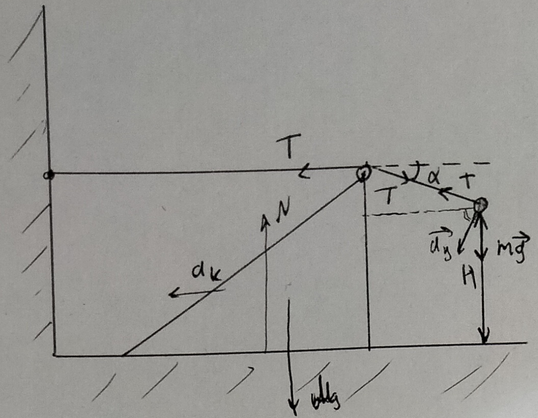
Часть 1

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

Шифр: **21202622**

ID профиля: **189518**

Вариант 1



α, H, g

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

$T \cdot \cos\alpha = m a \cdot \sin\alpha$

$mg - T \cdot \sin\alpha = ma \cdot \cos\alpha$

$T \cdot \sin\alpha = mg - ma \cdot \cos\alpha$

$T \cdot tg\alpha = \frac{g - a \cdot \cos\alpha}{a \cdot \sin\alpha}$

$M a_k = T - T \cdot \cos\alpha = T \cdot (1 - \cos\alpha)$

$\cancel{tg\alpha = \frac{T \cdot \cos\alpha}{mg - T \cdot \sin\alpha}}$

$a_k = \frac{T\left(1 - \frac{3}{5}\right)}{M} = \frac{2T}{5M}$

$g \cdot \cos^2\alpha$

$\boxed{\frac{9}{25} g}$

$\Delta H =$

$T = mg \cdot \sin\alpha$

$mg - T\sin\alpha$

$mg \cdot (1 - \sin^2\alpha) = mg \cdot \cos^2\alpha$

$L + \Delta L = \frac{h + \Delta H}{\sin\alpha}$

$\cancel{a_k = \frac{2mg \cdot \sin\alpha}{5M}}$ $\cancel{\frac{m}{M} = 5a_k}$

$L' = \frac{h'}{\sin\alpha}$

$\cancel{a_k = g}$

$\cancel{g = \frac{mg \cdot \sin\alpha}{5M}}$

$\frac{m}{M} = \frac{5}{\sin\alpha} = \frac{5 \cdot 5}{4} = \frac{25}{4}$

$H = \frac{g\tau^2}{2}$

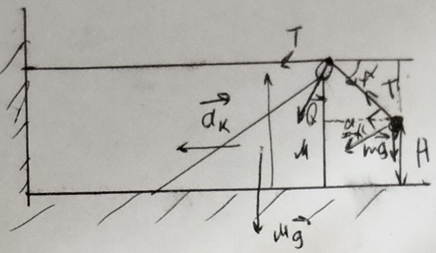
$\boxed{\sqrt{\frac{2H}{g}}}$

$\frac{L}{L_1} =$

21202622 (U189518 M1269464)

N1. $(T_0 - T_x)\cdot\left(\nu\int_{T_0}^{T_x} C\,dT - \frac{3}{2}\nu R\right)$

$\cos\alpha = \frac{3}{5}$



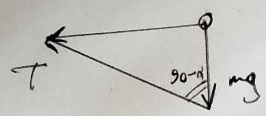
1) β

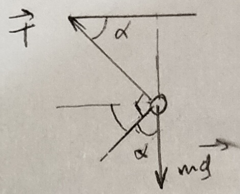
$\cancel{\cos\alpha(90-\alpha) = \sin}$

$\sin(90-\alpha) = \cos\alpha = \frac{3}{5}$

2) a_K - ?

