Часть 1

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

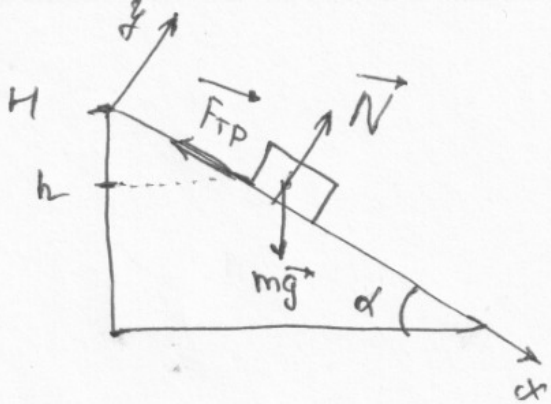
Шифр: **21206621**

ID профиля: **806985**

Вариант 4

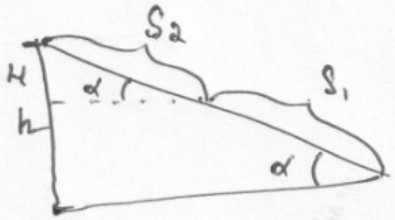
№2. 1) $Ox: mg\sin\alpha - F_{тр2} = ma_2$

$Oy: mg\cos\alpha - N = 0$



$Ox: mg\sin\alpha - F_{тр1} = -ma_1$

$Oy: mg\cos\alpha - N = 0$



ЗСЭ: $E_п + E_к = F_{тр1} \cdot S_1$

$mgh + \frac{mv_м^2}{2} = F_{тр1} \cdot S_1$

$S_1 = \frac{h}{\sin\alpha}$

$\sin\alpha = \sqrt{1-\cos^2\alpha}$

$\left(\frac{2gh + v_м^2}{2}\right) = g\cos\alpha\,\mu_1 \cdot \frac{h}{\sin\alpha}$

$2gh + v_м^2 = 2g\cos\alpha\,\mu_1 \frac{h}{\sin\alpha}$

$v_м^2 = \frac{2g\cos\alpha\,\mu_1 h}{\sin\alpha} - 2gh = 2g\left(\frac{\cos\alpha\,\mu_1 h}{\sin\alpha} - h\right) =$

$= 2g\left(\frac{\cos\alpha\,\mu_1 h - h\sin\alpha}{\sin\alpha}\right) = 2gh\left(\frac{\cos\alpha\,\mu_1 - \sin\alpha}{\sin\alpha}\right)$

$v_м = \sqrt{2gh\left(\frac{\cos\alpha\,\mu_1 - \sin\alpha}{\sin\alpha}\right)} = \sqrt{2gh\left(\frac{\cos\alpha\,\mu_1 - \sqrt{1-\cos^2\alpha}}{\sqrt{1-\cos^2\alpha}}\right)} =$

$= \sqrt{2 \cdot 10 \cdot 1{,}4 \cdot \left(\frac{\frac{24}{25} \cdot 0{,}5 - \sqrt{1 - \frac{24^2}{25^2}}}{\sqrt{1 - \frac{24^2}{25^2}}}\right)} = \sqrt{28 \cdot \left(\frac{\frac{12}{25} - \frac{7}{25}}{\frac{7}{25}}\right)} =$

$= \sqrt{20} = 2\sqrt{5}$ (м/с)

Ответ: $2\sqrt{5}$ (м/с)

№2. 2) $mgH = F_{тр2} \cdot S_2 + F_{тр1} \cdot S_1$

$H = \cos\alpha \mu_2 \cdot S_2 + \cos\alpha \mu_1 \cdot S_1$

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

$H = \frac{\cos\alpha \mu_2 \cdot H - \cos\alpha \mu_2 \cdot h + \cos\alpha \mu_1 \cdot h}{\sin\alpha}$

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

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

$H = \frac{h\cos\alpha(\mu_1 - \mu_2)}{\sin\alpha - \cos\alpha\mu_2} = \frac{h\cos\alpha(\mu_1 - \mu_2)}{\sqrt{1-\cos^2\alpha} - \cos\alpha\mu_2} =$

