

# Часть 1

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

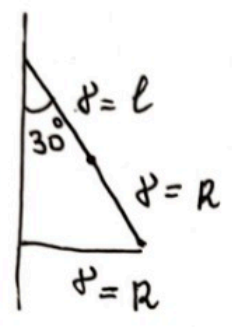
Шифр: **21204942**

ID профиля: **900400**

Вариант 4

(3)

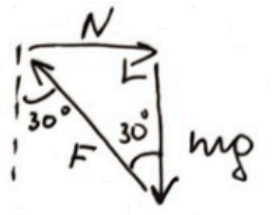
1)



Дано:  $R = 8 \text{ см}$ ;  $l = 8 \text{ см}$ ;  $m = 5,2 \text{ кг}$

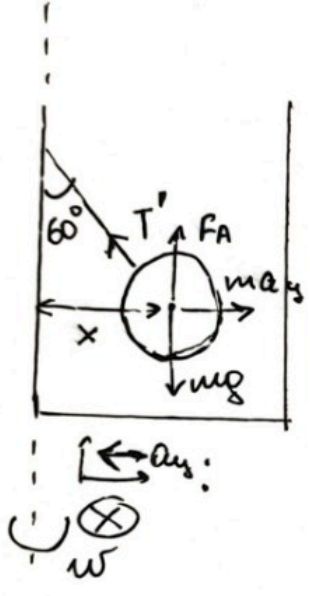
Решение:

$$\frac{mg}{F} = \cos 30^\circ$$

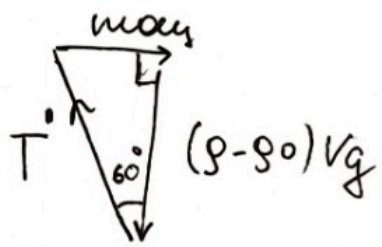


$$F = \frac{mg}{\cos 30^\circ} = \frac{52 \cdot 2}{\sqrt{3}} = \frac{104}{\sqrt{3}} \text{ (Н)}$$

2)



1)  $F_A = \rho_0 V g$ ;  $mg = \rho V g$ ;  $V = \frac{4}{3} \pi R^3$



2)  $\text{tg } \alpha = \frac{a_{ax}}{(\rho - \rho_0)Vg}$

$$\text{tg } \alpha = \frac{a_{ax}}{g(\rho - \rho_0 V)} \Rightarrow a_{ax} = \frac{\text{tg } \alpha (m - \rho_0 V) g}{m}$$

$$x = (R+l) \sin 60^\circ$$

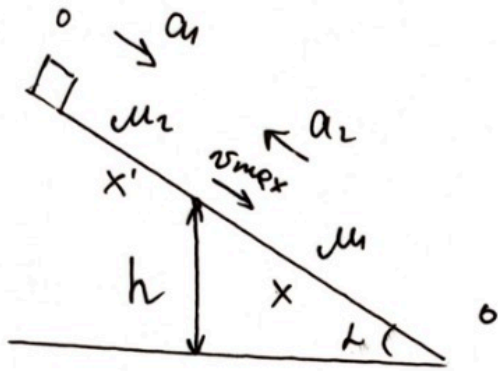
$$\frac{v^2}{x} = a_{ax} \Rightarrow v^2 = \sqrt{\frac{\text{tg } \alpha (m - \rho_0 V) g x}{m}}$$

$$T = \frac{2\pi x}{v} = \frac{2\pi (R+l) \sin 60^\circ}{\sqrt{\frac{\text{tg } 60^\circ (m - \rho_0 \frac{4}{3} \pi R^3) g (R+l) \sin 60^\circ}{m}}} \approx 0,72 \text{ с}$$

Ответ:  $F = \frac{104}{\sqrt{3}} \approx 60,12 \text{ Н}$ ;  $T \approx 0,72 \text{ с}$

Чистовики

(2)



Дано:  $\cos \alpha = \frac{24}{25}$ ;  $h = 1,4$

$\mu_1 = 0,5$ ;  $\mu_2 = 0,06$

Решим:

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

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

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

1)  $a_1 = 10\left(\frac{7}{25} - 0,0576\right) = 2,224 \text{ м/с}^2$

2)  $a_2 = 10\left(0,28 - \frac{24}{25} \cdot \frac{1}{2}\right) = -2 \text{ м/с}^2$

(1)

3)  $v_{\max} = \sqrt{\frac{2a_2 h}{\sin \alpha}} = \sqrt{20} \approx 4,47 \text{ м/с}$

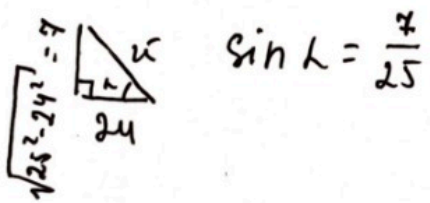
4)  $x = \frac{h}{\sin \alpha} = 5 \text{ м}$

5)  $v_m = \sqrt{x' \cdot 2 \cdot a_1} \Rightarrow x' = \frac{v_m^2}{2a_1} \approx 4,5 \text{ м}$

(2)

