Часть 1

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

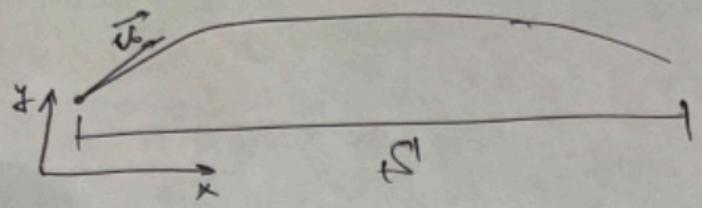
Шифр: **21206368**

ID профиля: **382155**

Вариант 3

1. Условие

$\alpha = 60°$
$S = 17$ м
1) V_0 - ?
2) F - ?



ox: $S = V_0 \cos\alpha \, t$
oy: $0 = V_0 \sin\alpha \, t - \frac{gt^2}{2} \Rightarrow t = \frac{2V_0 \sin\alpha}{g}$

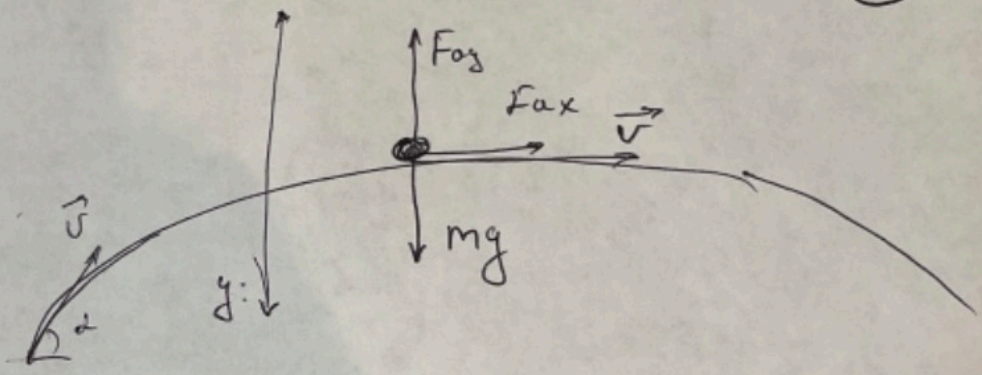
$S = \frac{2V_0^2 \sin\alpha \cos\alpha}{g}$; $V_0^2 = \frac{Sg}{2\sin\alpha\cos\alpha} = \frac{Sg}{\sin 2\alpha}$; $V_0 = \sqrt{\frac{Sg}{\sin 2\alpha}}$

14

Ответ: $V_0 =$ [illegible] м/с

(1)

2. $m = 1$ кг
$V = \frac{V_0}{4}$



~~0,2~~

II З:Н: ~~$F_{ay} - mg = \frac{mV^2}{R_{кр}}$~~ ; ~~$R_{кр}$~~ — центростремительное

~~$F_{ay} = m\left(\frac{V^2}{R_{кр}} + g\right)$~~

~~1,12~~

~~3,46~~

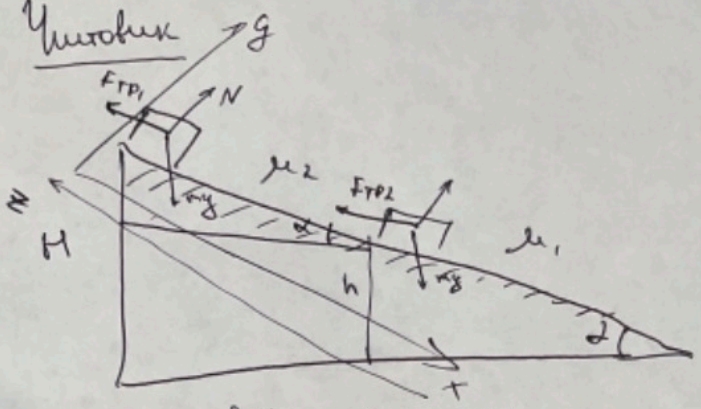
$mg - F_{ay} = \frac{mV^2}{R_{кр}}$

~~0,81~~

$F_{ay} = m\left(g - \frac{V^2}{R_{кр}}\right)$.

