Часть 1

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

Шифр: **21200297**

ID профиля: **825768**

Вариант 1

1. Дано

α

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

H

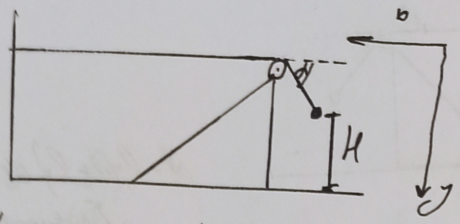
Найти:

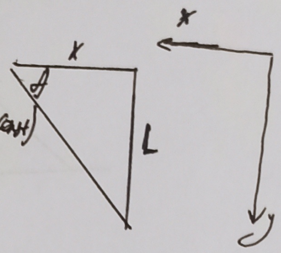
1) β
2) $a_к$ - ?
3) $\frac{m_ш}{M_к}$ - ?
4) τ - ?

Чистовик

11-01

Решение





① $tg\alpha = \frac{4}{3}$ $\quad tg\alpha = \frac{x+\Delta x}{L+\Delta L}$ (т.к. α - const)

$\frac{4}{3}(L+\Delta L) = x+\Delta x$ (*)

Продифф. (*)

$\frac{4}{3}v_y = v_x$

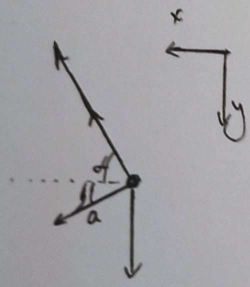
$\frac{4}{3}a_y = a_x$

$\frac{a_y}{a_x} = \frac{3}{4}$

$tg\beta = \frac{3}{4} \Rightarrow \cos\beta = \frac{4}{5};\ \sin\beta = \frac{3}{5}$

$a_y = a\sin\beta$

$a_x = a\cos\beta$



Г

II ЗН (для шара):

$y: -T\sin\alpha + mg = m_ш a_y$

$x: T\cos\alpha = m_ш a_x = m_ш a\cos\beta$

$T = \frac{m_ш a\cos\beta}{\cos\alpha} = \frac{m_ш a 4}{3}$

$-\frac{m_ш a 4}{3}\cdot\frac{4}{5} + mg = m_ш a\frac{3}{5} \quad |: m_ш$

$g = a\left(\frac{3}{5} + \frac{16}{15}\right) = a\,\frac{25}{15} = a\,\frac{5}{3}$

$a = \frac{3}{5}g$

L

$a_y = \frac{3}{5}g\sin\beta = \frac{9}{25}g$

④ $H = \frac{a_y\tau^2}{2} \Rightarrow \tau = \sqrt{\frac{2H}{a_y}} = \sqrt{\frac{50H}{9g}}$

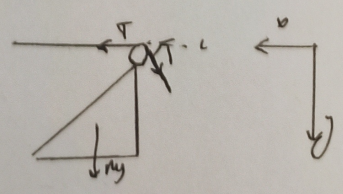
③ II ЗН (для клина)

$x: T - T\cos\alpha = M_к a_к$

$T(1-\cos\alpha) = M_к a_к$

$\frac{m_ш a 4}{3}\cdot\frac{2}{5} = M_к a_к$

$\frac{m_ш}{M_к} = \frac{15 a_к}{8a} = \frac{25 a_к}{8g}$



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2. Дано **Чистовик** Решение 11-01

ν, T_0

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

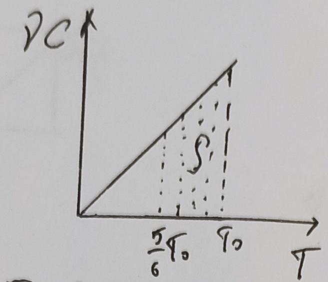
Найти:

1) $Q_1\ (T_0 \to \frac{5}{6}T_0)$

2) $T_x\ (A_{min})$ - ?

3) A_{min} - ?

