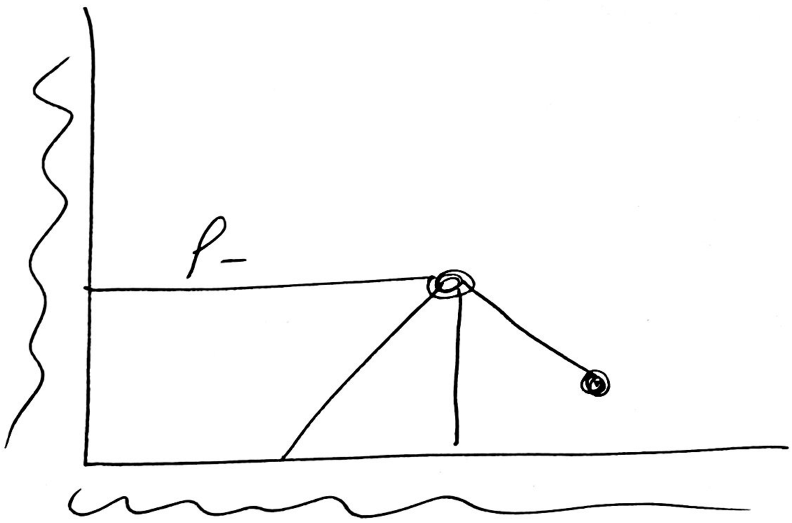
$a_x + a_x\frac{\cos\alpha}{1-\cos\alpha} = g\frac{\cos\alpha}{\sin\alpha}$

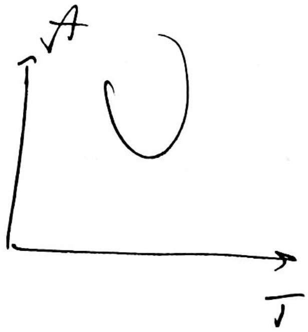
[illegible]





$\ell + h = \text{const}.$



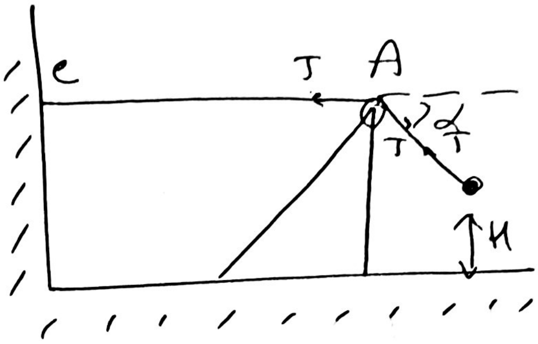


$$\frac{dA}{d\ell} = \frac{\partial R}{\partial \sigma}$$

$$\frac{2\partial R}{\partial \sigma} \uparrow$$

~~Черновик № 1~~

~~Задача~~



$$dQ = 2R\frac{T}{T_0}\nu\, dT$$

$$dQ = \frac{2\nu R}{T_0}(T\,dT)$$

$$\int_0^Q dQ = \frac{2\nu R}{T_0}\int_{T_0}^{T_1} T\,dT$$

$$\frac{36-25}{36} = \frac{11}{36}$$

$$Q = \cancel{2}\frac{\nu R}{T_0}\left(\frac{T_1^2}{\cancel{2}} - \frac{T_0^2}{\cancel{2}}\right)$$

$$Q = \frac{\nu R}{T_0}(T_1^2 - T_0^2)$$

$$Q_1 = -Q = \frac{\nu R}{T_0}(T_0^2 - T_1^2)$$

$$Q_1 = \frac{\nu R}{T_0}\left(T_0^2 - \left(\frac{5}{6}T_0\right)^2\right)$$

$$Q_1 = \frac{\nu R}{T_0}\left(T_0^2 - \frac{25}{36}T_0^2\right) = \frac{\nu R}{\cancel{T_0}}\cdot\frac{11}{36}T_0^{\cancel{2}} = \boxed{\frac{11}{36}\nu R T_0}$$

$$dQ = dU + dA.$$

$$2R\frac{T}{T_0}\nu\, dT = \frac{3}{2}R\nu\, dT + dA$$

$$\nu R\left(2\frac{T}{T_0}dT - \frac{3}{2}dT\right) = dA$$

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

$$\nu R\left(\int_{T_0}^{T} 2\frac{T}{T_0}dT - \int_{T_0}^{T}\frac{3}{2}dT\right) = A(T)$$

$$\nu R\left(\cancel{2}\cdot\left(\frac{T^2}{\cancel{2}} - \frac{T_0^2}{\cancel{2}}\right)\frac{1}{T_0} - \frac{3}{2}(T - T_0)\right) = A(T)$$

$$\nu R\left(\frac{1}{T_0}(T-T_0)(T+T_0) - \frac{3}{2}(T-T_0)\right) = A(T)$$

$$\frac{\nu R}{T_0}\left((T-T_0)(T+T_0) - \frac{3}{2}T_0(T-T_0)\right) = A(T)$$

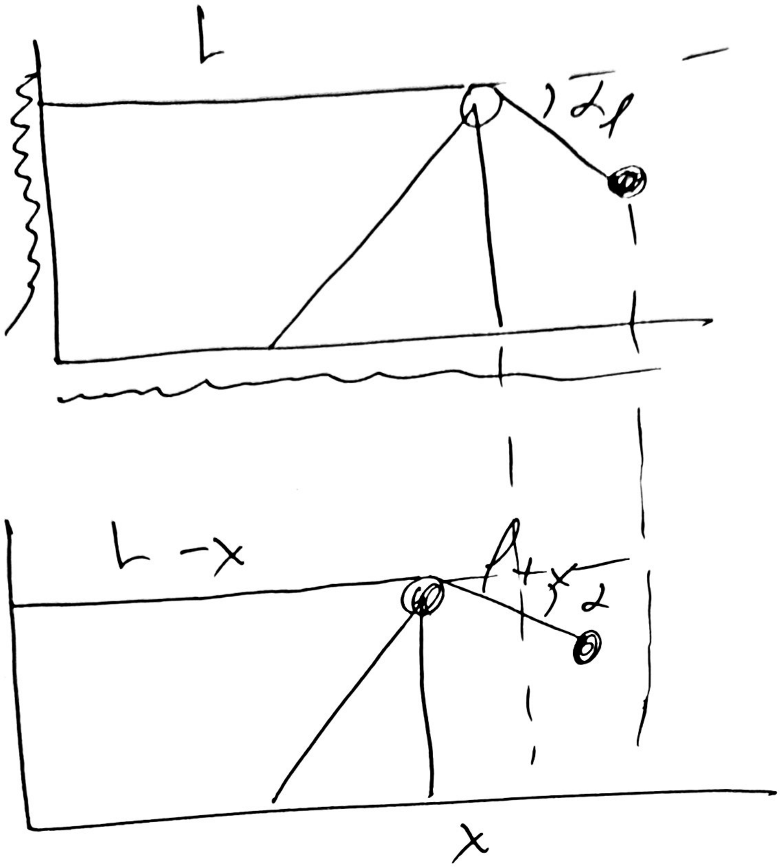
$$\frac{\nu R}{T_0}(T-T_0)\left(T+T_0-\frac{3}{2}T_0\right) = A(T)$$

