Часть 1

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

Шифр: **21206468**

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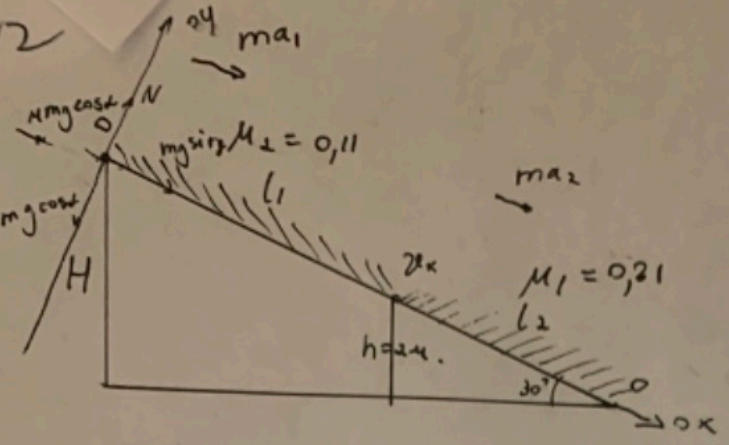
Вариант 3

№2



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

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

$= 10 \cdot \left(\frac{1}{2} - 0{,}11 \cdot \frac{\sqrt{3}}{2}\right) =$

$= 5(1 - 0{,}11\sqrt{3}) \approx 4{,}05\ м/с^2$

$l_1 + l_2 = \frac{H}{\sin 30^\circ} = 2H$

$l_2 = \frac{h}{\sin 30^\circ} = 2h = 4\ м.$

$l_2 = v_x T + \frac{a_2 T^2}{2}$

$a_2 = g(\sin\alpha - \mu_1\cos\alpha) =$

$= 5(1 - 0{,}21\sqrt{3}) = -2\ м/с^2$

$l_2 = v_x T - T^2$

$l_2 = T\frac{v_x}{2}$

$4 = T\frac{v_x}{2}$

$T = \frac{4 \cdot 2}{v_x} = \frac{8}{v_x}$

выражаем

$v_x = \frac{4 + T^2}{T} = \frac{4}{T} + T$

$T = \frac{8}{\frac{4}{T} + T}$

$4 + T^2 = 8$

$T^2 = 4$

$T = 2с.$

1

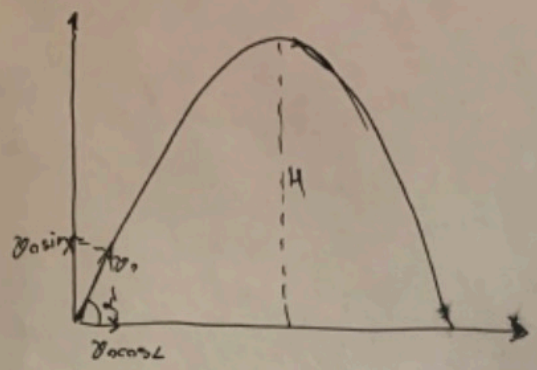
2) $v_x = \frac{4}{T} + T = 4\ м/с$

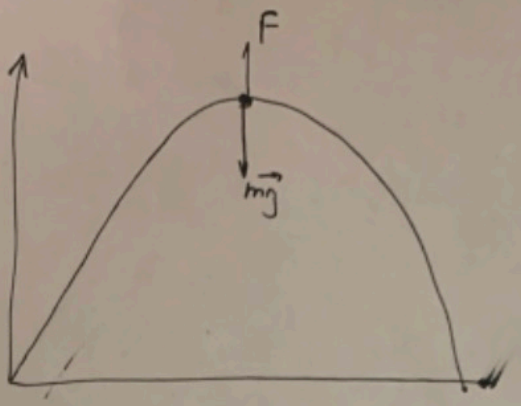
$l_1 = (2H - 4) = \frac{v_x}{2} t_1 = \frac{v_x}{2}\frac{v_x}{a_1} = \frac{v_x^2}{2a_1}$ | $a_1 t_1 = v_x$, $t_1 = \frac{v_x}{a_1}$

$H = \frac{\frac{v_x^2}{2a_1} + 4}{2} = \frac{v_x^2}{4a_1} + 2 = \frac{16}{4 \cdot 4{,}05} + 2 \approx 3\ м.$

Ответ: $T = 2с$ $H \approx 3\ м.$

~1





1) $v_0 \cos\alpha \cdot t = S$

$$v_0 = \frac{S}{\cos\alpha \cdot t}$$

$$v_0 \sin\alpha = \frac{gt}{2}$$

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

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

$$v_0 = \sqrt{\frac{gS}{2\sin\alpha\cos\alpha}} = \sqrt{\frac{gS}{\sin 2\alpha}} = \sqrt{\frac{10 \cdot 12}{\frac{\sqrt{3}}{2}}} \approx 14 \text{ м/с}$$

2) ~~F~~ $= \frac{\frac{v_0}{4} \cdot m}{\tau} = \frac{v_0 m}{4\tau}$

$$t = \frac{2 \cdot 14 \cdot \sqrt{3}}{2 \cdot 10} = 1{,}4\sqrt{3}$$

$H = v_0 \sin\alpha \cdot t - \frac{g t^2}{4} =$

$= 14 \cdot \frac{\sqrt{3}}{2} \cdot \frac{1{,}4\sqrt{3}}{2} - \frac{5 \cdot 1{,}4^2 \cdot 3}{4} =$

