

Часть 1

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

Шифр: **21200687**

ID профиля: **830828**

Вариант 3

Условие

$$N1$$

$$\sin \alpha = \frac{12}{13}$$

Дано:

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

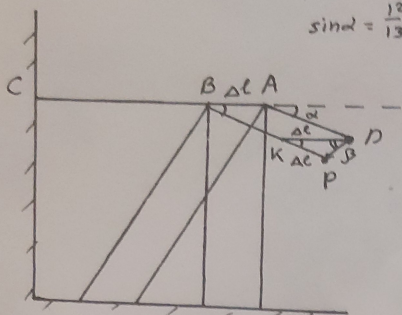
H

$$1) \angle \beta - ?$$

$$2) a_{\text{кар}} - ?$$

$$3) \frac{m_{\text{ш}}}{M_{\text{кар}}} - ?$$

$$4) t - ?$$



1) Рассмотрим смещение катка по горизонтали на величину Δl

Шарик переместится из м. D в м. P

Следует отметить, что шарик всегда будет двигаться вдоль

прямой DP т.к. угол наклона катка к горизонту не изменяется $\Rightarrow$ ускорение катка также будет направлено вдоль этой прямой.

AD = BK т.к. KBAD - параллелограмм

Нить удлинится на величину Δl т.е. KP = Δl

$\Rightarrow \triangle PKD$ - равнобедренный

По теореме синусов ($\triangle PKD$):

$$\frac{PD}{\sin \alpha} = \frac{KP}{\sin \beta} = \frac{\Delta l}{\sin \beta}$$

$$PD = 2\Delta l \cdot \sin \frac{\alpha}{2} = 2\Delta l \cdot \sqrt{\frac{1 - \cos \alpha}{2}} = \Delta l \sqrt{2 - 2\cos \alpha}$$

$$\sin \beta = \frac{\Delta l \cdot \sin \alpha}{PD} = \frac{\Delta l \cdot \sin \alpha}{\Delta l \sqrt{2 - 2\cos \alpha}} = \frac{\sin \alpha}{\sqrt{2 - 2\cos \alpha}} = \frac{12}{13} \cdot \frac{1}{\sqrt{2 - 2 \cdot \frac{5}{13}}} =$$

$$= \frac{12}{13} \cdot \frac{1}{\sqrt{\frac{26 - 10}{13}}} = \frac{12}{13} \cdot \frac{\sqrt{13}}{4} = \frac{3\sqrt{13}}{13} = \frac{3}{\sqrt{13}} \approx 0,832$$

$$2) a_{\text{кар}} = \frac{\Delta l}{\Delta t}$$

$$a_{\text{шар}} = \frac{PD}{\Delta t} = \frac{\Delta l \sqrt{2 - 2\cos \alpha}}{\Delta t} = a_{\text{кар}} \sqrt{2 - 2\cos \alpha}$$

Второй закон Ньютона для шара:

$$\begin{cases} m g - T \sin \alpha = m a_{\text{ш}} \sin \beta \\ T \cos \alpha = m a_{\text{ш}} \cos \beta \end{cases} \Rightarrow T = \frac{m a_{\text{ш}} \cos \beta}{\cos \alpha}$$

$$m g - \frac{m a_{\text{ш}} \cos \beta}{\cos \alpha} \cdot \sin \alpha = m a_{\text{ш}} \sin \beta$$

$$g - a_{\text{ш}} \cdot \tan \alpha \cos \beta = a_{\text{ш}} \sin \beta$$

$$a_{\text{ш}} = \frac{g}{\sin \beta + \tan \alpha \cos \beta}$$

$$\tan \alpha = \frac{\sin \alpha}{\cos \alpha} = \frac{12}{13} \cdot \frac{13}{5} = \frac{12}{5}$$

$$\sin \beta = \frac{3}{\sqrt{13}} \quad \cos \beta = \sqrt{1 - \sin^2 \beta} = \sqrt{1 - \frac{9}{13}} = \sqrt{\frac{4}{13}} = \frac{2}{\sqrt{13}}$$

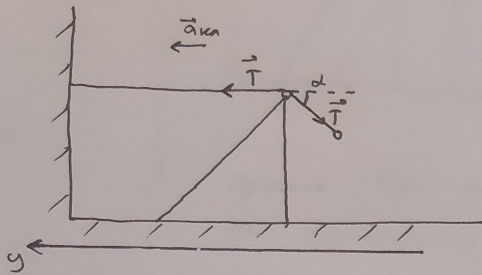
$$a_{\text{ш}} = \frac{g}{\frac{3\sqrt{13}}{13} + \frac{12}{5} \cdot \frac{2}{\sqrt{13}}} = \frac{g}{\frac{3\sqrt{13}}{13} + \frac{24}{5\sqrt{13}}} = \frac{g}{\frac{3\sqrt{13}}{13} + \frac{24\sqrt{13}}{65}} = \frac{g}{\frac{15\sqrt{13} + 24\sqrt{13}}{65}} = \frac{65g}{39\sqrt{13}} = \frac{5}{3\sqrt{13}} \cdot g$$

①

Ускорение

$$a_{\text{кн}} = \frac{a_{\text{мгп}}}{\sqrt{2-2\cos\alpha}} = \frac{\frac{5}{3\sqrt{13}} \cdot 9}{\sqrt{2-2 \cdot \frac{5}{13}}} = \frac{\frac{5}{3\sqrt{13}} \cdot 9}{\sqrt{\frac{26-10}{13}}} = \frac{59}{3 \cdot 4} = \frac{5}{12} 9 \approx 4,17 \frac{\text{м}}{\text{с}^2}$$

3) Второй закон Ньютона по каната:



$$\text{по } y: T - T \cos \alpha = M a_{\text{кн}} \Rightarrow T = \frac{M a_{\text{кн}}}{(1 - \cos \alpha)}$$