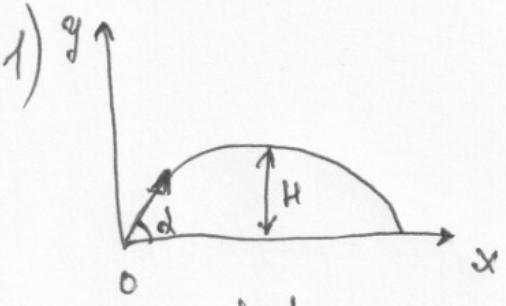
$= \frac{1,4 \cdot \frac{24}{25}(0,5 - 0,06)}{\frac{7}{25} - \frac{24}{25} \cdot 0,06} \approx 2,659 (м)$

$S = \frac{H}{\sin\alpha} = \frac{\frac{h\cos\alpha(\mu_1 - \mu_2)}{\sqrt{1-\cos^2\alpha} - \cos\alpha \cdot \mu_2}}{\sqrt{1-\cos^2\alpha}} \approx 9,5 (м)$

Ответ: 9,5 (м)

Чистовик Лист 3.

№1. 1)



$x = v_0 \cos\alpha \cdot t$

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

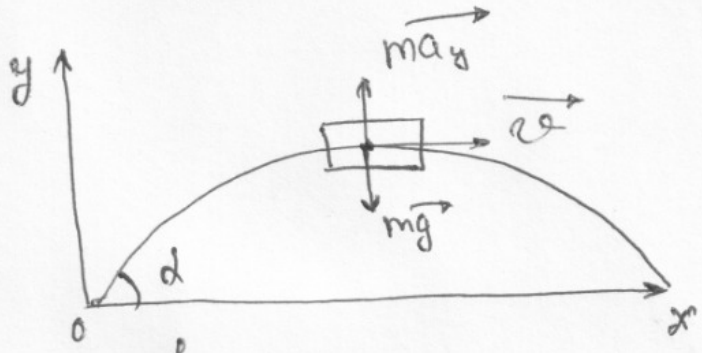
$v_x = v_0 \cos\alpha$

$v_y = v_0 \sin\alpha - gt = 0$

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

$H = \frac{v_0^2 \sin^2\alpha}{2g}$; $v_0 = \frac{\sqrt{2gH}}{\sin\alpha} = 20 (м/с)$

2)



$ma_y = \frac{1}{2} mg$

$a_y = \frac{1}{2} g$; $\frac{v^2}{R} = a_y \Rightarrow v = \sqrt{a_y R} =$

$= \sqrt{\frac{1}{2} g \frac{v_0^2 \cos^2\alpha}{g}} = \frac{v_0 \cos\alpha}{\sqrt{2}} =$

$= \frac{20 \cdot \frac{\sqrt{2}}{2}}{\sqrt{2}} = 10 (м/с)$

Ответ: 20 (м/с) ; 10 (м/с)

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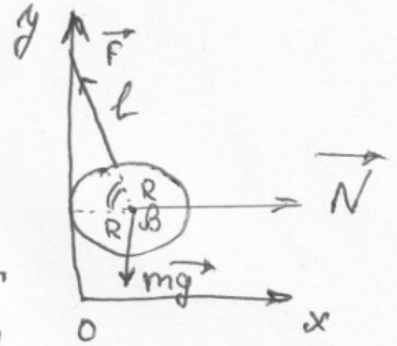
Чистовик Лист 4.

№3. 1) Oy: $F\cdot\sin\beta - mg = 0$

$F\sin\beta = mg$



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

$\sin\beta = \sqrt{1-\left(\frac{R}{R+l}\right)^2} = \sqrt{\frac{R^2-(l+R)^2}{R^2}}$

$\sin\beta = \sqrt{1-\left(\frac{R}{l+R}\right)^2} = \sqrt{\frac{(l+R)^2-R^2}{(l+R)^2}} =$