$S = x + x' \approx 9,5 \text{ м}$

Ответ:  $v_m \approx 4,47 \text{ м/с}$ ;  $S = 9,5 \text{ м}$

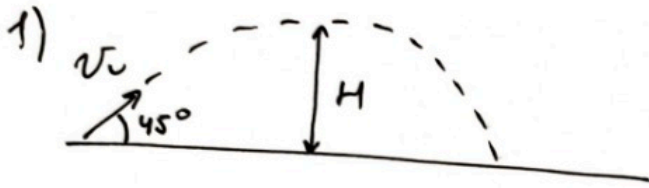


максимальное,  
т.е. дальнее  
ускорение направл.  
против движения

Числовим

1

Дано:  $\alpha = 45^\circ$ ;  $H = 10 \text{ м}$

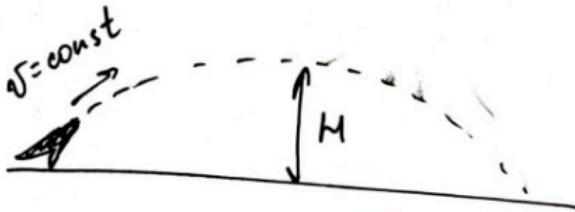


$$1) v_0 \sin \alpha = \sqrt{2Hg}$$

$\Downarrow$

$$v_0 = \frac{\sqrt{2Hg}}{\sin \alpha} \approx \underline{20 \text{ м/с}}$$

2)



$$F_{\text{тяг}} = \frac{mg}{2}; \quad mg - \frac{mg}{2} = \frac{mg}{2}$$

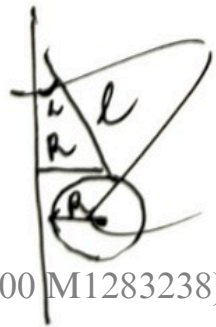
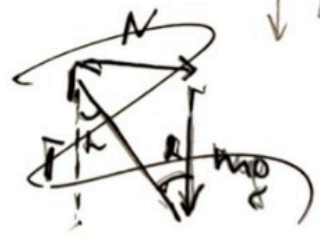
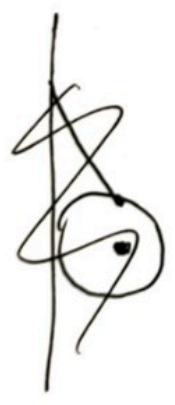
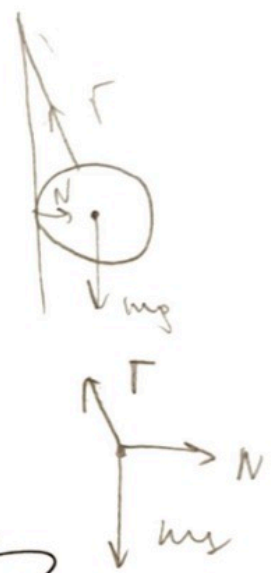
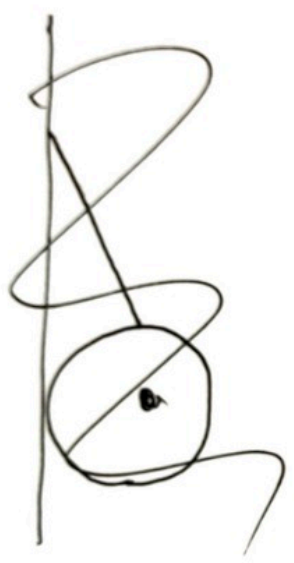
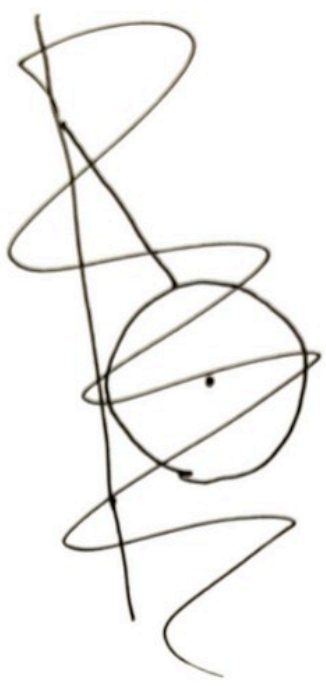
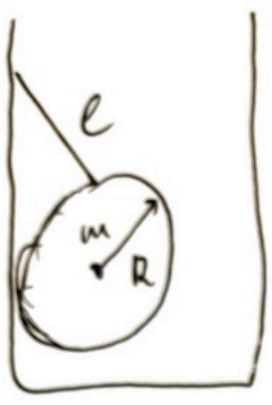
$$2) \frac{mg}{2} = \frac{mv^2}{H}$$

$$v = \sqrt{\frac{Hg}{2}} \approx \underline{7,07 \text{ м/с}}$$

Отвечать:  $v_0 = 20 \text{ м/с}$ ;  $v = 7,07 \text{ м/с}$

3.

# Черновики



$$\sin \alpha = \frac{R}{l} \quad \frac{mg}{T} = \cos \alpha$$

1

Черновик

$$a_{xy} = \frac{\text{tg} \lambda (m - \rho_0 V) g}{m} = \frac{v^2}{x} \approx 10,65$$

$$x = (R + l) \sin \omega^\circ = 0,1384$$

$$v = \sqrt{\frac{\text{tg} \lambda (m - \rho_0 V) g x}{m}}$$

$$T = \frac{2\pi x}{v} = \frac{2\pi x}{\sqrt{\frac{\text{tg} \lambda (m - \rho_0 V) g x}{m}}} = \frac{2\pi (R + l) \sin \omega^\circ}{\sqrt{\frac{\text{tg} 60 (m - \rho_0 V \frac{4\pi r^3}{3}) g (R + l) \sin \omega^\circ}{m}}}$$