из уравнения 2

$$T = \frac{m a_{\text{мгп}} \cos \beta}{\cos \alpha}$$

$$\frac{M a_{\text{кн}}}{1 - \cos \alpha} = \frac{m a_{\text{мгп}} \cos \beta}{\cos \alpha}$$

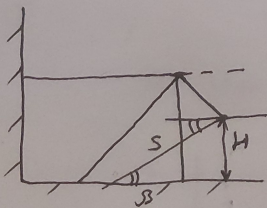
$$\frac{m}{M} = \frac{a_{\text{кн}} \cdot \cos \alpha}{(1 - \cos \alpha) \cdot a_{\text{мгп}} \cdot \cos \beta} = \frac{a_{\text{кн}}}{\sqrt{2-2\cos\alpha}} \cdot \frac{\cos \alpha}{(1 - \cos \alpha) a_{\text{мгп}} \cos \beta} = \frac{\cos \alpha}{\sqrt{2-2\cos\alpha} \cdot (1 - \cos \alpha) \cdot \cos \beta}$$

$$= \frac{\frac{5}{13}}{\sqrt{2 - \frac{10}{13}}} \cdot \frac{1}{(1 - \frac{5}{13})} \cdot \frac{1}{2} \cdot \sqrt{13} = \frac{\frac{5}{13}}{4} \cdot \sqrt{13} \cdot \frac{1}{\frac{8}{13}} \cdot \frac{1}{2} \cdot \sqrt{13} = \frac{5 \cdot \sqrt{13} \cdot \sqrt{13} \cdot 13}{13 \cdot 4 \cdot 8 \cdot 2} =$$

$$= \frac{5 \cdot 13}{4 \cdot 8 \cdot 2} = \frac{65}{64} = \frac{65}{64}$$

$$4) S = \frac{a_{\text{мгп}} t^2}{2} \quad S = \frac{H}{\cos \beta} \Rightarrow t = \sqrt{\frac{2S}{a_{\text{мгп}}}} = \sqrt{\frac{2 \cdot H}{\cos \beta} \cdot \frac{1}{5g} \cdot 3\sqrt{13}} =$$

$$= \sqrt{\frac{2H}{2} \cdot \sqrt{13} \cdot \frac{1}{5g} \cdot 3\sqrt{13}} = \sqrt{\frac{39H}{5g}} \approx 2,8 \sqrt{\frac{H}{g}}$$



Ответы: 1) $\sin \beta = \frac{3}{\sqrt{13}} \approx 0,832$

2) $a_{\text{кн}} = \frac{5}{12} 9 \approx 4,17 \frac{\text{м}}{\text{с}^2}$

3) $\frac{m}{M} = \frac{65}{64}$

4) $t = 2,8 \sqrt{\frac{H}{g}}$

Умножить

N2

Dано:

ν, T_0

$$c(T) = 3R \frac{T}{T_0}$$

1) $T_2 = \frac{3}{5} T_0$

$Q_1 - ?$

2) $T_x - ?$

3) $A_{min} - ?$

1) $\Delta Q = c(T) \nu \Delta T = 3R \frac{T}{T_0} \nu \Delta T$

Суммируем:

$$\Sigma \Delta Q = \int \Delta Q = \frac{3R\nu}{T_0} \cdot \frac{T_2^2 - T_0^2}{2} = \frac{3}{2} \frac{\nu R}{T_0} \cdot \left(\frac{9}{25} T_0^2 - T_0^2 \right) = \frac{3}{2} \frac{\nu R}{T_0} \cdot$$

$$\times \left(-\frac{16}{25} T_0^2 \right) = -\frac{24}{25} \nu R T_0 = Q_1'$$

$$Q_1 = |Q_1'| = \frac{24}{25} \nu R T_0$$

2) $\Delta Q = \frac{3}{2} \nu R \Delta T + \Delta A_{min}$

$$3R \frac{T}{T_0} \nu \Delta T = \frac{3}{2} \nu R \Delta T + \Delta A_{min}$$

Суммируем

$$\frac{3R\nu}{2T_0} (T_x^2 - T_0^2) - \frac{3}{2} \nu R (T_x - T_0) = A_{min}$$

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

$$\left(\frac{T_x^2}{T_0} - T_x \right)' = 2T_x \cdot \frac{1}{T_0} - 1 = 0$$

$$\frac{2T_x}{T_0} = 1 \Rightarrow T_x = \frac{T_0}{2} = T_x$$

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

$$|A_{min}| = \frac{3}{8} \nu R T_0$$

Ответ: 1) $\frac{24}{25} \nu R T_0$

2) $\frac{T_0}{2}$

3) $\frac{3}{8} \nu R T_0$

(3)

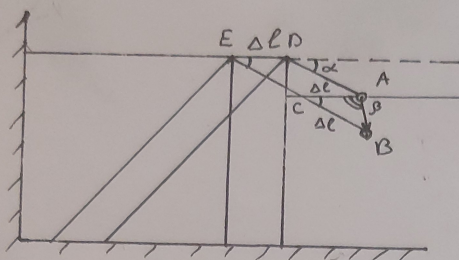
N1

Дано:

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

4

- 1) $\angle \beta$ - ?
- 2) $\alpha_{K\alpha}$ - ?
- 3) $\frac{m_m}{M_{K\alpha}}$ - ?
- 4) t - ?