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

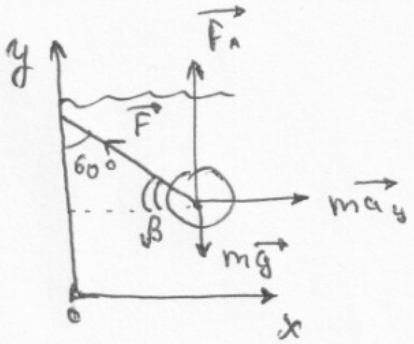
$F = \frac{mg}{\sin\beta} = \frac{mg}{\frac{\sqrt{l(l+2R)}}{l+R}} = \frac{mg(l+R)}{\sqrt{l(l+2R)}} =$

$= \frac{5{,}2\cdot 10\,(0{,}08+0{,}08)}{\sqrt{0{,}08\,(0{,}08+2\cdot 0{,}08)}} = \frac{52\cdot 0{,}16}{\sqrt{0{,}08\cdot 0{,}24}} = \frac{8{,}32}{\sqrt{0{,}0192}} =$

$= \frac{8{,}32}{0{,}139} = 59{,}86\ (H)$ Ответ: 59,86(H)

2) Ox: $ma_y - F\cdot\cos\beta = 0$

Oy: $F_A - mg + F\cdot\sin\beta = 0$



$ma_y = F\cdot\cos\beta$

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

$m\omega^2 = F\cdot\cos\beta$ $\quad F_A = \rho_{ж} g V =$

$\rho_{ж} g V = mg - F\cos\beta$ $\quad = mg - F\sin\beta$

$F\sin\beta = -\rho_{ж} g V + mg$

$F = \frac{mg - \rho_{ж} g V}{\sin\beta}$

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Человек лист 5

$$F = \frac{mg - \rho_{ж} g V}{\sin\beta}$$

$$m\omega^2 = \frac{g(m - \rho_{ж} V)}{\sin\beta} \cdot \cos\beta$$

$$m\omega^2 = \frac{g(m - \rho_{ж} V)}{\sin\beta} \cdot \cos\beta$$

$$\omega = \sqrt{\frac{g\cos\beta\,(m - \rho_{ж} V)}{m\sin\beta}}$$

$$\frac{2\pi}{T} = \sqrt{\frac{g\cos\beta\,(m - \rho_{ж} V)}{m\sin\beta}}$$

$$T = \frac{2\pi\sqrt{m\sin\beta}}{\sqrt{g\cos\beta\,(m - \rho_{ж} V)}};$$

$$\angle\beta = 90^\circ - \alpha = 90^\circ - 60^\circ = 30^\circ$$

Ответ: $T = \frac{2\pi\sqrt{m\sin\beta}}{\sqrt{g\cos\beta\,(m - \rho_{ж} V)}}$

$= \frac{1,344}{0,0576 -}$

$mgH = F_{тр2} S_2 + F_{тр1} S_1$

$H = \cos\alpha \mu_2 \cdot S_2 + \cos\alpha \mu_1 \cdot S.$

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

$H = \frac{\cos\alpha \mu_2 \cdot H - \cos\alpha \mu_2 \cdot h + \cos\alpha \mu_1 \cdot h}{\sin\alpha}$

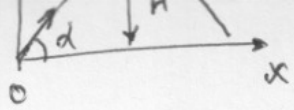
$H \sin\alpha = \cos\alpha \mu_2 \cdot H + \cos\alpha (\mu_1 h - \mu_2 h)$

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

$H = \frac{h \cos\alpha (\mu_1 - \mu_2)}{\sin\alpha - \cos\alpha \mu_2} = \frac{1,4 \cdot \frac{24}{25} \cdot 0,44}{\frac{7}{25} - \frac{24 \cdot 0,06}{25}} =$