$= 7 \cdot \frac{1{,}4 \cdot 3}{2} - \frac{15 \cdot 1{,}4^2}{4} =$

$= \frac{21 \cdot 1{,}4}{2} - \frac{15 \cdot 1{,}4^2}{4} = \frac{29{,}4}{2} - \frac{29{,}4}{4} = \frac{29{,}4}{4} = 7{,}35 \text{ м}.$

$$\tau \approx \frac{\sqrt{7{,}35^2 + \left(\frac{17}{2}\right)^2} \cdot 4}{20} = \frac{\sqrt{54 + 72{,}25} \cdot 4}{14} = 3{,}21 \text{ с}.$$

$$L = \frac{14 \cdot m}{4 \cdot 3{,}21} = 1{,}09 \text{ Н}$$

$t = \frac{2 \cdot 14 \cdot \sqrt{3}}{2 \cdot 10} = 1{,}4\sqrt{3} \approx 2{,}42$

$H = v_0 \sin\alpha \cdot t - \frac{g t^2}{2} =$

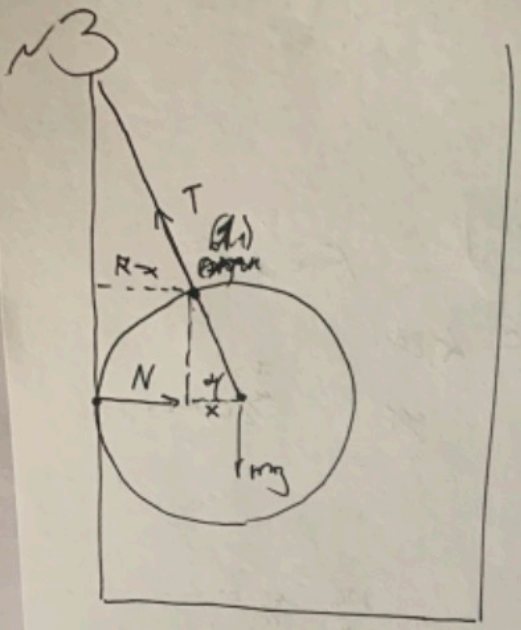
$= \frac{14 \cdot \sqrt{3}}{2} \cdot 2{,}42 - 5 \cdot 2{,}42^2 = 12\sqrt{3} - 29{,}28$

Ответ: 1) $v_0 \approx 14{,}4$ м/с

2) $F \approx 1{,}09$ Н.

3

№3



1) ур-е моментов отн. точки O

$mg \cdot x = N R \sin\alpha$

$N = \frac{mgx}{R\sin\alpha} = \frac{8 \cdot 0{,}0125 \cdot 25}{0{,}05\sqrt{609}} = \frac{50}{\sqrt{609}} \approx 2\text{Н}$

$\frac{x}{R} = \frac{R-x}{l} = \cos\alpha$

$15x - 25 = 5x$

$x = 1{,}25\text{ см}$

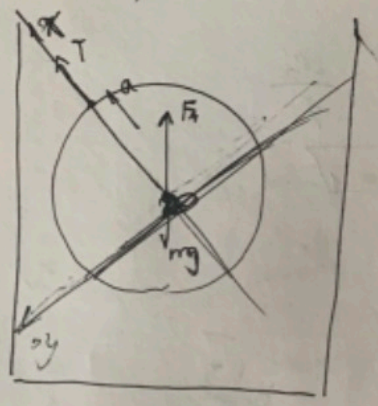
$\cos\alpha = \frac{1{,}25}{5} = \frac{4}{25}$

$\sin\alpha = \sqrt{1 - \frac{16}{625}} = \frac{\sqrt{609}}{25}$

$mg = T\sin\alpha$

$T = \frac{mg}{\sin\alpha} = \frac{\sqrt{609}}{25}$

2)



$v = \omega(R+l)$

$a = \frac{v^2}{R} = \frac{\omega^2(R+l)^2}{R} = \frac{100 \cdot 0{,}2^2}{0{,}04} = 80\,м/с^2$

$ma = F_A\cos\alpha + T - mg\cos\alpha$

oy: $mg = F_A$

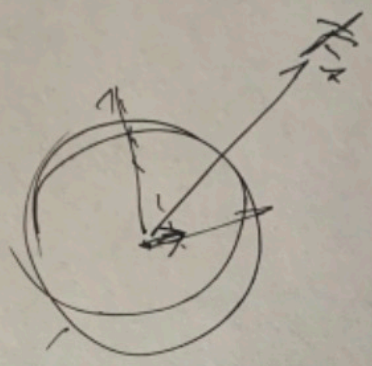
$ma = T\sin\alpha$

$\sin\alpha = \frac{ma}{T} = \frac{0{,}8 \cdot 80 \cdot 25}{\sqrt{609}} \approx 64$

(4)

Ответ: 1) $T \approx 2\text{Н}$

$$ma = F_t + T - mg\cos\alpha$$



$T + F_A$ $\quad v = \omega (R+l) \cdot \sin\alpha$

$$a = \frac{v^2}{R} = \frac{\omega^2 (R+l)^2 \sin^2\alpha}{R}$$

$ma =$

$$\frac{m\omega^2(R+l)^2}{R} \sin\alpha = T \sin\alpha$$

$$T = \frac{0{,}8 \cdot 100{,}2^2}{3{,}05} = 64\ H$$

$tg\alpha$

$\sin\alpha =$

$29{,}4\ |4$

$\frac{3cm}{R3}$

29. м/с кг.