2. $\alpha = 30°$
$h = 2$ м
$\mu_1 = 0{,}81$
$\mu_2 = 0{,}11$
$v_0 = 0$

1) $T - ?$
2) $H - ?$



Решение: разделим всё на 2 участка

I З. Н:

1) участок 1: $mg\sin\alpha - F_{тр1} = ma_1$; $F_{тр} = \mu N$; OY: $N = mg\cos\alpha$

$mg\sin\alpha - \mu_2 mg\cos\alpha = ma_1$

$a_1 = g\sin\alpha - \mu_2 g\cos\alpha$, заметим, что $g\sin\alpha > \mu_2 g\cos\alpha$

$\Rightarrow a_1$ – вдоль ОХ

2) участок 2:

OX: $F_{тр2} - mg\sin\alpha = ma_2$;

$\mu_1 mg\cos\alpha - mg\sin\alpha = ma_2$

$a_2 = \mu_1 g\cos\alpha - g\sin\alpha$, заметим, что $\mu_1 g\cos\alpha > g\sin\alpha$

$\Rightarrow a_2$ против оси ОХ $\Rightarrow$ участок торможения

$\frac{2S}{t_2^2} = \mu_1 g\cos\alpha - g\sin\alpha$

$t_2^2 = \frac{2S}{g(\mu_1\cos\alpha - \sin\alpha)}$; $S = \frac{h}{\sin\alpha}$

$t_2 = \sqrt{\frac{2h}{g\sin\alpha(\mu_1\cos\alpha - \sin\alpha)}}$

$T = t_2$; $S = \frac{v_0 + v}{2} \cdot t_2$

$\begin{cases} S = \frac{v}{2} t_2 \Rightarrow \\ 2a_2 S = v^2 \end{cases}$ $S = \frac{2aS}{2} t_2$

$a_2 = \frac{2S}{t_2^2}$

2) З. Э. Н.: Ответ: $t_2 = 4$ с.

$S^* = \frac{H-h}{\sin\alpha}$

$A_{тр1} + A_{тр2} = E_{м2} - E_{м1}$

- $A_{тр1} = F_{тр} \cdot S^* \cos 180° = -\mu_2 mg\cos\alpha(H-h)$
- $A_{тр2} = -\mu_1 mg\cos\alpha h$

$-\mu_2 mg\cos\alpha(H-h) - \mu_1 mg\cos\alpha h = 0 - mgH$

$\mu_2\cos\alpha(H-h) + \mu_1\cos\alpha h = H$

$H - \mu_2\cos\alpha H = \mu_1\cos\alpha h - \mu_2\cos\alpha h$

$H = \frac{\mu_1\cos\alpha h - \mu_2\cos\alpha h}{1 - \mu_2\cos\alpha} = \frac{h\cos\alpha(\mu_1 - \mu_2)}{1 - \mu_2\cos\alpha}$

Ответ: $H = 3$ м

2

3.

$R = 5$ см

$l = 15$ см

$m = 0{,}8$ кг

1) N – ?

2) α – ?

Решение

1)

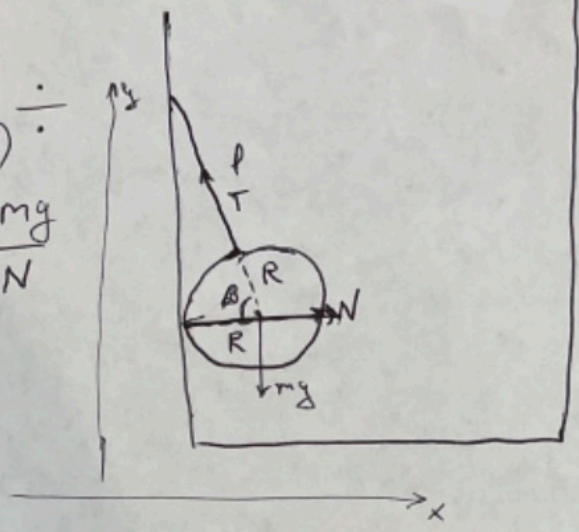
II З.Н:

Ox: $T\cos\beta = N$ (I)