7

N1 Upwobene

$$mg = T \quad T = \frac{ma \cos \beta}{\cos \alpha}$$

$$\tan \alpha = \frac{\sin \alpha}{\cos \alpha} = \frac{5}{13} \cdot \frac{12}{13} \cdot \frac{78}{5} = \frac{12}{5}$$

$$mg - \frac{ma \cos \beta}{\cos \alpha} \sin \alpha = ma \sin \beta$$

$$g - a \cdot \cos \beta \cdot \tan \alpha = a \sin \beta$$

$$a_{\text{max}} = \frac{g}{\sin \beta + \tan \alpha \cdot \cos \beta}$$

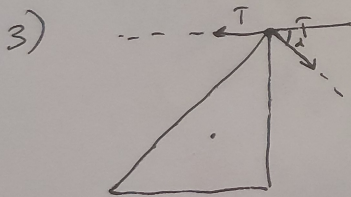
$$\sin \beta = \frac{3}{\sqrt{13}} \quad \cos \beta = \frac{2}{\sqrt{13}}$$

$$a_{\text{max}} = \frac{9}{\frac{3 \cdot 15}{\sqrt{13}} + \frac{12}{5} \cdot \frac{2}{\sqrt{13}}} = \frac{9 \cdot 5 \sqrt{13}}{15 + 24} = \frac{5 \sqrt{13} \cdot 9}{39} = \frac{5 \sqrt{13} \cdot 9}{3 \cdot 13} = \frac{5 \cdot 9}{3 \sqrt{13}}$$

$$a_{\text{kn}} = \frac{\Delta l}{\Delta t} \quad a_{\text{max}} = \frac{x}{\Delta t} = \frac{\Delta l \sqrt{2-2 \cos \alpha}}{\Delta t} = a_{\text{kn}} \cdot \sqrt{2-2 \cdot \frac{5}{13}} =$$

$$= a_{\text{kn}} \cdot \frac{4}{\sqrt{13}} = \frac{5 \cdot 9}{3 \sqrt{13}}$$

$$a_{\text{kn}} = \frac{\sqrt{13}}{4} \cdot \frac{5}{3 \sqrt{13}} \cdot 9 = \frac{5}{12} g$$



$$T - T \cos \alpha = M a_{\text{kn}}$$

$$M = \frac{T - T \cos \alpha}{a_{\text{kn}}}$$

$$a_{\text{max}} = \frac{T \cos \alpha}{m \cos \beta}$$

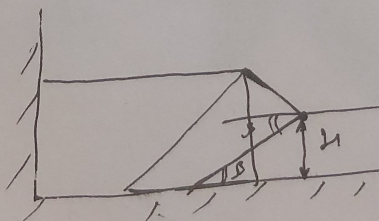
$$m = \frac{T \cos \alpha}{a_{\text{max}} \cos \beta}$$

$$\frac{m}{M} = \frac{T \cos \alpha}{a_{\text{max}} \cos \beta} \cdot \frac{a_{\text{kn}}}{T - T \cos \alpha}$$

4) $t = ? \quad S = \frac{a_{\text{max}} t^2}{2}$

$$S = \frac{21}{\cos \beta}$$

$$t = \sqrt{\frac{2S}{\cos \beta \cdot a_{\text{max}}}}$$



Черновик

N1

Дано:

$$\cos \alpha = 5/13$$

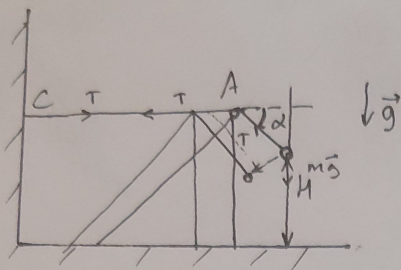
H

1) $a - ?$ (a_n)

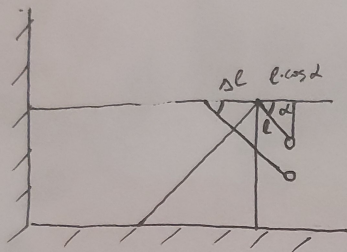
2) $a_{\text{н}} - ?$

3) $\frac{m_m}{M_{\text{н}}} - ?$

4) $t - ?$



2) $mg = T \cdot \sin \alpha$



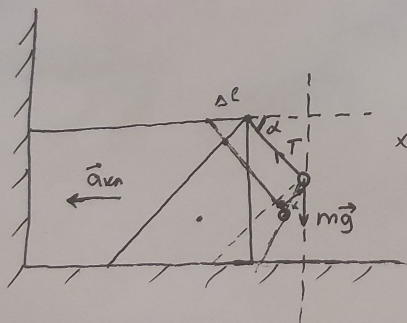
$$l_2 = l + \Delta l$$

$$(l + \Delta l) \cos \alpha \neq \Delta l + l \cos \alpha$$

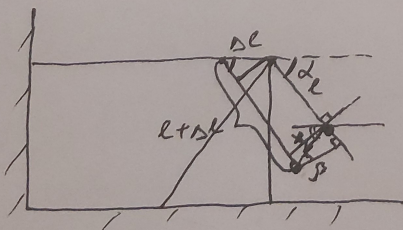
$$\begin{cases} mg - T \cdot \sin \alpha = m a_x \\ T \cos \alpha = m a_y \end{cases}$$

$$a = \sqrt{a_x^2 + a_y^2}$$

$$a = \left(\frac{mg - T \sin \alpha}{m} \right)^2 + \left(\frac{T \cos \alpha}{m} \right)^2$$



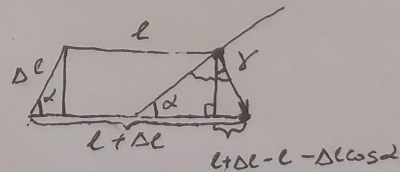
$$x = \Delta l \sin \alpha$$



Нужно найти угол

каким углом отклонится

шарик !!!

