Часть 1

Олимпиада: **Физика, 10 класс (1 часть)**

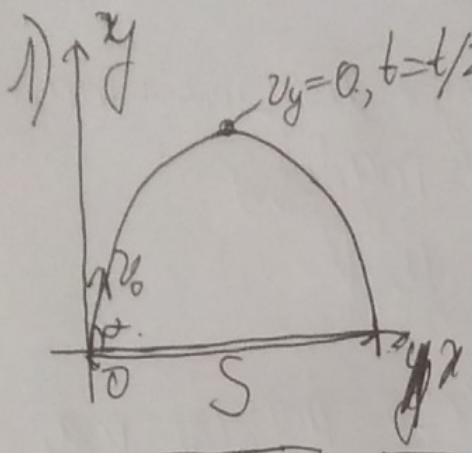
Шифр: **21204485**

ID профиля: **185626**

Вариант 3

Чистовик.

№1.

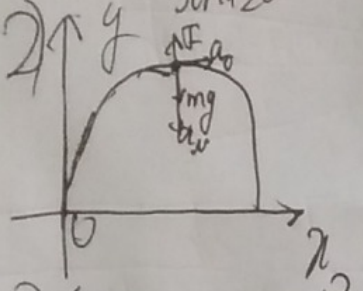
1) 

$S=v_0\cos\alpha\, t$

$v_0\sin\alpha=\frac{gt}{2}\Rightarrow t=\frac{2v_0\sin\alpha}{g}$.

$S=\frac{2v_0^2\sin\alpha\cos\alpha}{g}\Big|\Rightarrow v_0=\sqrt{\frac{Sg}{2\sin2\alpha}}$.

$v_0=\sqrt{\frac{17\cdot10}{\sin120^\circ}}=\sqrt{\frac{170\cdot2}{\sqrt3}}=\sqrt{\frac{340}{\sqrt3}}\approx14{,}01\left(\frac{м}{с}\right)$.

2) 

$v=\text{const}\Rightarrow a_\tau=0$.

Oy: $-ma_y=F-mg$

$ma_y=mg-F$. $F=m(g-a_y)$.

~~$F=ma_y=\frac{mv_0^2}{16\ell}$~~.

$y_k=0+v_0\sin\alpha\, t-\frac{gt^2}{2}$

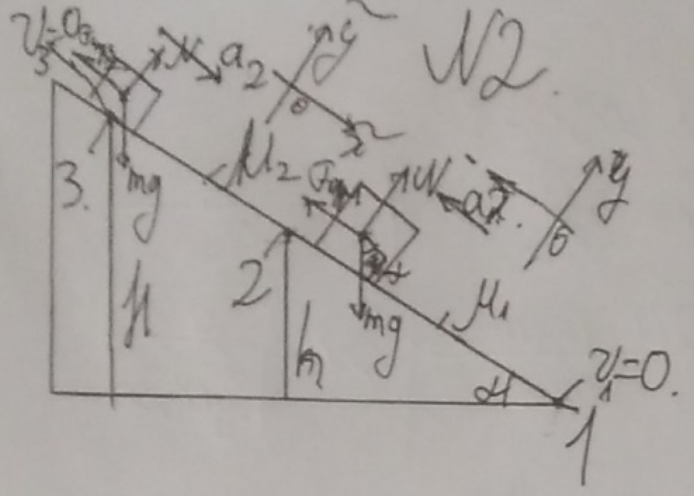
$x_k=v_0\cos\alpha\, t\Rightarrow t=\frac{x_k}{v_0\cos\alpha}$.

$y_k=\frac{v_0\sin\alpha\, x_k}{v_0\cos\alpha}-\frac{gx_k^2}{2v_0^2\cos^2\alpha}=\left(x_k\operatorname{tg}\alpha-x_k^2\left(\frac{g}{2v_0^2\cos^2\alpha}\right)\right)$.

Ответ: $v_0=14{,}01\frac{м}{с}$.

Чистовик.

