Часть 1

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

Шифр: **21202325**

ID профиля: **380010**

Вариант 2

Физика, 11 кл

Чистовик

1

α ($\cos\alpha = \frac{4}{5}$)

H

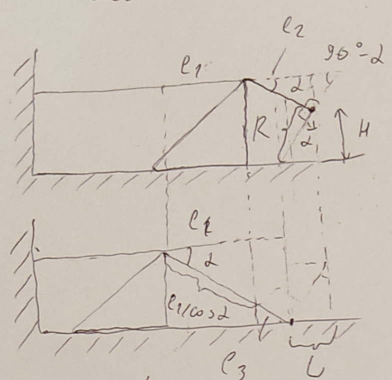
1) β - ?

2) $a_{кл}$ - ?

3) $\frac{m}{M}$ - ?

4) t - ?

$\sin\alpha = \sqrt{\frac{25-16}{25}} = \frac{3}{5}$



1) $L = R\sin\alpha$, $H = R\cos\alpha$

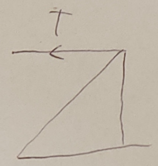
$\frac{L}{\sin\alpha} = \frac{H}{\cos\alpha} \Rightarrow L = H\,tg\,\alpha = \frac{3}{4}H$

$\boxed{\sin\beta = \sin\alpha = \frac{3}{5}}$

$l_3 = l_2 - \frac{L}{\cos\alpha} = l_2 - \frac{3}{4}H\cdot\frac{5}{4} = l_2 - \frac{15}{16}H$

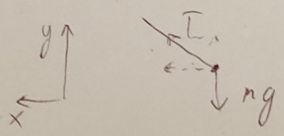
$l_1 + l_2 = \frac{l_1}{\cos\alpha} + l_3 \iff l_1 + l_2 = \frac{5}{4}l_1 + l_2 - \cancel{\frac{3}{4}H}\ \frac{15}{16}H \iff l_1 = \cancel{3H}\ \frac{15}{4}H$

2) Рассм. клин



$M a_{кл} = T$.

3) Рассм. шар.



$\cancel{mg = T\sin\alpha = \frac{3}{5}T}$

$\cancel{T = \frac{5}{3}mg}$

$m a_y = mg - \frac{3}{5}T$

$m a_x = T\cos\alpha = \frac{4}{5}T$

$T = \frac{5}{4}m a_x$

~~ОСКЛ~~ $l_1 = \frac{a_{кл}t^2}{2}$, $L = \frac{a_x t^2}{2}$

$\frac{l_1}{L} = \frac{a_{кл}}{a_x} \iff \frac{\frac{15}{4}H}{\frac{3}{4}H} = \frac{a_{кл}}{a_x} \iff a_{кл} = 5a_x$

$\frac{M a_{кл}}{m a_x} = \frac{T}{\frac{4}{5}T} \iff \frac{5M}{m} = \frac{5}{4} \iff \frac{m}{M} = \cancel{\frac{1}{6}}\ 4 \iff M = \frac{1}{4}m$

$a_{кл} = \frac{T}{M} = \frac{4T}{m} =$

Ответ: 1) $\sin\beta = \frac{3}{5}$; 2) , 3) $\frac{m}{M} = 4$

Чистовик

2

T_0

$C(T) = \frac{5}{2} R \frac{T}{T_0}$

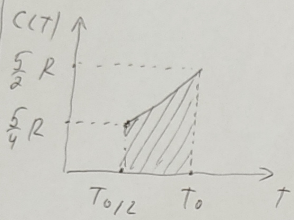
1) Q_1 - ?

2) T_1 - ?

3) A_{min} - ?

Решение

1) Т.к. $C(T) = \frac{5}{2} R \frac{T}{T_0}$, то нарисуем график зависимости $C(T)$



$$C\left(\frac{T_0}{2}\right) = \frac{5}{2} R \, \frac{\frac{T_0}{2}}{T_0} = \frac{5}{4} R$$

$$-Q_1 = \nu \cdot \frac{\left(\frac{5}{2}R + \frac{5}{4}R\right)}{2} \cdot \left(\frac{T_0}{2} - T_0\right) \Rightarrow$$

$$\Rightarrow \boxed{Q_1 = \nu R T_0 \cdot \frac{15}{8} \cdot \frac{1}{2} = \frac{15 \nu R T_0}{16}}$$

