Часть 1

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

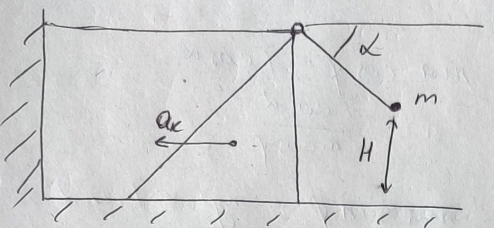
Шифр: **21201808**

ID профиля: **133095**

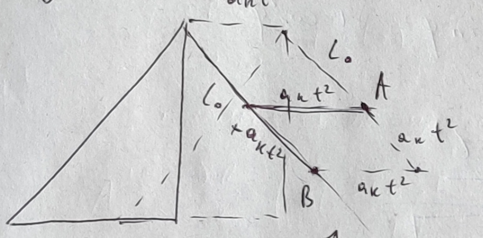
Вариант 3

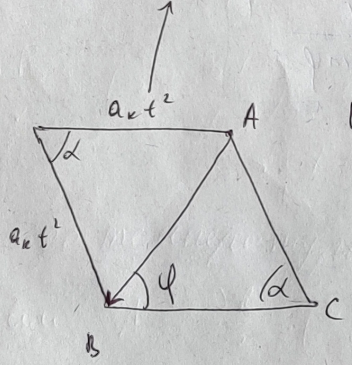
Чистовик. В11-03.

Задание 1



за время t клин ~~отк~~ отъедет влево на $a_к t^2$
и длина нити увеличится на $a_к t^2$.





$V_н = 0 \Rightarrow$ ~~V~~ перемещение сонапр. со скоростью, а скорость соотв. с a. $\Rightarrow$ φ – искомый.

$AB^2 = 2a_к^2 t^4 - 2a_к^2 t^4 \cdot \cos\alpha$

$\Downarrow$

$AB^2 = a_к^2 \cdot t^4 \cdot \frac{16}{13}$

$\Downarrow$

$a_к^2 \cdot t^4 = a_к^2 \cdot t^4 \cdot \frac{16}{13} + a_к^2 t^4 - 2a_к^2 t^4 \frac{4}{\sqrt{13}} \cdot \cos\varphi$

т. кос. для ABC ↗

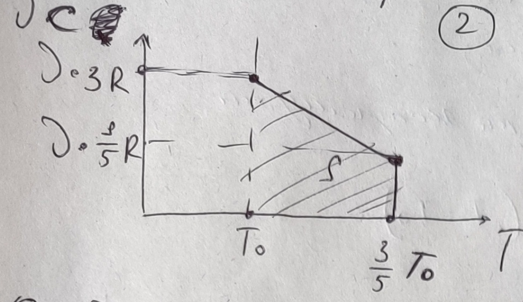
$\Downarrow$

$$\boxed{\cos\varphi = \frac{2\sqrt{13}}{13}}$$

1) Ответ: $\cos\varphi = \frac{2\sqrt{13}}{13}$

Черновик

②



$$3R \cdot \frac{3T_0}{5T_0} = \frac{9}{5}R$$

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

$$S = |Q| = \frac{\nu \cdot (3R + \frac{9}{5}R)}{2} \cdot \frac{2}{5}T_0 = $$

$$= \frac{\nu \cdot 24 R \cdot T_0}{25} = $$

$$= \frac{24}{25} \nu R T_0$$

$$Q = \nu C \cdot \Delta T = \nu C_{(T)} \left(\cancel{T_0 - \frac{3}{5}T_0}\right) = dT$$

$$dQ = \nu \cdot C(t) \cdot \cancel{(T_0 - dT)}$$

$$\cancel{Q = \nu \int 3RT\ 3R}$$

$$Q = \nu \cdot \int_{T_0}^{\frac{3}{5}T_0} C(t) \cdot dT =$$

$$= \nu \int_{T_0}^{\frac{3}{5}T_0} \frac{3R}{T_0} \cdot T\,dT =$$

$$|_0\ Q = \nu \frac{3R}{T_0} \cdot \left(\frac{T^2}{2} - \frac{T_0^2}{2}\right) = \nu \frac{3R}{T_0} \cdot \left(\frac{T^2}{2}\right)\Bigg|_{T_0}^{\frac{3}{5}T_0} =$$

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

$$= \nu \frac{3R}{T_0} \cdot \left(\frac{9T_0^2}{25 \cdot 2} - \frac{T_0^2}{2}\right) =$$

$$= \nu \frac{3R}{T_0} \cdot \left(\frac{9-25}{50} T_0^2\right) =$$

$$= -\nu\ 3R \cdot T_0 \cdot \frac{16}{50} =$$

$$= -\frac{\nu 3R \cdot T_0 \cdot 8}{25} = -\frac{\nu 24 R T_0}{25}$$

1) Ответ: $Q = \frac{24}{25} \nu R T_0$

$$\cancel{\nu R T_0 \cdot \frac{24}{25}}$$

2): $\Delta Q = \Delta U + A$

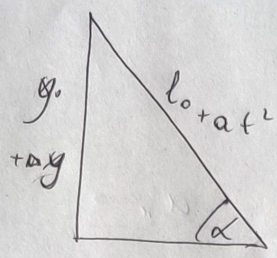
$$\Delta Q = \frac{i}{2} \cdot \nu R (T - T_0) + A \qquad A = \frac{3R\nu}{2T_0}\left(T^2 - T_0^2\right) - \frac{i\nu R}{2}(T - T_0) =$$