$\frac{м}{с}$ кг. $\frac{м}{с^2}$

кг·м/с²

$x = v_0 \cos\alpha \cdot t$ $\qquad t = \frac{2v_0\cos\alpha}{x}$

$y = v_0 \sin\alpha \cdot t - \frac{gt^2}{2}$

$y = v_0\sin\alpha \cdot \frac{2v_0\cos\alpha}{x} - \frac{g}{2}\cdot\frac{2v_0^2\cos^2\alpha}{x^2}$

8,5

$x^2 + y^2$

$1,4^2 \cdot 3$

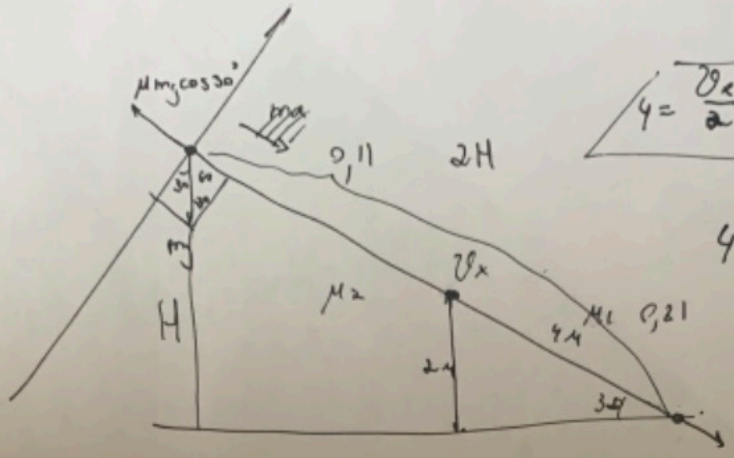
$\sqrt{3} \cdot 7 \cdot \sqrt{3}\ 1,4 =$

$1,4^2 \cdot 3 \cdot 5$ ~~4 2 3~~

15 $\qquad 3 \cdot 7 \cdot 1,4$

$21 \cdot 1,4$

21
1,4
8 4
2 1
2 9 1 4



$$y = \frac{v_x}{2} t_2$$

$$y = \sqrt{a(H-2)}\, T$$

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

$$a = g(\sin\alpha - \mu_1 g\cos\alpha) = 10\left(\frac{1}{2} - 0{,}11 \cdot \frac{\sqrt{3}}{2}\right) =$$