№2.



$$\begin{cases} Ox: F_{тр1} - mg\sin\alpha = ma_1 \\ Oy: N = mg\cos\alpha \\ F_{тр1} = \mu_1 N \end{cases}$$

$\mu_1 mg\cos\alpha - mg\sin\alpha = ma_1$

$a_1 = \mu_1 g\cos\alpha - g\sin\alpha = g(\mu_1\cos\alpha - \sin\alpha)$.

$$\begin{cases} \frac{h}{\sin\alpha} = \frac{v_2^2 - v_1^2}{2a_1} = \frac{v_2^2}{2a_1} \\ v_2 = a_1 T \end{cases}$$

$$\frac{h}{\sin\alpha} = \frac{a_1^2 T^2}{2a_1} \Rightarrow T = \sqrt{\frac{2h}{a_1\sin\alpha}} = \sqrt{\frac{2h}{g(\mu_1\cos\alpha - \sin\alpha)\sin\alpha}}$$

$$T = \sqrt{\frac{2\cdot 2}{0{,}5\cdot 10\cdot(0{,}8\cdot\frac{\sqrt{3}}{2} - 0{,}1)}} = \sqrt{\frac{8}{5(0{,}8\sqrt{3} - 1)}} \approx 1{,}99\,(с).$$

$v_3 = 0. \Rightarrow \frac{H-h}{\sin\alpha} = \frac{v_2^2}{2a_2} \Rightarrow \frac{H-h}{\sin\alpha} = \frac{a_1^2 T^2}{2a_2}$.

$$\begin{cases} Ox: mg\sin\alpha - F_{тр2} = ma_2 \\ Oy: N = mg\cos\alpha \\ F_{тр2} = \mu_2 N \end{cases}$$

$mg\sin\alpha - \mu_2 mg\cos\alpha = ma_2$

$a_2 = g(\sin\alpha - \mu_2\cos\alpha)$

$$\frac{H-h}{\sin\alpha} = \frac{2h\,g^2(\mu_1\cos\alpha - \sin\alpha)^2}{\sin\alpha\, g(\mu_1\cos\alpha - \sin\alpha)\cdot 2\cdot g(\sin\alpha - \mu_2\cos\alpha)}$$

$H - h = \frac{h(\mu_1\cos\alpha - \sin\alpha)}{\sin\alpha - \mu_2\cos\alpha}$

$H = h\left(\frac{\mu_1\cos\alpha - \sin\alpha + \sin\alpha - \mu_2\cos\alpha}{\sin\alpha - \mu_2\cos\alpha}\right) =$

$= h\cos\alpha\,\frac{\mu_1 - \mu_2}{\sin\alpha - \mu_2\cos\alpha}$

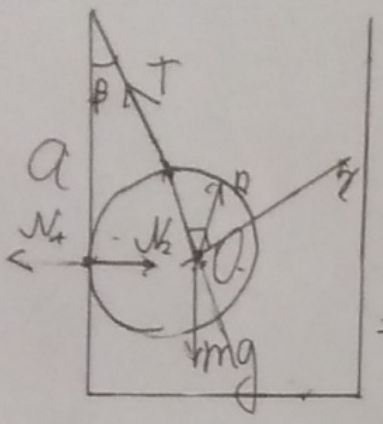
$H = 2\cdot\frac{\sqrt{3}}{2}\cdot\frac{0{,}81 - 0{,}11}{0{,}5 - 0{,}11\cdot\frac{\sqrt{3}}{2}} = \frac{2\sqrt{3}(0{,}81 - 0{,}11)}{1 - 0{,}11\sqrt{3}} \approx$

$\approx 3\,(м)$

Ответ: $T = 1{,}99с$, $H = 3\,м$

Чистовик.

№3



1. по III З. Плотность $N_1 = N_2$.