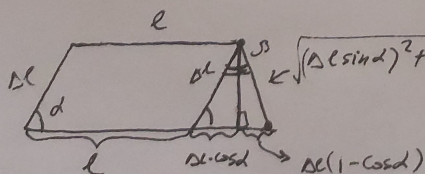


$$h = \Delta l \cdot \sin \alpha$$

$$\tan \delta = \frac{\Delta l - \Delta l \cos \alpha}{\Delta l \sin \alpha} = \frac{1 - \cos \alpha}{\sin \alpha} = \frac{1}{\sin \alpha} - \frac{1}{\tan \alpha}$$

$$\beta = \delta + 90^\circ - \alpha$$

$$\sqrt{2 - 2 \cos \alpha} = \sqrt{2(1 - \cos \alpha)}$$



$$(\Delta l \sin \alpha)^2 + (\Delta l - \Delta l \cos \alpha)^2 = \Delta l^2 (\sin^2 \alpha + 1 - 2 \cos \alpha + \cos^2 \alpha)$$

$$\begin{aligned} & \sqrt{(\Delta l \sin \alpha)^2 + (\Delta l (1 - \cos \alpha))^2} = \sqrt{\Delta l^2 \sin^2 \alpha + \Delta l^2 (1 - \cos \alpha)^2} = \sqrt{\Delta l^2 \sin^2 \alpha + \Delta l^2 (1 - 2 \cos \alpha + \cos^2 \alpha)} \\ & = \sqrt{\Delta l^2 \sin^2 \alpha + \Delta l^2 - 2 \Delta l^2 \cos \alpha + \Delta l^2 \cos^2 \alpha} = \sqrt{2 \Delta l^2 (1 - \cos \alpha)} \\ & = \Delta l \sqrt{2 - 2 \cos \alpha} \end{aligned}$$

Черновик
N2

Дано:

V, T_0

$$C(T) = 3R \frac{T}{T_0}$$

1) $T_2 = \frac{3}{5} T_0$

$Q_1 - ?$

2) $A_{\min} - T$

3) $A_{\min} - ?$

1) $\Delta Q = C(T) \cdot V \cdot \Delta T = 3R \frac{T}{T_0} V \Delta T$

$$\int T \Delta T = \frac{T^2}{2}$$

Суммирование

$$\Sigma \Delta Q = 3R \frac{V}{T_0} \frac{(T^2 - T_0^2)}{2} = \frac{3RV}{T_0} \cdot \frac{\frac{9}{25} T_0^2 - T_0^2}{2} = \frac{3RV}{8T_0} \cdot -\frac{16}{25} T_0^2 =$$

$$= \left(\frac{24}{25} \right) VRT_0$$

2) $\Delta Q = \frac{3}{2} V R \Delta T + A_{\min}$

$$3R \frac{T}{T_0} V \Delta T = \frac{3}{2} V R \Delta T + A_{\min}$$

Суммирование

$$\frac{3RV}{2T_0} (T^2 - T_0^2) - \frac{3}{2} V R (T - T_0) = A_{\min}$$

$$\frac{3}{2} V R \left(\frac{T^2 - T_0^2}{T_0} - T + T_0 \right) = A_{\min}$$

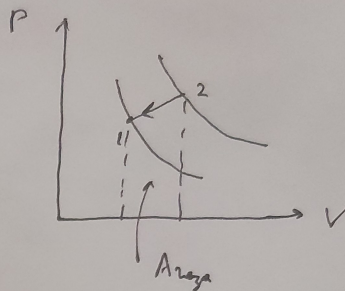
$$A_{\min} = \frac{3}{2} V R \left(\frac{T^2 - T_0^2 - T \cdot T_0 + T_0^2}{T_0} \right) = \frac{3}{2} V R \left(\frac{T^2 - T T_0}{T_0} \right) = \frac{3}{2} V R \left(\frac{T(T - T_0)}{T_0} \right)$$

$$\left(\frac{T^2}{T_0} - T \right)' = 2T \cdot \frac{1}{T_0} - 1 = 0$$

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

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

$$|A_{\min}| = \frac{3}{8} V R T_0$$



Uppräpning

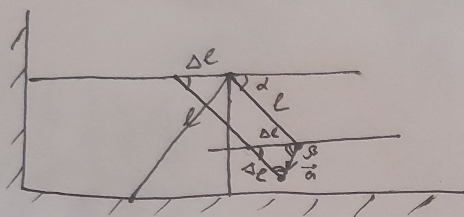
N1

$$1) \frac{\Delta L \sqrt{2-2\cos\alpha}}{\sin\alpha} = \frac{\Delta L \cos\alpha + \Delta L - \Delta L \cos\alpha}{\sin\beta}$$

$$\sin\beta = \frac{\sin\alpha}{\sqrt{2-2\cos\alpha}} = \frac{\sin\alpha}{\sqrt{2-2\cdot\frac{5}{13}}} = \frac{\sin\alpha}{\sqrt{\frac{26-10}{13}}} = \frac{\sin\alpha}{4} \cdot \sqrt{13}$$

$$\sin\alpha = \sqrt{1 - \frac{25}{169}} = \sqrt{\frac{169-25}{169}} = \frac{12}{13}$$

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

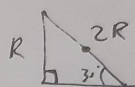


$$\frac{\sin\beta}{\Delta L}$$

$$S = a \cdot b \cdot \sin\alpha$$

$$S = b \cdot c \cdot \sin\beta$$

$$\frac{b}{\sin\beta} = \frac{a}{\sin\alpha} = \frac{c}{\sin\alpha} = 2R$$



$$\frac{c}{\sin\alpha} = 2R$$

$$\frac{R}{\sin\alpha} = 2R$$

$$\frac{\Delta L}{\sin\beta} = \frac{x}{\sin\alpha}$$

$$x = 2\Delta L \cdot \cos\left(\frac{180-\alpha}{2}\right) = \Delta L \cdot \sin\frac{\alpha}{2} \cdot 2$$

