Часть 1

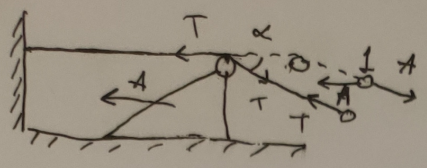
Олимпиада: **Физика, 11 класс (1 часть)**

Шифр: **21202711**

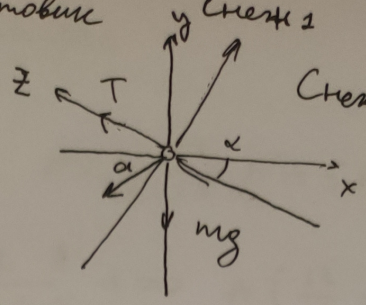
ID профиля: **279650**

Вариант 3

①

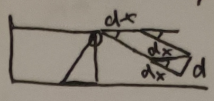


Чистовик

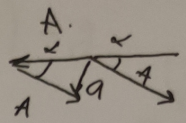


Снежинка Кимберга.

для ~~клина~~ шара.



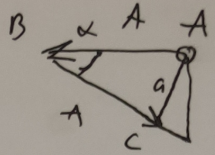
Треугольник Кимберга для шара:



Закон сложения скоростей:

$$\overline{V_{нер}} + \overline{V_{отн}} = \overline{V_{абс}}$$

1) Треугольник ABC - равнобедренный (два ребра равны) $\Rightarrow$ $\angle BAC = \frac{(180-\alpha)}{2} \approx 67,57 \approx 56,51^\circ \approx 1$ рад.



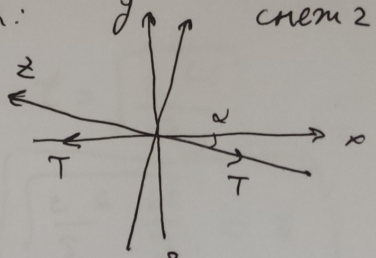
мр-к 1

56,31°

~~$\sin\left(\frac{180-\alpha}{2}\right) \approx \cos 5$~~

$\boxed{\sin(\angle BAC) \approx 0,84}$

Снежинка Кимберга для клина:



ox: $MA = T(1-\cos\alpha) = T\left(1-\frac{5}{13}\right)$

$= \left(\frac{13-5}{13}\right)T = \frac{8}{13}T$

из мр-к 1: $a \cdot \cos(\angle BAC) = A(1-\cos\alpha) = \frac{8}{13}A$

ox:

из снеж 1: $T\cos\alpha = ma\cos(\angle BAC) = m\cdot\frac{8}{13}A$

$$\begin{cases} MA = \frac{8}{13}T \\ m\cdot\frac{8}{13}A = T\cdot\frac{5}{13} \end{cases} \Rightarrow T = \frac{mA\cdot 8}{5}$$

$a\cdot\sin(\angle BAC) = A\cdot\sin\alpha \Rightarrow$ oy: $ma\sin(\angle BAC) = mg - T\sin\alpha$

$ma_y = mA\sin\alpha = mg - T\sin\alpha$; $\sin\alpha = \sqrt{1-\frac{25}{169}} = \sqrt{\frac{144}{169}} = \frac{12}{13}$

$$\frac{12}{13}mA = mg - T\cdot\frac{12}{13}$$

$$①/② : \frac{MA}{m\frac{8}{13}A} = \frac{\frac{8}{13}T}{\frac{5}{13}T} \Rightarrow \frac{M}{m}\cdot\frac{13}{8} = \frac{8}{5}\cdot\frac{5}{5} \Rightarrow$$

$$\Rightarrow \boxed{\frac{m}{M} = \frac{5}{8}\ \frac{65}{64}}$$

Чистовик

①

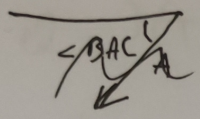
$T = mA\cdot\frac{8}{5}$ $\Rightarrow$ $\Rightarrow$ 3) $\frac{12}{13}\cdot mA = mg - \frac{12}{13}\cdot mA\frac{8}{5}$