$$\frac{\nu R}{T_0}(T-T_0)\left(T-\frac{1}{2}T_0\right) = A(T)$$

$$\frac{\nu R}{T_0}\left(T^2 \underbrace{- T_0T - \frac{1}{2}TT_0}_{-\frac{3}{2}T_0T} + \frac{1}{2}T_0^2\right) = A(T)$$

$$\frac{\nu R}{T_0}\left(2T - \frac{3}{2}T_0\right) = 0 \qquad 2T = \frac{3}{2}T_0 \qquad \boxed{T = \frac{3}{4}T_0}$$

$$A(T_2) = \frac{\nu R}{T_0}\left(\frac{3}{4}T_0 - T_0\right)\left(\frac{3}{4}T_0 - \frac{2}{4}T_0\right) = \frac{\nu R}{T_0}\left(-\frac{1}{4}T_0\right)\left(\frac{1}{4}T_0\right) = -\frac{\nu R}{T_0}\left(\frac{T_0^2}{16}\right) = \boxed{-\frac{\nu R T_0}{16}}$$



$y_1 = (l+x)\sin\alpha$

$y_0 = l\sin\alpha$

$\Delta y = l\sin\alpha + x\sin\alpha - l\sin\alpha = \underline{x\sin\alpha}$

$x_0 = L + l\cos\alpha$

$x_1 = (L-x) + (l+x)\cos\alpha$

$x_0 - x_1 = \cancel{L} + \cancel{l\cos\alpha} - \cancel{L} + x - \cancel{l\cos\alpha} - x\cos\alpha =$

$= \underline{x(1-\cos\alpha)}$

$tg\beta = \dfrac{\frac{4}{5}}{1-\frac{3}{5}} = \dfrac{\frac{4}{5}}{\frac{2}{5}} = \boxed{2}$

$\dfrac{\Delta y}{\Delta x} = \dfrac{dy}{dx} = \dfrac{\cancel{x}\sin\alpha}{\cancel{x}(1-\cos\alpha)} = \dfrac{\sin\alpha}{1-\cos\alpha}$

$tg\beta = \dfrac{\sin\alpha}{1-\cos\alpha}$

$$a_y = a_x \cdot \frac{\sin\alpha}{1-\cos\alpha} = \frac{\sin\alpha}{1-\cos\alpha} \cdot \frac{\cos\alpha}{\sin\alpha}(1-\cos\alpha)\, g =$$

$$= \cos\alpha\, g$$

$$H = \frac{a_y t^2}{2} \qquad \frac{2H}{a_y} = t^2 \qquad a_y = g\cos\alpha$$

$$\frac{2H}{g\cos\alpha} = t^2 \qquad \frac{a t^2}{2} = H$$

$$t^2 = \frac{2H}{a_y}$$

$$\sqrt{\frac{2H}{g \cdot \frac{3}{5}}} = t \qquad t^2 = \frac{2H}{g\cos\alpha} \qquad \boxed{t = \sqrt{\frac{2H}{g\cos\alpha}}}$$

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

$$a_{kn} = a_x \cdot \frac{1}{1-\cos\alpha} = \frac{\cos\alpha}{\sin\alpha} \cdot g$$

$$\boxed{T_2 = \frac{3}{2} T_0}$$

$$\begin{cases} M a_{kn} = T - T\cos\alpha \\ m a_x = T\cos\alpha \end{cases}$$

$$\frac{M}{m} \cdot \frac{a_{kn}}{a_x} = \frac{1-\cos\alpha}{\cos\alpha}$$

$$\frac{M}{m} \cdot \frac{\cancel{x}}{\cancel{x}(1-\cos\alpha)} = \frac{1-\cos\alpha}{\cos\alpha}$$

$$\frac{M}{m} = \frac{(1-\cos\alpha)^2}{\cos\alpha} = \frac{\left(1-\frac{3}{5}\right)^2}{\frac{3}{5}} = \frac{4}{25} \cdot \frac{5}{3} = \boxed{\frac{4}{15}}$$

$$\boxed{= \frac{\nu R T_0}{16}}$$

Часть 2

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

Шифр: **21200758**

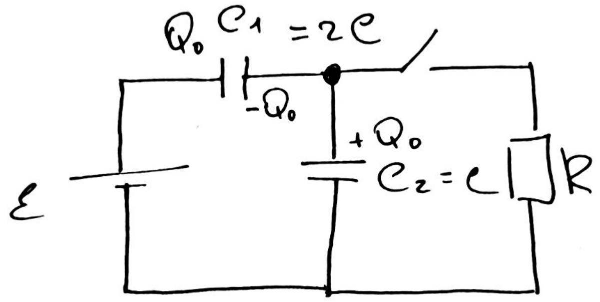
ID профиля: **332932**

Вариант 1

Чистовик

Задача №3.