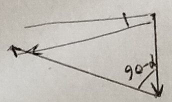
a





$M a_K = Q\cdot\cos\left(90-\frac{\alpha}{2}\right)$

$Q = 2T\cdot\cos\left(90-\frac{\alpha}{2}\right)$



$mg = m\frac{v^2}{R}$

$M a_K = 2T\cdot\cos^2\left(90-\frac{\alpha}{2}\right)$

$mg - T\cos(90-\alpha) = m a_y$

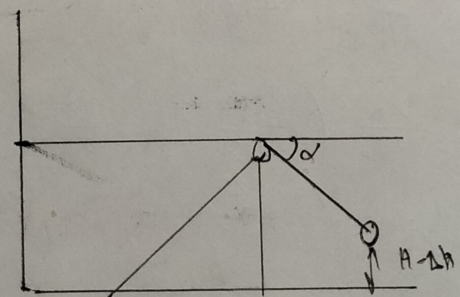
$\cos\alpha$

$\boxed{mg = 2T\,\sin\alpha}$

$\frac{L_0}{L} = \frac{H-\Delta H}{H} = 1 - \frac{\Delta H}{H}$

$T\cdot\cos(90-\alpha) = m\,a\cdot\cos(90-\alpha)$

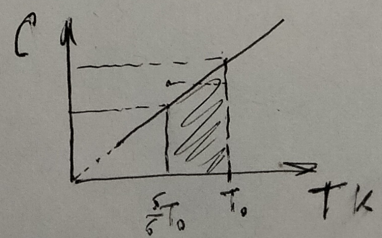
$mgH =$



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

$2R + \frac{5}{3}R$

$C(T) = 2R\frac{T}{T_0}$ $\qquad \frac{11}{6}R$ $\qquad \frac{Дж}{K\cdot моль}$



$Q_1 = \nu\frac{11}{6}R\cdot\frac{1}{6}T_0 = \nu\frac{11}{36}RT_0$

$-Q = \Delta U + A$

$A = Q - \Delta U = \nu\int_{T_0}^{T_x} C\,dT\cdot(T_0 - T_x) - \frac{3}{2}\nu R(T_0 - T_x)$

$$Q = \Delta U + A$$

$$\frac{2R + 2R\frac{T}{T_0}}{2} = R\cdot\left(1+\frac{T}{T_0}\right)$$

$$A = Q - \Delta U$$

$$A = 0$$

$$Q =$$

$$A =$$

$$Q = \nu \cdot R\left(1+\frac{T}{T_0}\right)\cdot(T_0 - T)$$

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

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

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

$$= \frac{\nu R}{2T_0}\left(-2T^2 + 5T_0 T - 3T_0^2\right)$$

$$T_0 = -\frac{5}{-4} = 1{,}25\,T_0$$

$$\frac{\nu R}{2\cancel{T_0}}\left(-2\left(\frac{5}{4}\right)^2 T_0^2 + 5T_0^2\cdot 1{,}25 - 3T_0^2\right)$$

$$= \frac{\nu R}{2T_0}\left(-\frac{25}{8}T_0^2 + \frac{25}{4}T_0 - 3T_0^2\right)$$

$$\frac{\nu R T_0}{8}$$

$2R$

21202622 (U189518 M1269464)

[illegible]

№ 1

Дано:

$\cos\alpha = \frac{3}{5}$,

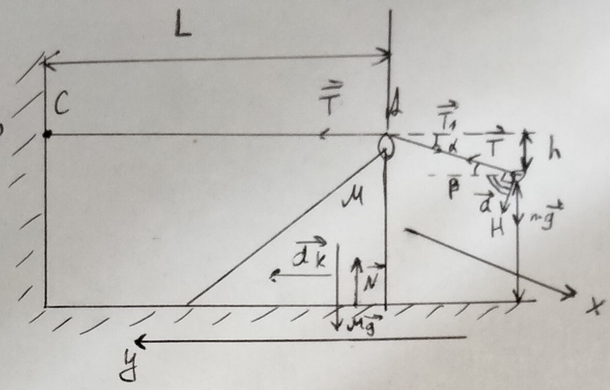
H.

1) β - ?

2) a_k - ?

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

4) τ - ?



Решение:

1) Т.к шарик только опускается, то его ускорение направлено по нормали к нити:

$\beta = 90° - \alpha$

$\sin\beta = \sin(90° - \alpha) = \cos\alpha = \frac{3}{5}$

2) $a_k = \ddot{L}$

$\ddot{L} = \frac{\ddot{h}}{\sin\alpha}$

Т.к. $\ddot{h} = g - \frac{T\sin\alpha}{m} = g\cdot\cos^2\alpha = \frac{9}{25}g$, то $a_k = \ddot{L} = \frac{\ddot{h}}{\sin\alpha} = \frac{\frac{9}{25}g}{\frac{4}{5}} = \frac{9}{20}g$