отн. O: $M_{mg} + M_{N_2} + M_T = 0 \Rightarrow M_T = 0 \Rightarrow$

$\Rightarrow$ нить идёт в центр шара. $\Rightarrow$

$\Rightarrow \sin\beta = \frac{R}{l+R}$

$Ox \perp T$

$a = \sqrt{(R+l)^2 - R^2}$

$N_2 \sin\beta = mg \sin\beta \Rightarrow$ ~~$N_2 = mg$~~

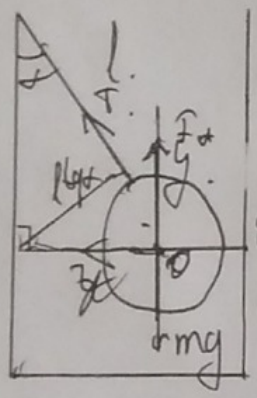
$N_2 \cos\beta$

$\operatorname{tg}\beta = \frac{R}{\sqrt{(R+l)^2 - R^2}}$

$N_2 = mg \operatorname{tg}\beta$.

$N_2 = \frac{mgR}{\sqrt{(R+l)^2 - R^2}}$ $N_2 = \frac{0{,}6 \cdot 10 \cdot 0{,}05}{\sqrt{(0{,}05+0{,}01)^2 - 0{,}05^2}} \approx 2{,}07$ (Н).

II.



отн. O: $\mathcal{E} = 0 \Rightarrow M_{mg} + M_{F_д} + M_T = 0 \Rightarrow M_T = 0 \Rightarrow$

$\Rightarrow$ T проходит через O.

Ox: $T \sin\alpha = m\omega^2 r$. $T \sin\alpha = m\omega^2 (l+R) \sin\alpha$

Oy: $T \cos\alpha + F_д - mg = 0$ $T = m\omega^2 (l+R)$.

$m\omega^2 (l+R)\cos\alpha = mg - \frac{4}{3}\pi R^3 \rho g \Rightarrow$

$\Rightarrow \cos\alpha = \frac{mg - \frac{4}{3}\pi R^3 \cdot \rho g}{m\omega^2 (l+R)} \Rightarrow \cos\alpha \approx 0{,}12 \Rightarrow \alpha \approx 80°$.

Ответ: ~~$\cos\alpha = 0{,}12$~~; $\alpha = 80°$. $N = 2{,}07$ Н.

Черновик

$v_к = v_н + a_2 T \Rightarrow v_н = v_к + a_2 T = g T$.

$S = \frac{v_к^2 - v_н^2}{2a_2} = \frac{g^2 T^2}{2a_1} = \frac{a_2 T^2}{2}$.

$\frac{h}{\sin\alpha} = \frac{a_2 T^2}{2} \Rightarrow T = \sqrt{\frac{2h}{a_2 \sin\alpha}} = \sqrt{\frac{2h}{g(\mu_2\cos\alpha - \sin\alpha)\sin\alpha}} =$

$= \sqrt{\frac{2 \cdot 2}{10 \cdot (0{,}81 \cdot \sqrt{3}/2 - 0{,}5) \cdot 0{,}5}} = \sqrt{\frac{8}{10 \cdot 0{,}81\sqrt{3}/2 - 0{,}5)}} \approx 1{,}99 \approx 1{,}99$ (с).

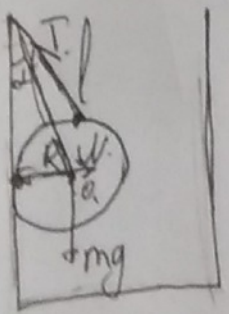
$v_н = a_2 T = g(\mu_2\cos\alpha - \sin\alpha) \cdot \sqrt{\frac{2h}{g(\mu_2\cos\alpha - \sin\alpha)\sin\alpha}} = \sqrt{\frac{2hg(\mu_2\cos\alpha - \sin\alpha)}{\sin\alpha}}$

$\frac{H-h}{\sin\alpha} = \frac{v_н^2}{2a_1}$ $\quad \frac{H-h}{\sin\alpha} = \frac{2hg(\mu_2\cos\alpha - \sin\alpha)}{\sin\alpha \cdot 2g(\sin\alpha - \mu_2\cos\alpha)}$

