Часть 1

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

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ID профиля: **858988**

Вариант 6

Чистовик

2. Дано

$C_V = \frac{5}{2}R$

$\alpha = 22{,}5°$

$\beta = 15°$

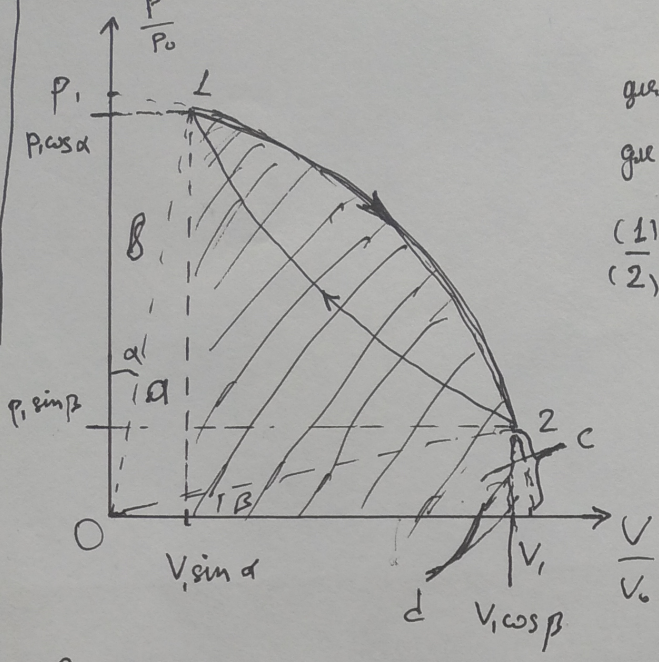
$i = 5$

1) $\frac{T_1}{T_2} - ?$

2) $\gamma - ?$

3) $\frac{A_y}{A_{1-2}} - ?$

Решение.



1) Согласно ур-нию Менделеева-Клапейрона

для сост. 1: $p_1 \cos\alpha V_1 \sin\alpha = \nu R T_1$ (1)

для сост. 2: $p_1 \sin\beta V_1 \cos\beta = \nu R T_2$ (2)

$\frac{(1)}{(2)}: \frac{\nu R T_1}{\nu R T_2} = \frac{p_1 \cos\alpha V_1 \sin\alpha}{p_1 \sin\beta V_1 \cos\beta}$

$\frac{T_1}{T_2} = \frac{\cos\alpha \sin\alpha}{\sin\beta \cos\beta}$ $\frac{T_1}{T_2} = \frac{\sin 2\alpha}{\sin 2\beta}$

$\frac{T_1}{T_2} = \frac{\sin 45°}{\sin 30°} = \frac{\sqrt{2}}{2} \cdot \frac{2}{1} = \sqrt{2}$

3). $A_y = A_{1-2} + A_{2-1}$

$A_{1-2} = S_{\text{фигуры}} = S_{\text{всего}} - \left(S_{\Delta a} + S_{\text{сектор } b} + \left(S_{\text{сектор } c} - S_{\Delta d}\right)\right)$

$A_{1-2} = \frac{1}{4}\pi p_1 V_1 - \left(\frac{1}{2} p_1 \cos\alpha V_1 \sin\alpha + \frac{22{,}5°}{360°} \cdot \pi p_1 V_1 + \left(\frac{15°}{360°} \pi p_1 V_1 - \frac{1}{2} p_1 \sin\beta V_1 \cos\beta\right)\right) =$

$= p_1 V_1 \left(\frac{\pi}{4} - \left(\frac{1}{2} \cdot \frac{1}{2} \sin 2\alpha + \frac{1}{16}\pi + \frac{1}{24}\pi - \frac{1}{2} \cdot \frac{1}{2} \sin 2\beta\right)\right) = \frac{1}{4} p_1 V_1 \left(1 - \left(\sin 45° + \frac{\pi}{4} + \frac{\pi}{6} - \sin 30°\right)\right)$

$= \frac{1}{4} p_1 V_1 \left(1 - \left(\frac{\sqrt{2}}{2} + \frac{\pi}{4} + \frac{\pi}{6} - \frac{1}{2}\right)\right) = \frac{1}{8} p_1 V_1 \left(3 - \left(\sqrt{2} + \frac{\pi}{2} + \frac{\pi}{3}\right)\right) = \frac{1}{8} p_1 V_1 \left(\pi\left(\frac{13}{6}\right) - \sqrt{2}\right)$