$= \frac{0,59136}{0,28 - 0,0576} = \frac{0,59136}{0,2224} = 2,6589 \text{ (м)}$

$S = \frac{2,6589}{\frac{7}{25}} = 9,5 \text{ (м)}$



$x = v_0 \cos\alpha \cdot t$

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

$v_x = v_0 \cos\alpha$

$v_y = v_0 \sin\alpha - gt = 0$

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

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

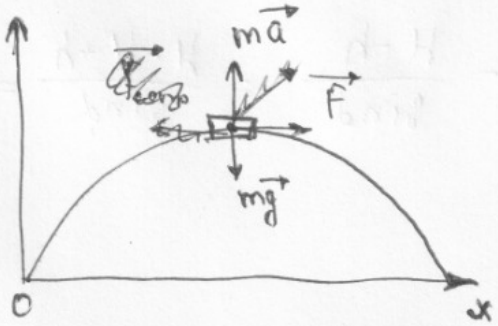
$\frac{v_0^2 \sin^2\alpha}{2g} = H$

$\sin^2\alpha = \frac{2gH}{v_0^2}$

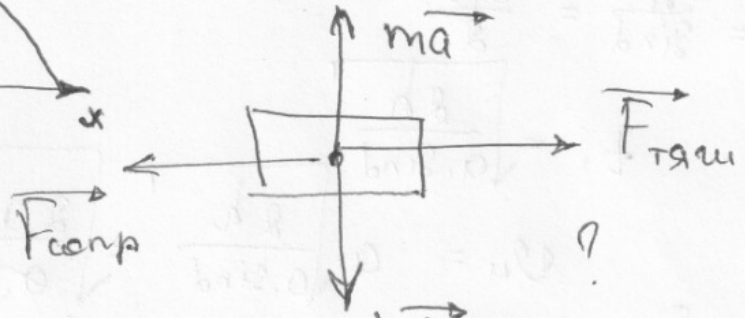
$\sin\alpha = \frac{\sqrt{2gH}}{v_0} = \frac{\sqrt{20 \cdot 10}}{v_0}$

$v_0 = \frac{\sqrt{2gH}}{\sin\alpha} = \frac{\sqrt{20 \cdot 10}}{\frac{\sqrt{2}}{2}} = \frac{2\sqrt{200}}{\sqrt{2}} = 2 \cdot 10 = 20$ (м/с)

2)



$F_{сопр}$ когда ха - ?



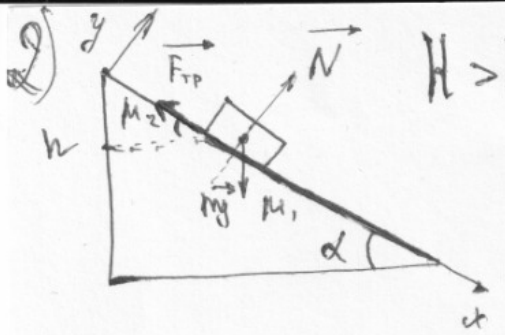
?

$ma_y = \frac{1}{2} mg$

$a_y = \frac{1}{2} g$

$v = \sqrt{a_y R} = \sqrt{\frac{1}{2} g \frac{v_0^2 \cos^2\alpha}{g}} =$

$= \frac{v_0 \cos\alpha}{\sqrt{2}}$

2) 

$H > h$: Ox: $mg\sin\alpha - F_{тр2} = ma_2$

Oy: $mg\cos\alpha - N = 0$

$H < h$: Ox: $mg\sin\alpha - F_{тр1} = -ma_1$

Oy: $mg\cos\alpha - N = 0$

$v_м = a_2 t_2$

$s_2 = \dfrac{a_2 t_2^2}{2}$

$a_y = g$, $v_{0\,верт.} = v_0\cos\alpha$

$R = \dfrac{v_0^2\cos^2\alpha}{g}$

$v = 0 = v_м - a_1 t_1$

$a_1 t_1 = v_м$

$s_1 = \dfrac{a_1 t_1^2}{2}$

$s_1 = v_м t_1 - \dfrac{a_1 t_1^2}{2}$

$\sin\alpha = \dfrac{H}{s_1 + s_2}$

$\sin\alpha = \dfrac{H-h}{s_2}$; $s_2 = \dfrac{H-h}{\sin\alpha}$

$s_1 + s_2 = \dfrac{H}{\sin\alpha}$

$s_1 = \dfrac{H}{\sin\alpha} - s_2 = \dfrac{H}{\sin\alpha} - \dfrac{H-h}{\sin\alpha} = \dfrac{H-H+h}{\sin\alpha} = \dfrac{h}{\sin\alpha}$