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

$$\cos 2\alpha = \cos^2\alpha - \sin^2\alpha = 1 - 2\sin^2\alpha$$

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

$$\sin\beta = \frac{\Delta L \cdot \sin\alpha}{2 \cdot x} = \frac{\Delta L \cdot \sin\alpha}{\Delta L \cdot \sin\frac{\alpha}{2} \cdot 2} = \frac{\sin\alpha}{\sqrt{1-\cos\alpha} \cdot 2} = \frac{12}{13} \cdot \frac{2}{\sqrt{\frac{8}{13}}} = \frac{12}{13} \cdot \frac{\sqrt{13}}{\sqrt{2}}$$

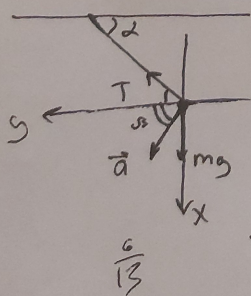
$$\sin\beta = \frac{3\sqrt{26}}{13 \cdot 2}$$

$$\frac{12}{\sqrt{2}} = \frac{6 \cdot \sqrt{2} \cdot 2}{\sqrt{2}} = 6\sqrt{2}$$

$$\sin\beta = \frac{\Delta L \sin\alpha}{\Delta L \cdot \sin\frac{\alpha}{2} \cdot 2} = \frac{\sin\alpha}{\sqrt{\frac{1-\cos\alpha}{2}} \cdot 2} =$$

$$= \frac{\sin\alpha}{\sqrt{2-2\cos\alpha}} = \frac{\sin\alpha}{\sqrt{2-2\cdot\frac{5}{13}}} = \frac{12}{13} \cdot \frac{\sqrt{13}}{\sqrt{26-10}} = \frac{12}{13} \cdot \frac{\sqrt{13}}{\sqrt{16}} = \frac{3\sqrt{13}}{13} = \frac{3}{\sqrt{13}}$$

$$2) \text{ Akumma} = \frac{\Delta L}{\Delta t}$$



$$Ox: (mg - T \cdot \sin\alpha = ma \sin\beta$$

$$Oy: T \cos\alpha = ma \cos\beta$$

$$\cos\beta = \sqrt{1 - \frac{9}{13}} = \sqrt{\frac{13-9}{13}} = \sqrt{\frac{4}{13}} = \frac{2}{\sqrt{13}}$$

$$\tan\beta = \frac{3}{2}$$

$$\sin\beta \cdot \cos\beta = \frac{\sin\alpha}{2}$$

$$\frac{\Delta L}{\sin\beta} = \frac{\Delta L \cdot 2 \cos\beta}{\sin\alpha} \Rightarrow \tan\beta =$$

$$a_{1n} = \frac{5}{3\sqrt{13}} \cdot 9 \cdot \sqrt{2 - 2 \cdot \frac{5}{13}} = \frac{5}{3}$$

Умножить Упростить

Часть 2

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

Шифр: **21200687**

ID профиля: **830828**

Вариант 3

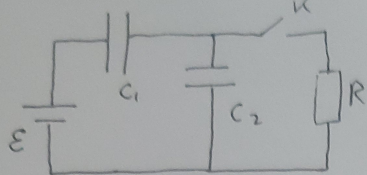
Условие

N3

Дано:

$\varepsilon, R,$

$C_1 = 4C, C_2 = C$



$$1) I_R = \frac{U_2}{R}$$

$$U_2 = \frac{Q_2}{C_2}$$

$$Q_2 = Q_1 = Q = \varepsilon \cdot C_{12}$$

$$C_{12} = \left(\frac{1}{C_1} + \frac{1}{C_2} \right)^{-1} = \frac{C_1 C_2}{C_1 + C_2} \Rightarrow Q_2 = \varepsilon \cdot \frac{C_1 C_2}{C_1 + C_2}$$

$$U_2 = \frac{\varepsilon C_1}{C_1 + C_2} \Rightarrow I_R = \frac{\varepsilon C_1}{C_1 + C_2} \cdot \frac{1}{R} = \frac{\varepsilon}{R} \cdot \frac{4C}{4C + C} = \frac{4}{5} \frac{\varepsilon}{R}$$

1) I_R - ?

2) Q - ?

3) I_0

U_R - ?

$$2) W_1 + A_{\text{ист}} = W_2 + Q$$

$$\frac{C_1 U_1^2}{2} + \frac{C_2 U_2^2}{2} + \varepsilon \cdot \Delta Q = \frac{C_1 \varepsilon^2}{2} + Q$$

(через замкнутый промежуток времени ток через резистор ~~идет~~ не будет и напряжение на первом конденсаторе будет равно ε)

$$\Delta Q = Q_{\text{кон}} - Q_{\text{нач}} = C_1 \cdot \varepsilon - \varepsilon C_{12} = 4C \cdot \varepsilon - \varepsilon \cdot \frac{4C \cdot C}{5C} =$$

$$= CE \left(4 - \frac{4}{5} \right) = CE \frac{16}{5}; \quad U_2 = \frac{4}{5} \varepsilon \quad \text{и} \quad U_1 = \frac{\varepsilon}{5}$$

$$\frac{4C \cdot U_1^2}{2} + \frac{C \cdot U_2^2}{2} + \varepsilon \cdot CE \frac{16}{5} = \frac{4CE^2}{2} + Q$$

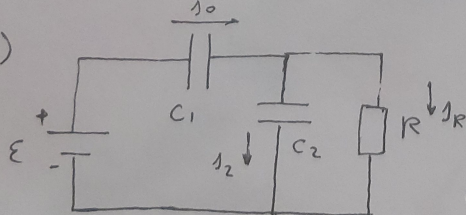
напряжение на конденсаторах в начальный момент времени

$$2C \cdot \frac{\varepsilon^2}{25} + \frac{C}{2} \cdot \frac{16}{25} \varepsilon^2 + CE^2 \cdot \frac{16}{5} = 2CE^2 + Q$$

$$Q = CE^2 \left(\frac{2}{25} + \frac{8}{25} + \frac{16}{5} - 2 \right) = CE^2 \cdot \frac{2+8+80-50}{25} =$$

$$= CE^2 \cdot \frac{40}{25} = \frac{8}{5} CE^2$$

3)



$$I_0 = I_2 + I_R$$

$$\varepsilon = U_1 + U_2$$

$$U_2 = R \cdot I_R = U_R$$

$$U_1' = U_2' = I_0 \cdot C_1 = I_2 \cdot C_2$$

$$I_0 \cdot 4C = I_2 \cdot C \Rightarrow I_2 = \frac{I_0}{4}$$

$$I_R = I_0 - I_2 = \frac{3}{4} I_0 \Rightarrow U_R = I_R \cdot R = \frac{3}{4} I_0 R$$