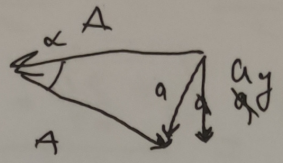
$\frac{12}{13}A = g - \frac{12\cdot 8}{13\cdot 5}A \Rightarrow A\left(\frac{12}{13}+\frac{96}{65}\right) = g$

$A\left(\frac{5\cdot 12}{5\cdot 13}+\frac{96}{65}\frac{12\cdot 8}{65}\right) = A\left(\frac{12(5+8)}{65}\right) = A\cdot\left(\frac{156}{65}\right) = g$

$\Rightarrow$ $\boxed{A = \frac{5}{12}\frac{65}{156}g}$

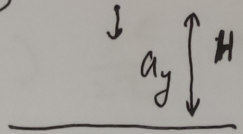
4)





$a_y = A\sin\alpha = A\cdot\frac{12}{13} = \frac{65}{156}g\cdot\frac{12}{13} = \frac{5}{13}g$

$\Rightarrow$

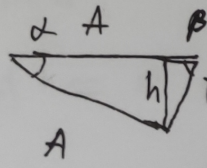


$g\cdot\frac{a_y t^2}{2} = H \Rightarrow t = \sqrt{\frac{2H}{a_y}}$

$t = \sqrt{\frac{2H}{5g}\cdot 13} = \boxed{\sqrt{\frac{26}{5}\frac{H}{g}} = t}$

Ответ: Найду угол более точно:

Т. косинусов: $A^2 + A^2 - 2A^2\cos\alpha = a^2$



$2A^2(1-\cos\alpha) = 2A^2\cdot\frac{8}{13} = a^2 \Rightarrow a = \sqrt{\frac{2\cdot 8}{13}}\cdot A$

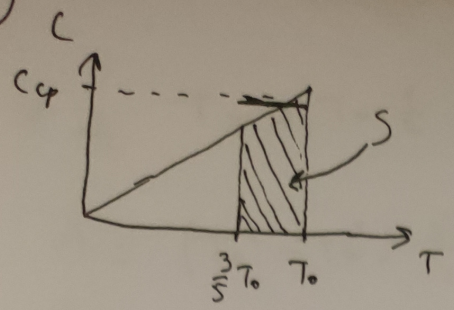
$h = a\cdot\sin\alpha = a\cdot\sin\beta$ $t = \sqrt{\frac{8\cdot 2}{13}}\cdot A\cdot\sin\beta$

$A\cdot\sqrt{\frac{169-25}{169}} = A\cdot\sqrt{\frac{144}{169}} \Rightarrow \frac{12}{13}A = \frac{\sqrt{16}}{\sqrt{13}}\cdot A\cdot\sin\beta \Rightarrow$

$\Rightarrow \sin\beta = \frac{12\cdot\sqrt{13}}{4\cdot 13} = \frac{3}{\sqrt{13}} = \frac{3\sqrt{13}}{13} \approx 0{,}83205033$

Ответ: 1) $\sin\beta = \frac{3\sqrt{13}}{13}$; 2) $A = \frac{5}{12}g$; 3) $\frac{m}{M} = \frac{65}{69}$; 4) $t = \sqrt{\frac{26}{5}\frac{H}{g}}$

(2)



$C = \frac{3R}{T_0} \cdot T$

$\int C\,dT = Q$

т.к. это процесс линейный, поэтому можно посчитать, как площадь под графиком.