3) $m\vec{g} + \vec{T} = m\vec{a}$

$x\ (x \perp a)$: $mg\cdot\sin\alpha = T \Rightarrow T = mg\cdot\sin\alpha$

$M\vec{g} + \vec{T} + \vec{T_1} + \vec{N} = M\vec{a_k} \quad (|\vec{T}| = |\vec{T_1}|)$

y: $T - T\cdot\cos\alpha = Ma_k \Rightarrow T = \frac{Ma_k}{1-\cos\alpha}$

$m\cancel{g}\sin\alpha = \frac{M\frac{9}{20}\cancel{g}}{1-\cos\alpha}$

$\frac{m}{M} = \frac{5}{4(1-\frac{3}{5})\cdot\frac{9}{20}} = \frac{5\cdot 20}{4\cdot 2\cdot 9} = \frac{100}{72} \approx 1{,}4$

4) $H = \frac{\frac{9}{25}g\tau^2}{2}$, $\tau = \sqrt{\frac{50H}{9g}} = \frac{5}{3}\sqrt{\frac{2H}{g}}$

Ответ: $\sin\beta = \frac{3}{5}$; $\frac{9}{20}g$; $1{,}4$; $\frac{5}{3}\sqrt{\frac{2H}{g}}$.

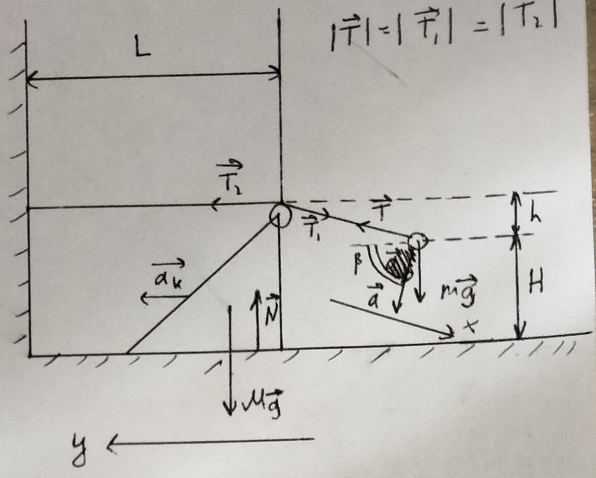
Чистовик.

№ 1

Дано:
$\cos\alpha = \frac{3}{5}$,
H

1) β - ?
2) $a_к$ - ?
3) $\frac{m}{M}$ - ?
4) τ - ?

Решение:



1) Т. к. шарик только что отпустили, то его ускорение направлено по нормали к нити:

$\beta = 90° - \alpha$, $\underline{\sin\beta = \cos\alpha = \frac{3}{5} = 0,6}$

2) $a_к = \ddot{L}$

$\sin\alpha = \frac{\ddot{h}}{\ddot{L}} \Rightarrow \ddot{L} = \frac{\ddot{h}}{\sin\alpha}$

$\ddot{h} = \frac{mg - T\cdot\sin\alpha}{m} = g - \frac{T\cdot\sin\alpha}{m}$

$m\vec{g} + \vec{T} = m\vec{a}$

$x\,(x\perp a)$: $mg\cdot\sin\alpha = T$

$\ddot{h} = g - g\cdot\sin^2\alpha = g\cdot\cos^2\alpha$

$\underline{a_к = \ddot{L} = \frac{\ddot{h}}{\sin\alpha} = \frac{g\cos^2\alpha}{\sin\alpha} = \frac{g\cdot\frac{9}{25}}{\frac{4}{5}} = \frac{9}{20}g = 0,45g}$

3) $M\vec{g} + \vec{N} + \vec{T_2} + \vec{T_1} = M\vec{a_к}$

y: $T - T\cdot\cos\alpha = Ma_к$

$\begin{cases} T = mg\cdot\sin\alpha \\ T = \frac{Ma_к}{1-\cos\alpha} \end{cases} \Rightarrow mg\cdot\frac{4}{5} = \frac{9Mg}{20-12}$, $\underline{\frac{m}{M} = \frac{9\cdot5}{8\cdot4} = \frac{45}{32} \approx 1,4}$

4) $\tau = \sqrt{}$

№2. Чистовик

Дано:

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

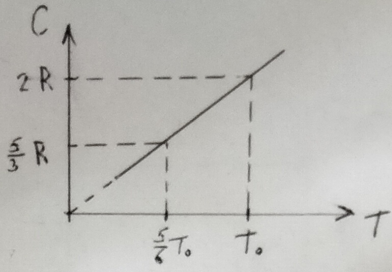
$T_0,\ \frac{5}{6}T_0$

1) Q_1 – ?