2) $Q = \Delta U + A \Rightarrow A = Q - \Delta U$

Пусть T_1 - темп., при которой $A = A_{min}$. Тогда:

$$A_{min} = \nu \left(\frac{\frac{5}{2}R + \frac{5}{2}R\frac{T_1}{T_0}}{2}\right)(T_1 - T_0) - \frac{3}{2}\nu R (T_1 - T_0)$$

$$A_{min} = \frac{5\nu R}{4 T_0}(T_0 + T_1)(T_1 - T_0) - \frac{3}{2}\nu R (T_1 - T_0)$$

$$A_{min} = \frac{5\nu R}{4 T_0} T_1^2 - \frac{5\nu R T_0}{4} - \frac{3}{2}\nu R T_1 + \frac{3}{2}\nu R T_0 = \frac{5\nu R}{4T_0} T_1^2 - \frac{3}{2}\nu R T_1 + \frac{1}{4}\nu R T_0$$

$$T_1 = \frac{\frac{3}{2}\nu R}{\frac{10}{4}\frac{\nu R}{T_0}} = \frac{3}{5} T_0$$

$$A_{min} = A(T_1) = \frac{5\nu R}{4 T_0} \cdot \left(\frac{3}{5}T_0\right)^2 - \frac{3}{2}\nu R \frac{3}{5} T_0 + \frac{1}{4}\nu R T_0 = -\frac{1}{5}\nu R T_0$$

Ответ: 1) $Q_1 = \frac{15 \nu R T_0}{6}$

2) $T_1 = \frac{3}{5} T_0$

3) $A_{min} = -\frac{1}{5}\nu R T_0$

2

N

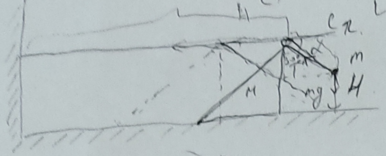
L

$\sin\alpha = \frac{H}{L}$

$L = \frac{H}{\sin\alpha}$

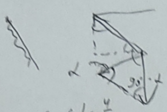
$\cos\alpha = \frac{4}{5}$

$\sin\alpha = \sqrt{1-\frac{4^2}{5^2}} = \sqrt{\frac{25-16}{25}} = \frac{3}{5}.$

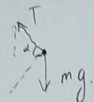


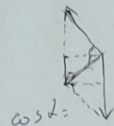
$mgH = \frac{mv^2}{2}$

$v = \sqrt{2gH}.$

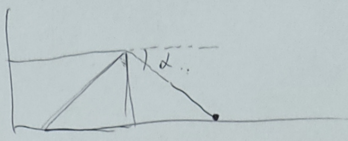


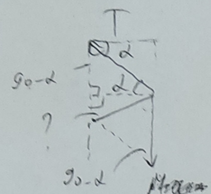
$\cos\alpha = \frac{4}{5}$

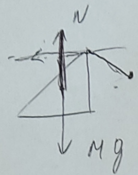




$\cos\alpha =$







$mv = \cancel{(M+m)}(m+M)u$

$C(T) = \frac{5}{2}R\frac{T}{T_0}$

Q_1 - ? (c T_0 до $\frac{T_0}{2}$)

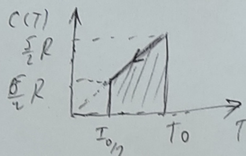
T - ? (A_{min})

A_{min} - ?

Решение.

$Q = \cancel{C(T)\Delta T}.\ \nu C(T)\Delta T.$

$C(T_0/2) = \frac{5}{4}R.$



$Q_1 = -$

$Q = \frac{(\frac{5}{4}R+\frac{5}{2}R)}{2}\cdot T_0/2 = \frac{3\nu R T_0}{816}$, $Q = \nu C(T)\Delta T.$

Q_{min}

$A =$ $Q = \Delta U + A$

$Q = \nu C(T)\Delta T.$

$\nu\frac{(\frac{5}{2}R+\frac{5}{2}R\frac{T}{T_0})}{2}(T-T_0) = \frac{3}{2}\nu R(T-T_0) + A.$

$\frac{3}{2}$ $\frac{12}{20}$ $\frac{5}{4}+\frac{5}{2}$ $= \frac{\frac{5+10}{4}}{82}$