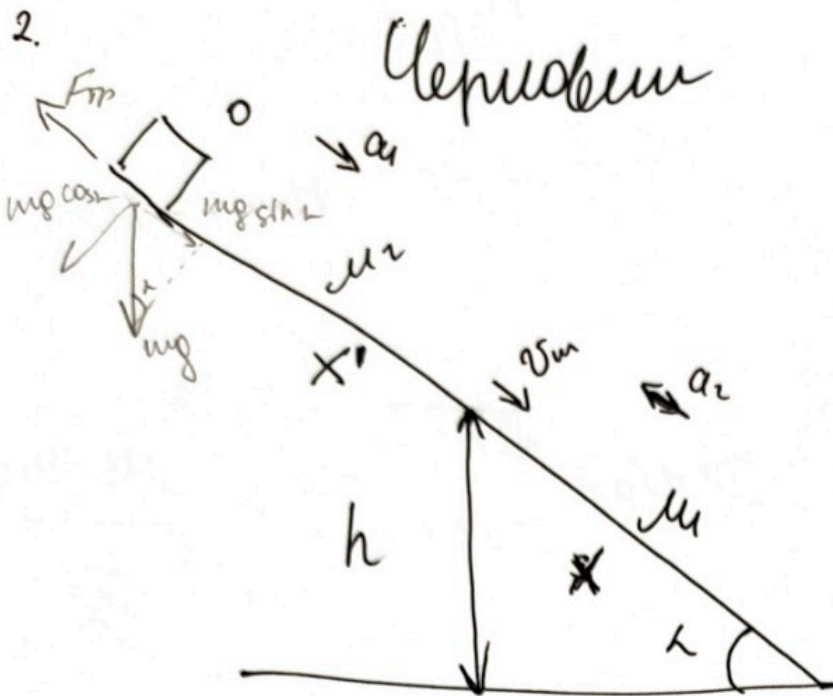
$= 0,72 \text{ c}$

$$V = 0,002$$

$$v^2 = 1,47$$

$$\underline{v = 1,21}$$

2



$$\cos \alpha = \frac{24}{25}$$

$$h = 1,4 \quad \mu_1 = 0,15$$

$$\mu_2 = 0,06$$

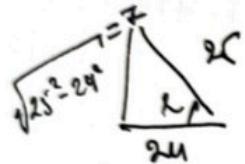
$$1) \quad m a_1 = -\mu_2 m g \cos \alpha + m g \sin \alpha$$

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

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

$$2) \quad a_2 = g \sin \alpha - \mu_1 \cos \alpha g$$

$$\sin \alpha = \frac{7}{25}$$



$$1)' \quad a_1 = 10 \left( \frac{7}{25} - 0,0576 \right) =$$

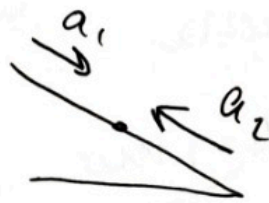
$$= 2,224$$

$$0,25$$

$$576$$

$$49$$

$$a_2 = 10 \left( 0,28 - 0,5 \cdot \frac{24}{25} \right) = -2$$



Упроблем

$$\frac{1}{2} \cdot \frac{24}{25}^{12} = \frac{12}{25}^{12}$$

$$= 0,48$$

$$5 = \frac{1,4 \cdot 25}{7} = \frac{h}{\sin \alpha} = \frac{v_m^2}{2 a_2}$$

$$v_m = \sqrt{\frac{2 a_2 h}{\sin \alpha}} = \sqrt{\frac{5,6 \cdot 25}{7}} = \sqrt{20} \approx 4,47$$

$$v_m = \sqrt{x' \cdot 2 a_1} \Rightarrow \frac{v_m^2}{2 a_1} = x' = \frac{20}{2 \cdot 2,224} = \frac{20}{4,448} \approx 4,5$$

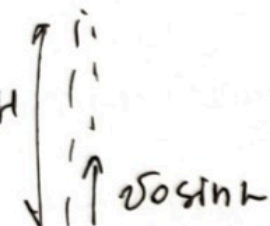
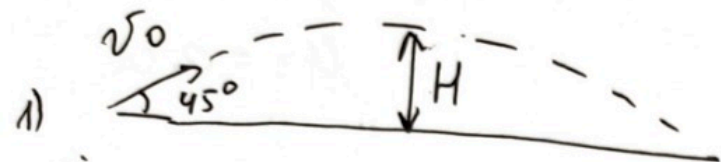
$$S = x + x' \approx 9,5 \text{ m}$$

③

# ЧЕРНОВИКИ

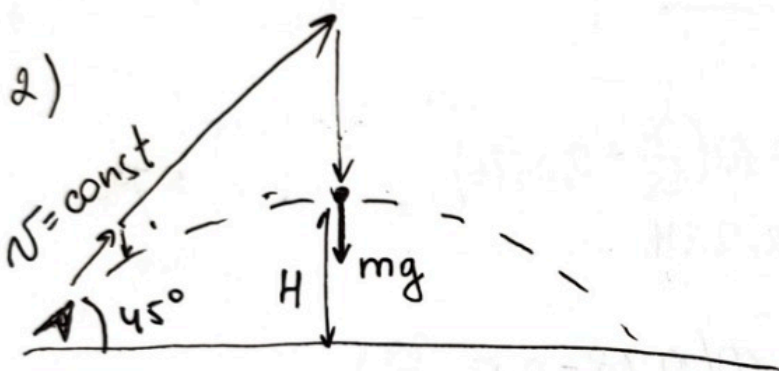
Дано:  $\alpha = 45^\circ$   $H_{max} = 10$

1.