$\Delta U_{2-1} = Q_{2-1} - A_{2-1}^{\nearrow}$ $Q_{2-1} = 0 \Rightarrow A_{2-1} = -\Delta U_{2-1} = -\left(\frac{i}{2}\nu R \Delta T\right)$ $\Delta(pV) = \nu R \Delta T$

$A_{2-1} = -\frac{i}{2}\left(p_1 \cos\alpha V_1 \sin\alpha - p_1 \cos\beta V_1 \cos\beta\right) = -\frac{i}{4} p_1 V_1 \left(\sin 2\alpha - \sin 2\beta\right)$

$A_{2-1} = -\frac{i}{4} p_1 V_1 \left(\frac{\sqrt{2}}{2} - \frac{1}{2}\right) = -\frac{i}{8} p_1 V_1 \left(\sqrt{2} - 1\right) = -\frac{5}{8} p_1 V_1 \left(\sqrt{2} - 1\right)$

$\frac{A_y}{A_{1-2}} = \frac{A_{1-2} + A_{2-1}}{A_{1-2}} = 1 + \frac{A_{2-1}}{A_{1-2}} = 1 + \frac{-\frac{5}{8} p_1 V_1 (\sqrt{2} - 1)}{\frac{1}{8} p_1 V_1 \left(\frac{13}{6}\pi - \sqrt{2}\right)} =$

$= 1 - \frac{5(\sqrt{2} - 1)}{\frac{13}{6}\pi - \sqrt{2}}$

Ответ. 1) $\frac{T_1}{T_2} = \frac{\sin 45°}{\sin 30°}$; $\frac{T_1}{T_2} = \sqrt{2}$ 3) $\frac{A_y}{A_{1-2}} = 1 - \frac{5(\sqrt{2} - 1)}{\frac{13}{6}\pi - \sqrt{2}}$

1

Чистовик.

1. Дано:

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

m, 2m

H,

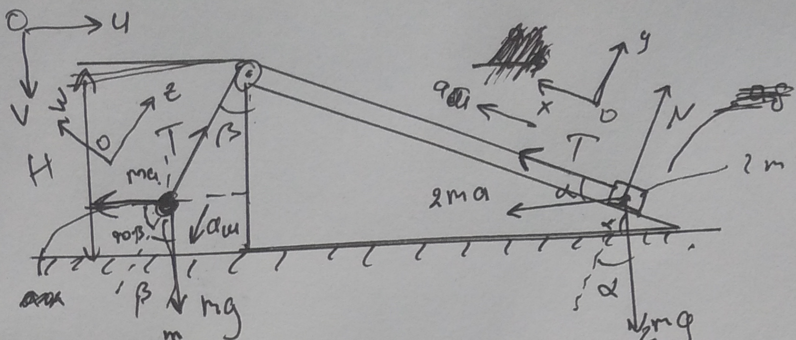
$\cos\beta = \frac{12}{13}$

1.) a - ?

2) $a_{отн}$ - ?

3) t - ?

Решение:



~~2ЗН „2m": Oy: N − 2mg cos α = $a_{\delta y}$ (1)~~

~~Ox: T − 2mg sin α = $a_{\delta x}$ (2)~~

~~2ЗН „m" Oz: T − mg cos β = a_{mz} $-a_{mz} = a_{\delta x}$ т.к. нить нерастяжима.~~

~~mg cos β − T = $a_{\delta x}$ (3)~~

~~$a_{mv} = \frac{-a_{mz}}{\cos\beta} = \frac{a_{\delta x}}{\cos\beta}$~~

(2) + (3):

НСО отн. клина: 2ЗН „m": Ow: $-mg\sin\beta + ma\sin(90-\beta) = 0$

$ma\cos\beta = mg\sin\beta$ $a = g\frac{\sin\beta}{\cos\beta}$, где $\sin\beta = \sqrt{1-\cos^2\alpha} = \sqrt{1-\frac{12^2}{13^2}} = \frac{5}{13}$

$a = 10\frac{м}{с^2}\cdot\frac{5}{13}\cdot\frac{13}{12} = \frac{25}{6}$ м/с²

2ЗН „2m"; Ox; $2ma\cos\alpha + T - 2mg\sin\alpha = 2ma_m$

$2a + T - 2g\sin\alpha = 2a_m$ (1)