2) T_1 – ?

3) A_{min} – ?

Решение:



1) $C_{ср} = \frac{C(\frac{5}{6}T_0) + C(T_0)}{2} = \frac{11}{6}R$

$\underline{Q_1} = -\nu C_{ср} \cdot \Delta T = -\nu \cdot \frac{11}{6}R \cdot (-T_0 + \frac{5}{6}T_0) = \underline{\frac{11}{36}\nu R T_0}$

2) $Q = A + \Delta U$

$A = Q - \Delta U$

$Q = -\nu \cdot \frac{C(T) + C(T_0)}{2} \cdot \Delta T = \nu R\left(1 + \frac{T}{T_0}\right)(T_0 - T)$

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

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

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

$\underline{T_1 = -\frac{3T_0}{-4} = \frac{3}{4}T_0}$

3) $\underline{A_{min}} = \frac{\nu R}{2T_0}\left(-2\cdot\frac{9}{16}T_0^2 + 3T_0\cdot\frac{3}{4}T_0 - T_0^2\right) = \frac{\nu R}{2T_0}\cdot\left(-\frac{9}{8}T_0^2 + \frac{18}{8}T_0^2 - \frac{8}{8}T_0^2\right) =$

$= \frac{\nu R}{2T_0}\cdot\frac{1}{8}T_0^2 = \underline{\frac{1}{16}\nu R T_0}$

Ответ: $\frac{11}{36}\nu R T_0$; $\frac{3}{4}T_0$; $\frac{1}{16}\nu R T_0$.

1 из 2.

Часть 2

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

Шифр: **21202622**

ID профиля: **189518**

Вариант 1

Чистовик

№3

Дано:

ε, $C_1 = 2C$,

$C_2 = C$, R,

I_0

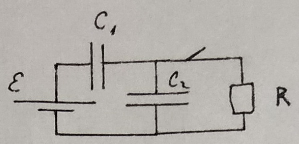
---

1) $I_R(0)$ – ?

2) Q – ?

3) I_R – ?

Решение:



1) До замыкания ключа

$\varepsilon = U_1 + U_2 = \frac{q}{2C} + \frac{q}{C} = \frac{3q}{2C}$ ($q_1 = q_2 = q$, т.к. посл. соед-е)

$q = \frac{2}{3} C\varepsilon$

После замыкания ключа

$U_2 = IR$

$U_2 = \frac{q}{C} = \frac{2}{3}\varepsilon$

$I = \frac{U_2}{R} = \frac{2}{3}\frac{\varepsilon}{R}$

---

2) $U_1' = \varepsilon$ (в уст. режиме ток через C_2 и R не идёт)

$U_1 = \frac{q}{2C} = \frac{1}{3}\varepsilon$

$Q = \Delta W = (W_1' - W_1) + (0 - W_2) = \frac{2C\varepsilon^2}{2} - \frac{2C\varepsilon^2}{18} - \frac{C4\varepsilon^2}{18} = \frac{2}{3}C\varepsilon^2$

---

3) $\begin{cases} \varepsilon = U_1' + I_R R \\ U_2' = I_R \cdot R \end{cases}$

Ответ: $\frac{2}{3}\frac{\varepsilon}{R}$; $\frac{2}{3}C\varepsilon^2$

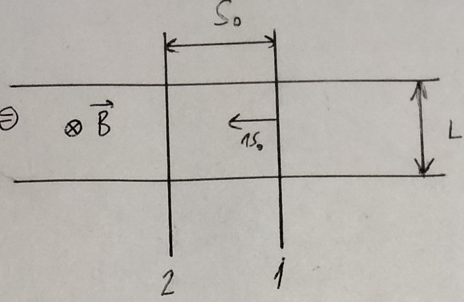
Чистовик

№4.

Дано:
B, L,
m, R,
$2m$, $2R$,
v_0

1) a_0 – ?
2) v_1 – ?
v_2 – ?
3) S – ?

Решение:



1) $\mathcal{E} = -\Phi' = -\frac{\Delta\Phi}{\Delta t} = -\frac{0 - B\cdot v_0\cdot\Delta t\cdot L}{\Delta t} = BvL$

$I = \frac{\mathcal{E}}{3R} = \frac{Bv_0L}{3R}$

$F_2 = B\cdot IL = \frac{B^2L^2v_0}{3R}$

$F_2 = 2m\cdot a_0$

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

2) Через продолжительный промежуток времени в системе установится равновесие. Т.е. $v_{отн} = 0$, $v_1 = v_2 = v$.