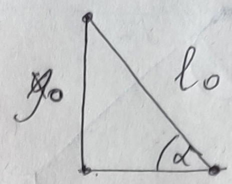
$$= \left(\frac{3R\nu}{2T_0}(T + T_0) - \frac{i \cdot \nu R}{2}\right)(T - T_0)$$

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

2стр

(1) Черновик.





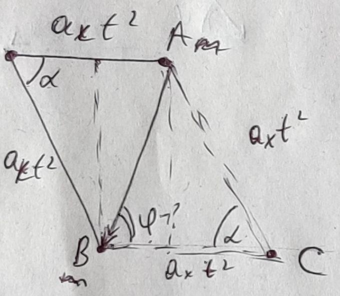
$$\boxed{y_0 = L_0 \cdot \sin\alpha}$$

$a_y =$

$$\cancel{\frac{y_0}{L_0} = \frac{y_0 + \Delta y}{L_0 + a_x t^2}}$$

$$\cancel{\Delta y = a_y t^2}$$

$$\cancel{y_0 \cdot L_0 + y_0 \cdot a_x t^2}$$



φ – искомый.

$$AB^2 = \underbrace{2a_x^2 t^4 - 2 \cdot a_x^2 t^4 \cdot \overset{\frac{5}{13}}{\cos\alpha}}_{=}$$

$$a_x^2 t^4 \cdot \left(\frac{26}{13} - \frac{10}{13}\right) =$$

$$= \boxed{a_x^2 \cdot t^4 \cdot \frac{16}{13}}$$

$$AB = a_x \cdot t^2 \cdot \sqrt{\frac{16}{13}} =$$

$$= \boxed{a_x \cdot t^2 \cdot \frac{4}{\sqrt{13}}}$$

$$a_x^2 t^4 = a_x^2 t^4 \cdot \frac{16}{13} + a_x^2 \cdot t^4 - 2 \cdot a_x^2 \cdot t^4 \frac{4}{\sqrt{13}} \cdot \cos\varphi$$

$$\cancel{1} = \frac{16}{13} + \cancel{1} - \frac{8}{\sqrt{13}} \cdot \cos\varphi$$

$$1)\ \boxed{\cos\varphi = \frac{16^2 \cdot \sqrt{13}}{13 \cdot 8} = \frac{2\sqrt{13}}{13}}$$

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Чистовик. В11-03.

2 зад.

$$\Delta Q = \nu c \Delta T \Rightarrow dQ = \nu c\, dT \;;\; Q = \nu \int_{T_0}^{\frac{3}{5}T_0} \frac{3R}{T_0} \cdot T\, dT =$$

$$= \nu \frac{3R}{T_0} \cdot \left(\frac{9T_0^2}{50} - \frac{T_0^2}{2} \right) = -\nu R T_0 \cdot \frac{24}{25}$$

$\Rightarrow$ 1) Ответ: газ отдаёт $\boxed{\nu R T_0 \cdot \frac{24}{25}}$

$\Delta Q = \Delta U + A \qquad \Delta U = \frac{i}{2}\nu R \Delta T \qquad i = 3$ для гелия (одноат. газ)

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

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

$A' = 0 \Rightarrow$ найдём экстремум.

$$A' = \frac{\nu R}{2} \left(\left(\frac{3T_0 - 3T}{T_0} - i \right)' \cdot (T - T_0) + \left(\frac{3T_0 - 3T}{T_0} - i \right) \cdot (T - T_0)' \right) =$$