Oy: $T\sin\beta = mg$ (II) $\div$

(II) : (I) $= tg\beta = \frac{mg}{N}$

$N = \frac{mg}{tg\beta}$



из Геометрии: $\cos\beta = \frac{R}{l+R}$

$\cos\beta = 0{,}25$

$\beta \approx 75{,}5°$

Ответ: $N = 2$ Н

2. $w = 10\frac{рад}{с}$

II З.Н: $F_{Ax} = \rho a_n V$, $F_{Ay} = \rho V g$

Ox: $F_{Ax} + T\sin\alpha = ma_n$

Oy: $F_{Ay} + T\cos\alpha = mg$

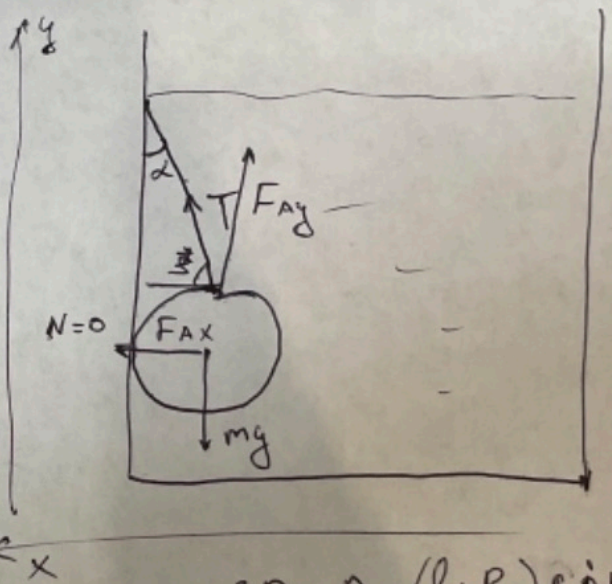
$m = \rho_т V_т$

$ma_n - \rho a_n V = T\sin\alpha$

$mg - \rho g V = T\cos\alpha$

$a_n(\rho_т V - \rho V) = T\sin\alpha$

$g(\rho_т V - \rho V) = T\cos\alpha$



(3)

$\frac{a_n}{g} = tg\alpha$

$a_n = w^2 R$; $R = (l+R)\sin\alpha$

$\frac{w^2(l+R)\sin\alpha}{g} = tg\alpha \overset{\frac{\sin\alpha}{\cos\alpha}}{\Rightarrow} \frac{w^2(l+R)}{g} = \frac{1}{\cos\alpha} \Rightarrow \cos\alpha = \frac{g}{w^2(l+R)}$

$\cos\alpha = \frac{1}{2}$

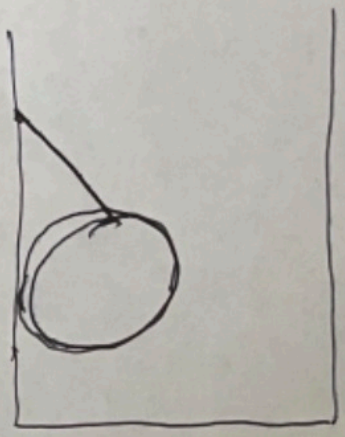
Ответ: $\alpha = 60°$

3. $R = 5$ см
$l = 15$ см
$m = 0{,}8$ кг

1) $N - ?$
2) $d - ?$

1.

Чертеж



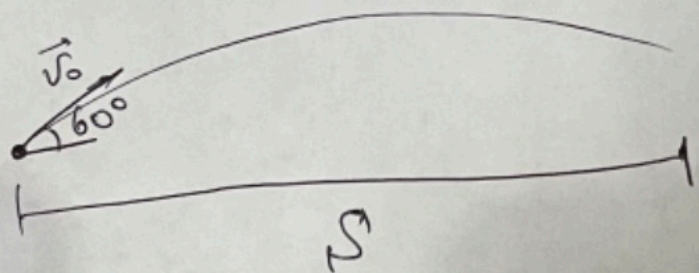
Черновик

0, 1696

$\alpha = 60°$

$S = 17$ м

1) $v_0 - ?$



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

$Oy: 0 = v_0 \sin\alpha \, t - \frac{gt^2}{2} \Rightarrow v_0 \sin\alpha \, t = \frac{gt^2}{2}$

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

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

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

2)

$\frac{170}{0,866}$

Черновик.

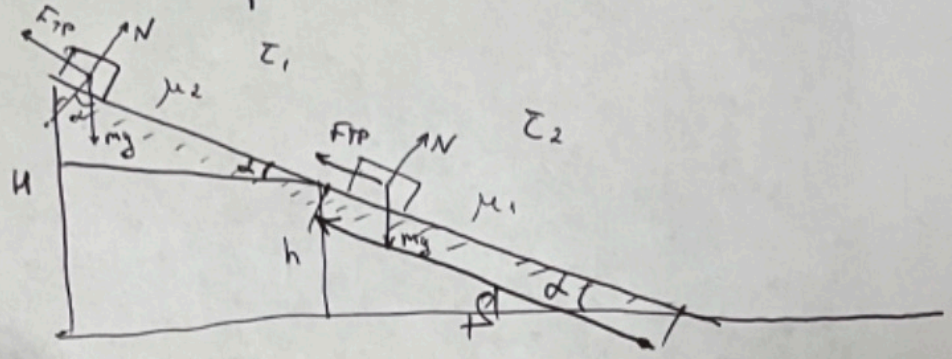
2. $\alpha = 30°$

$h = 2$ м

$\mu_1 = 0{,}81$

$\mu_2 = 0{,}11$

$v_0 = 0$



1) T – ? 1 участок: II З.Н:

ox: $mg\sin\alpha - F_{тр} = ma$; $F_{тр} = \mu N$ oy: $N = mg\cos\alpha$

$mg\sin\alpha - \mu_2 mg\cos\alpha = ma_1$ $\quad v = v_0 - at_1$ $\quad T = t_1 + t_2$