$H - h = \frac{h(\mu_2\cos\alpha - \sin\alpha)}{\sin\alpha - \mu_2\cos\alpha}$ $\quad H = h\left(\frac{\mu_1\cos\alpha - \sin\alpha + \sin\alpha - \mu_2\cos\alpha}{\sin\alpha - \mu_2\cos\alpha}\right) =$

$= h\cos\alpha \frac{\mu_1 - \mu_2}{\sin\alpha - \mu_2\cos\alpha}$. $\quad H = 2 \cdot \frac{\sqrt{3}}{2} \frac{0{,}81 - 0{,}11}{\frac{1}{2} - 0{,}11 \cdot \frac{\sqrt{3}}{2}} \approx 3$ (м)

№3



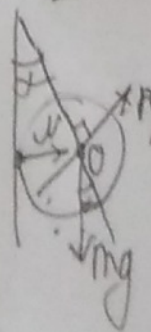
отн. O: $M_{mg} + M_N + M_T = 0$

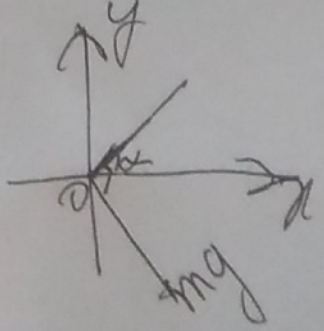
$M_T = 0$.

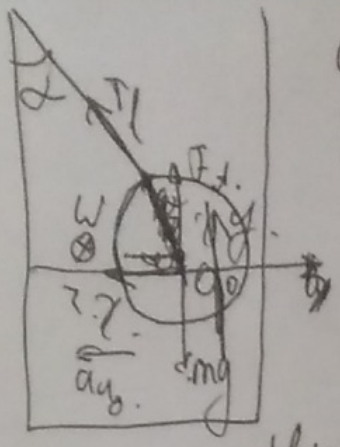
$\sin\alpha = \frac{R}{l+R}$.

$mg\sin\alpha = N\sin\alpha$

$mg = N$







отн. O. $M_{F_A} + M_{mg} + M_T = 0 \Rightarrow M_T = 0$

M

Ox $T\sin\alpha = ma_{oy}$

Oy: $T\cos\alpha = mg - F_A$

$r = (l+R)\sin\alpha$. $T\sin\alpha = (l+R)\sin\alpha\, w^2 m$

$v = wr$

$a_{oy} = \frac{v^2}{r} = w^2 r$

$T = (l+R)w^2 m$.

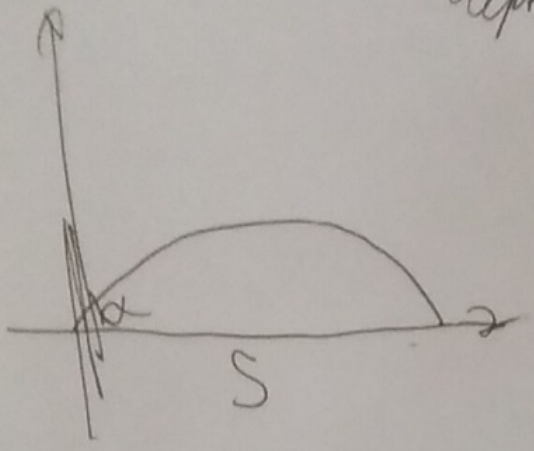
$(l+R)w^2 m\cos\alpha = mg - \rho_б V g$.

$\cos\alpha = \frac{mg - \rho_б V g}{(l+R)w^2 m}$.

$\cos\alpha = \frac{0{,}8 \cdot 10 - 1000 \cdot 10 \cdot \frac{4}{3}\pi \cdot 0{,}05^3}{(0{,}15+0{,}05) \cdot 10^2 \cdot 0{,}8} \approx 0{,}17 \Rightarrow \alpha \approx 80°$.

$0{,}2$

Цифровик.