1) Рассмотрим установившийся режим при разомкнутом ключе.



$$\mathcal{E}=\frac{Q_0}{C_1}+\frac{Q_0}{C_2}=Q_0\left(\frac{1}{C_1}+\frac{1}{C_2}\right)=Q_0\left(\frac{1}{2C}+\frac{1}{C}\right)$$

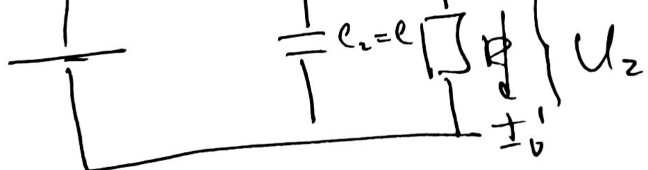
$$\mathcal{E}=Q_0\left(\frac{C+2C}{2C^2}\right)=Q_0\cdot\frac{3}{2C}$$

$$Q_0=\frac{2C\mathcal{E}}{3}$$

$$U_2=\frac{Q_0}{C_2}=\frac{\frac{2C\mathcal{E}}{3}}{C}=\frac{2\mathcal{E}}{3}$$

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

2) Ключ замкнули, сразу после замыкания ~~за~~ заряды и напряжения конденсаторов не изменились.



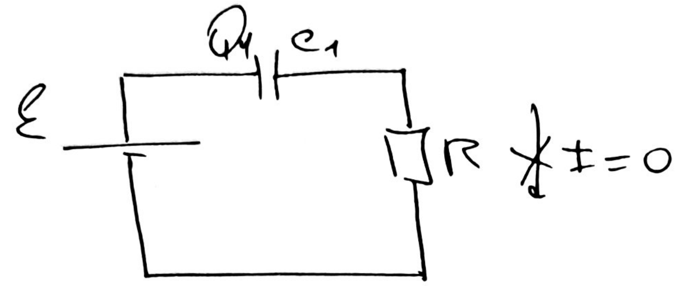
(1)

$$U_2=I_0'R \rightarrow I_0'=\frac{U_2}{R} \quad \boxed{I_0'=\frac{\frac{2\mathcal{E}}{3}}{R}=\frac{2\mathcal{E}}{3R}}$$

Чистовик

Задача №3

3) Рассмотрим установившееся состояние при замкнутом ключа.



$$\mathcal{E} = \frac{Q_1}{C_1} \qquad \underline{Q_1 = \mathcal{E} C_1 = 2C\mathcal{E}}$$

Запишем ЗСЭ для начального и конечного состояния

$$A_{ист} = \Delta W + Q$$

$$\mathcal{E}(Q_1 - Q_0) = \frac{C_1\mathcal{E}^2}{2} - \frac{\frac{2}{3}C\mathcal{E}^2}{2} + Q$$

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

$$\mathcal{E}\left(\frac{6C\mathcal{E} - 2C\mathcal{E}}{3}\right) = C\mathcal{E}^2 - \frac{1}{3}C\mathcal{E}^2 + Q$$

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

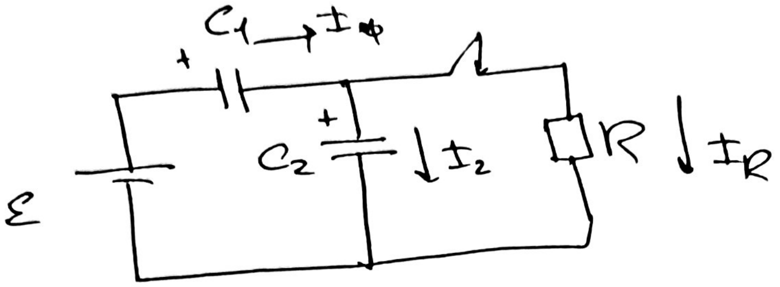
$$\frac{4}{3}C\mathcal{E}^2 - \frac{2}{3}C\mathcal{E}^2 = Q$$

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

2

Чистовик.

Задача №3



$$\mathcal{E} = U_1 + U_2$$

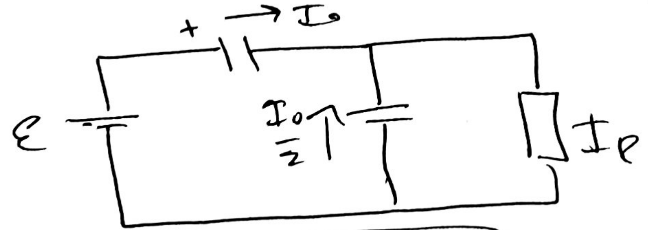
$$\mathcal{E} = \frac{Q_1}{C_1} + \frac{Q_2}{C_2} \quad ' \text{(продифференцируем)}$$

$$0 = \frac{I_0}{C_1} + \frac{I_2}{C_2}$$

$$\frac{I_2}{C_2} = -\frac{I_0}{C_1}$$

$$\boxed{I_2 = -\frac{C_2}{C_1} I_0} \qquad I_2 = -\frac{\cancel{C}}{2\cancel{C}} \cdot I_0 = -\frac{1}{2} I_0$$

Таким образом:

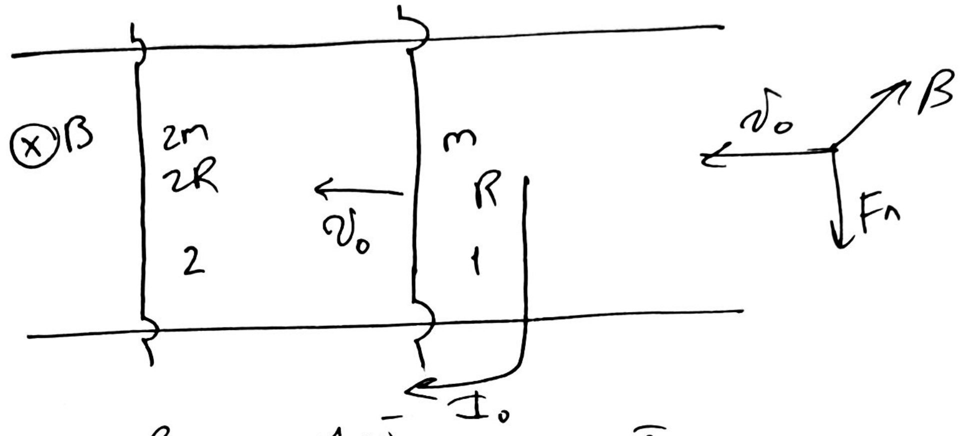


$$\boxed{I_R = I_0 + \frac{I_0}{2} = \frac{3}{2} I_0}$$

Ответ:
1) $I_0' = \frac{2\mathcal{E}}{3R}$
2) $Q = \frac{2}{3} C\mathcal{E}^2$
3) $I_R = \frac{3}{2} I_0$