$\frac{10}{1}$ $\frac{1}{5}$ 2

$\frac{15}{8}$

$A = \nu R\frac{\nu R}{2}\left(\cancel{\frac{5}{2}+\frac{5}{2}\frac{T}{T_0}}\right)\frac{5}{2}\left(1+\frac{T}{T_0}\right)(T-T_0)$

$\frac{9}{20}$

$5\nu R$

$\frac{3}{2}-\frac{5}{4} = \frac{6-5}{2} = \frac{1}{4}$

$pV = \nu RT.$

$\frac{9}{20} - \frac{9}{10} + \frac{1}{4}$

A pV

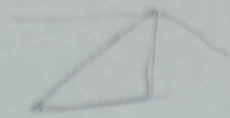
$\frac{5\nu R}{4T_0}T^2 - \frac{5\nu R}{4T_0}T_0^2$

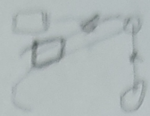
$\frac{9-18+5}{20} = -\frac{1}{5}\nu R T_0$

$A(T) = \frac{5\nu R}{4T_0}(T^2-T_0^2)$

$x_B = -\frac{b}{2a} =$

1





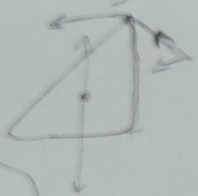
$T \sin\alpha = \frac{3}{5}T.$ $\quad \frac{3}{5}T = mg \Rightarrow T = \frac{5mg}{3}$

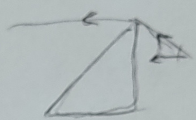
$m a_y = mg - T\sin\alpha$

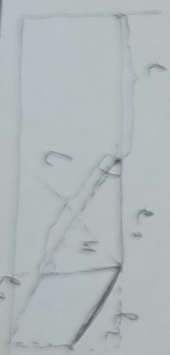
$\frac{gt^2}{2} = H \Rightarrow t = \sqrt{\frac{2H}{g}}$

$m a_x = T\cos\alpha$

$T = \frac{5mg}{3}$ $\quad M a_{кл} = \frac{5}{3}mg$ $\quad a_{кл} = \frac{5}{3} g \frac{m}{M}$ $\quad M a_{кл} = T$







$$Q = \frac{\left(\frac{5}{2}R + \frac{5}{4}R\right)}{2} \cdot \nu\left(\frac{T_0}{2} - T_0\right) =$$

T_1 $\quad Q = \frac{\left(\frac{5}{2}R + \frac{5}{2}R\frac{T_1}{T_0}\right)}{2} \cdot \nu(T_1 - T_0)$ $\quad \Delta U = \frac{3}{2}\nu R(T_1 - T_0)$

$$A_{min} = Q - \Delta U = \cancel{\frac{5\nu}{4}\nu R} \; \frac{5\nu R}{4T_0}(T_0 + T_1)(T_1 - T_0) - \frac{3}{2}\nu R(T_1 - T_0)$$

$$\frac{5\nu R}{4T_0}(T_1^2 - T_0^2) - \frac{3}{2}\nu R T_1 + \frac{3}{2}\nu R T_0$$

$$\frac{5\nu R}{4T_0} \cdot T_1^2 - \frac{5\nu R T_0}{4} - \frac{3}{2}\nu R T_1 + \frac{3}{2}\nu R T_0$$

~~[illegible]~~ $\quad T_1 = \frac{\frac{3}{2}\nu R \cancel{T_1} T_0}{\frac{5}{4}\nu R \cancel{T_0}} = \frac{6}{5}T_0.$

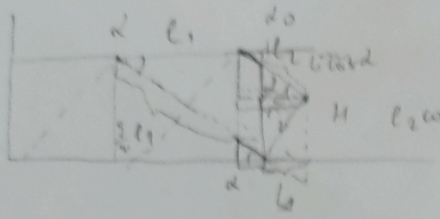
$$A_{min} = \frac{5\nu R}{4T_0}\left(\frac{6}{5}T_0\right)^2 - \frac{5\nu R T_0}{4} - \frac{3}{2}\nu R \frac{6}{5}T_0 + \frac{3}{2}\nu R T_0$$