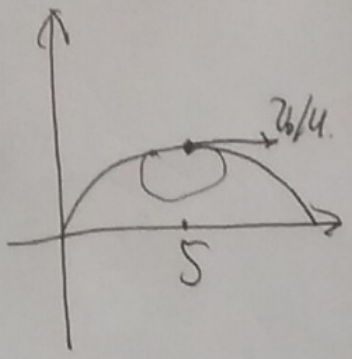
$S = v_0 \cos\alpha \cdot t$.

$v_0 \sin\alpha = \frac{gt}{2} \Rightarrow t = \frac{2v_0 \sin\alpha}{g}$.

$S = \frac{2v_0^2 \sin\alpha\cos\alpha}{g} = \frac{v_0^2 \sin 2\alpha}{g}$.

$v_0 = \sqrt{\frac{Sg}{\sin 2\alpha}}$

$v_0 = \sqrt{\frac{170 \cdot 10}{\sin 120^\circ}} = \sqrt{\frac{170 \cdot 10 \cdot 2}{\sqrt{3}}} = \sqrt{\frac{340}{\sqrt{3}}} \approx 14{,}01 \frac{м}{с}$.



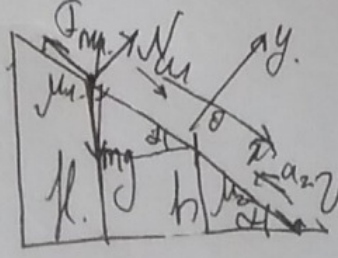
$h = \frac{v_0^2 \sin^2\alpha}{2g}$ $h = \frac{340 \cdot 3}{\sqrt{3} \cdot 2 \cdot 2 \cdot 10} = \frac{\sqrt{3} \cdot 17}{2} \approx$

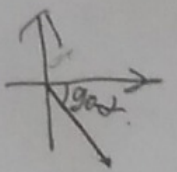
$\approx 14{,}72$ м.

$a_{ц} = \frac{v_0^2}{16R}$.

$mg - F = ma_{ц}$.

№2.





$mg\cos\alpha = N$

$a = g(\sin\alpha - \mu\cos\alpha)$.

$mg\sin\alpha - \mu N = ma$.

$mg\sin\alpha - \mu mg\cos\alpha = ma$

$a_1 = g(\sin\alpha - \mu_1\cos\alpha)$

$a_2 = g(\mu_2\cos\alpha - \sin\alpha)$.

Часть 2

Олимпиада: **Физика, 10 класс (2 часть)**

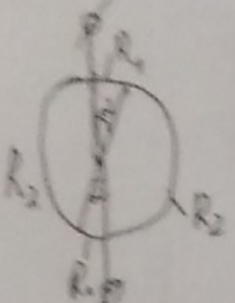
Шифр: **21204485**

ID профиля: **185626**

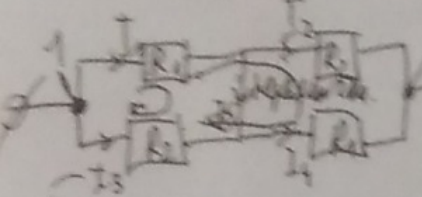
Вариант 3

Числовая.

№5.



1) Т.к. углы равны, то и дуги будут равны, и сопротивления этих дуг тоже будут равны. Сопротивление половины кольца будет равно $R/2$, а $R_1 = \frac{R \cdot \alpha}{2 \cdot 180} = \frac{R}{360}\alpha$, где α - угол поворота в градусах. ($0 \le \alpha \le 90°$). $R_2 = \frac{R}{2} - R_1$



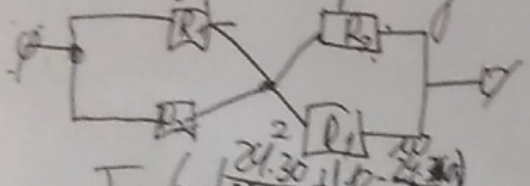
Запишем II правило Кирхгофа для большого и малого контуров. $\begin{cases} I_1 R_1 - I_3 R_2 = 0 \\ I_1 R_1 + I_2 R_2 - I_3 R_2 - I_4 R_1 = 0 \end{cases}$

получаем $\begin{cases} I_1 R_1 = I_3 R_2 \\ I_2 R_1 = I_4 R_1 \end{cases}$ Запишем I правило Кирхгофа для узла (1) $I_1 + I_3 = I = I_2 + I_4$.