Чистовик

Задача №4



1) Найдем ток в начальный момент

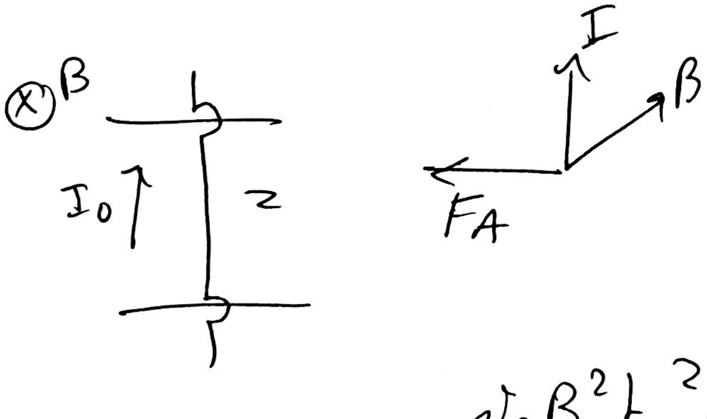
(эффект Холла)

ЭДС

$$\mathcal{E}_1 = v_0 B \cdot L$$

$$\mathcal{E}_1 = I_0 \cdot R + I_0 \cdot 2R = 3 I_0 R$$

$$I_0 = \frac{\mathcal{E}_1}{3R} = \frac{v_0 B L}{3R}$$



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

2 з-н:

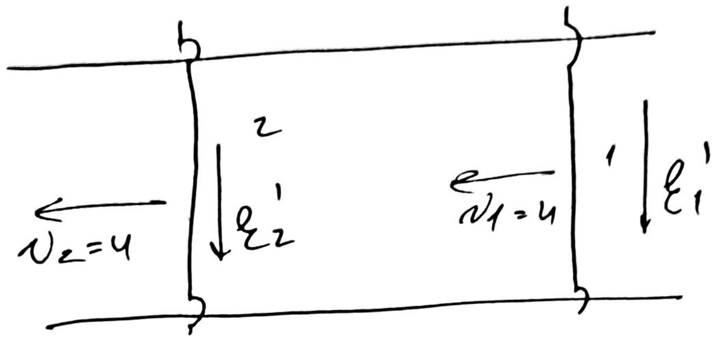
$$2 m a_{20} = F_A = \frac{v_0 B^2 L^2}{3R}$$

$$\boxed{a_{20} = \frac{v_0 B^2 L^2}{6mR}}$$

4

Чистовик

Задача №4



Через продолжительное время стержни не движутся относительно друг друга. Значит тока в цепи нет.

$$\mathcal{E}_2' = \mathcal{E}_1'$$

$$v_2 \cancel{BL} = v_1 \cancel{BL}$$

$$\boxed{v_2 = v_1} = u$$

ЗСИ:

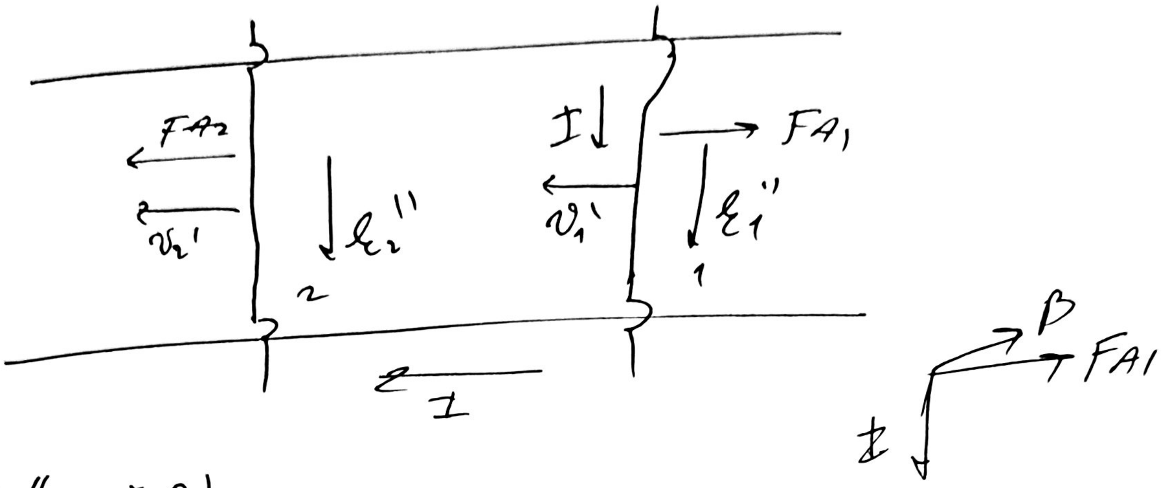
$$\cancel{m} v_0 = 2\cancel{m}u + \cancel{m}u$$

$$v_0 = 3u \to \boxed{u = \frac{v_0}{3}}$$

$$\boxed{v_1 = \frac{v_0}{3};\quad v_2 = \frac{v_0}{3}}$$

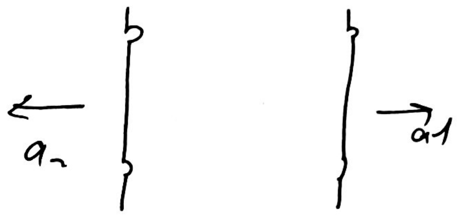
Чистовик

Задача № 4



$$\mathcal{E}_1'' = v_1 B L$$

$$\mathcal{E}_2'' = v_2 B L$$



$$(\mathcal{E}_1'' - \mathcal{E}_2'') = 3IR$$

$$(v_1 - v_2) B L = 3IR$$

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

$$F_{A1} = \frac{(v_1 - v_2) B^2 L^2}{3R} = F_{A2}$$

$$a_1 = \frac{F_{A1}}{m} = \frac{(v_1 - v_2) B^2 L^2}{3mR}$$

$$a_2 = \frac{F_{A2}}{2m} = \frac{(v_1 - v_2) B^2 L^2}{6mR}$$

$$a_{отн} = a_2 + a_1 = \frac{(v_1 - v_2) B^2 L^2}{3mR}\left(1 + \frac{1}{2}\right) = \frac{(v_1 - v_2) B^2 L^2}{\cancel{3}mR} \cdot \frac{\cancel{3}}{2} =$$