1) $C(T) = \frac{\Delta Q}{\nu \Delta T} \Rightarrow \Delta Q = C(T)\Delta T \nu$



$S = \nu\left|T_0 - \frac{5}{6}T_0\right| \cdot \frac{C(T_0)+C(\frac{5}{6}T_0)}{2} =$

$= \nu\frac{1}{6}T_0 \frac{2R\frac{T_0}{T_0} + 2R\frac{\frac{5}{6}T_0}{T_0}}{2} =$

$= \nu\frac{1}{6}T_0\left(R + \frac{5}{6}R\right) = \frac{11}{36}RT_0\nu$

$\Sigma \Delta Q = \Sigma C(T)\cdot\Delta T\nu$

$Q_1 = S$

$Q_1 = \frac{11}{36}RT_0\nu$

2) Если $A \to min$, то $(A)' = 0$

$Q = \Delta U + A$

$(Q)' = (\Delta U + A)' = (\Delta U)'$

$Q = \nu\left|T_x - T_0\right| \cdot \frac{C(T_0)+C(T_x)}{2} =$

$= \nu\left|T_x - T_0\right| \cdot \frac{2R\frac{T_0}{T_0} + 2R\frac{T_x}{T_0}}{2} =$

$= \left|T_x - T_0\right|\nu R\cdot\left(\frac{T_0}{T_0} + \frac{T_x}{T_0}\right) = R\frac{\left|T_x^2 - T_0^2\right|}{T_0}\nu$

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

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

$\frac{2T_x}{T_0} = \frac{3}{2}\nu$

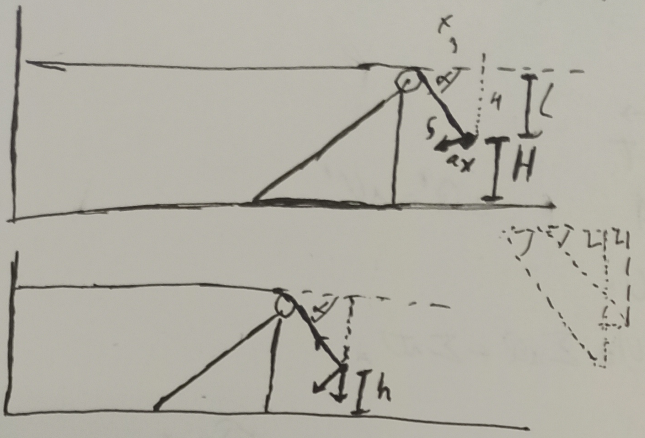
$T_x = \frac{3}{4}T_0$

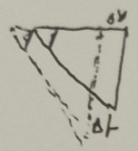
3) $Q = \Delta U + A$

$A = Q - \Delta U = \nu R\frac{\left|\frac{9}{16}T^2 - T_0^2\right|}{T_0} - \frac{3}{2}\nu R\left(\frac{3}{4}T_0 - T_0\right) =$

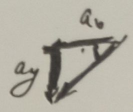
$= \nu RT_0\frac{7}{16} + \nu RT_0\frac{3}{8} = \frac{13}{16}\nu RT_0$

Черновик





$$tg\,\alpha = \frac{x}{L} = \frac{x+\Delta x}{L+(H-h)}$$



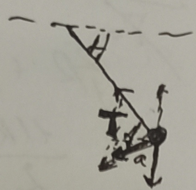
$$\frac{3}{4} = \frac{x+\Delta x}{L+(H-h)}$$

$$\frac{3}{4}(L+(H-h)) = x+\Delta x$$

$$\frac{3}{4}L + \frac{3}{4}\Delta h = x+\Delta x$$

$$\frac{3}{4}v_y = v_x$$

$$\frac{3}{4}a_y = a_x$$



$$T\sin\alpha - mg = ma_y$$

$$T\cos\alpha = ma_x$$

$$T = \frac{5}{3}ma_x$$

$$\frac{5}{3}ma_x - mg = ma_y$$

$$\frac{4}{3}ma\sin\beta$$

$$\frac{a_x}{a_y} = \frac{3}{4}$$

$$\frac{16}{9}+1 = \frac{1}{\cos^2\alpha}$$

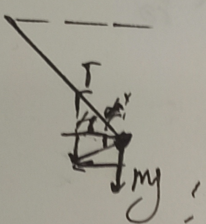
$$\cos^2\alpha = \frac{9}{25}$$

$$\frac{a_y}{a_x} = \frac{4}{3}$$

$$tg\,\beta = \frac{4}{3}$$

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

$$\sin\beta = \frac{4}{5}$$



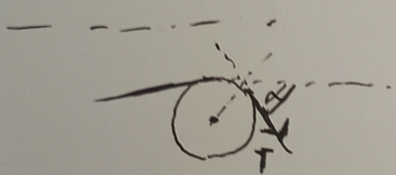
$$-T\sin\alpha + mg = ma_y = ma\sin\beta$$