$I_1 = \frac{R_2}{R_1} I_3$. $I_3\left(\frac{R_2}{R_1} + 1\right) = I_2\left(\frac{R_2}{R_1} + 1\right) \Rightarrow$

$I_4 = \frac{R_2}{R_1} I_2$. $\Rightarrow I_3 = I_2 \Rightarrow I_1 = I_4$.

$I_5 + I_2 = I_1$. Найдём общее сопротивление всей цепи:



$R_0 = \frac{R_1 R_2}{R_1 + R_2} \cdot 2$ $I_0 = \frac{U}{R_0}$ $I = \frac{U(R_1 + R_2)}{2 R_1 R_2}$

$I = \frac{6 \cdot \left(\frac{24 \cdot 30}{360} + (0 - \frac{24 \cdot 30}{360})\right)}{2 \cdot \frac{24 \cdot 30}{360}\left(12 - \frac{24 \cdot 30}{360}\right)} = 1{,}8\,(А)$ $P_1 = UI$ $P_1 = 1{,}8 \cdot 6 = 10{,}8\,(Вт)$

2) $I_5 = \frac{2}{3}\alpha$. $\begin{cases} I_5 + I_2 = I_1 \\ I_1 + I_2 = I_0 \end{cases}$

$\frac{I_1}{I_2} = \frac{R_2}{R_1} \Rightarrow I_1 = I_2 \frac{R_2}{R_1}$ $I_2 = I_0 - I_5$

$I_0 = \frac{U\left(\frac{R_2}{360}\alpha + R(180 - \alpha)\right)}{2R^2(180 - \alpha)} = \frac{360U(R_2\alpha + R(180 - \alpha))}{2R^2(180 - \alpha)} =$

$= \frac{360U \cdot 180}{2R_2(180 - \alpha)}$

$2I_1 - I_5 = I_0$ $I_1 = I_2 \frac{R_2}{R_1} = (I_1 - I_5)\frac{R_2}{R_1}$ $I_5 \frac{R_2}{R_1} = I_1\left(\frac{R_2}{R_1} - 1\right)$

$2 I_5 \frac{R_2}{R_1(R_2 - 1)} - I_5 = I_0$

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$I_5\left(\frac{2R_2 - R_2 + R_1}{R_2 - R_1}\right) = I_0$ $I_5 \frac{R_2 + R_1}{R_2 - R_1} = I_0$ $I_5 \frac{\frac{R_2}{360}\alpha + \frac{R(180 - \alpha)}{360}}{\frac{R(180 - \alpha)}{360} - \frac{R_2}{360}} = \frac{\alpha + 180 - \alpha}{180 - \alpha - \alpha} = \frac{180}{180 - 2\alpha}$

Чистовик

$I_0 = I_5 \frac{180}{180-2\alpha}$ $\quad \frac{180^2 U}{R\alpha(180-\alpha)} = I_5 \frac{180}{180-2\alpha}$

$\frac{I_5}{180-2\alpha} = \frac{180 U}{R\alpha(180-\alpha)}$

$I_5 R\alpha(180-\alpha) = 180 U(180-2\alpha)$

$180 I_5 R\alpha - I_5 R\alpha^2 = 180^2 U - 360 U\alpha$

$I_5 R\alpha^2 - (360U + 180 I_5 R)\alpha + 180^2 U = 0.$

$\alpha_{12} =$

$\frac{2}{3} \cdot 24\alpha^2 - (360 \cdot 6 + 180 \cdot \frac{2}{3} \cdot 24)\alpha + 180^2 \cdot 6 = 0.$