$g\sin\alpha - \mu_2 g\cos\alpha = \frac{v}{t_1}$ (1) $\quad v = a_2 t_2$

2 участок: ox: $mg\sin\alpha - \mu_1 mg\cos\alpha = ma_2$ oy: $N = mg\cos\alpha$ $\quad S' = \frac{h}{\sin\alpha}$

$g\sin\alpha - \mu_1 g\cos\alpha = a_2$ (II) $\quad v = v - a_2 t_2$

$v = a_2 t_2$

(1) $g(\sin\alpha - \mu_2\cos\alpha) = \frac{v}{t_1}$

(II) $g(\sin\alpha - \mu_1\cos\alpha) = \frac{v}{t_2}$

$S = \frac{v_2 + v_1}{2} \cdot t_2$

$S = \frac{v}{2} t_2$

$S' = \frac{v_2^2 - v_0^2}{-2a}$ $\quad \frac{2S}{v} = t_2$

$2a_2 S' = v^2$

$2S'(g\sin\alpha - \mu g\cos\alpha) = v^2$ $\quad S' = \frac{v^2}{2a}$

$v = \sqrt{2S'g(\sin\alpha - \mu_1\cos\alpha)}$

$\frac{v}{g(\sin\alpha - \mu_2\cos\alpha)} = t_1$

$t_1 = \frac{\sqrt{2Sg(\sin\alpha - \mu_1\cos\alpha)}}{g(\sin\alpha - \mu_2\cos\alpha)}$; $t_2 =$ $\quad S' = \frac{H - h}{\sin\alpha}$

2) H – ?

З.И.Э:

$A_{тр1} + A_{тр2} = 0 - mgH$; $A_{тр1} = F_{тр} \cdot S' \cos 180°$

$A_{тр1} = -\mu_2 mg\,ctg\alpha (H - h)$

$A_{тр2} = -\mu_1 mg\frac{\cos\alpha h}{\sin\alpha} = -\mu_1 mg\,ctg\alpha\, h$

$-\mu_1 mg\,ctg\alpha\, h - \mu_2 mg\,ctg\alpha (H - h) = -mgH$

$\mu_1 mg\,ctg\alpha\, h + \mu_2 mg\,ctg\alpha (H - h) = mgH$

$H = \mu_1 ctg\alpha\, h + \mu_2 ctg\alpha H - \mu_2 ctg\alpha\, h$

$H(1 - \mu_2 ctg\alpha) = \frac{\mu_1 ctg\alpha\, h - \mu_2 ctg\alpha\, h}{(1 - \mu_2 ctg\alpha)}$

3.

Черновик.

$R = 5$ см.

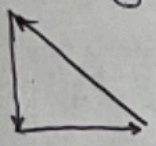
$l = 15$ см.

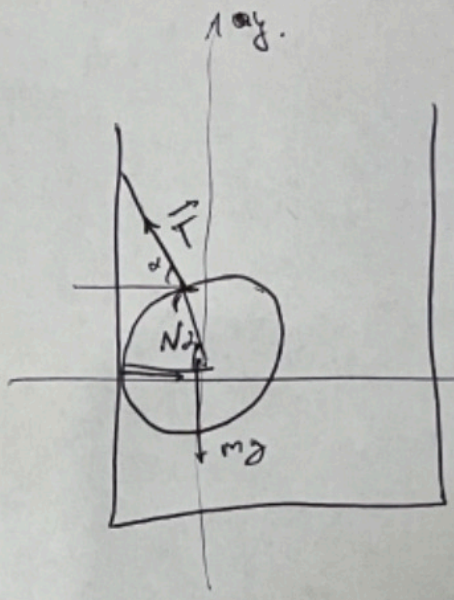
$m = 0{,}8$ кг

1) $N - ?$

II З.Н:

$\vec{T} + m\vec{g} + \vec{N} = 0$





Ox: $T\cos\alpha = N$

~~$T\sin\alpha =$~~

$T\sin\alpha = mg$

$\operatorname{ctg}\alpha = \frac{N}{mg}$

$N = mg\operatorname{ctg}\alpha$

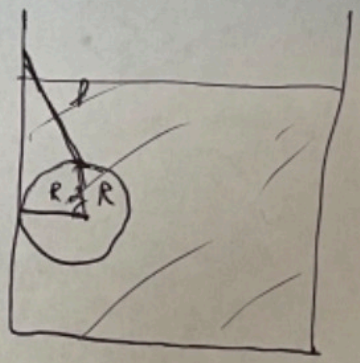
$N = 2$ Н

$\cos\alpha = \frac{R}{l+R}$

$\cos\alpha = \frac{5}{20} = 0{,}25$

$75{,}52^\circ$

$0{,}258$

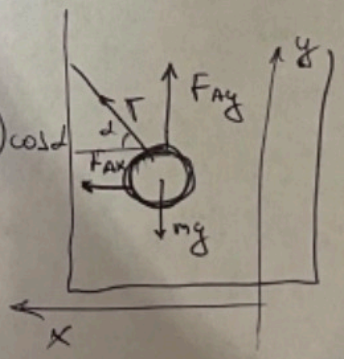


2) $w = 10\ \frac{\text{р}}{\text{с}}$

$l - ?$

Ox: $F_{Ax} + T\cos\alpha = ma_n$

Oy: ~~$F_{Ay} = mg$~~ $F_{Ay} + T\sin\alpha = mg$ $R = (l+R)\cos\alpha$



(3)

$\rho_в a_n V + T\cos\alpha = m w^2 R$

~~$\rho g V = mg$~~

$\rho g V + T\sin\alpha = mg$

$\rho_в a_n V + T\cos\alpha = m\underbrace{w^2 R}_{a_n}$

$a = w^2 R = w^2(l+R)\cos\alpha$

~~ρg~~

$\rho_т g V - \rho g V = T\sin\alpha \ \Big/ \div$

$\rho_т a V - \rho a V = T\cos\alpha$

$\frac{g(\rho_т V - \rho V)}{a(\rho_т V - \rho V)} = \operatorname{tg}\alpha$

$a = \frac{g}{\operatorname{tg}\alpha}$

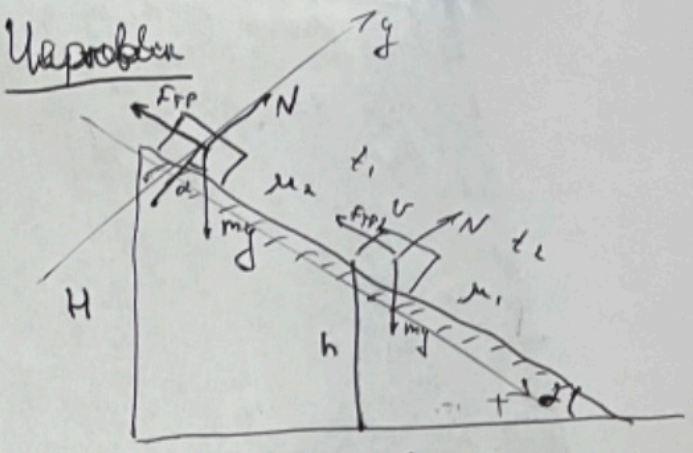
$\frac{\sin\alpha}{\cos\alpha}$

$\operatorname{tg}\alpha = \frac{g}{a w^2(l+R)\cos\alpha}$

$\sin\alpha = \frac{g}{w^2(l+R)}$

2. $\alpha = 30°$
$h = 2$ м
$\mu_1 = 0{,}81$
$\mu_2 = 0{,}11$
$V_0 = 0$

1) $T - ?$



разобьем на 2 участка, в каждом из которых своё время: $t_1 + t_2$

1. участок: $Ox: mg\sin\alpha - F_{тр1} = ma_1$; $Oy: N = mg\cos\alpha$

$mg\sin\alpha - \mu_2 mg\cos\alpha = ma_1$

$a_1 = g\sin\alpha - \mu_2 g\cos\alpha$

Кинематика:

$V = V_0 + a_1 t_1$

2. участок: $Ox: mg\sin\alpha - F_{тр2} = ma_2$; $F_{тр2} = \mu_1 mg\cos\alpha$

$Ox: \begin{cases} g\sin\alpha - \mu_1 g\cos\alpha = a_2 \\ -a_2 = \frac{V_к - V}{t_2} \end{cases}$