$S = Q = \frac{(T_1 - T_2)\cdot(T_1 + T_2)}{2} = \frac{T_1^2 - T_2^2}{2} = \frac{T_0^2}{2} =$

$Q = \frac{(T_1 - T_2)\cdot\left(\frac{3R}{T_0}T_1 + \frac{3R}{T_0}T_2\right)}{2} = (T_1 - T_2)(T_1 + T_2)\cdot\frac{3R}{2T_0} =$

$= \frac{(T_1^2 - T_2^2)\cdot 3R}{2T_0} = \frac{\left(T_0^2 - \left(\frac{3}{5}T_0\right)^2\right)\cdot 3R}{2T_0} =$

$= \frac{3R}{2T_0}\cdot T_0^2\left(1 - \frac{9}{25}\right) = \frac{3R}{2}\cdot T_0\left(\frac{16}{25}\right) = \boxed{\frac{24}{25}RT_0}$

2) $Q = u + A \Rightarrow A = Q - u = Q - (T_1^2 - T_2^2)\cdot\frac{3R}{2T_0} - (T_1 - T_2)C_v =$

$= \frac{(T_1 - T_2)(3R(T_1 + T_2)}{2T_0} -$

$A = Q - u = \left(T_0^2 - T_x^2\right)\cdot\frac{3R}{2T_0} - (T_0 - T_x)C_v \quad \Big| \frac{dA}{dT_x}$

$A' = 0 \Rightarrow \left(\left(T_0^2 - T_x^2\right)\cdot\frac{3R}{2T_0}\right)' - \left((T_0 - T_x)C_v\right)' = 0$

$\left(\left(T_0^2 - T_x^2\right)\cdot\frac{3R}{2T_0}\right)' = \left(T_0^2 - T_x^2\right)'\cdot\frac{3R}{2T_0} = \left(T_0^{2\prime} - T_x^{2\prime}\right)\cdot\frac{3R}{2T_0} =$

$= -2T_x\cdot\frac{3R}{2T_0}$

$\left((T_0 - T_x)C_v\right)' = (T_0 - T_x)'\cdot C_v = \left(T_0' - T_x'\right)C_v =$

$= -1\cdot C_v$

$\Rightarrow -2T_x\cdot\frac{3R}{2T_0} - (-C_v) = 0$

$\Rightarrow C_v = T_x\cdot\frac{3R}{T_0} \Rightarrow C_v = \frac{T_x}{T_0}3R = \frac{3}{2}R$

$\frac{T_x}{T_0}\cdot 3R = \frac{3R}{2} \Rightarrow T_x = \frac{1}{2}T_0$

Чистовик

Лист 4

(2)

3) $T_x = T_0 \cdot \frac{1}{2}$

$$A = (T_0^2 - T_x^2) \cdot \frac{3\nu R}{2T_0} - (T_0 - T_x) \cdot \nu C_v = \left(1 - \frac{1}{4}\right) \frac{T_0^2 \cdot 3\nu R}{2T_0} - $$

$$- \frac{1}{2} T_0 \cdot \nu C_v = \frac{3}{4} \cdot \frac{3}{2} T_0 \nu R - \frac{1}{2} \cdot \frac{3}{2} R T_0 \nu =$$

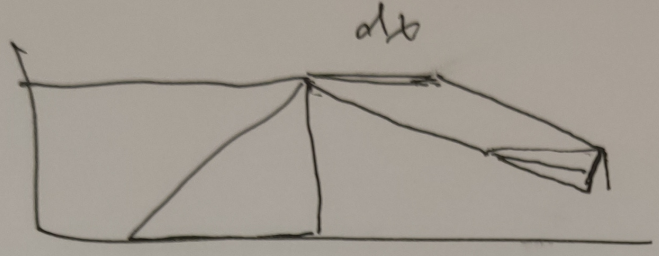
$$= \nu R T_0 \left(\frac{9}{8} - \frac{6}{8}\right) = \nu R T_0 \cdot \frac{3}{8}$$