$$= \frac{\nu R}{2} \cdot \left(3 - \frac{6T}{T_0} \right) = 0$$

$$\Rightarrow \boxed{T = \frac{1}{2} T_0}$$

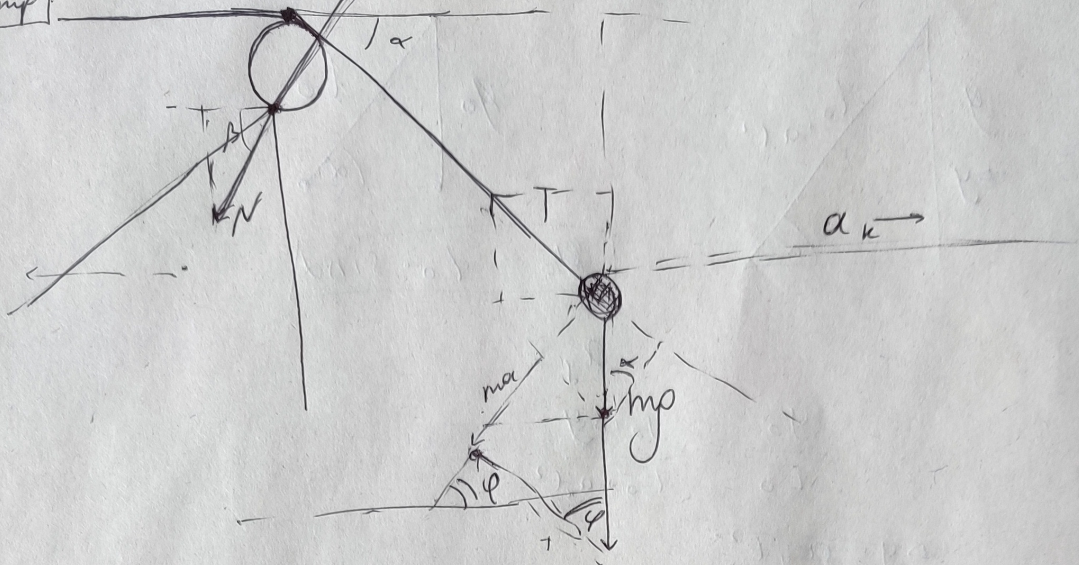
2) Ответ: до температуры $T = \frac{1}{2} T_0$

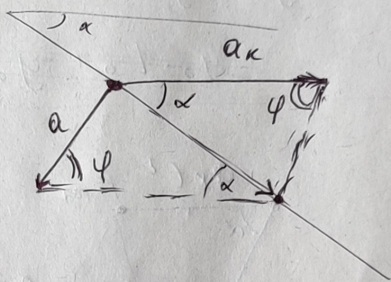
3) подставим: $A = \frac{\nu R}{2} \cdot \left(\frac{3T_0 - 1{,}5T_0}{T_0} - 3 \right) \cdot \left(-0{,}5 T_0 \right) =$

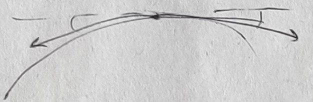
$$= \frac{\nu R T_0}{8} \cdot 3$$

3) Ответ: $\boxed{A_{min} = \frac{3}{8} \nu R T_0}$

Черновик.

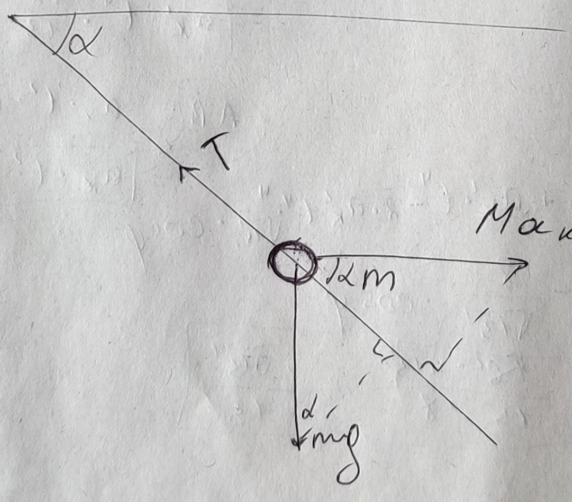






$$M a_к = N \cos\beta$$

В С.О. клина:



$$mg \sin\alpha + Ma_к \cdot \cos\alpha - T = m a_к.$$

~~$a_к \cdot (m - M)$~~ =

(He) - i=3

Черновик.

2 продолж.

если $A' = 0$, то это точка экстремума.

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

$$A' = \frac{\nu R}{2} \left(\left(\frac{3T_0 - 3T}{T_0} - i \right)' \cdot (T - T_0) + \left(\frac{3T_0 - 3T}{T_0} - i \right) \cdot (1) \right) =$$

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

0 если i=3

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

$$= \frac{\nu R}{2} \cdot \left(-\frac{6T}{T_0} + 3 \right) = 0$$

$$3 - \frac{6T}{T_0} = 0$$

$$\boxed{T = \frac{1}{2} T_0}$$

$$\frac{6 \cdot 0{,}5 \cdot T_0}{T_0} = 3$$

$$A = \frac{\nu R}{2} \cdot \left(\frac{3T_0 - 1{,}5T_0}{T_0} - 3 \right) (-0{,}5T_0) =$$

$$= \frac{\nu R}{2} \cdot (-1{,}5 + 3) \cdot (+0{,}5T_0) = \frac{\nu R \; 3 \; T_0}{2 \cdot 2 \; 2} = \boxed{\frac{3}{8} \nu R T_0}$$