По ЗСЭ:

$\frac{mv_0^2}{2} = \frac{mv_1^2}{2} + \frac{2mv^2}{2}$, $v = v_0\sqrt{3}$

Ответ: $\frac{B^2L^2v_0}{6mR}$; $v_1 = v_2 = v_0\sqrt{3}$

21202622 (U189518 M1269465)

Чистовик

№5

Дано:
$F = 9$ см,
$H = 9$ см,
$d_{\text{г}} = 36$ см,
$a = 24$ см

1) x - ?
2) $D_м$ - ?
3) S - ?

Решение:

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

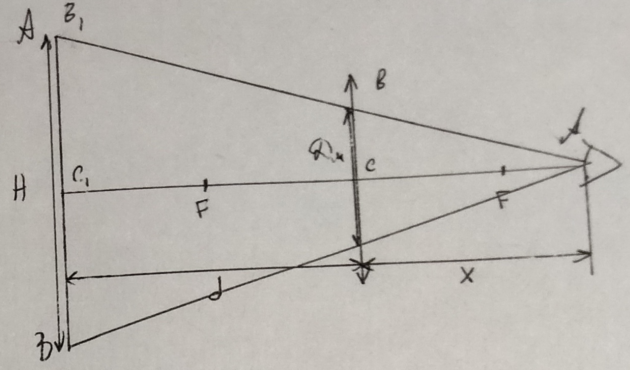
$x = \frac{F \cdot d}{d - F}$

$x = \frac{9\text{ см} \cdot 36\text{ см}}{36\text{ см} - 9\text{ см}} = 12$ см

2) Из $\triangle ABC \sim \triangle AB_1C_1$:

$\frac{H}{D_м} = \frac{d+x}{x}$, $D_м = \frac{Hx}{d+x}$

$D_м = \frac{9\text{ см} \cdot 12\text{ см}}{36\text{ см} + 12\text{ см}} = \frac{9}{4}$ см $= 2,25$ см



Ответ: 12 см ; 2,25 см.

21202622 (U189518 M1269465)

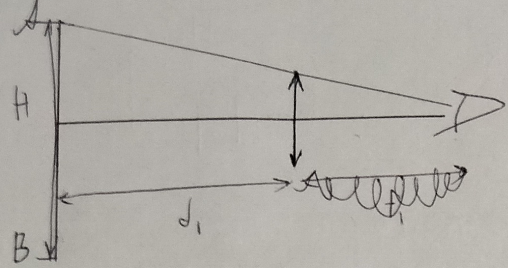
$F = 9\,\text{cm}$, $H = 9\,\text{cm}$

$d_1 = 36\,\text{cm}$

$f_1 = 24\,\text{cm}$

U_1'

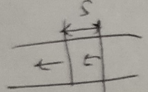
I_0

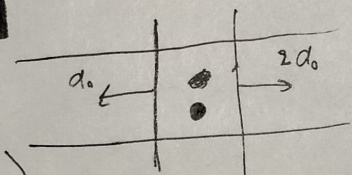


$$\frac{D_m}{\frac{H}{2}} = \frac{f_1}{d_1} \qquad D_m = \frac{Hf_1}{2d_1} = \frac{9\,\text{cm}\cdot 12\,\text{cm}}{2\cdot 36\,\text{cm}} = 1{,}5\,\text{cm}$$

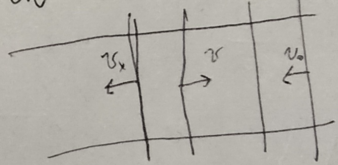
$$\frac{1}{F} = \frac{1}{d_1} + \frac{1}{f_1} \qquad f_1 = \frac{F\cdot d_1}{d_1 - F} = \frac{9\,\text{cm}\cdot 36\,\text{cm}}{27\,\text{cm}} = \boxed{12\,\text{cm}}$$