$$= \frac{(v_1 - v_2) B^2 L^2}{2mR}$$

6

$$a_{отн} = \frac{v_{отн} \cdot B^2 L^2}{2mR}$$

$$a_{отн} = \frac{v_{отн} \cdot B^2 L^2}{2mR}$$

Чистовик

Задача №4

$$\frac{dv_{отн}}{dt} = \frac{v_{отн} B^2 L^2}{2mR}$$

$$\frac{dv_{отн}}{dS} \cdot \left(\frac{dS}{dt}\right) = \frac{v_{отн} \cdot B^2 L^2}{2mR}$$

$-v_{отн}$

$$\frac{dv_{отн}}{dS} \cdot -\cancel{v_{отн}} = \frac{\cancel{v_{отн}} B^2 L^2}{2mR}$$

$$dv_{отн} = -\frac{B^2 L^2}{2mR} \cdot dS.$$

$$\int_{v_0}^{0} dv_{отн} = -\frac{B^2 L^2}{2mR} \int_{S_1}^{S_0} dS$$

$$-v_0 = -\frac{B^2 L^2}{2mR}(S_0 - S_1)$$

$$v_0 = \frac{B^2 L^2}{2mR}(S_0 - S_1)$$

$$\frac{2mR \cdot v_0}{B^2 L^2} = S_0 - S_1 \qquad \boxed{S_1 = S_0 - \frac{2mR v_0}{B^2 L^2}}$$

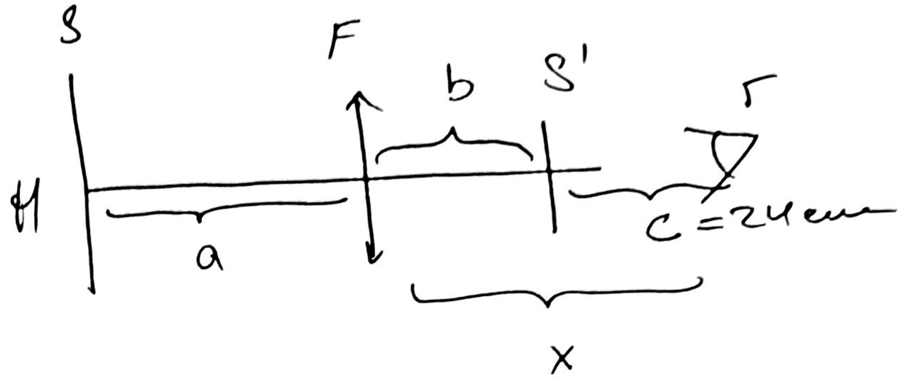
Ответ: 1) $a_{20} = \dfrac{v_0 B^2 L^2}{6mR}$

2) $v_1 = v_2 = \dfrac{v_0}{3}$

3) $S_1 = S_0 - \dfrac{2mR v_0}{B^2 L^2}$

Чистовик

Задача №25



1) $\frac{1}{a} + \frac{1}{b} = \frac{1}{F}$

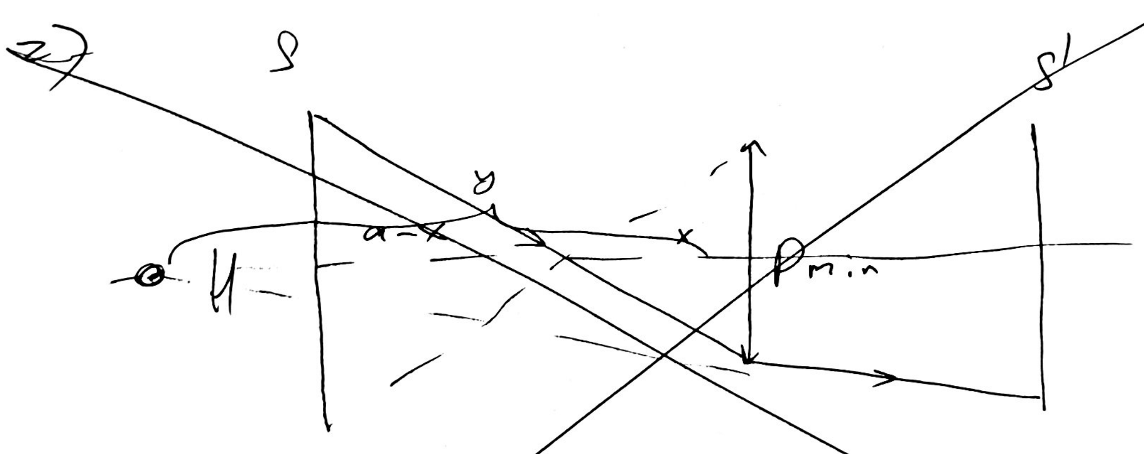
$\frac{1}{b} = \frac{1}{F} - \frac{1}{a} = \frac{a-F}{aF}$

$Г = \frac{F}{a-F} = \frac{9}{36-9} = \frac{9}{27} = \frac{1}{3}$

$b = \frac{aF}{a-F}$

$\boxed{x = \frac{aF}{a-F} + c} = \frac{36 \cdot 9}{36-9} + 24 = 12 + 24 = \boxed{36\text{ см}}$

2)