проверка:

$$\frac{3}{2} \frac{\nu R}{T_0} \left(\frac{1}{4} T_0^2 - T_0^2 \right) = \frac{3}{8} \frac{\nu R}{T_0} T_0^2 \cdot 3 =$$

$$= -\frac{9}{8} \nu R T_0$$

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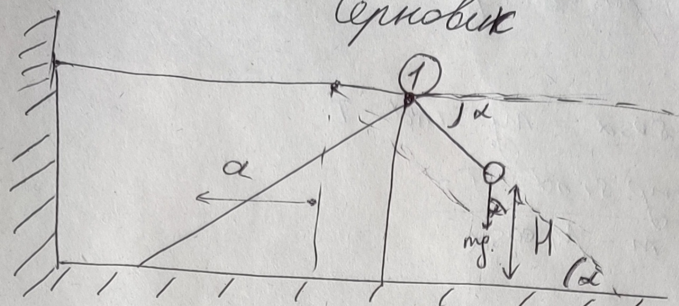
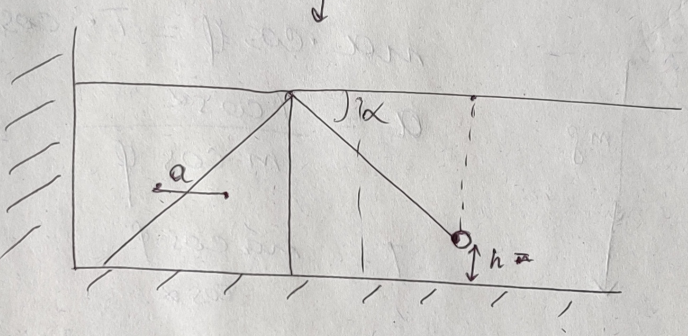
1стр

Черновик

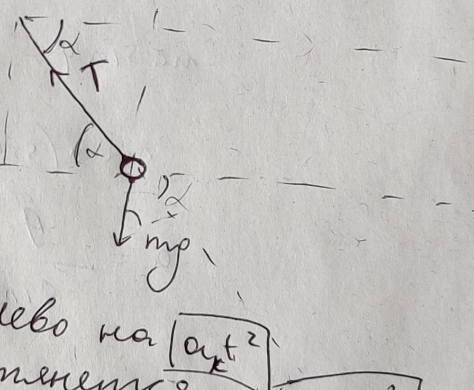


$\cos\alpha = \frac{5}{13}$



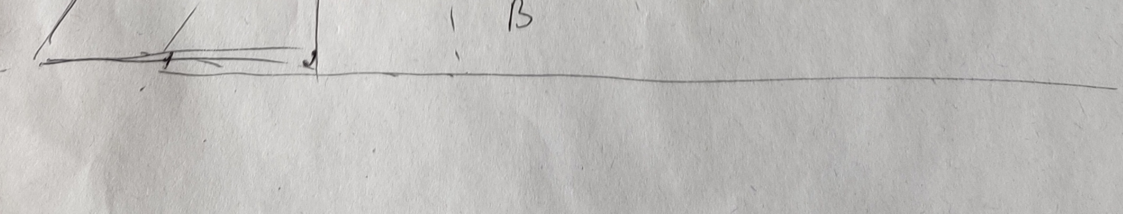
l нити = const

mg



за время t • клин влево на $\boxed{a_x t^2}$

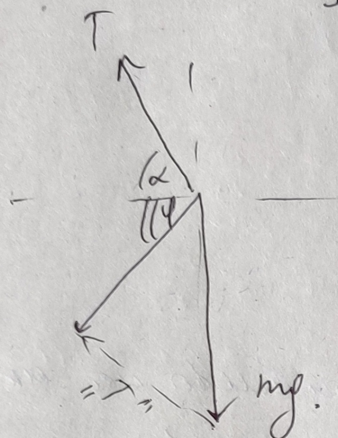
при этом нить растянется на $\boxed{a_к t^2}$



2 стр.

Чистовик.

Задание 1 продолжение.



$$ma \cdot \cos\varphi = T\cos\alpha$$

$$a = \frac{T\cos\alpha}{m\cos\varphi}$$

$$ma\sin\varphi = mg - T\sin\alpha$$

$$\Rightarrow \boxed{a = \frac{g}{\sin\varphi + \cos\varphi \cdot tg\alpha}}$$

$$tg\alpha = \frac{\sqrt{1-\cos^2\alpha}}{\cos\alpha}$$

$$\sin\varphi = \sqrt{1-\cos^2\varphi}$$

$T_{пад}$:

$$H = \frac{a \cdot \sin\varphi \cdot t^2}{2}$$

4) Ответ: $\boxed{t = \sqrt{\frac{2H}{a\sin\varphi}}}$

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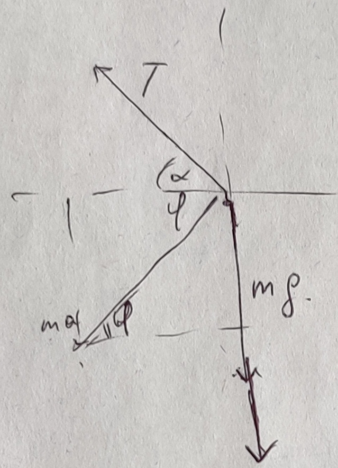
~~9~~ стр