$$T\cos\alpha = ma_x = ma\cos\beta$$

$$T = ma$$

$$-ma\sin\alpha + mg = ma\sin\beta$$

$$g = a(\sin\alpha + \sin\beta)$$



$$a_y = a\sin\beta = \frac{50}{8}\cdot\frac{4}{5} = 5\ м/с$$

$$a = \frac{g}{\sin\alpha+\sin\beta} = \frac{5}{8}g = \frac{50}{8} = \frac{25}{4} = \frac{12{,}5}{2} = 6{,}25$$

$$a_x = a\cos\beta = \frac{50}{8}\cdot\frac{3}{5} = \frac{30}{8} = \frac{15}{4} = \frac{7{,}5}{2} = 3{,}75$$

$$\vec{a}_{отн} = \vec{a}_{абс} + \vec{a}_{пер}$$

$$\vec{a}_{абс} = \vec{a}_{отн} + \vec{a}_{пер}$$

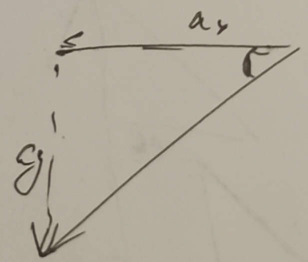
④ $$H = \frac{a_y t^2}{2}$$

$$t = \sqrt{\frac{2H}{a_y}} = \sqrt{0{,}4H}$$

$$T - T\cos\alpha = Ma_к$$

$$T(1-\cos\alpha) = Ma_к$$

$$ma\frac{2}{5} = Ma_к$$



$$T = (M+m)a_к$$

$$\frac{m a_к 4}{3} = (M+m)a_к$$

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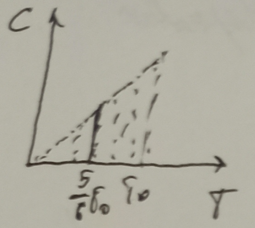
Черновик

2R

$C_x = \frac{\Delta Q}{\Delta T}$

$\Delta Q = \Delta T C_x$

$\int dT C_x =$



$\Delta Q = \Delta U + A$

$\Delta Q' = \Delta U'$

$A = \Delta Q - \Delta U =$

$\Sigma A = \Sigma(\Delta Q - \Delta U) = \Sigma \Delta Q + \Sigma \Delta U$

$\Delta Q = \Delta T C_x$

$Q = (T_0 - T_x) \cdot \frac{C(T_x) + C(T_0)}{2}$

$Q = (T_0 - T_x) \cdot R \frac{T_x + T_0}{T_0}$

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

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

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

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

$T_x = -\frac{T_0 \nu}{R} \frac{3}{4}$

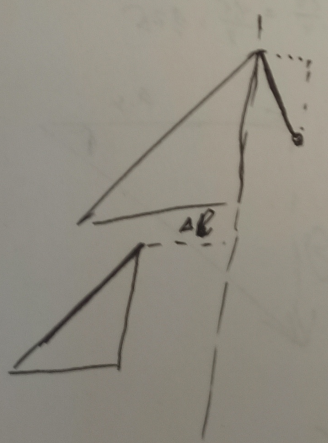
$(x^2)' = 2x$

$2R \frac{\frac{5}{6}T_0}{T_0}$

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

$\frac{11R}{2}$

$R + R\frac{T_x}{T_0}$



$\Delta l =$

$l = l$

$l = \Delta l \cdot \cos\alpha$

a

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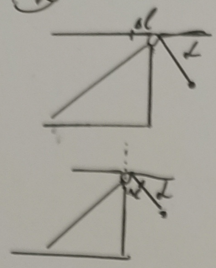
Чистовик

(2)

11-01



Т.к. нить нерастяжима

$l + \Delta l = (\Delta l_ю + l_0)\cos\alpha$ (**)

Продифф. (**):

$v_к = v_ю \cos\alpha$

$a_к = a_ю \cos\alpha$

$a_к = a\cos\beta\cos\alpha = \frac{3}{5}g\,\frac{4}{5}\cdot\frac{3}{5} = \frac{36}{125}g$