$$= \frac{10}{2}\left(1 - 0{,}11\cdot\sqrt{3}\right) =$$

$$= 5\left(1 - \sqrt{3}\cdot 0{,}11\right) =$$

$$= 4{,}05$$

$$H = (2H - y) = \frac{a t_1^2}{2}$$

$$t_1 = \sqrt{\frac{2(2H-y)}{a}}$$

$$v_x = a t_1 = \sqrt{2a(2H-y)} =$$

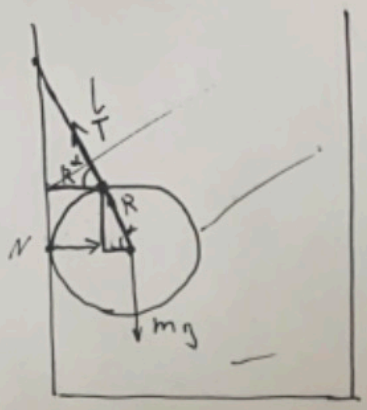
$$= 2\sqrt{a(H-2)}$$

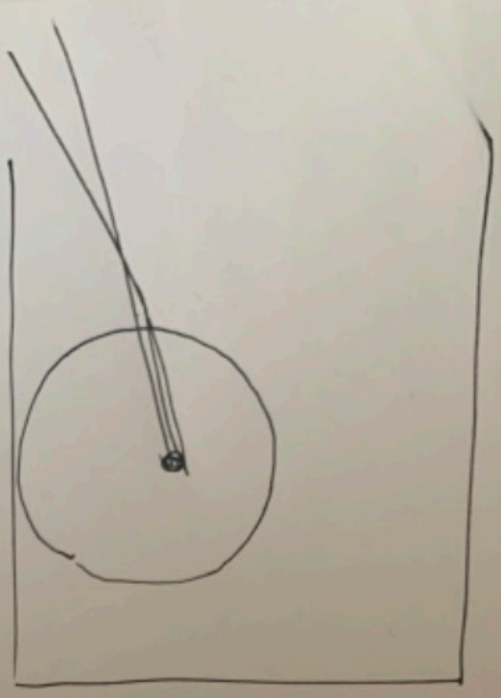
$$-v_x^2 = 2 a_x S$$

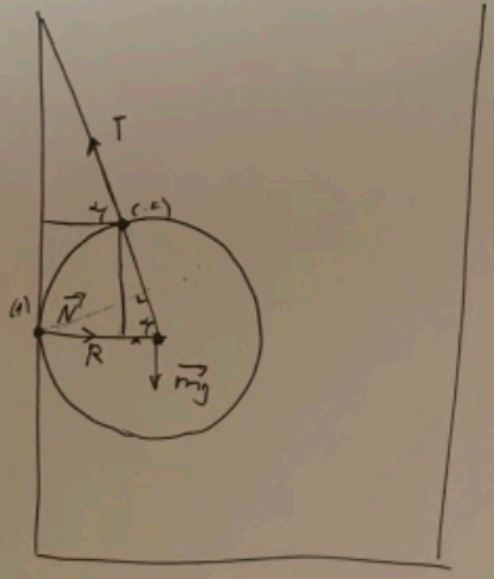
$$-4a - 4a(H-2) = 2 a_x S$$

$$-2a(H-2) = a_x S$$

$$a_x = \frac{-2a(H-2)}{S}$$







$$\cos\alpha = \frac{x}{R} = \frac{R-x}{L}$$

$$\frac{x}{5} = \frac{5-x}{15}$$

$$15x = 25 - 5x$$

$$20x = 25$$

$$x = \frac{25}{20} = \frac{5}{4} = 1{,}25 \text{ cm}.$$

$$\cos\alpha = \frac{1{,}25}{5} = \frac{4}{25}$$

1
2
5
25
125
50
625

625
−16
609

(a) $mgR = T \cdot \sin\alpha \cdot R$

$$mg = T\sin\alpha$$

$$mg = T\sqrt{1 - \frac{16}{625}}$$

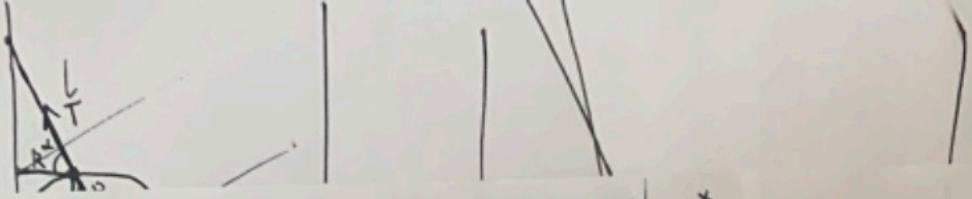
$$mg = T\frac{\sqrt{625-16}}{25} = \frac{\sqrt{609}}{25}T$$

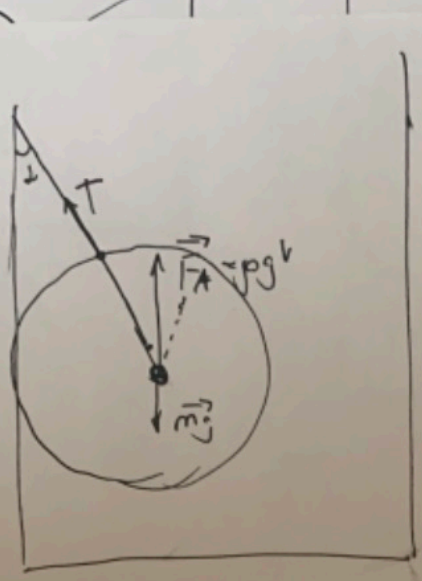
& $\boxed{T = \frac{8\cdot 25}{\sqrt{609}} = \frac{200}{\sqrt{609}}}$

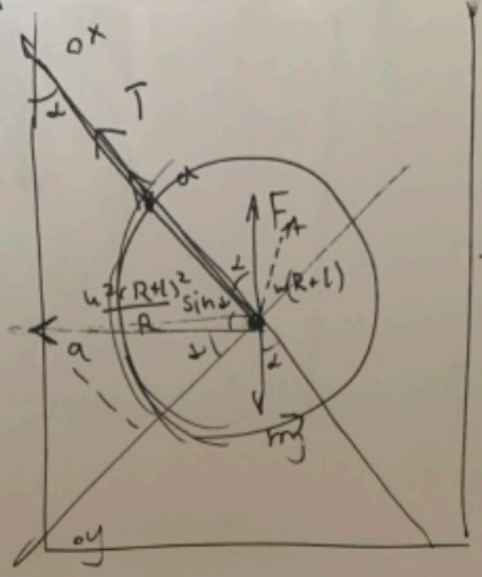
(2) $mgx = N R\sin\alpha$

$$N = \frac{mgx}{R\sin\alpha} =$$

$$= \frac{8\cdot 9{,}0125\cdot 25}{0{,}05\sqrt{609}} = \frac{50}{\sqrt{609}} \simeq 2\text{ N}$$







$\frac{\omega^2}{R}$ $\frac{v^2}{R}$

$v = \omega(R+l)$

$a = \frac{v^2}{R} = \frac{\omega^2(R+l)^2}{R}$

ox: $T + F_2$

$ma = F_A\cos\alpha + T - mg\cos\alpha$

$ma = \rho g V_m \cdot \cos\alpha + T - \rho g\, mg\cos\alpha$

oy: $mg\sin\alpha = F_A\sin\alpha$

mg

$ma = T \quad m\omega^2(R+l)^2 = T$

R

Часть 2

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

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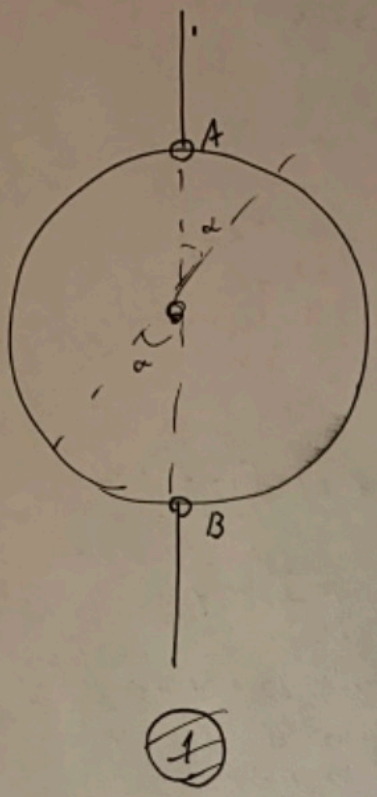
Вариант 3