$$v_0 \sin \alpha = \sqrt{2Hg} \Rightarrow v_0 = \frac{\sqrt{2Hg}}{\sin \alpha}$$
$$\frac{v_0^2 \sin^2 \alpha}{2g} = H$$

$$\frac{14,14 \cdot 2}{\sqrt{2}}$$



$$\frac{14,14 \cdot 2}{1,414} = 20$$

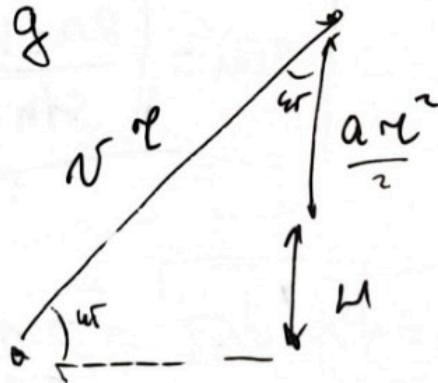
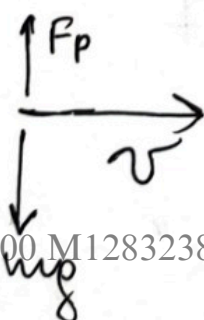
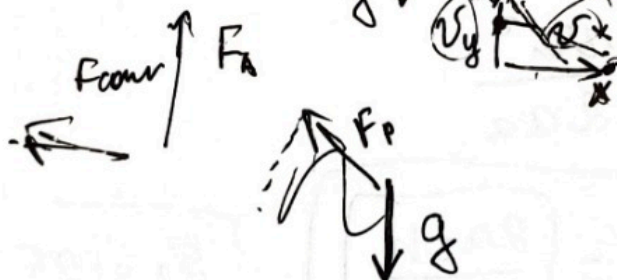
$$F_{равн} = \frac{mg}{2}$$

~~нужно вычислить угол?~~  
вправо по

И.е. скорость самолета

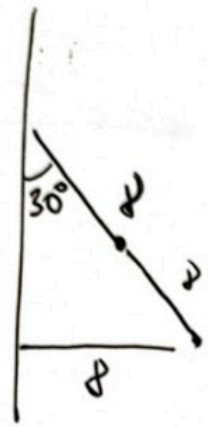
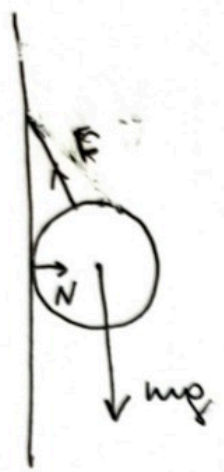
постоянна по всей тр., но сила не действует  $\Rightarrow$   $F_{равн}$   
угол  $\uparrow \downarrow$

об элементу по окружности наименьший угол





# Черновик



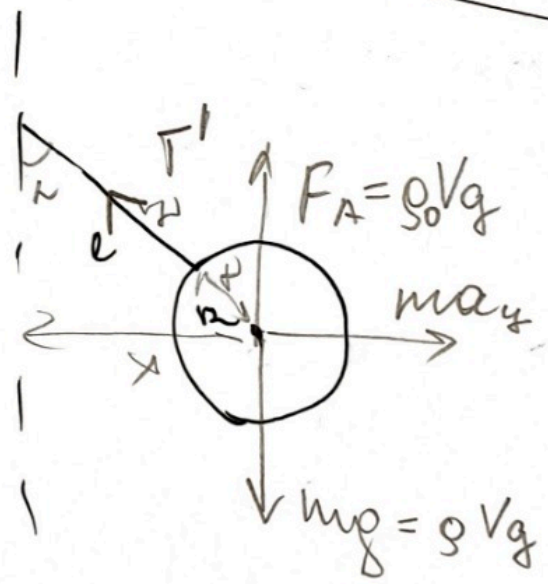
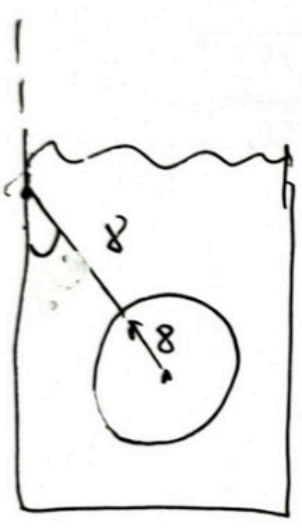
$$\frac{mg}{F} = \cos 30$$

$$F = \frac{mg}{\cos 30} =$$

$$= \frac{52}{\cos 30} \approx \frac{52 \cdot 2}{\sqrt{3}} =$$

$$= \frac{104}{\sqrt{3}}$$

$$\begin{aligned} \operatorname{tg} 60 &= \frac{\sin 60}{\cos 60} = \frac{\frac{\sqrt{3}}{2}}{\frac{1}{2}} = \sqrt{3} \approx 1.73 \end{aligned}$$