$\frac{m_ш}{m_к} = \frac{15 a_к}{8g} = \frac{15}{8}\cdot\frac{36}{125} = \frac{27}{50} = 0{,}54$

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Часть 2

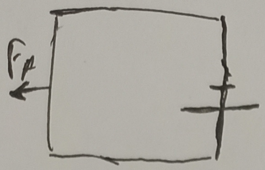
Олимпиада: **Физика, 11 класс (2 часть)**

Шифр: **21200297**

ID профиля: **825768**

Вариант 1

Черновик



$F_A = BIL$

$\mathcal{E} = BvL$

$I = \frac{\mathcal{E}}{2R+R} = \frac{BvL}{3R}$

$F_A = BL\frac{BvL}{3R} = \frac{B^2L^2v}{3R}$

$F_A = 2ma$

$a_2 = \frac{B^2L^2v_0}{6mR}$

$\mathcal{E} = \frac{BLv_{x}\Delta t}{\Delta t}$

$\vec{v}_{от} = \vec{v}_{абс} - \vec{v}_{пе}$

$\vec{v}_{т} = v_2 - v_1$

Bv_2L

$v_x = v_0 - \frac{B^2L^2v_x}{3mR}\Delta t$

$v_x = \frac{B^2L^2v_x}{6mR}\Delta t$

$2ma_2 = ma_1$

$2a_2 = a_1$

$\sum v_x = v_0 - \frac{B^2L^2}{3mR}\sum v_x\Delta t$

$\sum v_0 = \frac{BL^2}{6mR}\sum v_x\Delta t$

$v_0 - \frac{BL^2}{3mR}\sum v_x\Delta t = \frac{BL^2}{6mR}\sum v_x\Delta t$

v_2

v_1

$\mathcal{E} = -Bv_2L + Bv_1L$

$\mathcal{E} = \frac{BL(v_1-v_2)}{3R}$

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

$v_1 = v_0 -$

$v = v_0 - 2a_2\Delta t$

$v = a_2\Delta t$

$v = v_0 - 2v$

$v_0 = 3v$

$v = \frac{v_0}{3}$

$v_1 = v_0 - a\Delta t$

$\frac{2}{3}v_0 = \sum a_1\Delta t$

$\frac{1}{3}v_0 =$

$v_1 = v_2 = v_0 - a_1\Delta t$

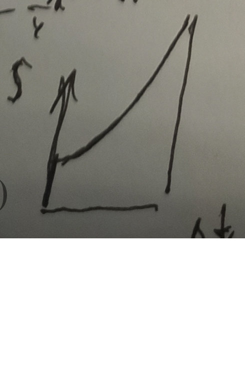
$v_1 = v_2 = v_0 - \sum a$

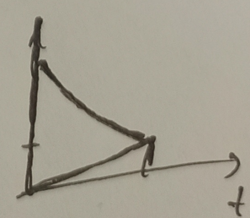
$\Delta S_1 = \frac{a_1\Delta t^2}{2} = \frac{a_1\Delta t^2}{4}$

$\Delta S_2 = v_0\Delta t - \frac{a_1\Delta t^2}{2} = v_0\Delta t - 2\Delta S_1$

$\Delta S_2 + 2\Delta S_1 = v_0\Delta t$

$v_0\Delta t - \frac{a_1\Delta t^2}{4}$

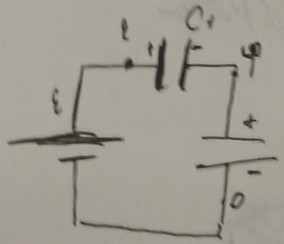




$\Delta v = v_0 - 2a_2\Delta t$

$v_{\Delta 2} = a_2\Delta t$

Черновик



$C_1U_1 = C_2U_2$

$2CU_1 = CU_2$

$2U_1 = U_2$

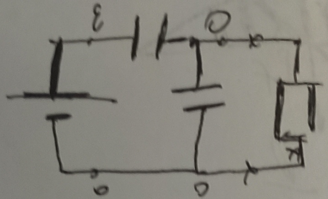
$U_1 = \varepsilon - \varphi$

$U_2 = \varphi - 0$

$2(\varepsilon - \varphi) = \varphi$

$2\varepsilon - 2\varphi = \varphi$

$\varphi = \frac{2\varepsilon}{3}$



$A_{ист} = \Delta W + Q$

$Q = A_{ист} - \Delta W$

$\Delta W =$

$\cancel{W_1 = (\varepsilon - \varphi)C_1 = \frac{\varepsilon}{3}C_1 = 2\frac{\varepsilon}{3}C}$