$g\sin\alpha - \mu_1 g\cos\alpha =$

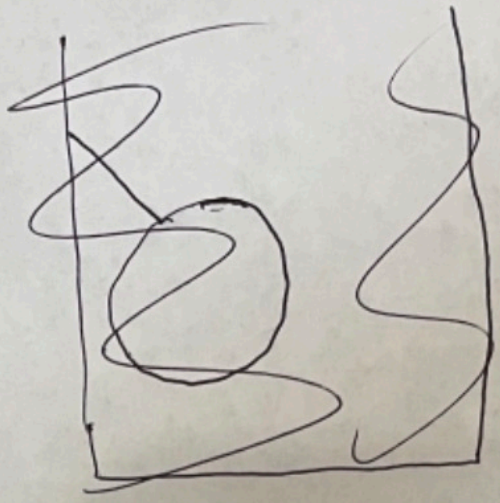
сравним $g\sin\alpha$ и $\mu_1 g\cos\alpha$

$\Rightarrow a_2$ будет направлено против оси Ox

$\Rightarrow$ будет торможение

$T = t_2$

~~Иванов~~ Петров



Часть 2

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

Шифр: **21206368**

ID профиля: **382155**

Вариант 3

4.

$m = 5{,}5\ г$

$t_0 = 0°C = 273\ K$

$S = 500\ см^2$

$p_0 = 10^5\ Па$

$c = 4180\ \frac{Дж}{кг \cdot K}$

$r = 2{,}26 \cdot 10^6\ \frac{Дж}{кг}$

$c_p = 2200\ \frac{Дж}{кг \cdot K}$

1) $Q_1 - ?$

2) $H - ?$

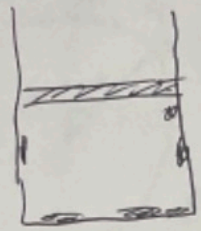
Числовик

$T = 373\ K;\ \Delta T = T - T_0$

1. $\Delta T = 100\ K$

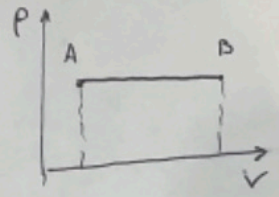
$Q_1 = cm\Delta T$

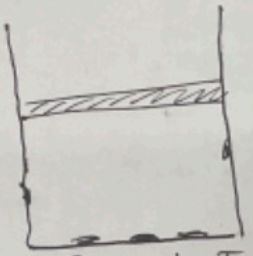
Ответ: $Q_1 = 2299\ Дж$



2. $p = const$; т.к. тепло подводят медленно.

$Q_2 = 14430\ Дж$





пока идет фазовый переход $T = const = T_0$

$Q_2 = mr + Q_n$; $Q_n = \Delta U + A$; $\Delta U = \frac{6}{2}\nu R \Delta T_2$

$A = p\Delta V$

Закон Менделеева - Клапейрона:

$\Delta T_2 = T' - T$

$p_0 V_1 = \nu RT$

$p_0 V_2 = \nu RT' \Rightarrow p_0 \Delta V = \nu R \Delta T_2 \Rightarrow \Delta U = 3 p_0 \Delta V$;

$Q_2 = mr + 4p_0 \Delta V$; $\Delta V = HS$

$Q_2 = mr + 4p_0 HS$

$4p_0 HS = Q_2 - mr$

Ответ: $H = \frac{Q_2 - mr}{4p_0 S}$; $H = 0{,}25\ м$

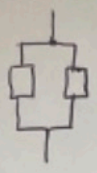
1

Числовик

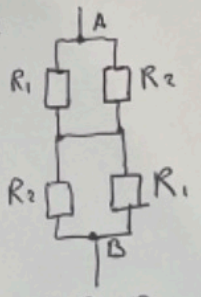
5. $R = 24$ Ом
$U = 6$ В
$\alpha = 30°$

1) P - ?
2) $\frac{l_2}{l_1}$ - ?