Ответ: 1) $Q = \frac{24}{25} \nu R T_0$; 2) $T_x = \frac{1}{2} T_0$; 3) $\frac{3}{8} \nu R T_0 = A$

$$A = (T_0^2 - T_x^2) \cdot \frac{3JR}{2T_0} - (T_0 - T_x) \cdot J C_v = T_0^2 (1 - 0{,}25) \cdot \frac{3JR}{2T_0} - \quad (0{,}25 = \frac{3}{4})$$

$$- 0{,}5 T_0 \cdot J C_v = \frac{3}{4} \cdot \frac{3JR}{2} \cdot T_0 - 0{,}5 \cdot \frac{3}{2} R J T_0 =$$

$$= J R T_0 \left(\frac{9}{8} - \frac{3}{4} \right) = J R T_0 \left(\frac{9}{8} - \frac{6}{8} \right) = \frac{3}{8} J R T_0$$



$$\frac{180 - \alpha}{2}$$

$$1^2 + 1^2 - 2 \cdot 1 \cdot 1 \cdot$$

$$a^2 + b^2 - 2ab \cos\alpha = c^2$$

$$(a - b)^2 = c^2$$

$$1^2 + 1^2 - 2 \cdot 1 \cdot 1 \cdot \cos\alpha = 2 - 2 \cdot \frac{5}{13} = 2\left(1 - \frac{5}{13}\right) =$$

$$= \sqrt{2 \cdot \left(\frac{8}{13}\right)}$$

$$\sqrt{2 \cdot \frac{8}{13}} \qquad \sqrt{\frac{16}{13}} \cdot \sin x = 1 \cdot \sin\alpha =$$

$$\sqrt{\frac{16}{13}} \cdot \sin x = 1 \cdot \frac{12}{13}$$

$$\sin x = \frac{12}{13} \cdot \frac{\sqrt{13}}{4} = \frac{3}{\sqrt{13}}$$

$$\frac{12}{13} \left(1 + \frac{8}{5}\right) = \frac{12}{13} \cdot \frac{13}{5} = \frac{12}{5}$$

Часть 2

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

Шифр: **21202711**

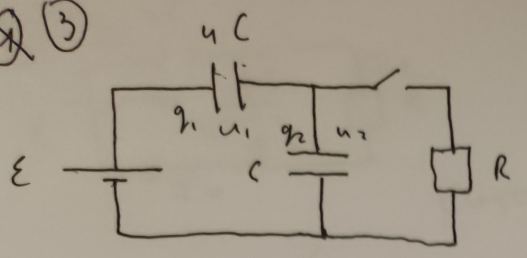
ID профиля: **279650**

Вариант 3

Чистовик

Лист 1

~~1~~ ③



т.к. до замыкания ток ~~по~~ на конденсаторах одинаковой всегда, то $q_1 = q_2$

$cu = q$ ~~4C~~ $\frac{q}{4C} + \frac{q}{C}$ $u_1 + u_2 = \mathcal{E}$

$u_1 = \frac{q}{4C}$; $u_2 = \frac{q}{C}$

$\frac{q_1}{4C} + \frac{q_1}{C} = \mathcal{E} \Rightarrow \frac{5q_1}{4C} = \mathcal{E} \Rightarrow \frac{q_1}{C} = \frac{\mathcal{E} \cdot 4}{5} \Rightarrow u_2 = \frac{4}{5}\mathcal{E}$

$u_1 = \frac{1}{5}\mathcal{E}$

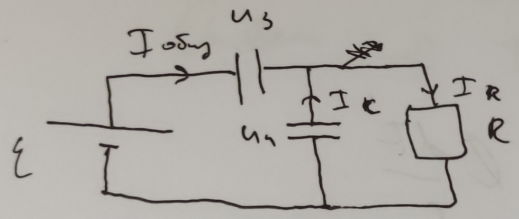
$\Rightarrow$ ~~I R =~~ С.П.З.: $I_0 R = u_2 \Rightarrow I_0 R = \frac{4\mathcal{E}}{5}$

$\Rightarrow I_0 = \frac{4\mathcal{E}}{5R}$

2) $W_1 + A_б = W_2 + Q$ (ЗСЭ)

$W_1 = W_{c1\,0} + W_{c2\,0}$; $W_c = \frac{cu^2}{2} \Rightarrow W_1 = \frac{4C \cdot (\frac{1}{5}\mathcal{E})^2}{2} + \frac{C \cdot (\frac{4}{5}\mathcal{E})^2}{2} =$