$\cancel{W_2 = (\varphi - 0)C_2 = \frac{2}{3}\varepsilon C_2 = \frac{2}{3}C\varepsilon}$

$W_K = W_1 + W_2 = \frac{4}{3}C\varepsilon$

$A_{ист} = \varepsilon q^*$

$\cancel{W_K = \varepsilon C_1} = 2C\varepsilon$

$W_1 = \frac{C(\varepsilon - \varphi)^2}{2} = C\frac{\varepsilon^2}{9}$

$W_2 = \frac{C_2(\varphi)^2}{2} = C\frac{2\varepsilon^2}{9}$

$W_H = C\varepsilon^2\frac{1}{3}$

$W_K = \frac{C_1\varepsilon^2}{2} = C\varepsilon^2$

$q_1 = +C_1(\varepsilon - \varphi) = \frac{2}{3}C\varepsilon$

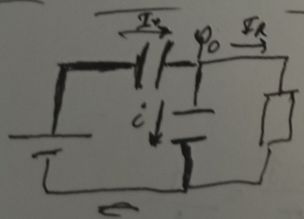
$q_2 = +C_1(\varepsilon) = +2C\varepsilon$

$q^* = \frac{4}{3}C\varepsilon$

$A_{ист} = \frac{4}{3}C\varepsilon^2$

$\Delta W = W_K - W_H = C\varepsilon^2\frac{2}{3}$

$Q = C\varepsilon^2\frac{2}{3}$



$I_0 = C_1U'_{C_1} \Rightarrow \frac{U_{C_1}}{\Delta t}^* = \frac{I_0}{C_1}$

$I_R R = \varphi - 0$

$I_0 = I_R + i$

$I_R = I_0 - i$

$I = C_1U'$ $\quad I_0\Delta t = C_1U_x$

$\frac{\varphi_0 - 0}{R} = I_R$

$\varphi_0 = \varphi$

$\varepsilon - \varphi$

$(\varepsilon - U_1)C$

$\frac{(\varepsilon - U_1)'}{R} = I_R$

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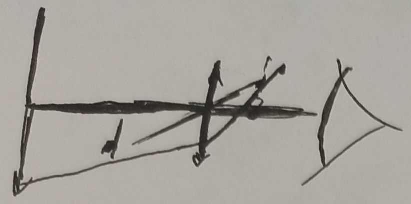
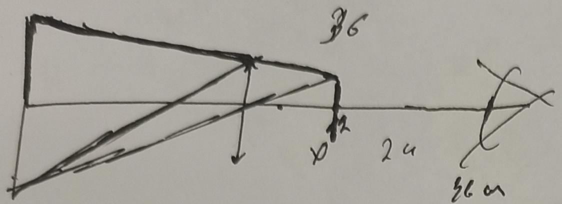
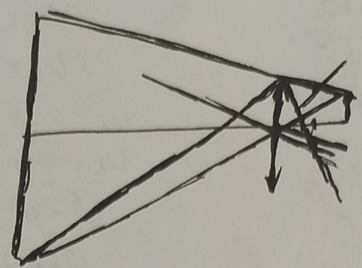
Черновик

$\frac{9}{2}$





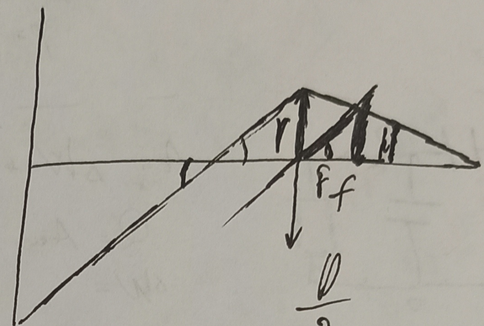


$\frac{1}{d} + \frac{1}{f} = \frac{1}{F}$

$\frac{1}{36} + \frac{1}{f} = \frac{1}{9}$

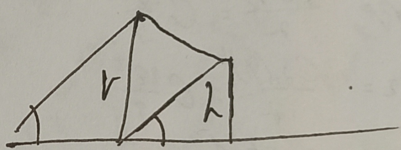
$\frac{1}{f} = \frac{1}{9} - \frac{1}{36} = \frac{3}{36}$