$\frac{a-x}{H} = \frac{x}{D_m}$

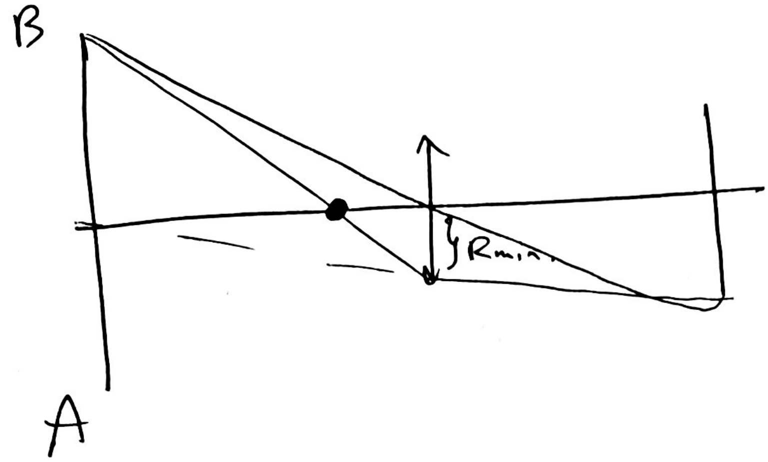
$aD_m - xD_m = xH$

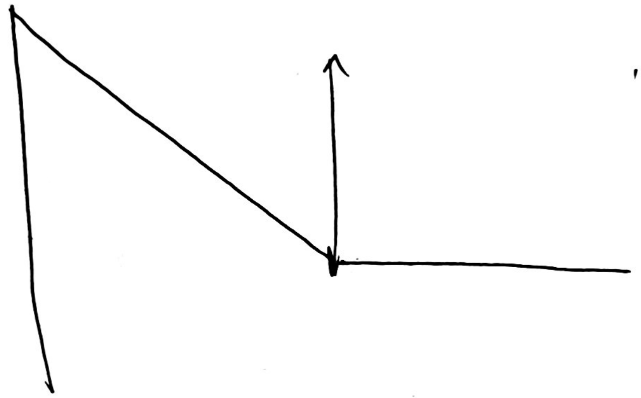
$aD_m = x(H + D_m) \rightarrow x = \frac{aD_m}{H + D_m}$

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

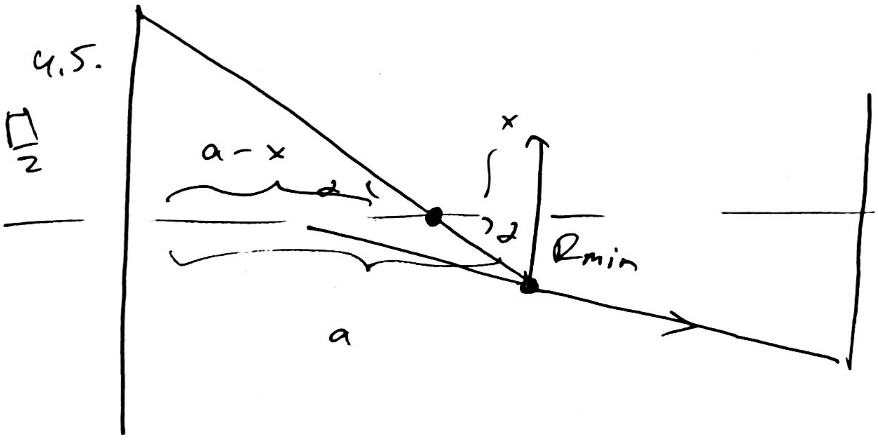
Ответ: 1) $x = \frac{aF}{a-F} + c = 36$ см

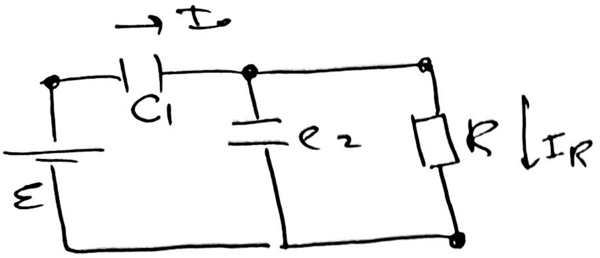
8

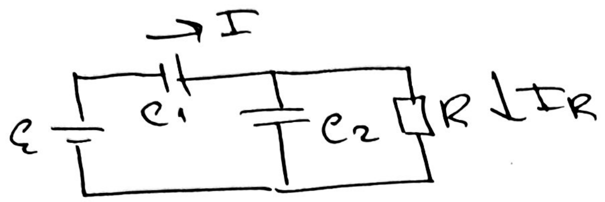


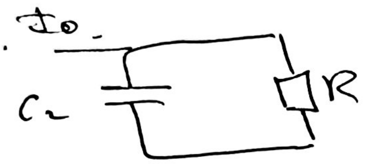


4.5.