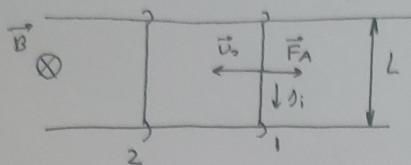
Отсюда: 1) $\frac{4}{5} \frac{\varepsilon}{R}$ 3) $\frac{3}{4} I_0 R$
2) $\frac{8}{5} CE^2$

①

Умови
N4

Дано:
L
m₁ = 2m, R₁ = R
m₂ = m, R₂ = 3R
v₀

- 1) a₁ - ?
- 2) v₁, v₂ - ?
- 3) S₀
S_x - ?



$$1) F_A = B \cdot i_1 \cdot L$$

$$i_1 = \frac{E_i}{R_{\text{одн}}} = \frac{E_i}{R_1 + R_2} = \frac{E_i}{4R}$$

$$E_i = B v_0 L$$

$$F_A = B \cdot L \cdot \frac{B \cdot v_0 L}{4R} = \frac{B^2 L^2 v_0}{4R} = m_1 a_1 = 2m a_1$$

$$a_1 = \frac{B^2 L^2 v_0}{8mR}$$

- 2) Через горизонтальний провідник протікає струм $v_1 = v_2$ т.к. швидкість не змінюється, ускорення кожного провідника дорівнює нулю
 $\Rightarrow F_A = 0 = B \cdot i \cdot L \Rightarrow i = 0$

Можливо рівно протікає струм, коли $E_{i1} - E_{i2} = 0$

$$B v_1 L - B v_2 L = 0 \quad v_1 = v_2$$

Заменим закон збереження імпульсу:

$$2m v_0 = (2m + m) v_1$$

$$v_1 = \frac{2}{3} v_0$$

$$3) a_1 = \frac{F_A}{2m} = \frac{B(i \cdot L)}{2m} = \frac{B \cdot i(t) \cdot L}{2m} = \frac{BL}{2m} \cdot \frac{E_{i1} - E_{i2}}{4R} = \frac{BL}{8mR} (B v_1 L - B v_2 L) = \frac{B^2 L^2}{8mR} (v_1 - v_2) \quad K = \frac{B^2 L^2}{8mR}$$

$$\text{Аналогічно:} \quad a_2 = \frac{B^2 L^2}{4mR} (v_1 - v_2) = 2K (v_1 - v_2)$$

$$a_1 = \frac{dv_1}{dt} \quad v_1 = \frac{ds_1}{dt} \quad a_2 = \frac{dv_2}{dt} \quad v_2 = \frac{ds_2}{dt}$$

S₁ - рух першого провідника, S₂ - другого

$$a_1 = K (v_1 - v_2)$$

$$\frac{dv_1}{dt} = K \left(\frac{ds_1}{dt} - \frac{ds_2}{dt} \right)$$

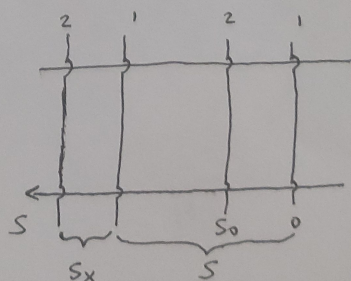
$$dv_1 = K (ds_1 - ds_2)$$

Сгруппируем:

$$\Delta v_1 = K (\Delta S_1 - \Delta S_2)$$

$$\Delta v_1 = K (S - (S_x + S - S_0)) = K (S - S_x - S + S_0) = K (S_0 - S_x)$$

$$v_1 - v_0 = K (S_0 - S_x)$$



$$\Delta S_1 = S$$

$$\Delta S_2 = S_x + S - S_0$$

(2)

Задача

$$\frac{2}{3} U_0 - U_0 = K(S_0 - S_x)$$

$$-\frac{1}{3} U_0 = K(S_0 - S_x)$$

$$-\frac{1}{3} U_0 = K S_0 - K S_x$$

$$S_x = \left(K S_0 + \frac{1}{3} U_0 \right) \cdot \frac{1}{K} = S_0 + \frac{1}{3} \frac{U_0}{K} = S_0 + \frac{1}{3} \cdot \frac{U_0}{B^2 L^2} \cdot 8mR$$

$$\text{Прим.: } 1) \quad q_1 = \frac{B^2 L^2 U_0}{8mR}$$

$$2) \quad U_1 = U_2 = \frac{2}{3} U_0$$

$$3) \quad S_x = S_0 + \frac{1}{3} \frac{U_0}{B^2 L^2} \cdot 8mR$$

Задача №3

Дано:

$\mathcal{E}, R,$

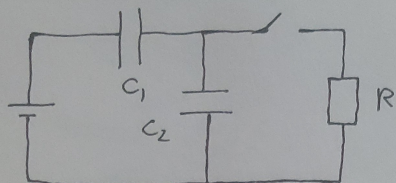
$C_1 = 4C, C_2 = C$

1) $I_R - ?$

2) $Q - ?$

3) I_0

$U_R - ?$



$$1) I_R = \frac{U_2}{C_2}$$

$$U_2 = q_2 \cdot C_2$$

$$q_2 = q_1 = q = \mathcal{E} \cdot C_1$$

$$C_{12} = \left(\frac{1}{C_1} + \frac{1}{C_2} \right)^{-1} = \left(\frac{C_1 + C_2}{C_1 C_2} \right)^{-1} = \frac{C_1 C_2}{C_1 + C_2}$$

$$q_2 = \mathcal{E} \cdot \frac{C_1 C_2}{C_1 + C_2}$$

$$U_2 = \mathcal{E} \cdot \frac{C_1 C_2}{C_1 + C_2}$$

Упражнение

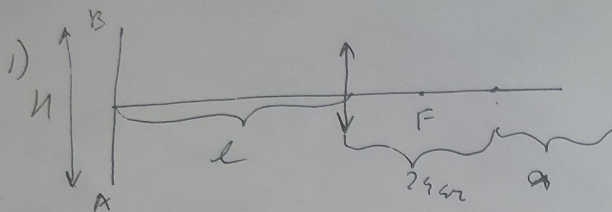
N3

$$F = 18 \text{ cm}$$

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

$$L = 72 \text{ cm}$$

$$\text{архимедовая: } 24 \text{ cm} = 9$$

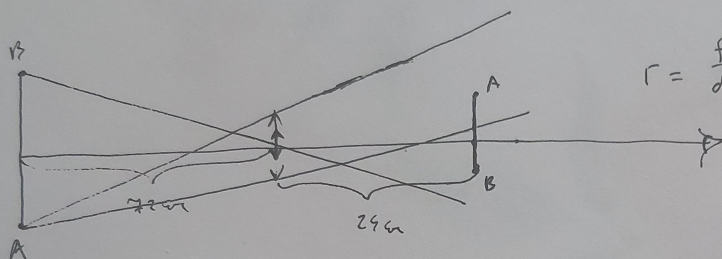


$$\frac{1}{L} + \frac{1}{F} = \frac{1}{F'} \quad \frac{1}{F'} = \frac{1}{F} - \frac{1}{L}$$

$$f = \frac{FL}{L-F} = \frac{18 \cdot 72}{54} = 24 \text{ cm}$$

$$x = 48 \text{ cm}$$

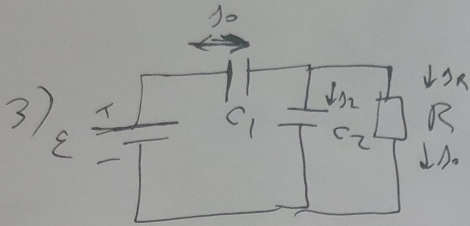
2)



$$f = \frac{f}{d} = \frac{24}{72} = \frac{1}{3}$$



Uppg. 3



$$I_0 = I_2 + I_R$$

$$\varepsilon - U_1 = I_R \cdot R = U_2$$

$$I_2 = \frac{\Delta q_2}{\Delta t}$$

$$U_2 = \frac{q_2}{C_2}$$

$$\left\{ \begin{array}{l} \varepsilon = U_1 + U_2 \\ U_2 = I_R \cdot R \\ I_R + I_2 = I_0 \\ U_1 = \frac{q_1}{C_1} \\ U_2 = \frac{q_2}{C_2} \\ I_0 = \frac{dq_1}{dt} \quad I_2 = \frac{dq_2}{dt} \end{array} \right.$$

$$U_2 = \frac{q_2}{C_2} = \frac{I_2 \cdot \Delta t}{C_2}$$

$$I_R = \frac{I_2 \Delta t}{C_2 \cdot R}$$

$$I_0 = \frac{I_2 \Delta t}{C_2 R} + I_2$$

$$I_2 = \frac{I_0}{1 + \frac{\Delta t}{C_2 R}}$$

$$\frac{dU}{dt} = q$$

$$\frac{dq}{dt} \cdot C$$

3. a) gesamt kondensator

$$\varepsilon =$$

$$U_C = \frac{q_C}{C} = \varepsilon - I_R$$

$$\frac{q_C}{C} = \varepsilon - \frac{dq_C}{dt} R$$

$$\frac{q_C}{C} = \varepsilon - \frac{\Delta q}{\Delta t} R$$

$$I_2 = \frac{\Delta q}{\Delta t}$$

$$I_2 \cdot \Delta t = q_{02} - q_2$$

$$\varepsilon = U_1 + R \cdot I_R$$

$$I_R = \frac{\varepsilon - U_1}{R}$$

$$I_0 = I_2 + \frac{\varepsilon - U_1}{R}$$

$$I_2 = I_0 - \frac{\varepsilon - U_1}{R}$$

$$U(t)$$

$$U'(t) = \frac{dU}{dt} = \frac{dq}{dt} \cdot C = I \cdot C$$

~~Условие~~ Условие

N3

Дано:

$\mathcal{E}, R$

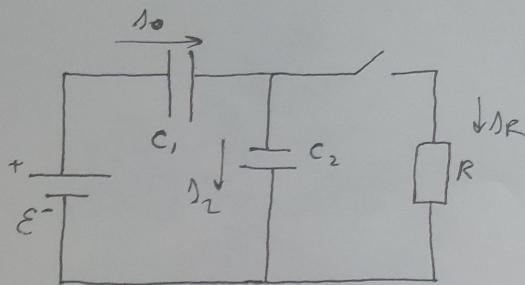
$C_2 = C, C_1 = 4C$

1) I_R - ?

2) Q - ?

3) I_0

U_R - ?