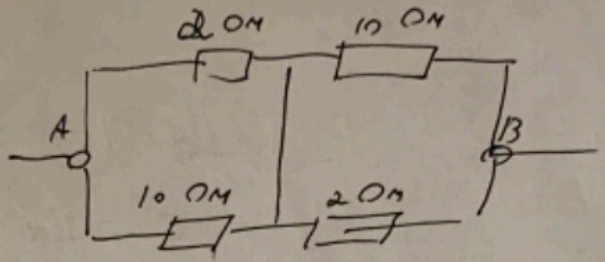


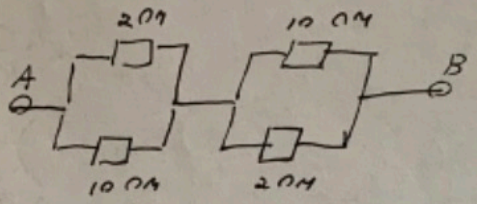
1

1) т.к $\alpha = 30°$, то

$$\frac{360}{30} = \frac{R}{R_x}$$

$$R_x = \frac{R}{12} = \frac{24}{12} = 2\,\text{Ом}$$

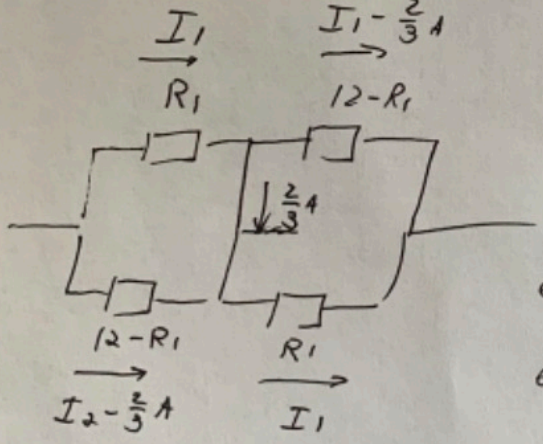




$$R_0 = \frac{20}{12}\cdot 2 = \frac{60}{6}\cdot 2 = \frac{20}{6} = \frac{10}{3}$$

$$P = \frac{U^2}{R} = \frac{36\cdot 3}{10} = 10{,}8\,\text{Вт}$$

2)



$$6 = 2R_1 I_1$$

$$3 = R_1 I_1 \qquad I_1 = \frac{3}{R_1}$$

$$6 = I_1 R_1 + \left(I_1 - \frac{2}{3}\right)(12 - R_1)$$

$$3 = \left(\frac{3}{R_1} - \frac{2}{3}\right)(12 - R_1)$$

$$3 = \frac{36}{R_1} - 3 - 8 + \frac{2}{3}R_1$$

$$14 = \frac{36}{R_1} + \frac{2}{3}R_1 \quad |\cdot R_1$$

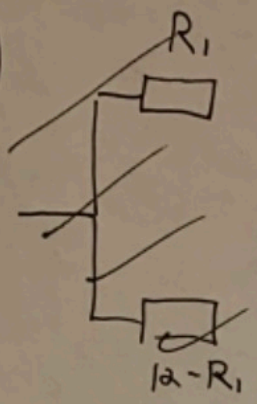
$$14R_1 = 36 + \frac{2}{3}R_1^2$$

$$42R_1 = 108 + 2R_1^2$$

$$R_1^2 - 21R_1 + 54 = 0$$

$$D = 21^2 - 54\cdot 4 = 225$$

1

2) 

$$R_1 = \frac{21+15}{2} = \frac{6}{2} = 3\,\text{Ом}.$$

$$R_2 = 12-3 = 9\,\text{Ом}.$$

$$n = \frac{R_2}{R_1} = \frac{9}{3} = 3$$

3) $P_2 = I_0 \cdot U = 6I_0 = 6\left(I_1 + I_1 - \frac{2}{3}\right) =$

$= 6\left(2I_1 - \frac{2}{3}\right) = 12I_1 - 4 =$

$= 12 \cdot \frac{3}{R_1} - 4 = 12 - 4 = 8\,\text{Вт}.$

Ответ: 1) $P_1 = 10{,}8\,\text{Вт}$

2) $n = 3$

4) $P_2 = 8\,\text{Вт}$

№4

1) $Q_1 = cm100 = 4180 \cdot 100 \cdot 0,055 = 4180 \cdot 0,55 \approx 2300$ Дж

2) чтобы превр. всю воду в пар нужно

$Q_4 = rm = 12430$ Дж $< Q_2$

⇓

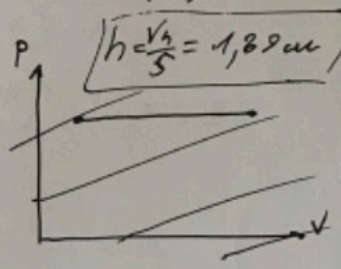
вся вода превр. в пар и он займет этот объем