1) было:



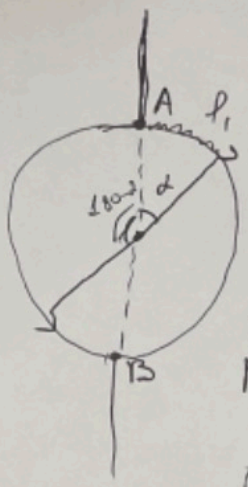
стало:



$R_{цепи} = 2\frac{R_1 \cdot R_2}{R_1 + R_2} =$

$R_{цепи} = 3{,}2$ Ом

$P = \frac{U^2}{R_{цепи}}$; Ответ: $P = 11{,}25$ Вт



$R = \frac{\rho l}{S}$

$l = 2\pi r$

$l_1 = \frac{\alpha \pi r}{180} = \frac{\pi r}{6}$

$R_1 = \frac{\rho \pi r}{6S} \Rightarrow R_1 = \frac{R}{12}$

$R = \frac{\rho 2\pi r}{S}$

$R_1 = 2$ Ом

$l_2 = \frac{120 \cdot \pi r}{180} = \frac{2\pi r}{3}$

$R_2 = \frac{2\rho \pi r}{3S} \Rightarrow R_2 = \frac{R}{3}$

$R_2 = 8$ Ом

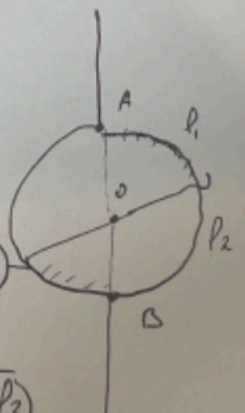
2) $I = \frac{2}{3}$ А

$R_{общ2} = \frac{U}{I} = 9$ Ом

$R_{общ2} = 2\frac{R_1' R_2'}{R_1' + R_2'}$; т.к. $R_1 = \frac{\rho l_1}{S}$, $R_2 = \frac{\rho l_2}{S}$, то

$R_{общ2} = \frac{\rho l_1 l_2}{S(l_1 + l_2)}$; т.к. $R = \frac{2\rho(l_1 + l_2)}{S}$

то $\frac{\rho}{S} = \frac{R}{2(l_1 + l_2)}$



2

$R_{общ2} = R_x$

$R_{общ2} = \frac{R l_1 l_2}{2(l_1 + l_2)^2} \Rightarrow 2 l_1^2 R_{общ2} + 4 l_1 l_2 R_{общ2} + 2 R_{общ} l_2^2 = R l_1 l_2$

$l_1 \frac{9}{12} = \frac{l_1 l_2}{(l_1 + l_2)^2}$

$2 l_1^2 R_x + 4 l_1 l_2 R_x = R l_1 l_2 + 2 R_x l_2^2 = 0$

$2 l_1^2 R_x + l_1 l_2 (4R_x - R) + 2 R_x l_2^2 = 0$

$D = (4R_x - R)^2 - 4 R_x^2 l_2^2 = l_2^2 (4R_x^2 - 4R_x R + R^2 - 4R_x)$

$D \approx 13{,}4 l_2$

$l_1 = \frac{-l_2(2R_x - R) \pm 13{,}4 l_2}{2R_x} =$

Черновик.

1. $m = 5{,}5\,г$
$t_0 = 0°C$; $T_0 = 273\,K$
$S = 500\,см^2$
$p_0 = 10^5\,Па$
$c = 4180$
$r = 2{,}26 \cdot 10^6$
$c_p = 2200$