Черновик.

$$\cancel{m_a}\ ma_к - Ma_к \cdot \cos\alpha = mg\sin\alpha - T$$

$$a_к = \frac{mg\sin\alpha - T}{m - M\cos\alpha}$$



$$ma \cdot \cos\varphi = T \cdot \cos\alpha.$$

$$a = \frac{T\cos\alpha}{m\cos\varphi}$$

$$T = \frac{ma\cos\varphi}{\cos\alpha}.$$

$$ma \cdot \sin\varphi = \cancel{T \cdot \sin\alpha} \cdot mg - T\sin\alpha$$

$$ma\sin\varphi = mg - ma\cos\varphi \cdot tg\alpha$$

$$\cancel{m}a \cdot (\sin\varphi + \cos\varphi \cdot tg\alpha) = \cancel{m}g.$$

$$a = \frac{g}{\sin\varphi + \cos\varphi \cdot tg\alpha}$$

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Часть 2

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

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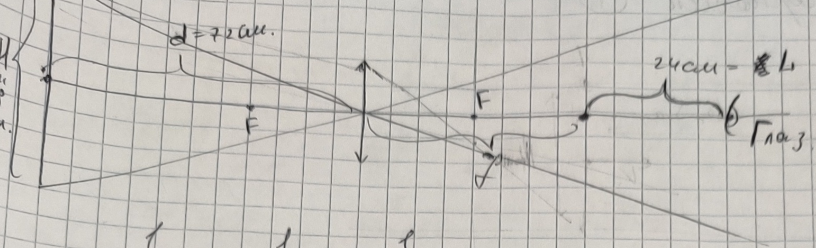
Вариант 3

Черновик 5



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

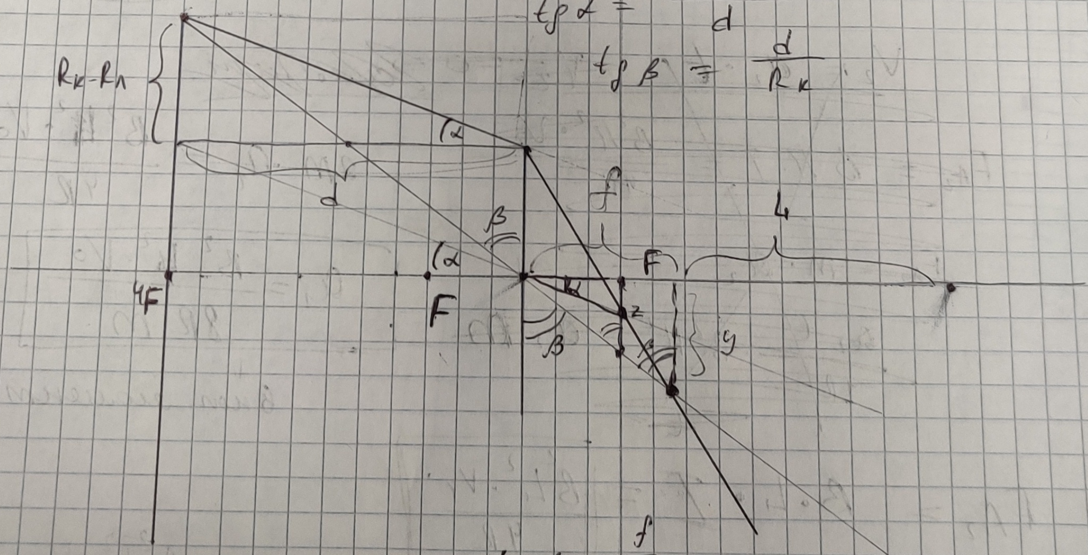
$$\frac{1}{f} = \frac{d-F}{dF} \qquad f = \frac{dF}{d-F} = \frac{72 \cdot 18}{72-18} =$$

$$= \frac{72 \cdot 18}{54} = 24 \text{ см} = f$$

$$\Rightarrow 1) \ \boxed{x = 24 + 24 = 48 \text{ см}}$$

$$tg\,\alpha = \frac{R_к - R_л}{d}$$

$$tg\,\beta = \frac{d}{R_к}$$

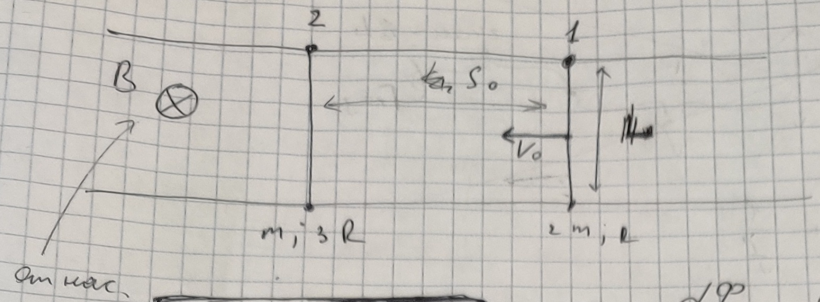


$$tg\,\beta = \frac{f}{y}$$

$$z = \frac{F}{tg\,\beta} = \frac{F \cdot R_к}{d} = \frac{18 \cdot 8,}{724 \cdot 2} = \frac{8}{8}$$

$$y = \frac{f}{tg\,\beta} = \frac{f \cdot R_к}{d} = \frac{24 \cdot 4,5}{72} = \frac{9}{6}$$