2ЗН „m": Oz; $T - ma\cos(90-\beta) - mg\cos\beta = -ma_m$

$T - a\sin\beta - g\cos\beta = -a_m$ (2)

(1)−(2): $2a\cos\alpha - 2g\sin\alpha + a\sin\beta + g\cos\beta = 3a_m$ $\sin\alpha = \frac{3}{5}$ $a_m = a_{отн.}$

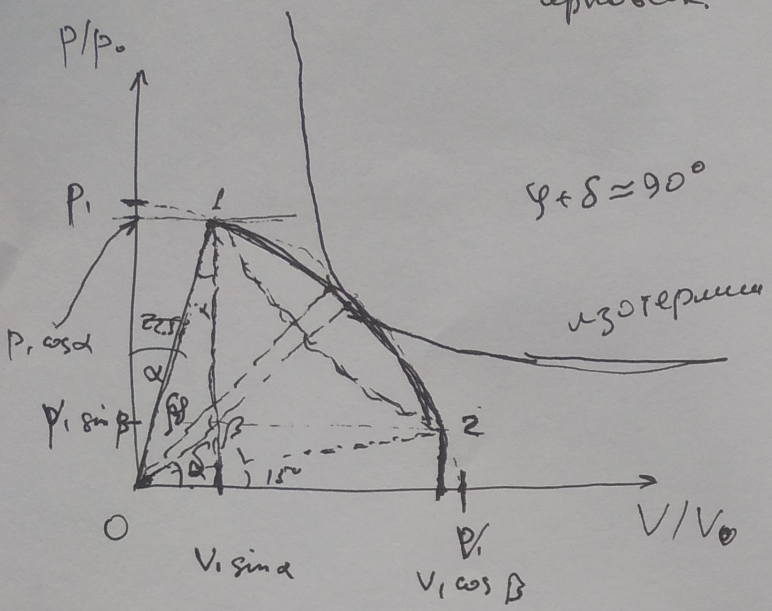
$a_m = \frac{a(2\cos\alpha + \sin\beta) + g(\cos\beta - 2\sin\alpha)}{3}$ $a_m = \frac{\frac{25}{6}\frac{м}{с^2}\left(2\cdot\frac{4}{5}+\frac{5}{13}\right) + 10\frac{м}{с^2}\left(\frac{12}{13} - 2\cdot\frac{3}{5}\right)}{3} =$

$= \left(\frac{25}{18}\left(\frac{8}{5}+\frac{5}{13}\right) + \frac{10}{3}\left(\frac{12}{13} - \frac{6}{5}\right)\right)\frac{м}{с^2}$

Ответ: 1) $a = g\frac{\sin\beta}{\cos\beta}$, где $\sin\beta = \frac{5}{13}$ $a = \frac{25}{6}\frac{м}{с^2}$ 2) $a_{от} = \frac{a(2\cos\alpha + \sin\beta) + g(\cos\beta - 2\sin\alpha)}{3}$

(2)

2. Черновик



$\varphi + \delta \simeq 90°$

$C = 0 \Rightarrow T \uparrow$ но $Q = 0$

изотерма

$\Delta U = A'$

Q

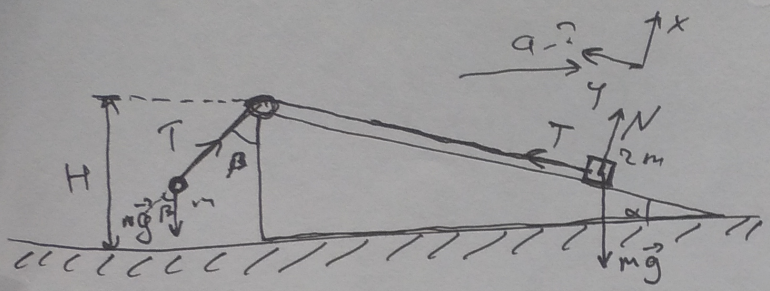
3) $A_{1-2} = \pi p_0 V_0 - \left(\frac{1}{2} p_1 \cos\alpha \, V_1 \sin\alpha + \frac{2\pi \cdot 30}{2 \cdot 150} \pi p_0 V_0 + \left(\frac{3 \cdot 60°}{150} \pi p_1 V_1 - \frac{1}{2} p_1 \sin\beta \, V_1 \cos\beta \right) \right) =$