На нагревание пара уйдет

$Q_3 = Q_2 - Q_4 = 17430 - 12430 = 5000$ Дж

Объем получ. пара:

$$V_n = \frac{mRT}{\mu P_0} = \frac{0,0055 \cdot 8,31 \cdot 373}{18 \cdot 10^5} = 9,47 \cdot 10^{-6}\ м^3$$



$h = \frac{V_n}{S} = 1,89$ см

$Q_3 = \Delta U + A$

$\Delta U = c_p m \Delta T \quad A = P_0 \Delta V$

$5000 = c_p m \Delta T + P_0 \Delta V$

$$\Delta V = \frac{5000 - c_p m \Delta T}{P_0}$$

$$(V_x - V_n) = \frac{5000 - c_p m \left(\frac{P_0 V_k \mu}{mR} - 373\right)}{P_0}$$

$$V_x \cdot 10^5 - 9,47 \cdot 10^{-1} = 5000 - \frac{c_p P_0 V_k \mu}{R} - c_p m \cdot 373$$

$V_x \cdot 10^5 + 4765342,96 V_x = 5000 - 4513,3 + 0,947$

$$V_x = \frac{5000 - 4513,3 + 0,947}{10^5 + 4765342,96} = \frac{487,647}{4765342,96} \approx$$

перемещение за время от начала кипения

$\approx 1,02 \cdot 10^{-6}$

$$H = \frac{V_x}{S} = \frac{1,02 \cdot 10^{-6} \cdot 10^4}{500} = \frac{1,02 \cdot 10^{-2}}{500} = 0,0000204\ м = 0,2\ см$$

(3)

Ответ: 1) $Q = 23 \text{ Дж}$

2) $H = 0{,}2$ см. – перемещение с момента начала закипания воды

~~$h = h - H = 1{,}87$ см~~ перемещение с момента

$P_{нас} T$ $\rho = \frac{P\mu}{RT}$

10.

$$(V_к - V_п) = \frac{5000 - C_p m \left(\frac{P_0 V_к \mu}{mR} - 373\right)}{}$$

0,31

$$h = \frac{9,47 \cdot 10^{-2}}{5m} = \frac{9,47 \cdot 0,1}{5m} = 0,0189\,\frac{g}{м} =$$

$= 1,89$ ам.

H

$$\frac{2R_1(R_1-12)}{12} = R_0$$

$$\frac{R_1(R_1-12)}{6} = R_0$$

$$R = \frac{U^2}{I}$$

$$I = \frac{6}{R_0} = \frac{36}{R_1(R_1-12)} = \frac{2}{3}$$

$$108 = 2R_1^2 - 24R_1$$

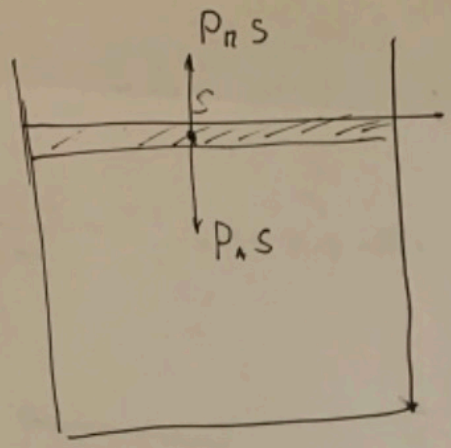
$$R_1^2 - 12R_1 - 54 = 0$$

$$\Delta = 144 + 216 = 360$$

$$R_1 = 12 -$$

1
36
3
108

1
54
4
216
144
360



$p = \frac{F}{S}$

$Q_1 = cm(t_{кип} - t_0) = 4200 \cdot 2299$ Дж

$Q_2 = Lr \cdot M$ M - воды, перешедш. в пар.

$M = \frac{Q_2}{r} = \frac{17430}{2,26 \cdot 10^6} = 0,00771$ кг $= 7,72$ г

$V = \frac{MRT}{\mu p_0} = \frac{Q_2 RT}{\mu p_0}$ ⇓ вся вода перейдет в пар и займет объем

кол-во теплоты, треб. для парообр. всей воды:

$Q_3 = Q_2 - mr = 17430 - 0,0055 \cdot 2,26 \cdot 10^6 =$

$= 17430 - 12430 = 5000$ Дж

$Q_3 = cpm\Delta t = Q_3$

$\Delta t = \frac{Q_3}{cpm} = 413,22$ °C

$\Delta U = \nu(C_p - R) \cdot \Delta t = \frac{\nu C_p Q_3}{cpm} = \frac{\nu Q_3}{m} = \frac{931,5 \cdot 5000}{0,0055} = 281,42$ Дж

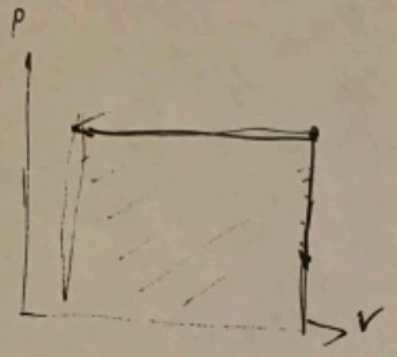
$Q_3 = \Delta U + p_0 \Delta V_1$ $\Delta V_1 = \frac{Q_3 - \Delta U}{p_0}$

$\Delta V_2 = \frac{mRT}{\mu p_0}$

$\Delta V = \Delta V_1 + \Delta V_2 = \frac{mRT + \mu(Q_3 - \Delta U)}{\mu p_0} = Sh$