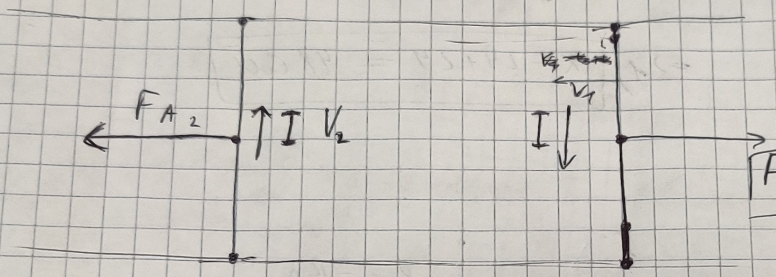
Черновик (4)



в нач момент

$$\mathcal{E} = \frac{d\Phi}{dt} = \frac{d\, B \cdot \cancel{H}L \cdot V dt}{dt} = BHV$$

$$\cancel{I} = \frac{\mathcal{E}}{R_\Sigma} = \frac{B\cancel{H}LV}{4R}$$



$$\boxed{F_{A_1} = B \cdot L \cdot I} = \boxed{\frac{B^2 L^2 \cdot V_1}{4R}}$$

$V_1 = V$

~~$V_2 = a_2 \cdot t$ $V_2 = 0$ ...~~

$$\cancel{F_{A_2} = B \cdot H \cdot I = \frac{B^2 H^2 \cdot V_2}{4R}}$$

$$\cancel{F_{A_2} = m \cdot a_2}$$

$$\cancel{\frac{a_2\, t}{4R} \cdot B^2 H^2 = a_2\, m}$$

$$\cancel{t =}$$

$$2m \cdot a_1 = \frac{B^2 L^2 \cdot V_0}{4R}$$

$$\boxed{a_1 = \frac{B^2 L^2 \cdot V_0}{8R\, m}}$$

в нач. момент.

$$F_{A_2} = B \cdot L \cdot I = \boxed{\frac{B^2 L^2 \cdot V_1}{4R}}$$

$$a_1 = \frac{B^2 L^2 \cdot V_1}{8R\, m}$$

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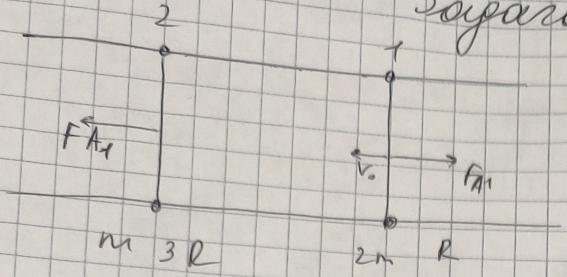
Задача 4.



начало: $V_2 = 0 \quad V_1 = V_0$

$$\mathcal{E} = \frac{d\Phi}{dt} \Rightarrow \mathcal{E} = \frac{BLV_0dt}{dt} = BLV_0$$

$$I = \frac{\mathcal{E}}{R_\Sigma} = \frac{BLV_0}{4R} \qquad F_{A_1} = BLI = \frac{B^2L^2\cdot V_0}{4R}$$

$$2ma_1 = F_{A_1} \Rightarrow a_1 = \frac{F_{A_1}}{2m} = \frac{B^2L^2V_0}{8Rm}$$

1) Ответ: $a_1 = \frac{B^2L^2V_0}{8Rm}$

2) через большое T движение установится ($V_1 = V_2$)

и $\mathcal{E} = \frac{d\Phi}{dt} = 0 \Rightarrow V_1 = V_2 = const$.

$$\frac{2\cancel{m}V_0^2}{2} = \frac{2mV_1^2}{2} + \frac{mV_1^2}{2}$$

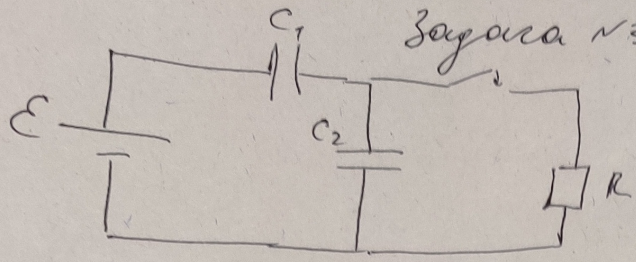
$$2V_0^2 = 2V_1^2 + V_1^2$$

$$V_1^2 = \frac{2}{3}V_0^2 \Rightarrow \boxed{V_1 = \sqrt{\frac{2}{3}}\cdot V_0} = V_2$$

2) Ответ: $V_1 = \sqrt{\frac{2}{3}}V_0$; $V_2 = \sqrt{\frac{2}{3}}\cdot V_0$

Чистовик: 11-03.