$f = 12$ см

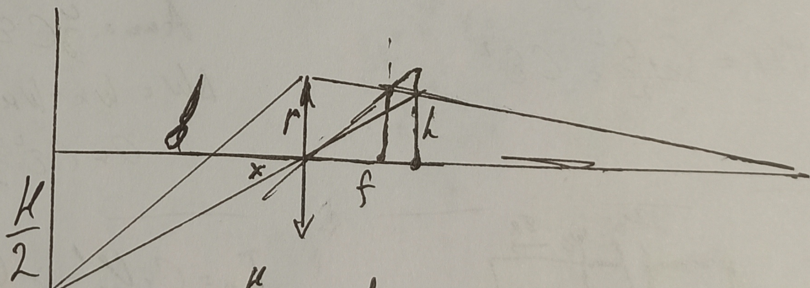


$\frac{\frac{H}{2}}{r} =$

$\frac{f}{d} = \frac{1}{3}$ $\quad \frac{h}{H} = \frac{1}{3} \quad h = \frac{H}{3} = \frac{3}{2} = 1{,}5$



$\xi = BVl$



$\frac{\frac{H}{2}}{r} = \frac{d-x}{x}$

$\frac{f}{F} = \frac{h}{c}$

$\operatorname{tg}\alpha = \frac{c}{F}$

$\operatorname{tg}\alpha = \frac{v}{u}$

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4. Дано: | Решение | Чистовик

$L, m, R, 2m, 2R$

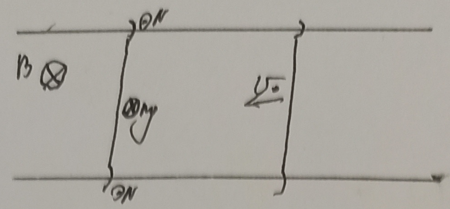
v_0

Найти:

1) a_2 - ?

2) v_1 и v_2 - ?

3) S - ?



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

$I_0 = \frac{\mathcal{E}_0}{R_{об}} = \frac{\mathcal{E}_0}{2R+R} = \frac{B v_0 L}{3R}$

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

II ЗН для 2m:

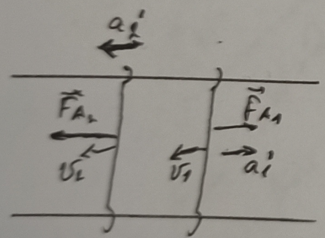
$\vec{F_A} + 2m\vec{g} + \vec{N} = 2m\vec{a}_2$

$F_A = 2m a_2$

$B^2 L^2 v_0 \frac{1}{3R} = 2m a_2$

$a_2 = \frac{B^2 L^2 v_0}{6Rm}$

2) Запишем в произвольный момент времени v_2, v_1



$\mathcal{E}_i = \mathcal{E}_2 - \mathcal{E}_1 = BL(v_2 - v_1)$

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

На перемычку 1: $F_{A_1} = \frac{B^2 L^2 (v_2 - v_1)}{3R}$

На перемычку 2: $F_{A_2} = \frac{B^2 L^2 (v_2 - v_1)}{3R}$ $\Big\}$ $|F_{A1}| = |F_{A2}|$

II ЗН для 1 перемычки

$\vec{F_A} + \vec{N} + m\vec{g} = m a_1' \Rightarrow F_A = m a_1'$

II ЗН для 2 перемычки:

$\vec{F_A} + \vec{N} + 2m\vec{g} = 2m a_2' \Rightarrow F_A = 2m a_2'$ $\Big\}$ $2a_2' = a_1'$

Что есть, когда $v_2 = v_1$, - сила $F_A = 0$ и движение равномерное

$\Delta v_2 = a_2 \Delta t$; $\Delta v_1 = v_0 - a_1 \Delta t$ $\Rightarrow$ $v_2 = \Sigma a_2 \Delta t$; $v_1 = v_0 - \Sigma 2a_2 \Delta t$ $\Rightarrow$ $v_1 = v_0 - 2v_2$