$= p_0 V_0 (\ldots)$

$\Delta U = Q - A'$

$A' = Q - \Delta U \quad Q = 0$

$A' = -\Delta U \qquad \Delta U = \frac{i}{2} \nu R \Delta T = \frac{i}{2} \nu R \Delta (p_0 V_0) = \frac{i}{2} R$


a
x
y
T
T
N
2m
H
β
m
mg
α
mg

Часть 2

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

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Вариант 6

Беловик (Чистовик)

3. Дано

$C_1 = C$

$C_2 = 3C$

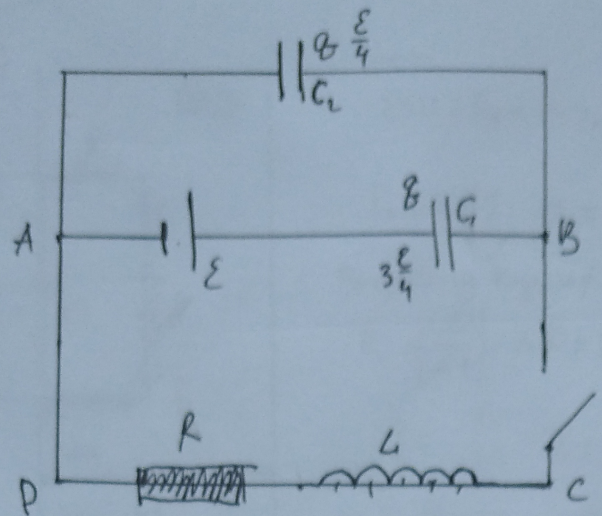
$\mathcal{E}, R, L$

1) $J' - ?$

2) $Q - ?$

3) $U_R - ?$

при $J = J_0$ через C_2



$C = \frac{q}{U} \Rightarrow U = \frac{q}{C}$

$U_1 = \frac{q}{C_1} = \frac{q}{C} = 3U$ $U_2 = \frac{q}{C_2} = \frac{q}{3C} = \frac{3U}{3} = U$

Дозамык: $\mathcal{E} = 3U + U$ $\mathcal{E} = 4U$

$U = \frac{\mathcal{E}}{4}$ $U_1 = \frac{3\mathcal{E}}{4}$ $U_2 = \frac{\mathcal{E}}{4}$

сразу после замык ключа: ~~т.к. U_3 за L~~ J через катушку равен $=0$

По правилу Кирхгофа для контура ABCDA: $\mathcal{E} + \mathcal{E}_i = U$, $\mathcal{E}_i = -LJ'$

$\mathcal{E} - LJ' = \frac{3}{4}\mathcal{E}$ $LJ' = \frac{\mathcal{E}}{4}$ $J' = \frac{\mathcal{E}}{4L}$

Ответ 1) $J' = \frac{\mathcal{E}}{4L}$

Чистовик.

5) Дано.

$d_1 = 25$ см

$\frac{D_1}{D_2} = \frac{7}{3}$

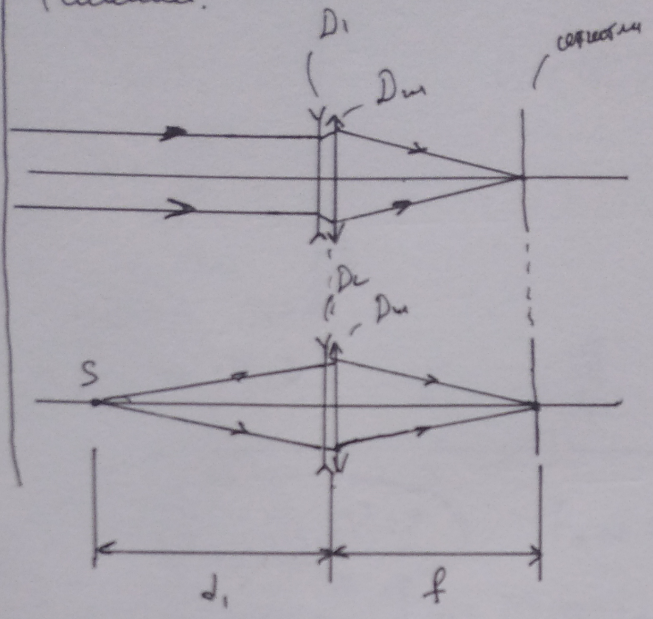
$d_2 = 50$ см

1) x – ?

D_1 – ?

2) D_3 – ?

Решение.