$s_1 = \dfrac{h}{\sin\alpha} = \dfrac{a_1 t_1^2}{2}$

$t_1 = \sqrt{\dfrac{2h}{a_1\sin\alpha}}$

$v_м = a_1\sqrt{\dfrac{2h}{a_1\sin\alpha}} = \sqrt{\dfrac{2a_1^2 h}{a_1\sin\alpha}} = \sqrt{\dfrac{2a_1 h}{\sin\alpha}}$

$ma_1 = F_{тр1} - mg\sin\alpha$

$a_1 = \dfrac{F_{тр1} - mg\sin\alpha}{m}$; $F_{тр1} = \mu_1 mg\cos\alpha$

$a_1 = \dfrac{\mu_1 mg\cos\alpha - mg\sin\alpha}{m} = \sqrt{\mu_1 g\cos\alpha - g\sin\alpha} =$

$= \sqrt{g(\mu_1\cos\alpha - \sin\alpha)}$

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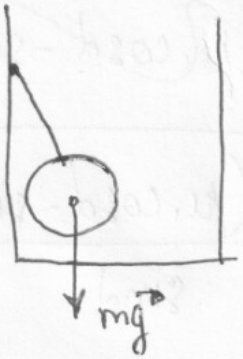
3) $Ox: ma - F\cdot\cos\beta = 0$