Задача №3.



$C_2 = C$

$C_1 = 4C$.

до замык:

1) $\frac{q_1}{C_1} + \frac{q_2}{C_2} = \mathcal{E}$ $\quad q_1 = q_2 = q$

$$\frac{q + 4q}{4C} = \mathcal{E} \Rightarrow \frac{q}{C} = \frac{4}{5}\mathcal{E}.$$

$$U_{C_2} = \frac{q}{C} = \frac{4}{5}\mathcal{E} = U_R = I(0)R.$$

$$I(0) = \frac{4\mathcal{E}}{5R}.$$

1) Ответ: $I(0) = \frac{4\mathcal{E}}{5R}$.

2) $\cancel{\frac{qC_2^2}{2}} = \cancel{\Delta Q} = \cancel{\frac{4\mathcal{E}\cdot C^2 \cdot C}{5\cdot 2}}$ $\quad \Delta Q = \frac{CU^2}{2} = \frac{C \cdot \cancel{16}^{8}\,\mathcal{E}^2}{\cancel{2}\cdot 25} = \frac{8}{25}C\mathcal{E}^2$

$\cancel{x = \frac{4}{5}\mathcal{E}C}$ $\quad$ Ответ: $\Delta Q = \frac{8}{25}C\mathcal{E}^2$.

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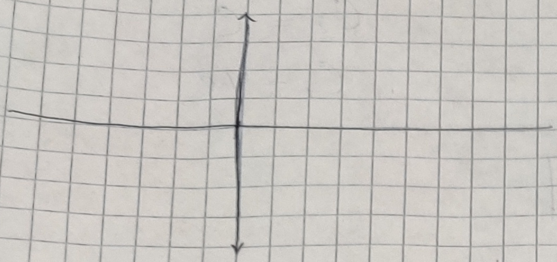
$$\int e^{ax}\,dx = \frac{1}{a}\int e^{ax}\,d\,ax = \frac{1}{a}e^{x}$$



$$V_1 = V_2$$

$$\cancel{V_0}\cdot\cancel{e}\,e^{\frac{B^2L^2t}{8Rm}} = \cancel{2}\cancel{V_0}\left(1-e^{\frac{B^2L^2t}{8Rm}}\right)$$

$$3e^{\frac{B^2L^2t}{8Rm}} = 2$$

$$e^{\alpha t} = \frac{2}{3}$$

$$\alpha t\cdot\ln e = \ln\frac{2}{3}$$

$$t = \frac{\ln\frac{2}{3}}{\alpha} = \frac{\ln\frac{2}{3}\cdot 8Rm}{B^2L^2}$$

$$\frac{mV_0^2}{2} = \frac{2mV_1^2}{2} + \frac{mV_1^2}{2}$$

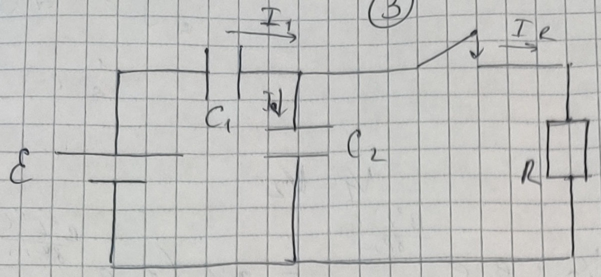
$$V_0^2 = 3V_1^2$$

$$V_1 = \frac{V_0}{\sqrt{3}}$$

V

Черновик.