$D_1 + D_{лин} = \frac{1}{f}$ (1) $\frac{1}{d} = 0$ при $d \to \infty$

$D_2 + D_{лин} = \frac{1}{f} + \frac{1}{d_1}$

$D_2 = \frac{3}{7} D_1$ $\frac{3}{7} D_1 + D_{лин} = \frac{1}{f} + \frac{1}{d_1}$ (2)

1)

(2) – (1): $\frac{3}{7} D_1 - D_1 = \frac{1}{d_1} \Rightarrow -\frac{4}{7} D_1 = \frac{1}{d_1}$ $D_1 = -\frac{7}{4 d_1}$, $D_1 = -\frac{7}{4 \cdot 0{,}25\text{ м}} = -7$ дптр.

Изображение: $D_{лин} = \frac{1}{f} + \frac{1}{x} \Rightarrow \frac{1}{x} = D_{лин} - \frac{1}{f}$ из (1): $D_1 = \frac{1}{f} - D_{лин} = -\left(D_{лин} - \frac{1}{f}\right)$ (3)

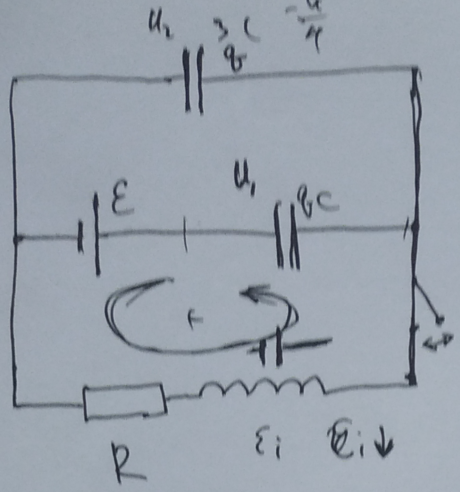
$\frac{1}{x} = -D_1 \Rightarrow x = -\frac{1}{D_1}$ $x = \frac{4 d_1}{7}$ ~~$\left(\frac{100}{7}\text{ см}\right)$~~ $x = \frac{4 \cdot 25\text{ см}}{7} = \frac{100}{7}$ см $\approx 14{,}3$ см

2) $D_3 + D_{лин} = \frac{1}{f} + \frac{1}{d_2} \Rightarrow D_3 = \left(\frac{1}{f} - D_{лин}\right) + \frac{1}{d_2}$

Подставим (3), имеем: $D_3 = D_1 + \frac{1}{d_2}$ $D_3 = -\frac{7}{4 d_1} + \frac{1}{d_2}$ $D_3 = -7$ дптр $+ \frac{1}{0{,}5\text{ м}} = -5$ дптр

Ответ. 1) $x = \frac{4 d_1}{7}$, $x = \frac{100\text{ см}}{7} \approx 14{,}3$ см; $D_1 = -\frac{7}{4 d_1}$, $D_1 = -7$ дптр. 2) $D_3 = -\frac{7}{4 d_1} + \frac{1}{d_2}$, $D_3 = -5$ дптр

Черновик.



$C=\frac{q}{U}$ $U=\frac{q}{C}$ $U_1=\frac{q}{C}$ $U_2=\frac{q}{3C}$

$U_1+U_2=$ $=U$ $=\frac{U}{3}$

$U+\frac{U}{3}=\varepsilon$

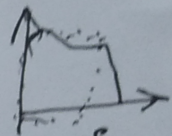
$\frac{4}{3}U=\varepsilon$ $\boxed{U=\frac{3}{4}\varepsilon}$

$\varepsilon_i=-L\frac{dI}{dt}$ U_2

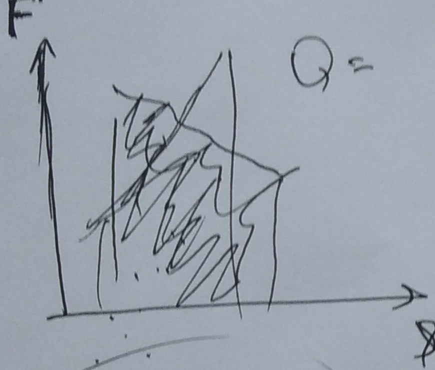
$$F_A=\frac{(Bd)^2 v}{R}$$

$F_A\Delta x=\frac{m}{2}\Delta(v^2)$

$F_A(S)=m\,a(S)$ $Q=\Delta H$



$Q=\frac{U^2}{R}t$ $Q=I^2Rt$

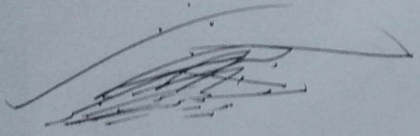


$Q=$

$F_A(S)=Bd\,I(S)$ $Q=\frac{(\varepsilon_i)^2}{R}t=\frac{(Blv)^2}{R}\Delta t$ $\Delta t=\frac{\Delta S}{v}$