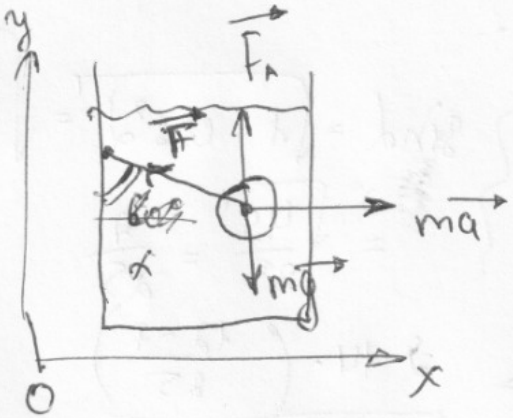
$Oy: F_A - mg + F\sin\beta = 0$



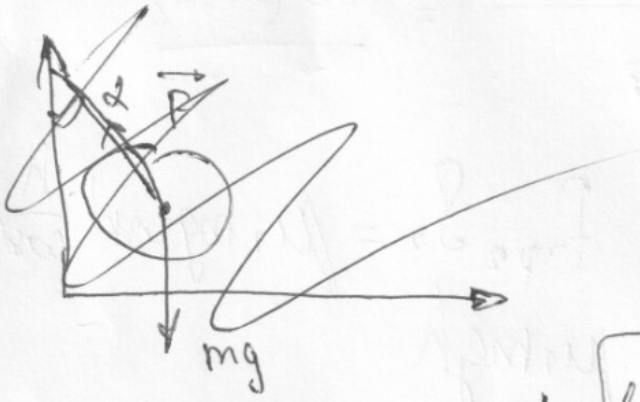
$ma = F\cos\beta$

$F_A + F\sin\beta = mg$

$$F = mg\cdot\frac{R+l}{R} = 52\cdot 0{,}03$$



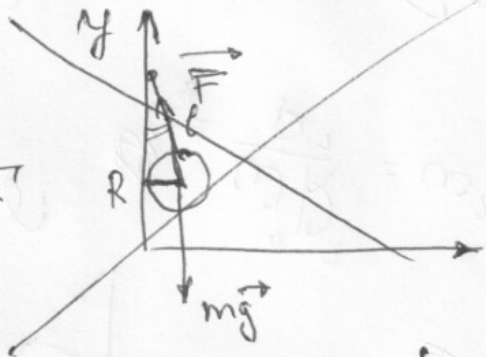
$Oy: F\sin\alpha = mg$



$$h = \sqrt{l^2 - R^2}$$

$$\sin\beta = \frac{\sqrt{l^2-R^2}}{l}$$

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

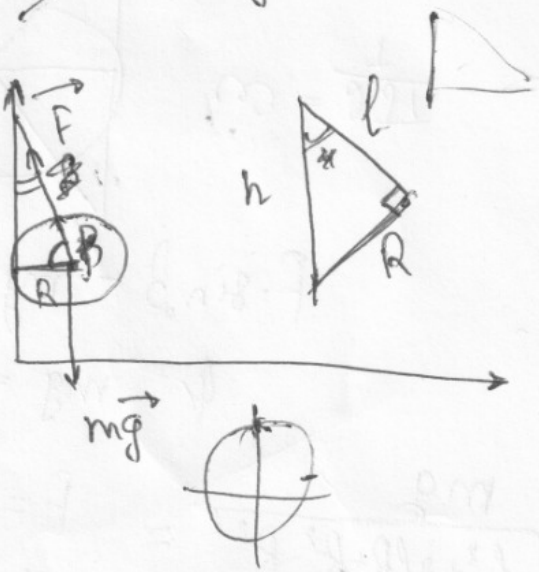


$-mg + F\cdot\sin(90^\circ - \beta) = 0$

$mg = F\cdot\sin(90^\circ - \beta)\,B$

$$mg = F\cdot\frac{\sqrt{l^2-R^2}}{l}$$

$$F = \frac{mgl}{\sqrt{l^2-R^2}}$$



$$v_м = \sqrt{g(\mu_1 \cos\alpha - \sin\alpha)} \cdot \sqrt{\frac{2h}{a_1 \sin\alpha}}$$

$$= \sqrt{\frac{2hg(\mu_1 \cos\alpha - \sin\alpha)}{\sin\alpha}} = \sqrt{\frac{2 \cdot 1{,}4 \cdot 10\left(0{,}5 \cdot \frac{24}{25} - \frac{7}{25}\right)}{\frac{7}{25}}} =$$

$$\left\{ \sin\alpha = \sqrt{1 - \cos^2\alpha} = \sqrt{\frac{25^2 - 24^2}{25^2}} = \frac{\sqrt{(25-24)(25+24)}}{25} = \right.$$

$$\left. = \frac{\sqrt{49}}{25} = \frac{7}{25} \right\}$$

$$= \frac{2 \cdot 14 \cdot \left(\frac{12-7}{25}\right)}{\frac{7}{25}} = \frac{2 \cdot 14^2 \cdot 25 \cdot \frac{5}{25}}{7} = 20\ (м/с)$$

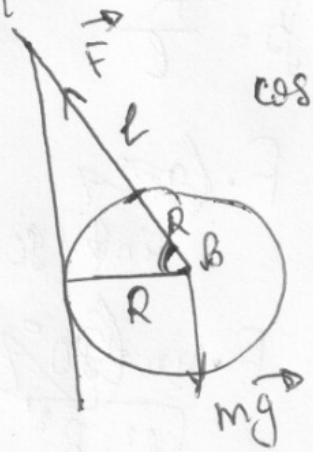
$$\frac{v_м^2 \cdot m}{2} = \frac{2v_м^2 \cdot m}{2} = A_{тр2} = f_{тр2} s_2 = \mu_2 mg \cos\alpha \frac{h}{\cos\alpha} =$$

$$= \mu_2 mgh$$

$$v_м = \sqrt{2\mu_2 gh}$$

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

$$\frac{1}{T} = \omega$$



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

$$F \cdot \sin\beta - mg = 0$$

$$mg = F\sin\beta$$

$$F = \frac{mg}{\sin\beta} = \frac{mg}{\sqrt{1 - \frac{R^2}{(l+R)^2}}} =$$

$$= \frac{mg}{\sqrt{\frac{l^2 + 2lR + R^2 - R^2}{(l+R)^2}}} = \frac{mg(l+R)}{\sqrt{l^2 + 2lR}}$$

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Часть 2

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

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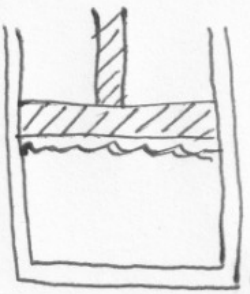
Вариант 4

Листовик ЛИСТ 1.