$\Delta U = \frac{3}{2}\nu R(T_1 - T_0)$

$\frac{5\nu R}{4T_0}(T_0+T_1)(T_1-T_0) - \frac{3}{2}\nu R(T_1-T_0)$

$\frac{5\nu R}{4T_0}(T_1^2 - T_0^2)$

$\cos\alpha = \frac{l_1}{l}$ $l_1 + l_2$



$L = \frac{5}{4}l_1$

$l_2 = \frac{L}{\cos\alpha}$

$l_2\cos\alpha = L$

d

$l_1 + l_2 = \frac{5}{4}l_1 \cdot l_2 = \frac{L}{\cos\alpha}\ \frac{5}{4}L$

$-\frac{1}{4}l_1 = $

$\frac{5}{4}L = \frac{1}{4}l_1$ $L = \frac{1}{5}l_1$

$l_1 =$

$Ma_M = T$ $ma_x = T\cos\alpha = \frac{4}{5}T$

$a_M = \frac{T}{M}$

$a_x = \frac{4T}{5m}$

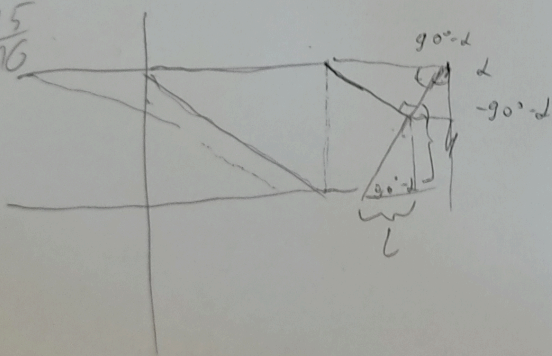
$L = \frac{a_M t^2}{2} = \frac{T t^2}{M\,2}$, $l_1 = \frac{4Tt^2}{5m\,2}$

$\cancel{\frac{T t^2}{M\,2} = \frac{16 T^2 t}{25 m^2 2}}$ $\frac{T}{M} = \frac{4T}{m}$ $\frac{4}{25}$

$l_2 =$

$\frac{4}{16} = \frac{15}{16}$

$l_4 = \frac{15}{4}$



$l_3 =$

$\frac{L}{H} = \mathrm{tg}\,\alpha =$

$\frac{\sqrt{15}}{4}$

5

Часть 2

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

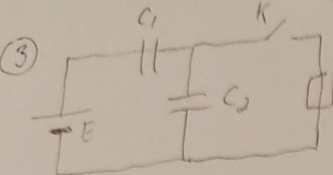
Шифр: **21202325**

ID профиля: **380010**

Вариант 2

Чистовик.

③



$C_2 = C$

$C_1 = 3C$

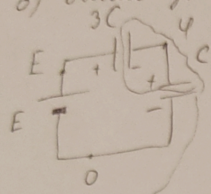
1) $I_R(0)$ – ?

2) Q – ?

3) U_R – ?

Решение.

0) Рассм. цепь до замык. ключа. Уст. сост. ⇒ тока нет



исп. метод потенциалов

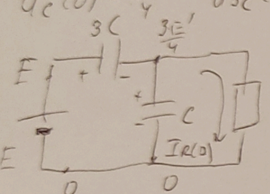
$-3C(E-\varphi)+C\varphi=0 \Rightarrow -3CE+3C\varphi+C\varphi=0$

$3CE=4C\varphi \Rightarrow \varphi=\frac{3E}{4}$

$U_C=\frac{3E}{4}$, $U_{3C}=E-\frac{3E}{4}=\frac{E}{4}$

1) Рассм. цепь сразу после замык. Напр. на ⊣⊢ скачком не изм.

$U_C(0)=\frac{3E}{4}$, $U_{3C}(0)=\frac{E}{4}$

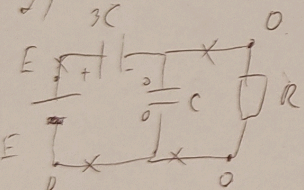


исп. метод потенц.

$I_R(0)=\frac{(\frac{3E}{4}-0)}{R}=\frac{3E}{4R}$

$W(0)=\frac{C(3E)^2}{4^2\cdot 2}+\frac{3CE^2}{4^2\cdot 2}=\frac{12CE^2}{32}=\frac{3CE^2}{8}$

2) Рассм. цепь в уст. сост. Тока ч/з ⊣⊢ нет. ⇒ Тока нет в цепи

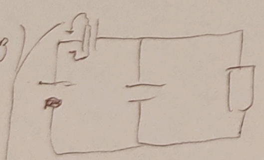


исп. метод потенц.