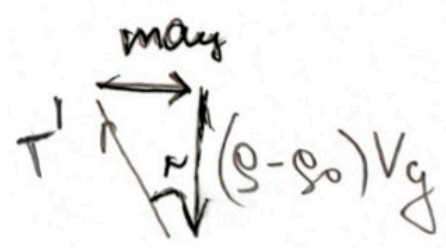


$$a_y = \frac{v^2}{r} \quad T = \frac{2\pi r v}{v}$$

$$\operatorname{tg} \alpha = \frac{m a_y}{(\rho - \rho_0) V g}$$

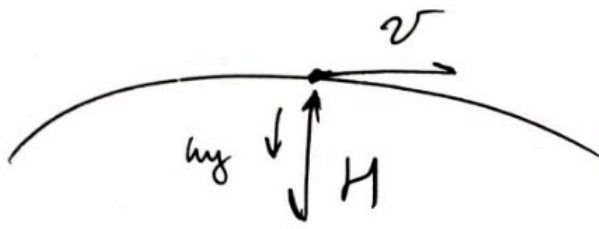
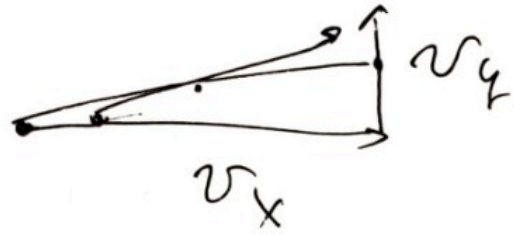
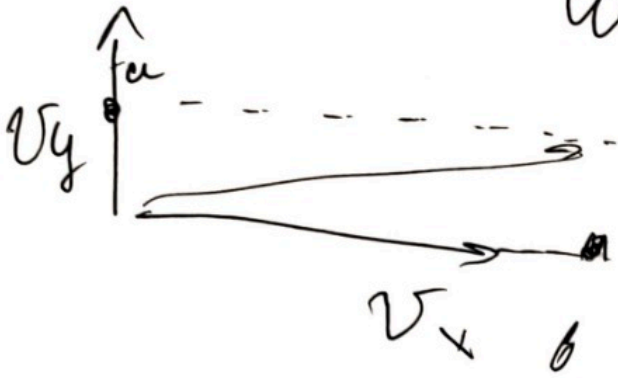
$$\operatorname{tg} \alpha = \frac{m a_y}{(\rho - \rho_0) V g} \Rightarrow a_y = \frac{\operatorname{tg} \alpha (\rho - \rho_0) V g}{m}$$

$$V = \frac{4}{3} \pi r^3$$



5

# Циркуляция



$$\frac{m_y}{2} = \frac{H v^2}{H}$$

$$v = \sqrt{\frac{H m_y}{2}}$$



# Часть 2

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

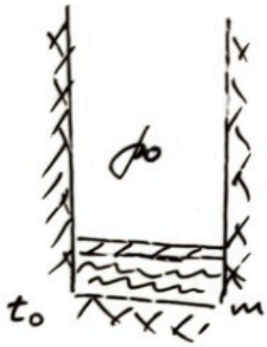
Шифр: **21204942**

ID профиля: **900400**

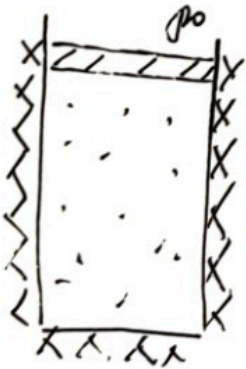
Вариант 4

Чистовик

4)



↓ Q



$T_2$  - конеч. темп.

$T_{100}$  - темп. кип  $100^\circ\text{C}$

$V_1$  - объем кип  $100^\circ\text{C}$

$$4) p_0 V_1 = \nu R T_{100} = \frac{m \nu}{\mu_{H_2O}} R T_{100}$$

$$V_1 = \frac{m \nu R T_{100}}{p_0 \mu_{H_2O}} = 0,017 \text{ м}^3$$

$$\Delta Q = 1,5 \nu R (T_2 - T_{100}) + p_0 \Delta V =$$

$$= 1,5 \frac{m \nu}{\mu_{H_2O}} \cdot 8,31 \cdot (320,7) + 10^5 \Delta V$$

$$\Downarrow$$

$$\Delta V \approx 0,048 \text{ м}^3 = \frac{\Delta Q - 1,5 \nu R (T_2 - T_{100})}{p_0}$$

$$V = V_1 + \Delta V = 0,017 + 0,048 = \underline{0,065 \text{ м}^3}$$

Ответ:  $V = 0,065 \text{ м}^3$ ;  $Q_1 = 3344 \text{ Дж}$

Дано:  $m = 10 \text{ г}$ ;  $20^\circ\text{C} = t_0$ ;

$p_0 = 10^5 \text{ Па}$ ;  $Q = 3344 \text{ Дж}$

Решим:

$$1) Q_1 = m \nu c \nu (100 - 20) = \underline{3344 \text{ Дж}}$$

$$2) Q' = m \nu c \nu (100 - 20) + m \nu r = 3344 +$$

$$+ 22600 = 25,944 \text{ Дж}$$

↓

Q хватает, чтобы испарить всю воду

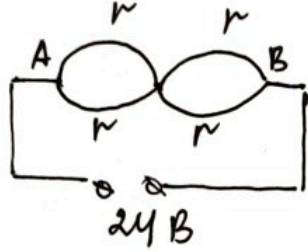
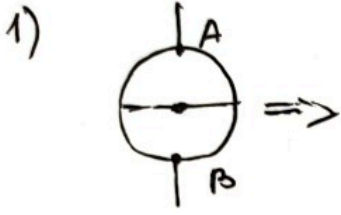
$$3) \Delta Q = 7056 \text{ Дж}$$

$$\Delta Q = c_p m p (T_2 - T_{100})$$

$$T_2 = \frac{\Delta Q}{c_p m p} + T_{100} = 420,7^\circ\text{C}$$

# Умнобум

5



Дано:  $R_{\text{кн}} = 72 \text{ Ом}$

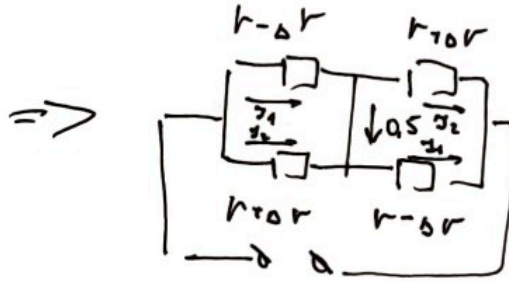
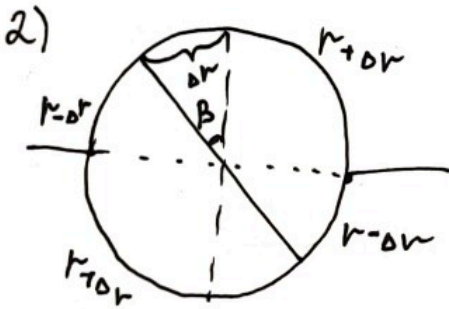
$U = 24 \text{ В}$