№4. 1) $Q_1 = cm(T_к - T_0)$

$Q_1 = 4180 \cdot 0{,}01 \cdot (373-293) = 3344$ (Дж)

2) 

$Q = cm(T_к - T_0) + rm + c_p m(T_к' - T_к)$

$c_p m T_к' = Q + c_p m T_к - rm - cm(T_к - T_0)$

$T_к' = \dfrac{Q + c_p m T_к - rm - cm(T_к - T_0)}{c_p m}$

$pV = \nu RT = \dfrac{m}{M} RT$

$\nu = \dfrac{m}{M}$; $V = \dfrac{\nu R T_к'}{P_0} = \dfrac{mRT_к'}{P_0 \cdot M} =$

$= \dfrac{mR}{P_0 M}\left(\dfrac{Q + c_p m T_к - rm - cm(T_к - T_0)}{c_p m}\right) =$

$= \dfrac{R}{P_0 M}\left(\dfrac{Q + c_p m T_к - rm - cm(T_к - T_0)}{c_p}\right) =$

$= \dfrac{8{,}31}{10^5 \cdot 0{,}018}\left(\dfrac{33000 + 2200 \cdot 0{,}01 \cdot 373 - 2{,}26 \cdot 10^6 \cdot 0{,}01 - 3344}{2200}\right) =$

$= \dfrac{8{,}31}{10^5 \cdot 0{,}018} \cdot \dfrac{(33000 + 8206 - 22600 - 3344)}{2200} =$

$= \dfrac{8{,}31 \cdot 6{,}937}{10^5 \cdot 0{,}018} = 0{,}032 \ (м^3)$

Ответ: 3344 (Дж) ; 0,032 ($м^3$)

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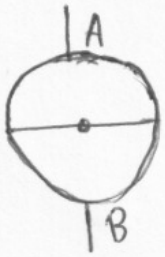
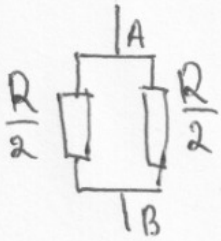
№5. 1) Если перемычка будет стоять под углом 90°, то ток через неё не потечёт.



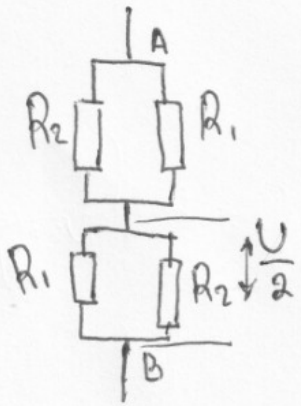
$$R_1 = \frac{\frac{R}{2}\cdot\frac{R}{2}}{\frac{R}{2}+\frac{R}{2}} = \frac{R}{4}$$



$$P = UI = \frac{U^2}{R_1} = \frac{24^2}{18} = 32\ (\text{Вт})$$

2) $I_1 = \frac{U}{2R_1}$

$I_2 = \frac{U}{2R_2}$



$$I = I_1 - I_2 = \frac{U}{2R_1} - \frac{U}{2R_2}$$

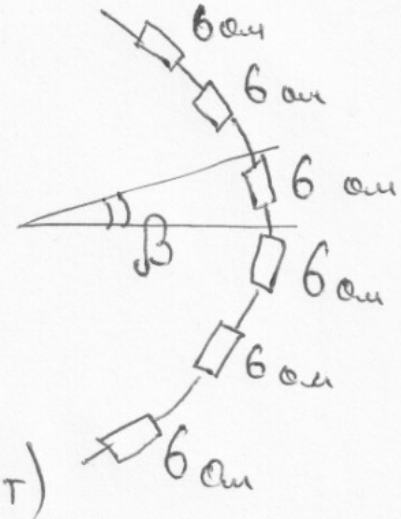
$$2R_1R_2I = UR_2 - UR_1$$

$$R_1 = \frac{UR_2}{2R_2I + U}$$

$$\begin{cases} R_1 = \frac{24R_2}{R_2+24} \\ R_1 + R_2 = 36 \end{cases}$$

$R_1 = 12\ (\text{Ом})$

$R_2 = 24\ (\text{Ом})$



Получаем: $\angle B = 30°$

3) $P_2 = \frac{U^2}{2\cdot\frac{12}{24}} = \frac{U^2}{16} = \frac{24^2}{16} = 36\ (\text{Вт})$