$U_{3C}(t_{уст})=E$, $U_C(t_{уст})=0$

$W(t_{уст})=\frac{3CE^2}{2}+0=\frac{3CE^2}{2}$

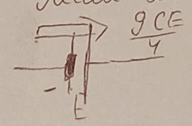
3)



был $\frac{3CE}{4}$ → протекло $\frac{9CE}{4}$

стал $3CE$

4) Рассм. ист.

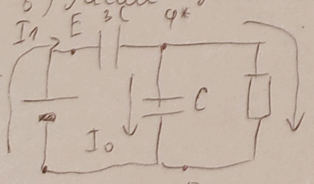


$A_{ист}=\frac{9CE^2}{4}$

5) ЗСЭ: $A_{ист}=W(t_{уст})-W(0)+Q$ ⇒

$Q=A_{ист}-W(t_{уст})+W(0)=\frac{9CE^2}{4}-\frac{3CE^2}{2}+\frac{3CE^2}{8}=\frac{9CE^2}{8}$

6) Рассм. цепь в мом., когда ток ч/з C_2 равен I_0



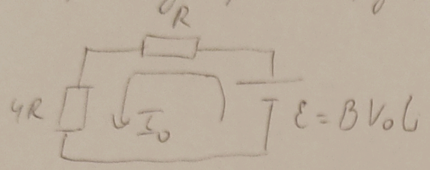
исп. метод потенц.

①

Ответ: 1) $\frac{3E}{4R}$; 2) $\frac{3CE^2}{8}$.

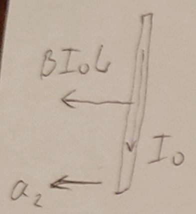
Чистовик.

(4) 1) В начале в 1-ой перемычке возникнет инд. ток, который по правилу правой руки течет вверх: В ней возн. ЭДС инд.



$$I_0 = \frac{BV_0 l}{5R}$$

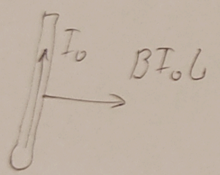
2) На правую и левую перемычки действуют силы Лоренца, напр. в против. сторон. Рассм 2-ую перемычку



$$\frac{m}{2} a_2 = BI_0 l$$

$$a_2 = \frac{2BI_0 l}{m} = \frac{2B^2 l^2 V_0}{5mR}$$

Рассм правую перемычку:



$$m a_1 = BI_0 l$$

$$a_1 = \frac{B^2 l^2 V_0}{5mR}$$

Скорости перемычек ч/з большой пром времени станут равными ∞, и расстояние м/у ними также ∞.

Ответ: 1) $\frac{2B^2 l^2 V_0}{5mR}$; 2) ∞; ∞; 3) ∞).

Физика, 11 кл.

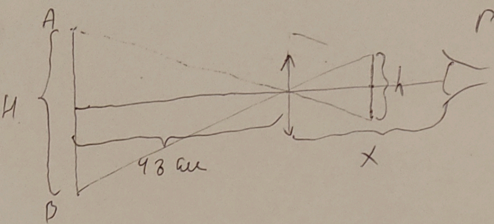
Чистовик

(3) Решение.

$F = 12$ см
$H = 9$ см
$d = 48$ см
$l = 24$ см

1) x - ?
2) $D_м$ - ?
3) L - ?

1)



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

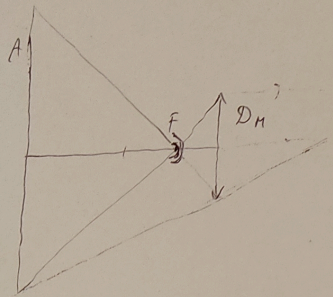
$$f = \frac{Fd}{d-F} = \frac{48 \cdot 12}{36} = 16 \text{ (см)}$$