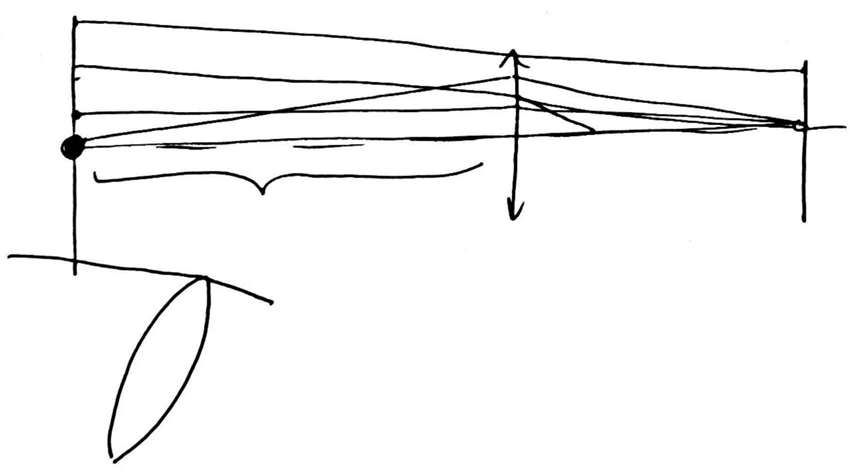
$$\mathcal{E} = U_1 + U_R.$$

$$\mathcal{E} = U_1 + U_R$$

$$\frac{Q_2}{C_2} = I_R R.$$

$$I_0 = -\frac{dQ_2}{dt} + I_R$$

$$I_0 + \frac{dQ_2}{dt} = I_R.$$



Чистовик

Задача №5

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

$$\frac{H+D_m}{aD_m} - \frac{1}{y} = \frac{1}{F}$$

$$\frac{H+D_m}{aD_m} = \frac{1}{F} + \frac{1}{y}$$

$$\frac{y}{D_m} = \frac{y+b}{H'}$$

$$H' = \Gamma \cdot H \quad \frac{y}{D_m} = \frac{y+b}{\Gamma H}$$

$$y\Gamma H = (y+b)D_m.$$

$$y\Gamma H = yD_m + bD_m$$

$$y(\Gamma H - D_m) = bD_m.$$

$$y = \frac{bD_m}{\Gamma H - D_m}$$

$$\frac{H+D_m}{aD_m} = \frac{1}{F} + \frac{\Gamma H - D_m}{bD_m}$$

$$\frac{H+D_m}{a} = \frac{D_m}{F} + \frac{\Gamma H - D_m}{b}$$

$H+D_m$

Чистовик

Задача №5

$b = 12$ см

$$\frac{y}{Dm} = \frac{y+b}{Г \cdot H}$$

$$\frac{y}{Dm} = \frac{y+12}{\frac{1}{3}H}$$

$$\frac{y}{Dm} = \frac{y+12}{3}$$

$$3y = Dm(y+12)$$

$$3y = Dm \cdot y + 12Dm$$

$$(3-Dm)y = 12Dm$$

$$y = \frac{12Dm}{3-Dm}$$

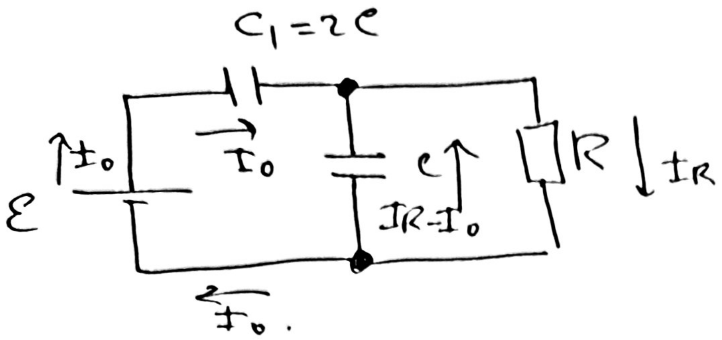
$$\frac{1}{x} - \frac{1}{y} = \frac{1}{F}$$

$$\frac{9+Dm}{36 \cdot Dm} - \frac{3-Dm}{12Dm} = \frac{1}{F}$$

$$\frac{9+Dm-(9-3Dm)}{36Dm} = \frac{1}{9}$$

$$Dm + 4Dm$$

Задача №3



$U_R = U_{C_2}'$

$U_R = I_R \cdot R$

$U_1' = \mathcal{E} - U_R$

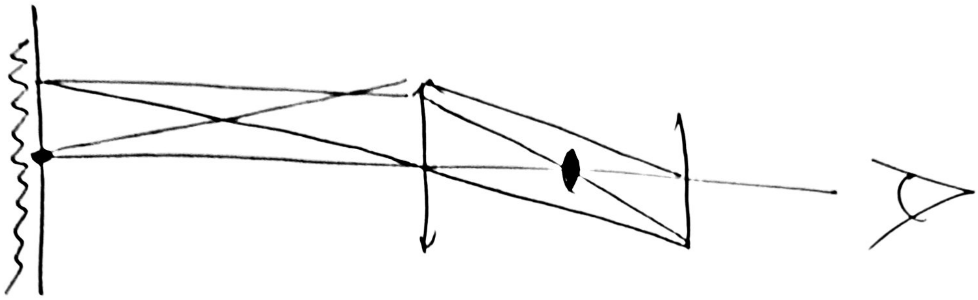
<u>ЗСЭ дифф. по времени:</u>

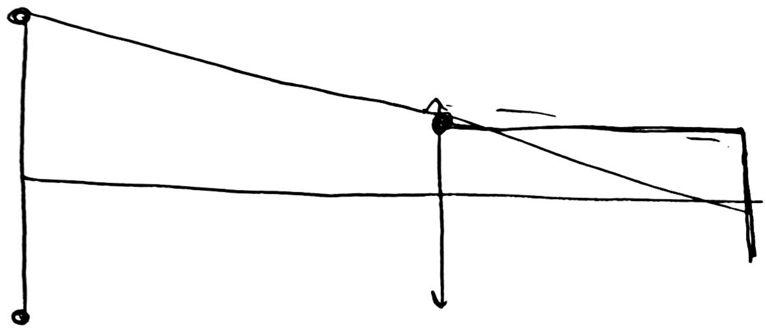
$$\mathcal{E}\cdot I_0 = U_1'\cdot I_0 - (I_R - I_0)\cdot U_R + U_R \cdot I_R$$

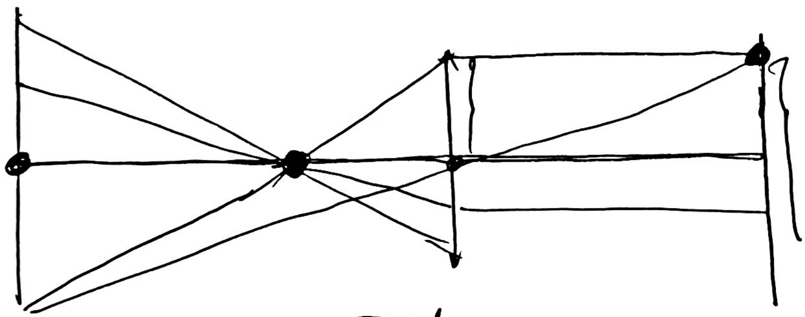
$$\mathcal{E}\cdot I_0 = (\mathcal{E} - I_R\cdot R) I_0 - (I_R - I_0) I_R R + I_R\cdot R\, I_R$$

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

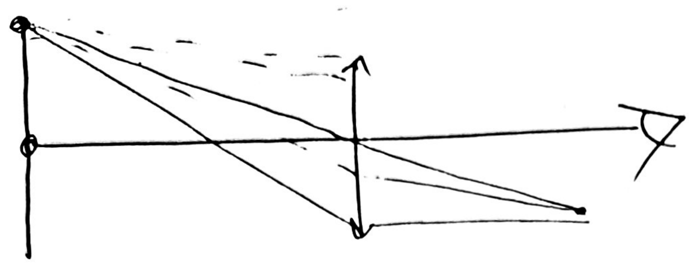
$$\cancel{I_R^2\cdot R = I_R\cdot R\cdot I_R}$$