$= \frac{4C\mathcal{E}^2}{50} + \frac{16C\mathcal{E}^2}{50} = \frac{20C\mathcal{E}^2}{50}$



установившееся состояние $\Rightarrow$

~~$I_{обр} = 0 \Rightarrow I_R = I_C$ уста~~

~~I_C, I~~ $I_C = 0$; $I_{обр} = 0 \Rightarrow$

$I_R = I_{обр} + I_C = 0 \Rightarrow \mathcal{E} = u_3 + I_R \cdot R =$

$= u_3 \Rightarrow u_3 = \mathcal{E} \Rightarrow$ ~~W=~~ $I_R \cdot R = u_4 = 0$

$\Rightarrow w_2 = W_{c2x} = \frac{4C \cdot \mathcal{E}^2}{2} = 2C\mathcal{E}^2$

$\frac{q_1}{C} = \frac{4}{5}\mathcal{E} \Rightarrow q_1 = \frac{4\mathcal{E}C}{5}$; $\frac{q_2}{4C} = \mathcal{E} \Rightarrow q_2 = 4C\mathcal{E}$

$A_б = \mathcal{E} \cdot \Delta q$; $\Delta q = 4\mathcal{E}C - \frac{4\mathcal{E}C}{5} = \frac{16}{5}\mathcal{E}C$; $A_б = \mathcal{E} \cdot \frac{16}{5}\mathcal{E}C =$

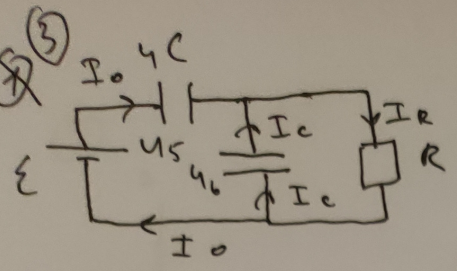
$= \frac{16}{5}\mathcal{E}^2 C \Rightarrow W_1 + A_б - W_2 = Q \Rightarrow$

$Q = \frac{20C\mathcal{E}^2}{50} + \frac{16}{5}\mathcal{E}^2 C - 2C\mathcal{E}^2 = Q = \frac{7}{8}C\mathcal{E}^2\left(\frac{2}{5} + \frac{16}{5} - \frac{10}{5}\right) =$

$= C\mathcal{E}^2\left(\frac{8}{5}\right)$

Чистовик

Лист 2



~~$I_R = I_R \cdot R = U_R$~~

~~$C U_3 = \frac{d I_R C}{dt}$~~ $\quad I_0 + I_c = I_R$

$$\Rightarrow (I_0 + I_c) \cdot R = U_3 = \frac{q}{C}$$

$$\begin{cases} \text{~~I_R~~} \cdot C \frac{dU_2}{dt} = I_c \\ 4C \frac{dU_4}{dt} = I_0 \end{cases} \qquad \begin{cases} dU_1 = dU_R \\ dU_2 = dU_R \end{cases} \Rightarrow dU_1 = dU_2 = dU$$

$$dU = \frac{I_c\, dt}{C} = \frac{I_0\, dt}{4C}$$

$$\frac{I_c \text{~~dt~~}}{C} = \frac{I_0 \text{~~dt~~}}{4C} \Rightarrow I_c = \frac{I_0}{4}$$

$$\Rightarrow U_3 = \left(\frac{I_0}{4} + I_0\right) \cdot R = \frac{5}{4} I_0$$

Ответ: 1) $I_0 = \frac{4}{5} \frac{\mathcal{E}}{R}$; 2) $Q = C\mathcal{E}^2 \left(\frac{8}{5}\right)$; 3) $U_3 = \frac{5}{4} I_0$