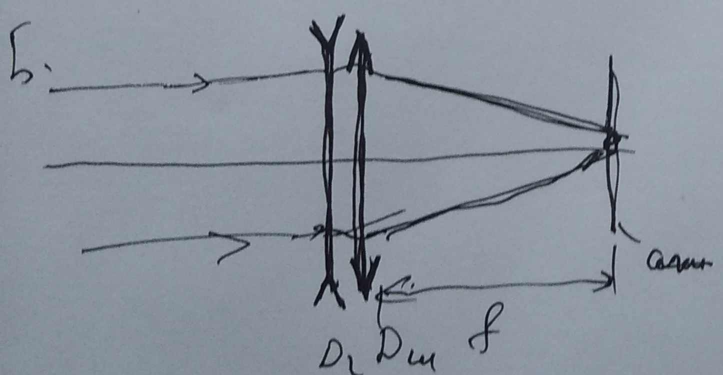
$I(S)-?$ $I=\frac{\varepsilon_i}{R}=\frac{B\Delta S}{\Delta t R}=\frac{Bl}{R}\frac{\Delta x}{\Delta t}$

$\frac{Blv(S)}{R}$



$\frac{mv_1^2}{2}+\frac{mv_2^2}{2}=$ v ΔQ

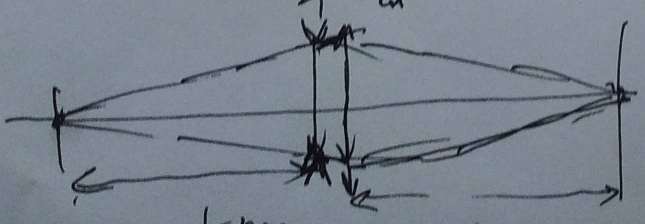
$Q=\frac{(Bl)^2 v\Delta S}{R}$ F_A



$D_2+D_л=\frac{1}{f}$

$\frac{D_2}{D_1}=\frac{7}{3}$

$D_2=\frac{7}{3}D_1$



$D_1+D_л=\frac{1}{d}+\frac{1}{f}$

$D_л=\frac{1}{f}+\frac{1}{x}$ $\frac{1}{x}=D_л-\frac{1}{f}$

Боловак (Чистовик)

4. Дано

d

$B = \frac{d}{4}$

v_0, R, B

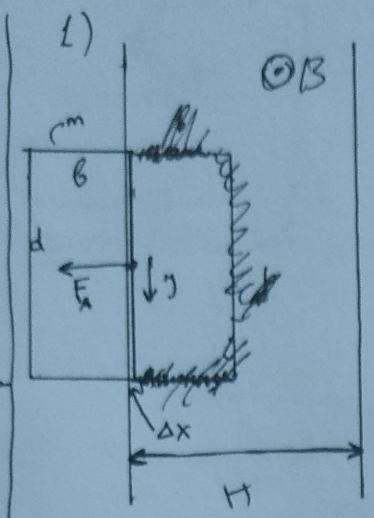
$v(t) = v_0$

$H = 2d$

1) $a_0 - ?$

2) $v_1 - ?$

3) $v_2 - ?$



Решение.

2ЗН: $F_A = ma_0$ $a_0 = \frac{F_A}{m}$

$F_A = BdJ$ $a_0 = \frac{BdJ}{m}$ (1)

По правилу Кирхгофа: $\mathcal{E}_i = JR$

$\mathcal{E}_i = \left|\frac{\Delta\Phi}{\Delta t}\right|$ $\Delta\Phi = B\Delta S = B \cdot d \cdot \Delta x$ $\mathcal{E}_i = \frac{B \cdot d \cdot \Delta x}{\Delta t} = Bdv$

$J = \frac{\mathcal{E}_i}{R}$ $J = \frac{Bdv}{R}$ (2)

Подставим (2) в (1) $a_0 = \frac{(Bd)^2 v}{mR}$

Ответ. 1) $a_0 = \frac{(Bd)^2 v}{mR}$