$h = \frac{mRT + \mu(Q_3 - \Delta U)}{\mu p_0 S}$

$$\Delta t = \frac{Q_3}{c_p m} = \Delta U = \nu c_p \Delta t = \nu c_p \frac{Q_3}{c_p m} = \frac{\nu Q_3}{m} = \frac{0{,}31 \cdot 5000}{0{,}0055} = 281.818\,\text{К}$$



$$V_2 = \frac{mRT}{\mu p_0}$$

$$V_1 = \frac{\Delta U - Q_3}{p_0}$$

$$\Delta V = |V_2 - V_1| = \left| \frac{mRT}{\mu p_0} - \frac{\Delta U - Q_3}{p_0} \right| =$$

$$= \left| \frac{0{,}0055 \cdot 8{,}31 \cdot 273}{12 \cdot 10^5} - \frac{281818 - 5000}{10^5} \right| =$$

$$= |0{,}000000997 - 2{,}76812| =$$

$$\approx 2{,}76812$$

$$h = \frac{\Delta V}{S} = \frac{2{,}76812 \cdot 10^4}{5000\,\text{см}^2} = 55{,}36\ \text{м}$$

$$6 = 3 + (12 - R_1)\left(\frac{3}{R_1} - \frac{2}{3}\right)$$

$$3 = (12 - R_1)\left(\frac{3}{R_1} - \frac{2}{3}\right) \qquad 12 \cdot \frac{2}{3} =$$