И $v_1 = v_2 = v'$, $v' = v_0 - 2v' \Rightarrow v' = \frac{v_0}{3}$

$v_1 = v_2 = v' = \frac{v_0}{3}$

2

5. Дано:

$F = 9$ см

$H = 9$ см

$d = 36$ см

$a = 24$ см

Найти:

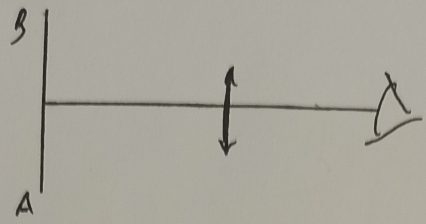
1) b - ?

2) D_m - ?

3) l - ?

Решение

Чистовик



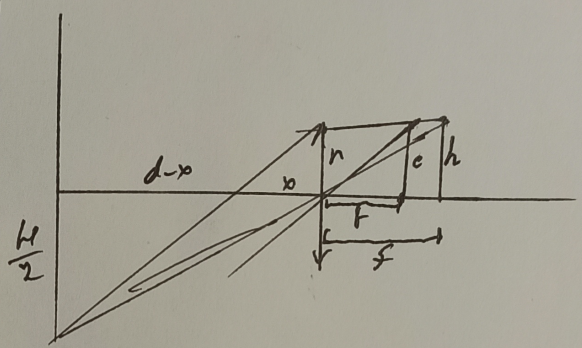
1) $\frac{1}{d} + \frac{1}{f} = \frac{1}{F}$

$\frac{1}{f} = \frac{d-F}{dF}$

$f = \frac{dF}{d-F} = 12$ см

$b = a + f = 36$ см

2)



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3. Дано:

Решение

Чистовик

$E, R, C_1 = 2C, C_2 = C$

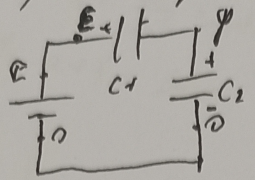
Найти:

1) I_{R0} - ?

2) Q - ?

3) $I_R(I_0)$ - ?

1) Рассмотрим цепь до замыкания ключа.



МУП

$$C_1U_1 = C_2U_2 \quad (U_1 = E - \varphi;\ U_2 = \varphi - 0)$$

$$2C(E-\varphi) = C(\varphi - 0)$$

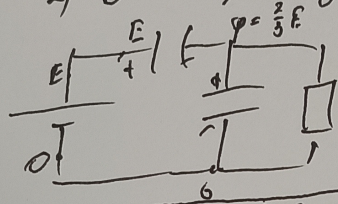
$$2E - 2\varphi = \varphi$$

$$\varphi = \frac{2}{3}E$$

$$W_{C1} = \frac{C_1U_1^2}{2} = C\frac{E^2}{9}$$

$$W_{C2} = \frac{C_2U_2^2}{2} = 2C\frac{E^2}{9}$$

2) Рассмотрим цепь сразу после замыкания ключа



МУП

$$I_{R0} = \frac{U_R}{R} = \frac{\varphi - 0}{R} = \frac{2}{3}\frac{E}{R}$$

3) $A_{ист} = \Delta W + Q$

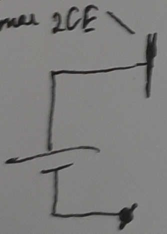
$Q = A_{ист} - \Delta W$

$q^* = q_2 - q_1 = \frac{4}{3}CE$

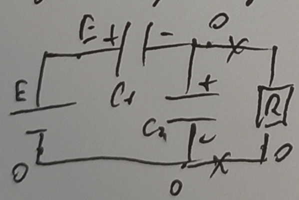
$A_{ист} = Eq^*$

был $\frac{2}{3}CE$

стал $2CE$



Рассмотрим цепь в уст. режиме



МУП

$$\Delta W = W_к - W_н =$$

$$W_н = W_{C1} + W_{C2} = \frac{1}{3}CE^2$$

$$W_к = W_{C1}' = CE^2$$

$$= \frac{2}{3}CE^2$$

$$Q = E\cdot\frac{4}{3}CE - \frac{2}{3}CE^2 = \frac{2}{3}CE^2$$

1