$16\alpha^2 - 180 \cdot (2 \cdot 6 + 16)\alpha + 180^2 \cdot 6 = 0.$

$16\alpha^2 - 180 \cdot 28\alpha + 180^2 \cdot 6 = 0.$

$\alpha^2 - 45 \cdot 7\alpha + 45^2 \cdot 6 = 0.$

$\alpha^2 - 315\alpha + 12150 = 0$

$\alpha_{12} = \frac{315 \pm \sqrt{315^2 - 4 \cdot 12150}}{2}$ $\quad \left[\begin{array}{l} \alpha = 45° \\ \alpha = 270° \end{array}\right. \Rightarrow \alpha = 45°$

$n = \frac{135}{45} = 3/1.$

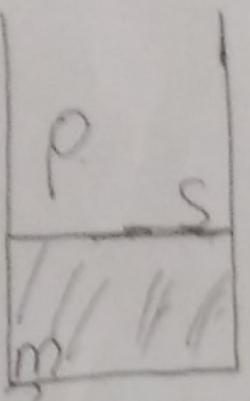
$P_2 = U I_0 = \frac{U^2(R_1+R_2)}{2R_1R_2}$ $\quad P_2 = \frac{6^2\left(\frac{24 \cdot 45}{360} + \frac{24(180-45)}{360}\right)}{2 \cdot \frac{24 \cdot 45}{360} \cdot \frac{24(180-45)}{360}} = \frac{360 \cdot 6^2 \cdot (45+135)}{2 \cdot 45 \cdot 24 \cdot 135} =$

$= 8 (Вт)$

Ответ: $P_1 = 10{,}8$ Вт, $n = 3$, $P_2 = 8$ Вт.

Чистовик

№1.



1) $Q_1 = cm\Delta t$.

$Q_1 = 4180 \cdot 0{,}0055 \cdot 100 = 2299$ (Дж).

2) $Q_п = \lambda m$

$Q_п = 2{,}26 \cdot 10^6 \cdot 0{,}0055 = 226 \cdot 55 = 12430$ (Дж) < 17430 Дж.

Значит пар продолжал нагреваться.

$Q_п = 17430 - 12430 = 5000$ Дж $Q_п = c_п m \Delta t \Rightarrow \Delta t = \frac{Q_п}{c_п m}$

$\Delta t = \frac{5000}{2200 \cdot 0{,}0055} \approx 413{,}2231$ (°C) $\Rightarrow t_{кон} = 413{,}2231$ °C

$pV = \nu RT$. $pV = \frac{m}{\mu} R T_к$. $\Rightarrow pSH_к = \frac{mRT_к}{\mu} \Rightarrow$

$\Rightarrow H_к = \frac{RmT_к}{\mu Sp}$ $H_к = \frac{8{,}31 \cdot 0{,}0055 \cdot (513{,}223 + 273)}{18 \cdot 10^{-3} \cdot 10^5 \cdot 500 \cdot 10^{-4}} \approx 39{,}93$ (м).

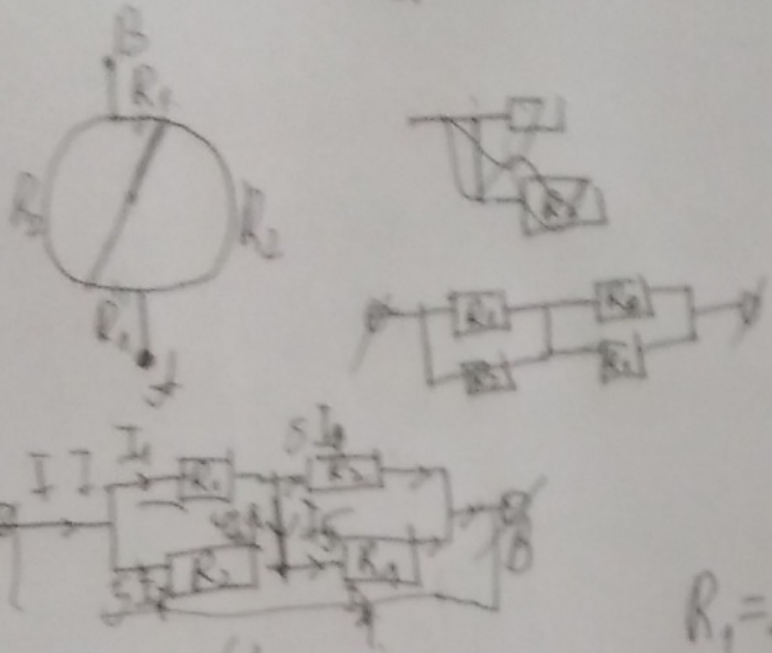
$m = \rho V = \rho S H_п$ $H_п = \frac{m}{\rho S}$ $H_п = \frac{0{,}0055}{1000 \cdot 500 \cdot 10^{-4}} = \frac{0{,}055}{500} = 0{,}00011$ (м)