Решение:  
 $P = \frac{U^2}{R}$

$r = \frac{R_{\text{кн}}}{4}$ , (м.к.  $R_{\text{кн}} = \rho \frac{l}{S} \Rightarrow$   
 мин. значение  $l \Rightarrow$   
 $\Rightarrow r = \frac{1}{4} R_{\text{кн}}$ )

$R = \frac{r}{2} + \frac{r}{2} = r = \frac{R_{\text{кн}}}{4}$

$P = \frac{U^2 \cdot 4}{R_{\text{кн}}} = \underline{\underline{32 \text{ Вт}}}$



$R_{\text{кв}} = \frac{r^2 - \Delta r^2}{r}$

$G_{00} = \frac{24r}{r^2 - \Delta r^2}$

1)  $\frac{G_1}{G_2} = \frac{r+\Delta r}{r-\Delta r} \Rightarrow G_2 = \frac{24r}{\left(1 + \frac{r+\Delta r}{r-\Delta r}\right)(r^2 - \Delta r^2)}$

2)  $G_1 + G_2 = G_{00}$

$r = 18 \text{ Ом}$

3)  $G_1 = G_2 + 0,5$

$\frac{24r}{\left(1 + \frac{r+\Delta r}{r-\Delta r}\right)(r-\Delta r)^2} = \frac{24}{\left(1 + \frac{r+\Delta r}{r-\Delta r}\right)(r^2 - \Delta r^2)} + 0,5$

$\frac{24 \cdot 18}{(18 - \Delta r + 18 + \Delta r)(18 - \Delta r)} = \frac{24}{36(18 + \Delta r)} + 0,5$

21204942 (U900400 M1283239)

$\frac{12}{18 - \Delta r} = \frac{2}{3(18 + \Delta r)} + 0,5$

2 см

5)

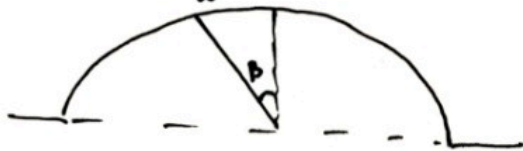
$$\frac{(18 + 5\Delta r) \cdot 4}{3(18^2 - \Delta r^2)} = \frac{1}{2}$$

$$\Delta r^2 + 40\Delta r - 180 = 0$$

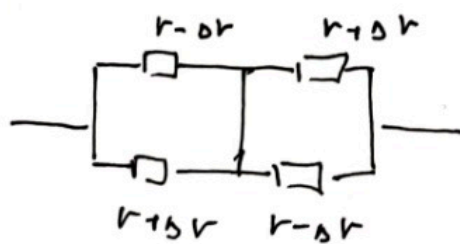
$$D = 1600 + 180 \cdot 4 = 2320$$

$$\Delta r = \frac{-40 \pm \sqrt{2320}}{2} \approx 4 \text{ Ом}$$

$$\frac{\frac{\Delta r}{R_{\text{ном}}}}{2} = \frac{1}{9} \Rightarrow \beta = \frac{1}{9} \cdot 180 = \underline{20^\circ}$$



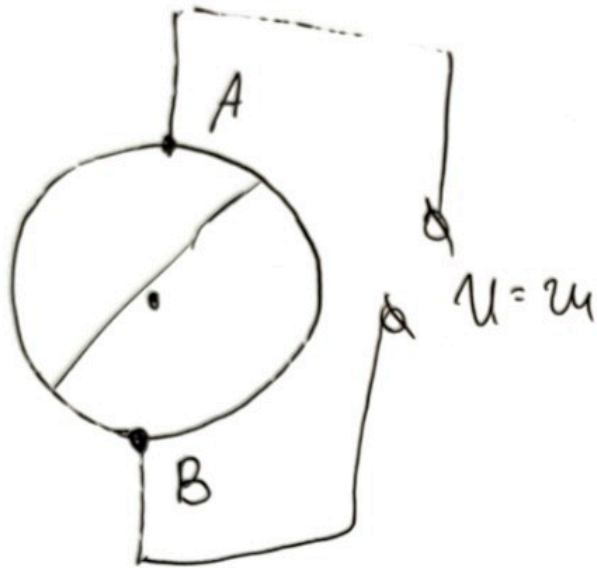
3)



$$P_2 = \gamma U = \frac{2U^2 \cdot r}{r^2 - \Delta r^2} = \frac{U^2 r}{r^2 - \Delta r^2} \approx \underline{33,66 \text{ Вт}}$$

Відповідь:  $P = 32 \text{ Вт}$ ;  $\beta = 20^\circ$ ;  $P_2 = 33,66 \text{ Вт}$

5.



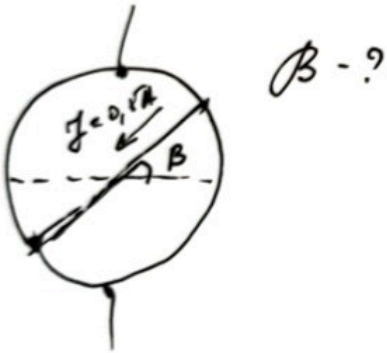
Цепь

$R_{\text{кн}}$

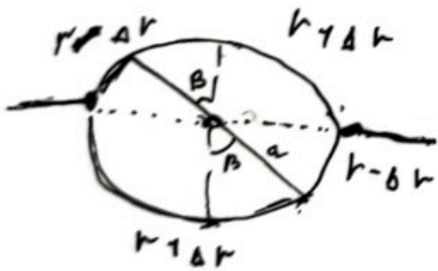
Радиус = 72 Ом  
упр.