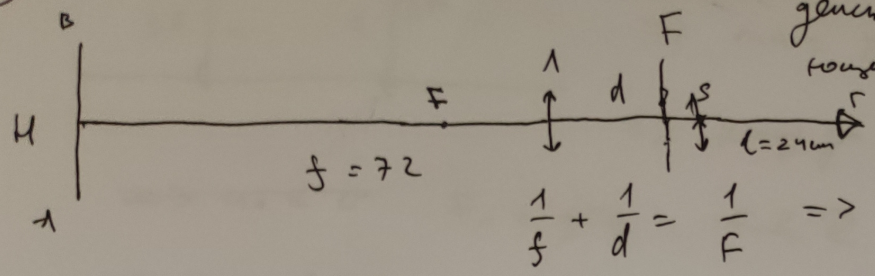
(4) Чистовик

Лист 4

Чистовик

Лист 3

(5)



действ. изображение => 1 - собирающая

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

$= \frac{1}{18} - \frac{1}{72} = \frac{1}{2 \cdot 9} - \frac{1}{8 \cdot 9} =$

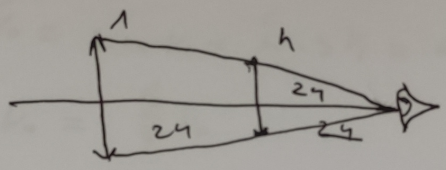
$= \frac{4}{8 \cdot 9} - \frac{1}{8 \cdot 9} = \frac{3}{72} = \frac{3}{8 \cdot 9} = \frac{1}{8 \cdot 3} = \frac{1}{24} \Rightarrow d = 24$ см

$\Rightarrow x = 2d + l = 24 + 24 = 48$ см

$\frac{f}{d} = \frac{H}{h} = \frac{72}{24} = \frac{8 \cdot 3}{8 \cdot 3} = 3$

$\Rightarrow h = \frac{H}{3} = 3$ см

~~$D_л = h = 3$ см~~

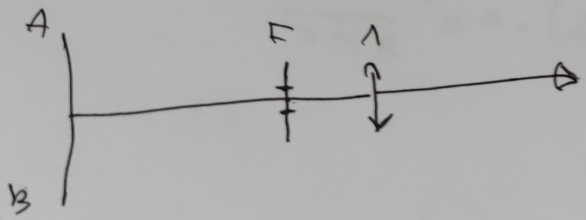


$\frac{D_л}{d+l} = \frac{h}{l} \Rightarrow \frac{D_л}{2l} = \frac{h}{l} \Rightarrow$

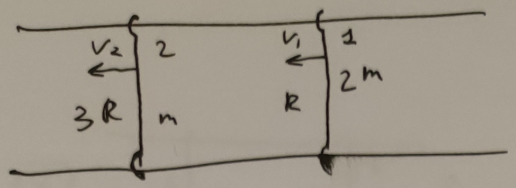
$\Rightarrow D_л = 2h = 6$ см

Ответ: 1) $x = 48$ см ; 2) $D_л = 2h = 6$ см;

Ответ: 3) в ее фокусе с задней стороны $\Rightarrow L = F = 18$ см



(4)



Вначале покой $\Rightarrow a = 0$

$\Rightarrow ma = \Sigma F = 0$

$\Rightarrow$ когда тележки ~~стали неподвижны~~

~~$\Rightarrow a_0 = 0$~~ $f_A = qvB$. ~~$f_A \ell R$~~ $f_A \cdot \ell = Uq \Rightarrow \ell q v B = Uq =$

$\Rightarrow U = \ell v B \Rightarrow I = \frac{\ell v B}{R}$. т.к. стержень 2 покоится, то на ~~на~~ стержень оди 1 $\Sigma F = ma$ $f_A = IB\ell$

~~$\Rightarrow a_0 = 0$~~

$\Rightarrow \frac{\ell v_0 B}{R} \cdot B\ell = 2m \cdot a_0 \Rightarrow a_0 = \frac{\ell^2 B^2 v_0}{2mR}$