3



$C_2 = C$

$C_1 = 4C$

в нач. момент: $\frac{q_1}{C_1} + \frac{q_2}{C_2} = \mathcal{E}$

$\frac{q_1}{4C} + \frac{q_2}{C} = \mathcal{E}$

u_1 u_2

$C = \frac{q}{V}$

$V = \frac{q}{C}$

$q = CV$

$q_1 = q_2 = q$

$\frac{q + 4q}{4C} = \mathcal{E}$

$\frac{5q}{4C} = \mathcal{E}$ $\frac{q}{C} = \mathcal{E} \cdot \frac{4}{5}$

на C_2 в нач. момент времени

$U = IR$ $I = \frac{U}{R}$

$U_2 = \frac{4}{5}\mathcal{E}$

$$\boxed{I(0) = \frac{4\mathcal{E}}{5R}}$$

3) $I_1 = I_0 + I_R$ $R \cdot I_R = U_R$

$I_R = I_1 - I_0$ $\frac{q_1}{4C} + U_R = \mathcal{E}$ $\frac{Cu^2}{2}$

$\frac{q_1}{4C} + \frac{q_2}{4C} = \mathcal{E}$

$ma_2 = \frac{B^2L^2\cdot V_1}{4R}$ Черновик ④

когда $V_1 = V_2$
ток прекратится
т.к. $\frac{d\varphi}{dt} = 0$

$a_2 = \frac{B^2L^2V_1}{4Rm}$

$a_2 = 2a_1$

$\cancel{a_2 \cdot t = (V_0 - a_1 t)}$

$\cancel{V_0 = (a_1 + a_2)\cdot t}$

$\cancel{a_1 = \frac{B^2\cdot L^2}{8Rm}\cdot(V_0 - a_1 t)}$

$\cancel{a_1 \cdot (t+1) = \frac{B^2L^2}{8Rm}\cdot V_0}$

$\cancel{a_1 = \frac{B^2\cdot L^2}{8Rm} V_0 \frac{1}{t+1}}$

$\mathcal{E} = \frac{d\varphi}{dt} = \frac{B(V_1 - V_2)\cdot L\cdot t}{t} = B(V_1 - V_2)\cdot L$

$\mathcal{E} = BL\cdot(V_1 - V_2)$ $V_1 = V_2 \Rightarrow \mathcal{E} = 0$

$\cancel{V_1 = V_0 - \frac{B^2\cdot L^2\cdot V_1}{8Rm}\, dt}$ $V_2 =$

$F = \frac{B^2L^2\cdot V_1}{4R} \Rightarrow$

для 1:
$a_1 = \frac{B^2L^2\cdot V_0\cdot e^{\frac{B^2L^2t}{8Rm}}}{8Rm}$

$a_2 = \frac{B^2L^2\cdot V_0\cdot e^{\frac{B^2L^2t}{8Rm}}}{4Rm}$

$\frac{dV_1}{dt} = \frac{B^2L^2\cdot V_1}{8Rm}$ $\cancel{\frac{dV_2}{dt} = \frac{B^2L^2\cdot V_1}{4Rm}}$

$\frac{dV_1}{V_1} = \frac{B^2L^2t\,dt}{8Rm}$

$V_2 = \int_0^t a_2 = \frac{B^2L^2V_0\cdot 8Rm}{4Rm\cdot B^2L^2\cdot t}\cdot e^{\frac{B^2L^2t}{8Rm}} =$

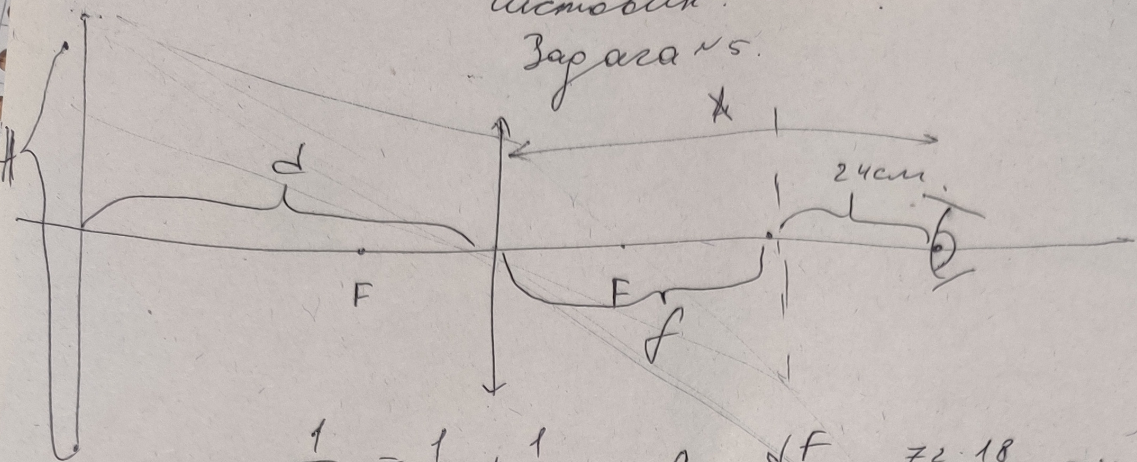
$\ln V_1 = \frac{B^2L^2t}{8Rm}$ $V_1 = Ae^{\frac{B^2L^2t}{8Rm}}$

$\boxed{V_1 = V_0\cdot e^{\frac{B^2L^2t}{8Rm}}}$

$V_2 = \boxed{2V_0\cdot e^{\frac{B^2L^2t}{8Rm}} - 2V_0}$

Чистовик. 11-03.

Задача №5.



$$\frac{1}{F} = \frac{1}{d} + \frac{1}{f}, \quad f = \frac{dF}{d-F} = \frac{72 \cdot 18}{72-18} = 24\text{см}$$

$$\Rightarrow x = 24\text{см} + f = 48\text{см}.$$

Ответ: $x = 48$ см.

2) $D =$

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