$$x = f + l = 16 + 24 = 40 \text{ см}$$

$$\Gamma = \frac{f}{d} = \frac{16}{48} = \frac{1}{3}$$

$$h = \Gamma H = \frac{1}{3} \cdot 9 = 3 \text{ см}$$

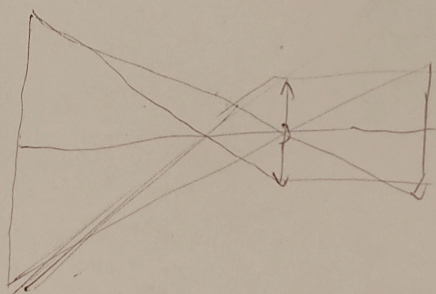
2)



$$\frac{D_м}{12} = \frac{H}{48-12} \Rightarrow D_м = \frac{9 \cdot 12}{36} = 3 \text{ см}$$

Т.е. луч. проход. через фокус сможет дойти до ↕

(2)



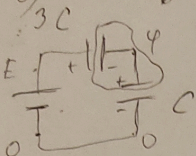
Ответ: 1) 40 см, 2) 3 см ; 3).

0) Рассм цепь до замык. ключа. Это цепь в уст. сост =>

$C_2 = C$

$C_1 = 3C$

1) I_0 - ?
2) Q - ?
3) U - ?



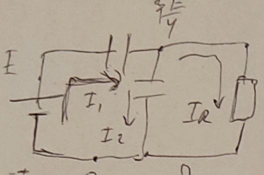
$-3C(E-\varphi)+C\varphi=0$

$-3CE+3C\varphi+C\varphi=0$

$4C\varphi=3CE \Rightarrow \varphi=\frac{3E}{4}$

$U_C=\frac{3E}{4}$, $U_{3C}=\frac{4E-3E}{4}=\frac{E}{4}$

1) Рассм. цепь сразу после замыкания. Напр. на -||- скачком не изм, сл-но, $U_C(0)=\frac{3E}{4}$, $U_{3C}=\frac{E}{4}$

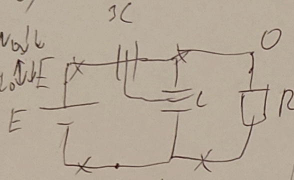


$\boxed{I_R(0)=\frac{3E}{4R}}$, $W(0)=\frac{C\left(\frac{3E}{4}\right)^2}{2}+\frac{3C}{4^2}\frac{E^2}{2}$

$U_L = LI'$

$I_0 = CU'$

2) Рассм цепь в уст. сост, пока ч/з -||- нет. Тока тогда нет.



$U_{3C}(t_{уст})=$

$I_C = CU'$

был $\frac{3E}{4}$, стал φ^*

утекло $\frac{3E}{4}-\varphi^*$

был $\frac{E}{4}$ стал $E-\varphi$

натекло $E-\varphi^*$

$I_1=I_0+I_2$, $\frac{q^2}{2C}=\frac{CU^2}{2}$

$I_1=3C(E-\varphi)'$

$I_1=3C\cdot$

$B = A\cdot Dm.$

$\varphi^*=Cq$

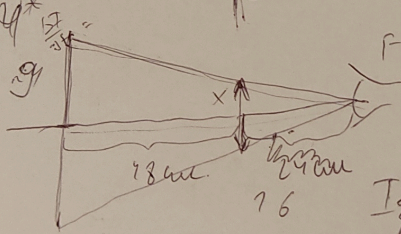
$q = CU$

$\frac{12}{32}=\frac{6}{16}=\frac{3}{8}$

$I_0=CU^{*\prime}$

$q=CU^*$

$F = 12$ см.



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

$\frac{1}{12}=\frac{1}{48}+\frac{1}{x} \Rightarrow \frac{3}{48}=\frac{1}{x}$

$f=\frac{48}{3}$ см $=\boxed{16\ \text{см}}$

$\frac{18-12+3}{8}=\frac{9CE^2}{8}$

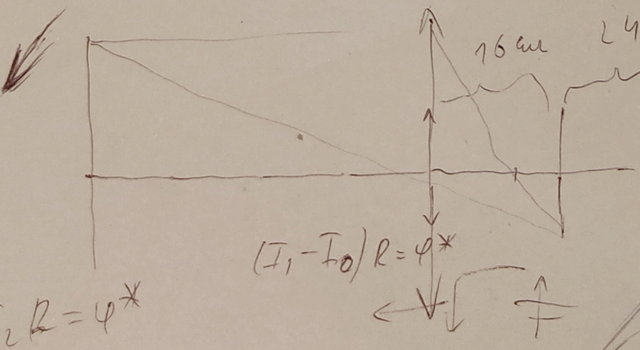
Выделено $W = q$

$\left(\frac{3E}{4}-q\right)$ утекло.