$U = 24 \text{ В}$

2)



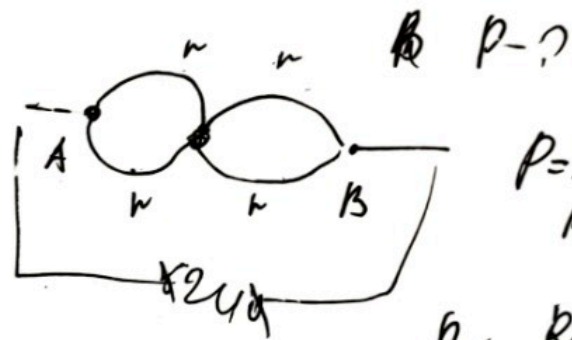
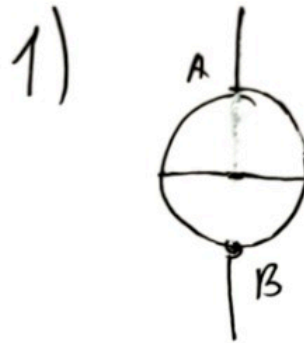
$B - ?$



$\beta [p\alpha g]$

$\Delta r = \beta \cdot R_{\text{кн}} \cdot a$

$R_{\text{кн}} = 2 \frac{l}{a}$



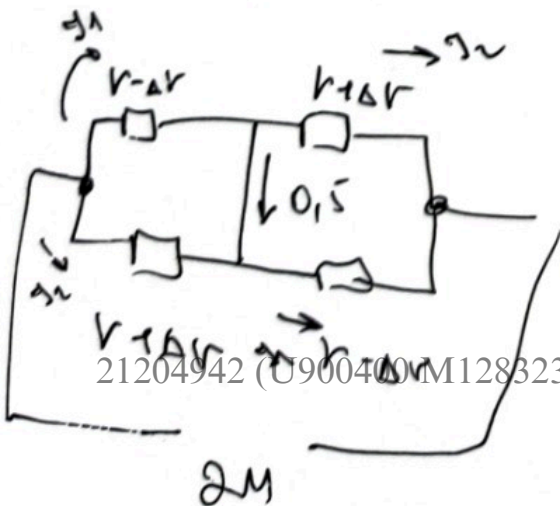
$P = \frac{U^2}{R}$

$R = \frac{R_{\text{кн}}}{4}$

$R_{\text{кн}} = r = \frac{R_{\text{кн}}}{4} \rightarrow \text{m.u. } R_{\text{кн}} = 9 \frac{l}{5} \Rightarrow$

$\text{m.u. of } l \Rightarrow r = \frac{1}{4} R_{\text{кн}}$

$P = \frac{U^2 \cdot 4}{R_{\text{кн}}} = 32 \text{ Вт}$



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1

Упробем

$$\frac{r^2 - \Delta r^2}{2r} = R_{\text{ав}}$$

$$J_{\text{ав}} = \frac{24 \nu}{r^2 - \Delta r^2}$$

$$1) \frac{J_1}{J_2} = \frac{r + \Delta r}{r - \Delta r} \Rightarrow J_1 = \frac{r + \Delta r}{r - \Delta r} J_2$$

$$2) J_1 + J_2 = J_{\text{ав}}$$

$$J_{\text{ав}} = J_2 \left( 1 + \frac{r + \Delta r}{r - \Delta r} \right) = \frac{24 \nu}{r^2 - \Delta r^2}$$

$$J_2 = \frac{24 \nu}{\left( 1 + \frac{r + \Delta r}{r - \Delta r} \right) (r^2 - \Delta r^2)}$$

$$3) J_1 = J_2 + 0,5$$



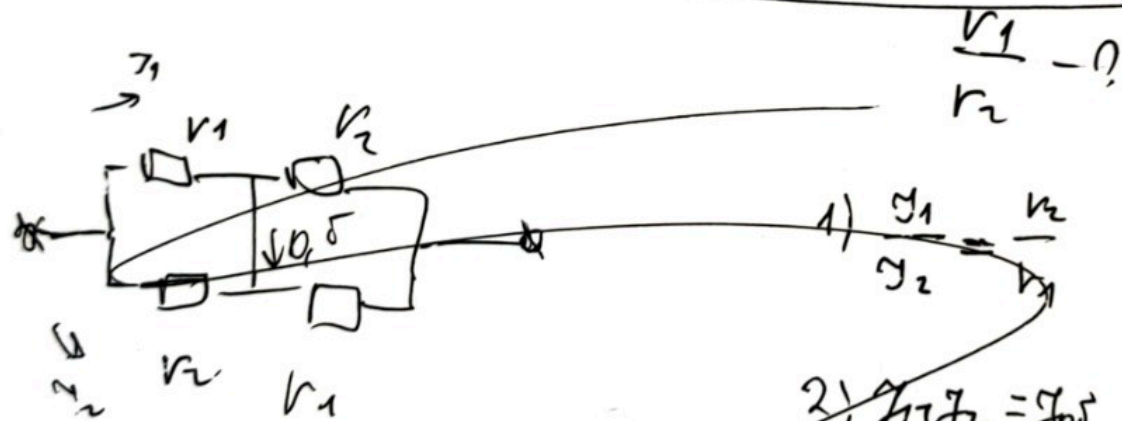
# Черновик

$$\frac{2uV (r + \Delta r)}{(1 + \frac{r + \Delta r}{r - \Delta r}) (r - \Delta r)^2} = \frac{2uV}{(1 + \frac{r + \Delta r}{r - \Delta r}) (r^2 - \Delta r^2)} + 0,5$$

$$\frac{2uV}{(1 + \frac{r + \Delta r}{r - \Delta r}) (r - \Delta r)^2} = \frac{2u}{(1 + \frac{r + \Delta r}{r - \Delta r}) (r^2 - \Delta r^2)} + 0,5$$