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

$$\mathcal{E} = U_1 + U_2, \text{ где}$$

U_1 - напряжение на конденсаторе емкостью

$C_1, U_2 - C_2$.

$$U = \frac{Q}{C} \quad U \sim \frac{1}{C} \quad Q_1 = Q_2 = Q = \mathcal{E} \cdot C_{12}$$

$$U_2 = \frac{\mathcal{E} \cdot C_{12}}{C_2}$$

$$C_{12} = \left(\frac{1}{C_1} + \frac{1}{C_2} \right)^{-1} = \frac{C_1 C_2}{C_1 + C_2} = \frac{4C^2}{5C} = \frac{4}{5}C$$

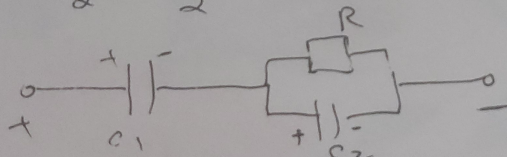
$$U_2 = \frac{\mathcal{E} \cdot C_{12}}{C_2 (C_1 + C_2)} = \frac{\mathcal{E} C_1}{C_1 + C_2} = \frac{\mathcal{E} \cdot 4C}{5C} = \frac{4}{5}\mathcal{E}$$

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

$$2) Q = U_R \cdot I_R \cdot \Delta t$$

$$A_{\text{ист}} + W_1 = Q + W_2$$

$$\frac{4C U_1^2}{2} + \frac{C U_2^2}{2} + A_{\text{ист}} = Q + \frac{C_1 U_1^2}{2}$$



$$\mathcal{E} = U_1 + I \cdot R$$

$$U_1 = \frac{4}{5}\mathcal{E} = \frac{\mathcal{E} \cdot \frac{4}{5}C}{4C} = \frac{\mathcal{E}}{5}$$

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

$$Q = \frac{C_2 U_2^2}{2}$$

Через время t в резисторе становится 0.

$$U_1 = \mathcal{E} \quad \Delta Q = Q_{\text{кон}} - Q_0 = 4C \cdot \mathcal{E} - \frac{4}{5}C \mathcal{E} = \frac{20-4}{5}C \mathcal{E} = \frac{16}{5}C \mathcal{E}$$

$$\frac{4C U_1^2}{2} + \frac{C U_2^2}{2} + \frac{16}{5}C \mathcal{E}^2 = Q + \frac{4C \cdot \mathcal{E}^2}{2}$$

$$2C \cdot \frac{\mathcal{E}^2}{25} + \frac{C}{2} \cdot \frac{16\mathcal{E}^2}{25} + \frac{16}{5}C \mathcal{E}^2 = Q + 2C \mathcal{E}^2$$

$$Q = C \mathcal{E}^2 \left(\frac{2}{25} + \frac{8}{25} + \frac{16}{5} - 2 \right) = \frac{2+8+80-50}{25} = \frac{40}{25} = \frac{8}{5}C \mathcal{E}^2$$

№4

Цепь в магн. поле

Дано:

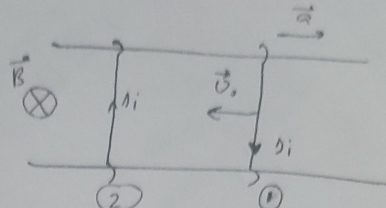
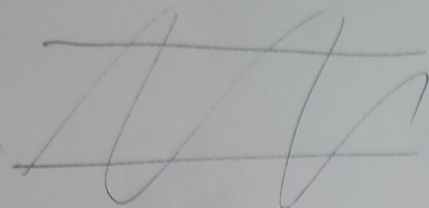
$L, (2m, R): 1$

$2: m; 3R$

1) $a_1 - ?$

2) $U_1, U_2 - ?$

3) $S_0, S_1 - ?$



$$1) F_A = BIL$$

$$I = \frac{\mathcal{E}}{4R} = \frac{BU_0 L}{4R}$$

$$F_A = B \cdot \frac{BU_0 L}{4R} \cdot L = \frac{B^2 L^2 U_0}{4R} = ma$$

$$a = \frac{B^2 L^2 U_0}{4Rm}$$

$$2) mU_0 = (m + 2m)U_1$$

$$F = 0$$

$$U_1 = \frac{U_0}{3}$$

Условие сохранения импульса $\Delta = 0$ т.к. $U = \text{const}$

3) $S_0 -$

$$X_1 = \int v dt$$

Второй закон Ньютона
в проекции на ось Ox $0 = \sum F_x$

$$v(t) = \int a dt$$

$$a = \frac{F_A}{m} = \frac{BIL(t)L}{m}$$

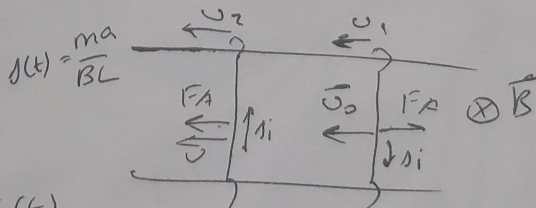
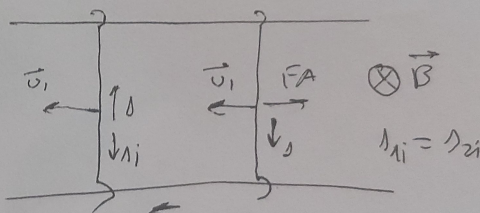
$$I(t) = \frac{\mathcal{E}(t)}{4R} = \frac{\mathcal{E}_1(t) - \mathcal{E}_2(t)}{4R}$$

$$I(t) = \frac{BU_1 L - BU_2 L}{4R}$$

$$\frac{ma}{BL} = \frac{BU_1 L - BU_2 L}{4R}$$

$$a_1 = \frac{B^2 L^2}{m \cdot 4R} (U_1 - U_2)$$

$$a_2 = \frac{B^2 L^2}{2m \cdot 4R} (U_1 - U_2)$$



Вот решение! Удачи!

71 ~~решение~~!

$$a_1 = a_2 = a \quad \text{т.к.} \quad U_1 = U_2 = U$$

$$F_{A1} = F_{A2} = F_A \quad \text{т.к.} \quad I_1 = I_2 = I$$