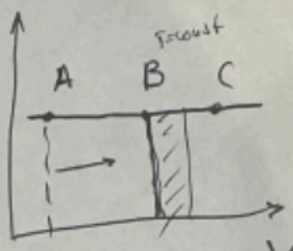
$Q_1 - ?$
$H - ?$

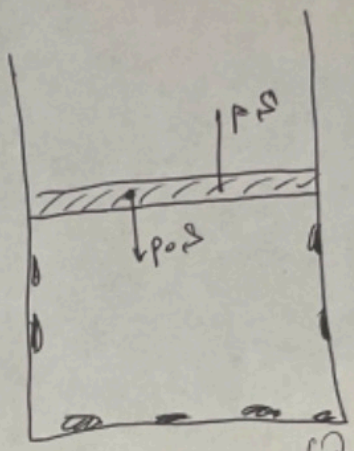
1) $Q_1 = cm\Delta T$

$p = p_0 + p$

$Q_1 = 4180 \cdot 5{,}5 \cdot 10^{-3} =$
$23\,Дж$

2) $Q_2 = 17430\,Дж$
12430





$Q_2 = 5{,}5 \cdot 10^{-3}$

$p = const$

$Q_2 = Q_B + Q_c$

$Q_B = mr$

$Q_c = \Delta U + A$

$\Delta U = 3\nu R\Delta T$

$A = p\Delta V$

$Q_c = 4\Delta p\Delta V$

$p\Delta V = \nu R\Delta T$

$Q_2 - Q_B = 4p\Delta V$

$Q_2 - mr = 4p\frac{\Delta H}{H}S$

$H = \frac{Q_2 - mr}{4pS}$; $H = 25\,см.$

$4 \cdot 10^5 \cdot 500 \cdot 10^{-4}$

$40 \cdot 500 = 20000$

$pV = \nu RT$

$p_{газ} = \frac{\nu RT}{V}$

$p_0 = p_{газ} + p$

Черновик

$R = 240$ Ом

$U = 6$ В

$\alpha = 30°$

$P - ?$

$l = \frac{2\pi R}{360}$

$l = \frac{\pi R}{180}$

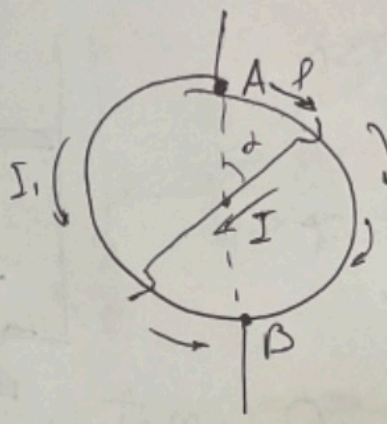
$l = \frac{\pi R \alpha}{6}$

1. $P = \frac{U^2}{R}$

$P = \frac{36}{2} = 18$ Вт

$R_1 = \frac{\rho l}{S}$

$R_2 = \frac{\rho}{S} \frac{\pi r}{6}$



$l = 2\pi r$

$R_1 = \frac{\rho 2\pi r}{S}$

$R_2 = \frac{\rho \pi r}{6S}$

$\frac{R_1}{R_2} = \frac{\rho 2\pi r}{S} \cdot \frac{6S}{\rho \pi r}$

$R_2 = \frac{R_1}{12}$

$\frac{R_1}{R_2} = 12$

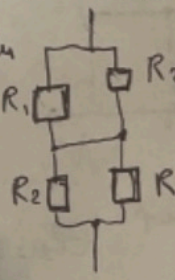
$R_2 = 2$ Ом

$\frac{120}{180} = \frac{60 \cdot 2}{60 \cdot 3} = \frac{2}{3}$

$l_1 = \frac{2\pi R}{3}$ $\frac{l_2}{l_1} = \frac{180 \cdot 3}{120} = 1,5$

$l_2 = \frac{2 \cdot 2\pi R}{180}$ . .

Было: $180 - 60 = 120°$



$R = 2\frac{R_1 R_2}{R_1 + R_2}$

$R = 2\frac{2 \cdot 3}{10} = 3,2$

2. $n > 1$

$R = \frac{2\pi R}{360} = \frac{\pi R}{180}$

$l_1 = \frac{\pi R}{6}$ $R = \frac{\rho l}{S}$

$l_2 = \frac{2\pi R}{3}$

$R = \frac{\rho 2\pi R}{S}$ $R_1 = \frac{R}{12} = 2$

$R_1 = \frac{\rho \pi R}{6S}$ $R_2 = \frac{R}{3} = 8$

$R_2 = \frac{\rho 2\pi R}{3S}$

$R = \frac{\rho(l_1 + l_2)}{S}$

$l_1 + l_2 = \frac{SR}{\rho}$

$\frac{l_1}{l_2}$

18

$R_{общ} = 2\frac{R_1 R_2}{R_1 + R_2}$

$18 - 6 = 12$ $R_{общ} = 2$

144

4.81

$R_1 R_2$

$\frac{\frac{\rho l_1}{S} \cdot \frac{\rho l_2}{S}}{\frac{\rho l_1}{S} + \frac{\rho l_2}{S}} = \frac{\frac{\rho^2}{S^2} l_1 l_2}{\frac{\rho}{S}(l_1 + l_2)} = \frac{\rho}{S}\frac{l_1 l_2}{l_1 + l_2}$

324

225 4·81

$R_{общ} = \frac{R l_1 l_2}{(l_1 + l_2)^2}$

$D = 4(R_1 - R_2)^2 - 4R_1^2$

$\sqrt{D} = 24$

$l_1 = \frac{8 - 2l_2 R_1 \pm 24}{}$

$R_1 l_1^2 + 2 l_1 l R_1 + l_2^2 R_1 = R_2 l_1 l_2$

$R_1 l_1^2 + 2 l_1 l_2 (R_1 - R_2) + l_2^2 R_1$

$l_1 l_2 = l$ $l_1 \cdot l_2 = l_2^2 R_1$

$l_1 \cdot l_1' = l_2^2 R_1$ $\frac{l_1}{l_2} = R$