(2) ~~ЗСИ~~ ~~$U_1 = U_2$~~ $I_1 = I_2$; ~~$U_1 = U_2$~~

$\Rightarrow \frac{\ell v_2 B}{3R} = \frac{\ell v_1 B}{R} \Rightarrow v_2 = 3v_1$

ЗСИ $2m \cdot v_0 = 2m v_2 + m \cdot v_2 \Rightarrow$

$\Rightarrow 2m \cdot v_0 = 2m \cdot v_1 + m \cdot 3v_1 = mv_1 \cdot 5 \Rightarrow v_1 = \frac{2mv_0}{m \cdot 5} = \frac{2}{5} v_0$

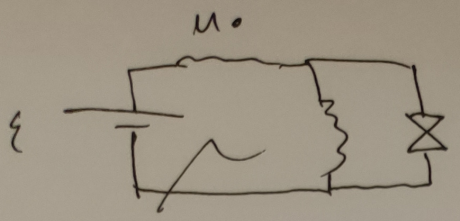
$v_2 = 3 \cdot \frac{2}{5} v_0 = \frac{6}{5} v_0$

~~Через долгое время $I = 0 \Rightarrow v_1 = v_2$~~

Они разойдутся на какое-то расстояние и будут двигаться с одинаковой скоростью $2mv_0 = 2mv_1 + mv_1 \Rightarrow v_1 = \frac{2mv_0}{3m} = \frac{2}{3} v_0$

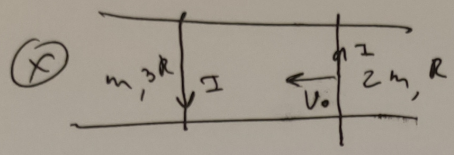
(внешние силы компенсируются $\Rightarrow \sum p = const$)

Ответ: 1) $\frac{\ell^2 B^2 v_0}{2mR} = a_0$ (2) $v = \frac{2}{3} v_0$

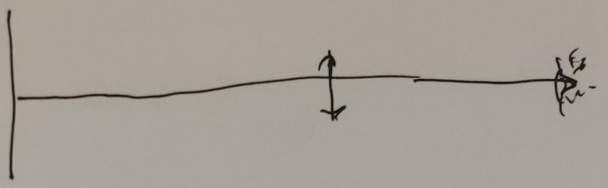


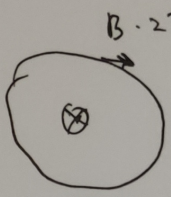
$(I_0 + I_c)R = \mathcal{E}$ (1)

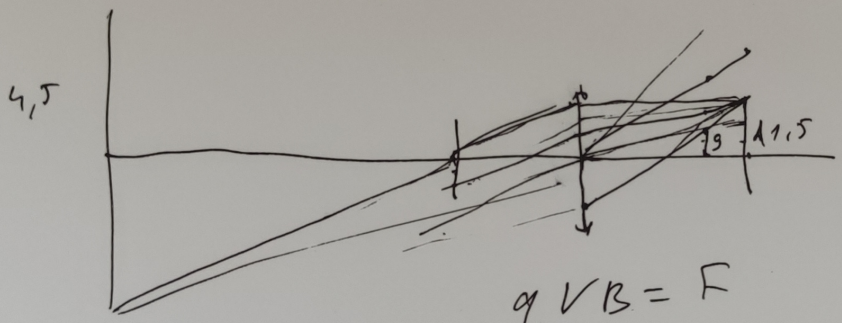
$u_3 = \frac{2u}{C}$; $q_3 = \mathcal{E} - \frac{2q}{4C}$



$F = 18u$ $BIl = F$







$qVB = F$

$F \cdot l = u q$ $u I$

$\frac{lVB}{R} = I$ ~~$F \cdot l \, dt = F l \cdot dt = u I = u \cdot \frac{u}{R}$~~

$u^2 = F l \; qVB \cdot R \, dt$

$qVB l = u q$

$\Rightarrow u = VBl$

$\Rightarrow u_2 =$

$I \cdot Bl$ $l \frac{dI}{dt} = u$