$$3 = \frac{36}{R_1} - 8 - 3 + \frac{2}{3}R_1$$

$$14 = \frac{36}{R_1} + \frac{2}{3}R_1$$

$$14R_1 = 36 + \frac{2}{3}R_1^2$$

$$\frac{2}{3}R_1^2 - 14R_1 + 36 = 0$$

$$2R_1^2 - 42R + 108 = 0$$

$$R_1^2 - 21R + 54 = 0$$

$$\Delta = 21^2 - 54 \cdot 4$$

$2 - \frac{2}{3}$

$$\frac{4}{3} \cdot 6 = \frac{24}{2}$$

$$102 = 2R_1(12-R_1)$$

$$102 = 24R_1 - 2R_1^2$$

$$2R_1^2 - 24R_1 + 102 = 0$$

$$R_1^2 - 12R_1 + 54 = 0$$

$$\Delta = 144 - 54.4$$

$$6 = I_1R_1 + (12-R_1)(I_1 - \tfrac{2}{3})$$

~~$6 = I_1R_1 - (12-R_1)(I_1 - \frac{2}{3})$~~

$$6 = I_1R_1 + I_1R_1$$

$$6 = 2I_1R_1$$

$$3 = I_1R_1$$

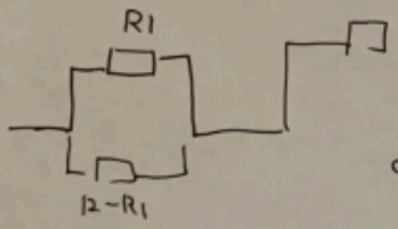
$$I_1 = \frac{3}{R_1}$$

$$\frac{2}{3} = \frac{6}{R_0}$$

$$12 = 2R_0$$

$$R_0 = 9$$

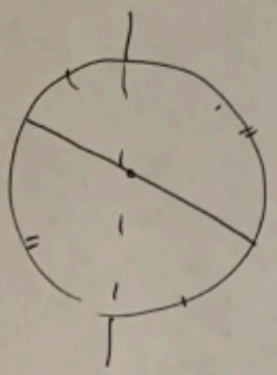
$$\frac{54}{216}$$

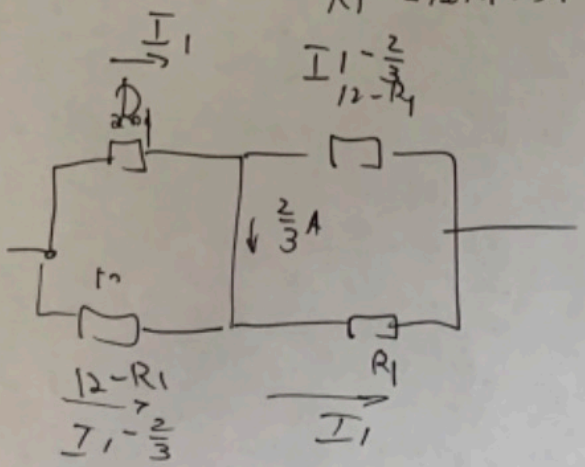


$$2 \cdot \frac{R_1(12-R_1)}{12} = 9$$

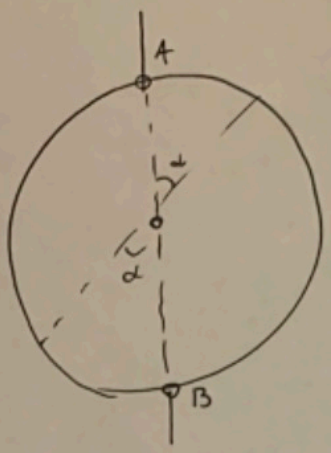
$$12R_1 - R_1^2 = 54$$

$$R_1^2 - 12R_1 + 54 = 0$$





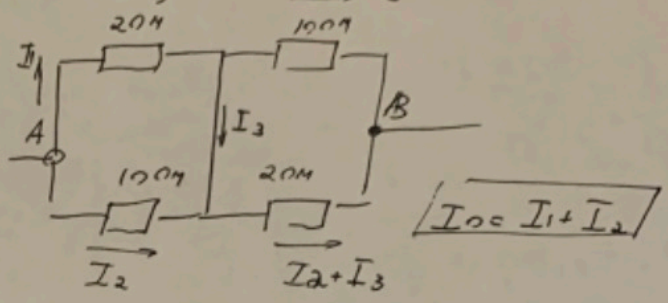
№5



1) т.к $\alpha = 30°$, то

$$\frac{360}{30} = \frac{R}{R_x}$$

$$R_x = \frac{R}{12} = \frac{24}{12} = 2\ \text{Ом}.$$



$I_0 = I_1 + I_2$

$6 = 2I_1 + 10(I_1 - I_3)$

$6 = 2I_1 + 10I_1 - 10I_3$

$6 = 12I_1 - 10I_3$ $\quad I_1 = \frac{6+10I_3}{12}$

$6 = 2I_1 + 2I_2 + 2I_3$

$3 = I_1 + I_2 + I_3$

$3 = \frac{6+10I_3}{12} + I_2 + I_3$

$I_2 = 3 - I_3 - \frac{6+10I_3}{12} =$

$= \frac{36 - 12I_3 - 6 - 10I_3}{12} =$

$= \frac{30 - 22I_3}{12}$

$6 = 10I_2 + 10I_1 - 10I_3$

$0{,}6 = I_2 + I_1 - I_3$

$0{,}6 = \frac{30-22I_3}{12} + \frac{6+10I_3}{12} - I_3$

$7{,}2 = 30 - 22I_3 + 6 + 10I_3 - 12I_3$

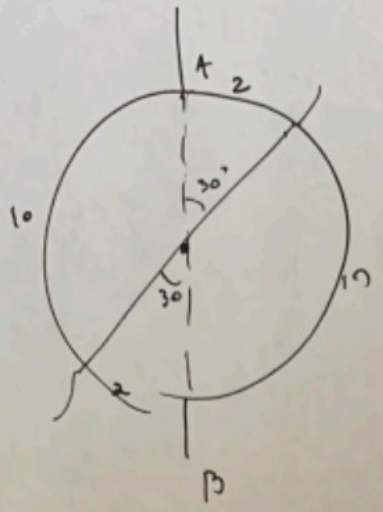
$7{,}2 - 30 - 6 = -24I_3$

$36 - 7{,}2 = 24I_3$ $\quad I_3 = 1{,}2$ А $\quad I_1 = 1{,}5$ А

$I_2 = 0{,}3$ А

$I_0 = I_1 + I_2 = 1{,}5 + 0{,}3 = 1{,}8$ А

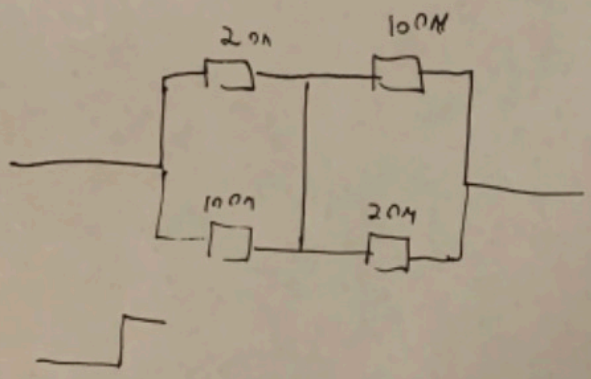
$P = I_0^2 R = I_0^2 \frac{U}{I} = UI = 6 \cdot 1{,}8 = 10{,}8$ Вт.



$R = 24.$ $\frac{60}{360}$ $\frac{30}{12 \cdot 30}$

$\frac{360}{30} = \frac{R}{R_x}$

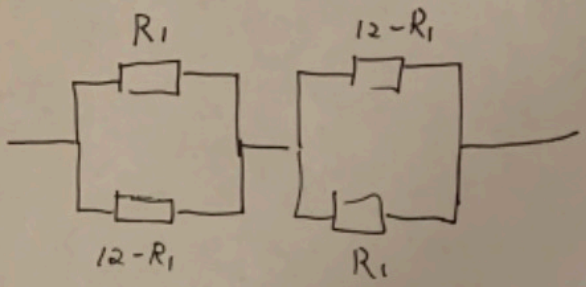
$R_x = \frac{30R}{360} = \frac{R}{12} = \frac{24}{12} = 2$



$P = I^2 R_0 = \frac{U^2}{R_0} = \frac{36}{R_0}$

$\frac{1}{R_1} = \frac{1}{2} + \frac{1}{10}$

$R_1 = \frac{20}{12} = \frac{10}{6} = \boxed{\frac{5}{3}}$



$R_0 = \frac{5}{3} \cdot 2 = \frac{10}{3}$

$P = \frac{36 \cdot 3}{10} = 10{,}8$ Вт.

$I = \frac{U}{R_0} = \frac{2}{3} = \frac{6}{R_0}$

$R_0 = 2 \cdot \frac{R_1(12-R_1)}{12} = \frac{R_1(12-R_1)}{6}$

$I = \frac{6 \cdot 6}{R_1(12-R_1)} = \frac{36}{R_1(12-R_1)} = \frac{2}{3}$