$I_R \cdot R = U_2'$





$U_1' =$



$$\frac{m v_0^2}{x} = \frac{3 m v^2}{x}$$

$$\boxed{v = v_0\sqrt{3}}$$

$$\begin{cases} \mathcal{E} = U_1 + I_R \cdot R \\ U_2 = I_R R \end{cases}$$

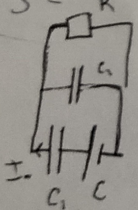
$I^2 R t$

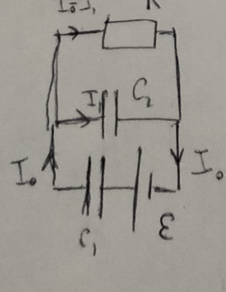
$\Delta q\, I_R R$

$$\mathcal{E} = U_1' + \underbrace{(I_0 - I_1)}_{I_R} R$$

$$U_2' = \underbrace{(I_0 - I_1)}_{I_R} R$$

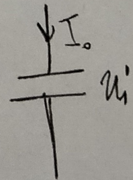
S = R





$$I_R = \frac{\mathcal{E} - U_1'}{R}$$

$$I_R = \frac{U_2'}{R}$$

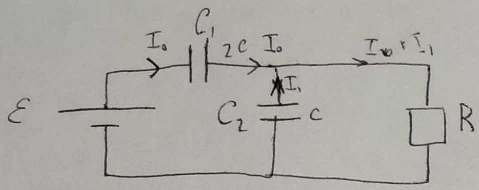


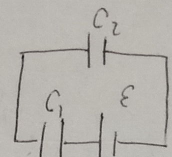
$$\mathcal{E}\Delta q = \frac{2CU_1^2}{2} + \frac{C(\mathcal{E} - U_1)^2}{2} + \Delta q\, I_R R$$

$$U_1' = \frac{q_1}{2C}$$

W =

21202622 (U189518 M1269465)





$$t' = \frac{(1+\sqrt{3})v_0}{2a}$$

$$t'-t$$

$$CU = q \qquad t = \frac{v_0\sqrt{3}}{a} \qquad t' = \frac{v_0(\sqrt{3}-1)}{2a}$$

$$C_0 = \frac{C_1 C_2}{C_1 + C_2} = \frac{2}{3}C$$

$$U = \frac{q}{c}$$

$$v_0\sqrt{3} = 0 + at$$

$$v_0\sqrt{3} - v_0 = 2at'$$

$$q = \frac{2}{3}CU$$

$$U = IR \qquad I = \frac{U_2}{R} = \frac{q}{CR}$$

$$\begin{cases} \mathcal{E} = U_1' + I_2 R \\ U_2' = I_2 R \end{cases}$$

$$\mathcal{E} = U_1' + I_R R$$

$$U_2' = I_R \cdot R$$

$$\mathcal{E} = U_1 + U_2 \qquad \mathcal{E} - U_1' = U_2'$$

$$\frac{(1+\sqrt{3})v_0 \, 6mR}{B^2L^2v_0}$$

$$\mathcal{E} = q \cdot 2C + q \cdot C = 3qC$$

$$\frac{CU^2}{2} = \frac{qU}{2} = \frac{q^2}{2c}$$

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

$$\frac{\mathcal{E}}{3C} \cdot C = \frac{\mathcal{E}}{3} \qquad CU = q$$

$$\frac{(1+\sqrt{3})\cancel{v_0} \, 6mR}{2B^2L^2\cancel{v_0}} \qquad C = \frac{q}{U}$$

$$\mathcal{E} = U_1' + I_2 R$$

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

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

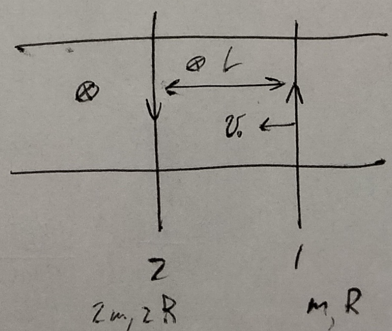
$$\mathcal{E} = 2C_{eq}q_1 + Cq_2$$

$$\Delta t = \frac{(\sqrt{3}+1)\,3mR}{B^2L^2}$$

$$\frac{18C\mathcal{E}^2}{18} - \frac{6C\mathcal{E}^2}{18}$$

$$\frac{12}{18}C\mathcal{E}^2$$

$$\mathcal{E} = \Phi' = \frac{B \cdot v_0 \cdot \Delta t}{\Delta t} = Bv_0$$



$$I = \frac{\mathcal{E}}{3R}$$

$$a = \frac{F}{2m} = \frac{BIl}{2m} = \frac{B\mathcal{E}l}{3R\,2m} = \boxed{\frac{B^2 v_0 L}{6Rm}}$$

$$S = S_0 + \frac{(\sqrt{3}-1)\,3mRv_0}{(BL)^2}$$