$H = H_к - H_п = 0{,}3993 - 0{,}00011 \approx 0{,}3992$ (м) $= 39{,}92$ (см)

Ответ: $Q_1 = 2299$ Дж, $H \approx 39{,}92$ см.

(3)

Цепь собрана



$R_1 = 2R_0 \frac{1}{2\pi} [\Omega]$ $R_1 = R_0 \frac{1}{2\pi} =$

$R_2 = R_0 + R_0 \frac{1}{2} R_1$ $R_2 = \frac{R_0}{2} - R_1$

$R_{11} = \frac{R_0}{2} = 2(\Omega) = R_2 = 10\Omega$

$$\begin{cases} I_1 R_1 + I_3 R_2 - I_4 R_1 - I_2 R_2 = 0 \\ R_1(I_1 - I_4) + R_2(I_3 - I_2) = 0 \\ I_2 + I_5 = I_4 \\ I_1 = I_5 + I_3 \\ I = I_1 + I_2 = I_3 + I_4 \end{cases}$$

$$\begin{cases} 2I_1 + 10I_3 - 2I_4 - 10I_2 = 0 \\ I_2 + I_5 = I_4 \\ I_1 = I_5 + I_3 \\ I_1 + I_2 = I_3 + I_4 \\ 2I_1 - 10I_2 = 0 \end{cases}$$

$$\begin{cases} 2I_1 = 10I_2 \\ 10I_3 = 2I_4 \\ I_2 + I_5 = I_4 \\ I_5 + I_3 = I_1 \\ I_1 + I_2 = I_3 + I_4 \end{cases}$$

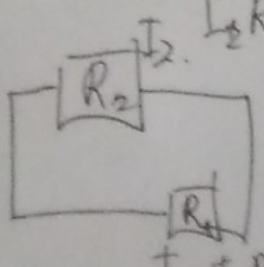
$$\begin{cases} I_1 = 5I_2 \\ I_4 = 5I_3 \\ I_2 + I_5 = I_4 \\ I_5 + I_3 = I_1 \\ I_1 + I_2 = I_3 + I_4 \end{cases}$$

$6I_2 = 6I_3$

$I_2 = I_3$

$I_1 = I_4$

$I_5 = I_3 - I_1$



$I_2 R$

$I_1 I_1 R_1$

$R_0 = \frac{2R_1R_2}{R_1 + R_2}$

$R_0 = \frac{220}{240} = \frac{1}{3}(\Omega)$

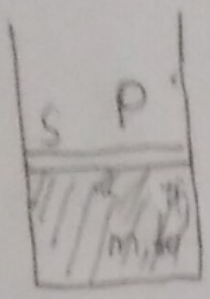
$I = \frac{6 \cdot 3}{10} = 1{,}8(A) \Rightarrow I_1 = 0{,}3A,\ I_2 = 1{,}5A$

$P_1 = I_1^2 R_1 + 2 I_2^2 R_2$

$P_1 = 2 \cdot 0{,}09 \cdot 10 + 2 \cdot 2{,}25 \cdot \frac{10}{2} = 45{,}36\ Вт.$

Начальник

Чертовых



$Q = const$

$Q_1 = 4200 \cdot 0{,}0055 \cdot 100 = 42{,}55 = 230\ (Дж/с)$