$$\frac{2u \cdot 18}{(1 + \frac{18 + \Delta r}{18 - \Delta r}) (18 - \Delta r)^2} = \frac{2u}{(1 + \frac{18 + \Delta r}{18 - \Delta r}) (18^2 - \Delta r^2)} + 0,5$$

$$\frac{2u \cdot 18}{(1 + \frac{18 + \Delta r}{18 - \Delta r}) (18 - \Delta r)^2} = \frac{2u}{(1 + \frac{18 + \Delta r}{18 - \Delta r}) (18 - \Delta r)(18 + \Delta r)} + 0,5$$



$$1) \frac{Y_1}{Y_2} = \frac{r_2}{r_1}$$

$$2) Y_1 Y_2 = Y_{ad}$$

$$Y = 2\omega - Y_2$$

$$1) \frac{Y\omega - Y_2}{Y_2} = \frac{r_2}{r_1}$$

$$24 \cdot 18$$

= 24, *первое*

$$\left( (18 - \Delta r) + 18 + \Delta r \right) (18 - \Delta r)$$

$$\frac{24 \cdot 18}{2 \cdot 18 (18 - \Delta r)} = \frac{24}{\cancel{18} + 0,5} \cdot 0,5$$

$$\frac{24 \cdot 12}{2(18 - \Delta r)} = \frac{24 \cdot 12 \cdot 0,5}{\underset{+18}{36} (18 + \Delta r)} + 0,5$$

$$\frac{12}{18 - \Delta r} = \frac{2}{3(18 + \Delta r)} + 0,5$$

$$\frac{12(3(18 + \Delta r)) - 2(18 - \Delta r)}{3(18 - \Delta r)(18 + \Delta r)} = 0,5$$

$$\frac{12(54 + 3\Delta r - 36 + 2\Delta r)}{3(18 + 5\Delta r)}$$

$$\frac{(18 + 5\Delta r) \cdot 12}{3(324 - \Delta r^2)} = \frac{1}{2}$$

$$\frac{(18 + 5\Delta r)}{824 - \Delta r^2} = \frac{1}{8}$$

(Y)

$$\Delta Q = c_p m p (T_2 - T_{\text{min}}) \rightarrow$$

$$T = 470,7 \quad "$$

Упрости

$$324 - \Delta r^2 = \cancel{36} \quad 144 + 40 \Delta r$$

$$\Delta r^2 + 40 \Delta r - 180 = 0$$

$$A = 1600 + 180 \cdot 4 = 2320$$

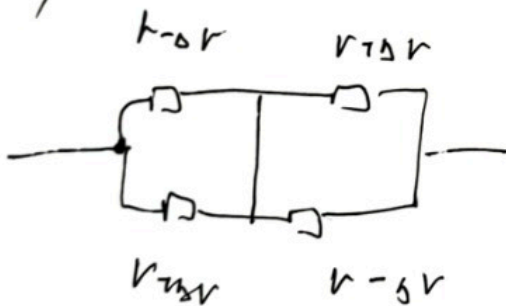
$$\Delta r = \frac{-40 + 48,2}{2} \approx 4$$



$$\beta = \frac{180}{9} = 20^\circ$$

$$\alpha = 90 - 20 = 70^\circ$$

3)



$$P_2 = \gamma U = \frac{2U^2 \cdot r}{r^2 - \Delta r^2} =$$

$$= \frac{10368}{308} = 33,66$$

5

$$\Delta Q = c_p m p (T_2 - T_{\text{room}}) \rightarrow$$

$$T_2 = 420,7$$

Упробем

$$\Delta Q = \frac{m_B}{\mu_{H_2O}} \cdot 1,5 \cdot 8,31 (320,7) + 10^5 \cdot \Delta V$$

$18 \cdot 10^{-3}$

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2226,85

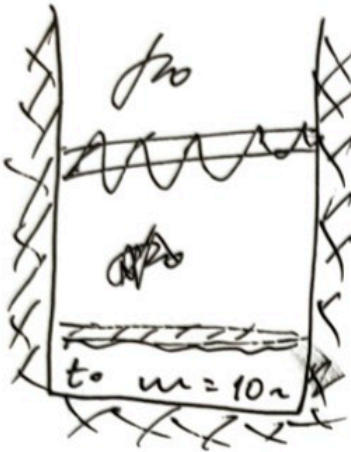
$$\Delta V = \frac{4835,15}{10^5} \approx 0,048$$

$$V = 0,017 + 0,048 = \underline{\underline{0,065}}$$



Черновик

4.



$Q = 33 \text{ кДж}$



1)  $Q_1 = m C_B (100 - 20) =$

$m_B = 10 \text{ г}$

$= 3344 \text{ Дж}$

$C_B = 4180$

2)  $Q_1 = 33 \text{ кДж}$

$Q = m_B C_B 80 + m_B L =$

$= 3344 + 22600 =$

$5604 \text{ Дж} = 5,604 \text{ кДж}$

⇓

Q хватает, вода испарится без остатка

$\mu_0 V_1 = \nu R T = \frac{m_B}{\mu_{H_2O}} R T_{100}$

$V_1 = \frac{m_B R T_{100}}{\mu_0 \mu_{H_2O}} = 0,017$

$V = V_1 + \Delta V =$

~~$Q = \nu \mu_0 (P_2 T_2 - P_1 T_1) = \mu_0 \nu (P_2 T_2 - P_1 T_1)$~~

~~$\Delta Q = \nu (P_2 T_2 - P_1 T_1) + \mu_0 \Delta V =$~~

~~$= 2,5 \mu_0 \Delta V \Rightarrow \Delta V = \frac{\Delta Q}{2,5 \mu_0} = 0,03$~~

$T_2 = \frac{\Delta Q}{C_p m_B} + T_{100} = 420,9 \text{ °C}$

$Q_2 =$

(7)