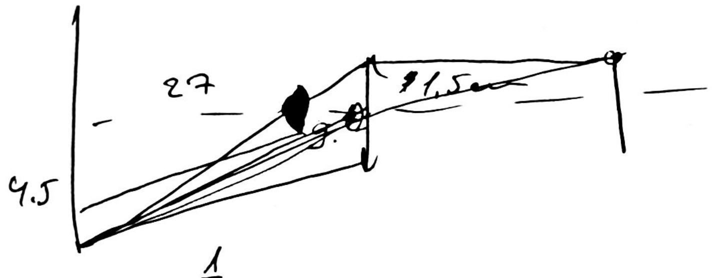
$P_m = \Gamma \cdot M \quad \Gamma =$



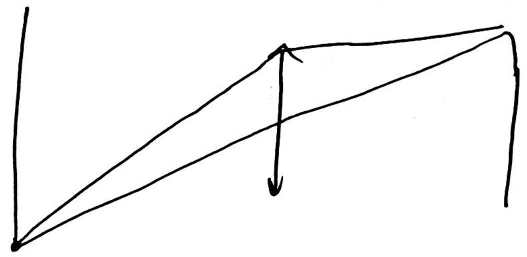
$$\Gamma = \frac{F}{a-F} = \frac{9cm}{36-9} = \frac{9}{27} = \frac{1}{3}$$

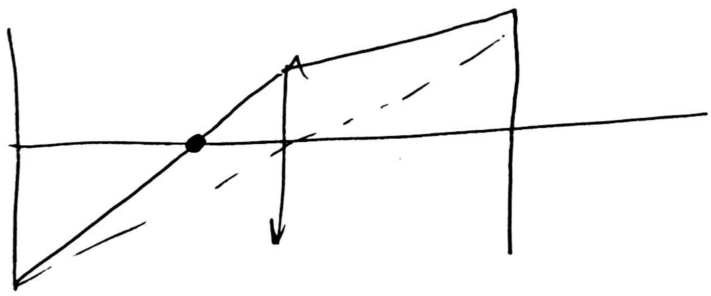
$$\frac{1}{a} + \frac{1}{b} = \frac{1}{F}.$$

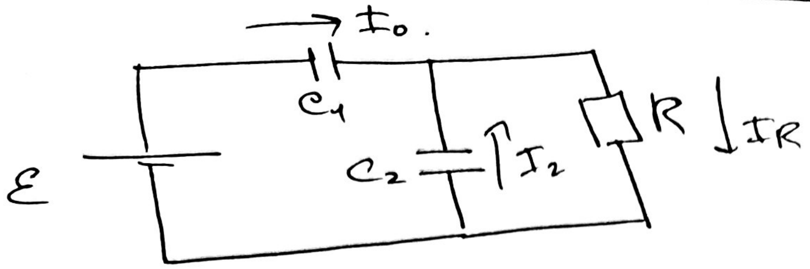
$\frac{1}{3} \cdot 9 = 3cm$ $\quad$ $\frac{1}{3} \cdot 9 = 3cm$



$\frac{1}{a}$







$\mathcal{E} = U_1 + U_R \qquad \frac{Q_1}{C_1} = \mathcal{E} - U_R$

$U_2 = U_R \qquad \frac{Q_2}{C_2} = U_R$

$$\frac{I_0}{C_1} = -\frac{dU_R}{dt}$$

$$\frac{I_2}{C_2} = \frac{dU_R}{dt}$$

$$\frac{I_0}{C_1} = -\frac{I_2}{C_2} \qquad I_2 =$$

$$I_2 = \frac{C_2}{C_1} I_0.$$

$$\mathcal{E} = U_2 + U_2 \cdot \frac{C_2}{C_1} = \frac{3}{2} U_2$$

$$\underline{U_2 = \frac{2}{3}\mathcal{E}}$$

$$Q_2 = \frac{2}{3} C\mathcal{E}.$$

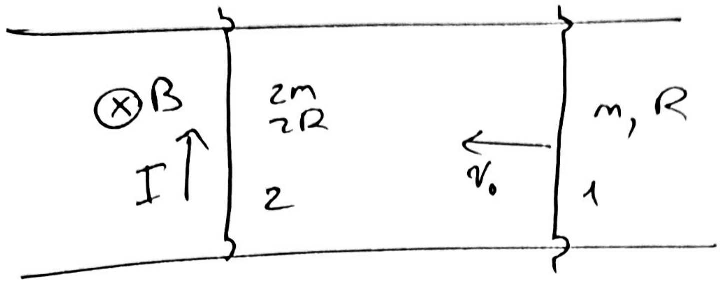
$IR = \frac{2}{3}\mathcal{E} \qquad Q_1 = C_1\mathcal{E}$

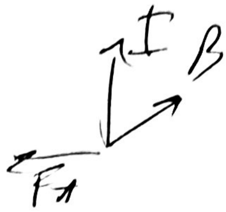
$\boxed{I = \frac{2\mathcal{E}}{3R}} \qquad Q_1 = 2C\mathcal{E}.$

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

$$C\mathcal{E}^2\left(2 - \frac{2}{3}\right) = C\mathcal{E}^2 - \frac{1}{3}C\mathcal{E}^2 + Q$$

$$\boxed{\frac{2}{3}C\mathcal{E}^2 = Q} \qquad C\mathcal{E}^2 \cdot \frac{4}{3} = \frac{2}{3}C\mathcal{E}^2 + Q$$





$$\mathcal{E}_0 = v_0 B L$$

$$I_0 = \frac{\mathcal{E}_0}{3R} = \frac{v_0 B L}{3R}.$$

$$F_A = \frac{v_0 B L}{3R} \cdot BL = 2ma_0$$

$$\frac{v_0 B^2 L^2}{3R} = 2ma_0$$

$$\boxed{\frac{v_0 B^2 L^2}{6mR} = a_0}$$