$\frac{9}{x}=\frac{48+16}{16}$

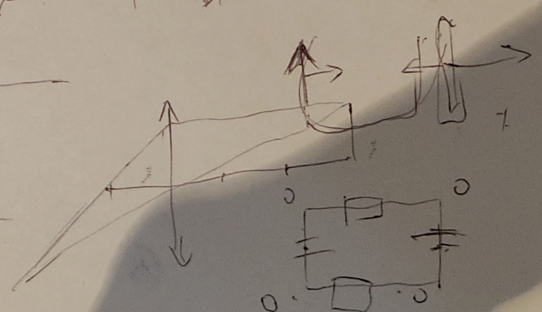
$x=\frac{9\cdot16}{48+16}=\frac{9\cdot16}{64}=\frac{9}{4}=$

2,25



$(I_1-I_0)R=\varphi^*$

$I_2R=\varphi^*$

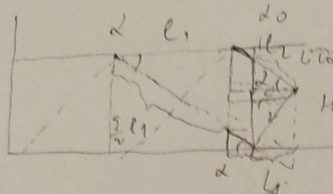


$\cos\alpha = \frac{l_1}{l}$ $l_1 + l_2$

$l = \frac{5}{4} l_1$

$l_2 - \frac{l_1}{\cos\alpha}$

$l_2\cos\alpha$



$ma = BIl$

$l_1 + l_2 = \frac{5}{4} l_1 \cdot l_2 - \frac{l_1}{\cos\alpha}$ $\frac{5}{4} l$

$-\frac{1}{4} l_1 =$

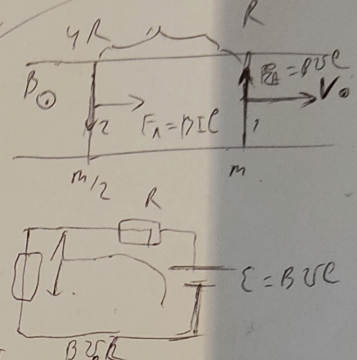
$\frac{5}{4} l = \frac{1}{4} l_1$ $l = \frac{1}{5} l_1$

$l_1 =$

$Ma = T$ $ma_x = T\cos\alpha = \frac{4}{5} T$

$a_{x} = \frac{T}{M}$ $a_x = \frac{4T}{5m}$

$l = \frac{a_x t^2}{2} = \frac{T^2 t}{M^2 2}$, $l_1 =$ $l_1 = \frac{4Tt^2}{5m2}$



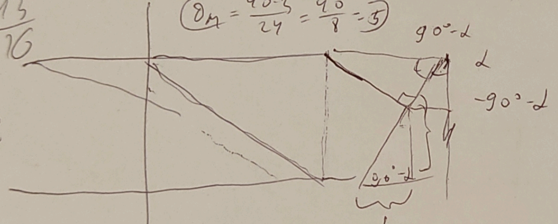
$I_0 = \frac{Bv_0 l}{5R}$

$\frac{T}{M} = \frac{4T}{m}$

$\frac{\vartheta_M}{40} = \frac{3}{24}$

$\vartheta_M = \frac{40 \cdot 3}{24} = \frac{40}{8} = 5$

$\frac{11}{16} = \frac{15}{16}$



$l_4 = \frac{15}{4}$

$\frac{l}{H_{1}} = tg\,\alpha =$

$\frac{\vartheta_M}{16} = 9$

$\mathcal{E} = Bvl$. $I(t) =$

$q = \frac{C}{\varphi^*}$

$\varphi^* = I_1 R$

$\left(\frac{3E}{4} + \varphi^*\right)$

$q = \frac{C}{I_0 R}$

$F_A = BIl =$

$I = \frac{Bvl}{5R}$

$\frac{ma}{2} = Bl \cdot \frac{Bvl}{5R} = \frac{B^2 v_0 l^2}{5R}$

$q_2 =$

$BV_2 l$

$Bl(V_2 - V_1) =$