Ответ: 32 (Вт); 30°; 36 (Вт)

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Черновик

~~Вопрос такой:~~

$\nu = \frac{pV}{RT}$ - ~~ну~~

воды - ? = $\nu_{воды} = \nu_{пара}$

~~18 - не дано~~

$A = \frac{0,018 \cdot 8,31 \cdot}{10000}$

$T_к' = \frac{33000 + 2200 \cdot 0,01 \cdot 873 - 2260000 \cdot 0,01 - 3344}{2200 \cdot 0,01}$

$= \frac{33000 + 8206 - 22600 - 3344}{22} = 693,72 (k)$

$V = \frac{0,018 \cdot 8,31 \cdot 693,72}{10000} = 0,01037 (м^3)$

$V_{начальный} = \frac{0,018 \cdot 0,01}{1000} = 0,01 (л)$ — 10 (л)

Изобарный

$Q = A + \Delta U =$

$= \frac{i}{2} p\Delta V + p\Delta V = p\Delta V\left(\frac{i}{2} + 1\right)$

$pV = \nu RT$

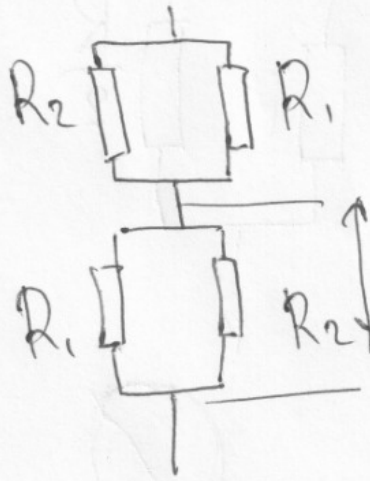
$\frac{i}{2} \nu R \Delta T$

$I_2 = I_4 - I$ Чернових

$I_1 + I_2 = \frac{U}{R_{AB}} = I_1 + I_4 - I = 2I_1 - I$

$I_1 = I_4 = \frac{\frac{U}{R_{AB}} + I}{2}$

$I_2 = I_3 = \frac{\frac{U}{R_{AB}} + I}{2} - I$



$I_1 = \frac{U}{2R_1}$

$I_2 = \frac{U}{2R_2}$

$I = I_1 - I_3 = I_1 - I_2 = \frac{U}{2R_1} - \frac{U}{2R_2}$

$2R_1R_2I = UR_2 - UR_1$

$R_1 = \frac{UR_2}{2R_2I + U}$

$R_1 = \frac{24R_2}{R_2 + 24}$; $R_1 + R_2 = 36$

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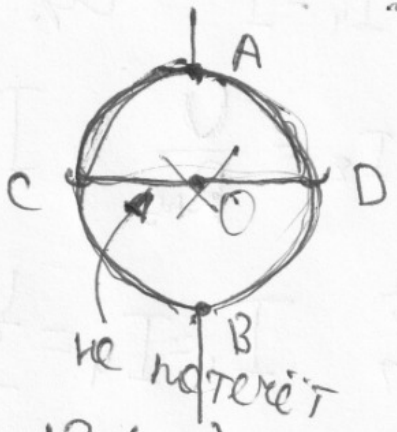
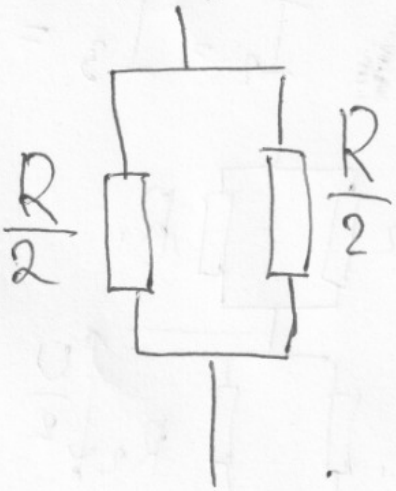
5) Черновик $R = \frac{U}{I}$

1) $R = 72$ (Ом)



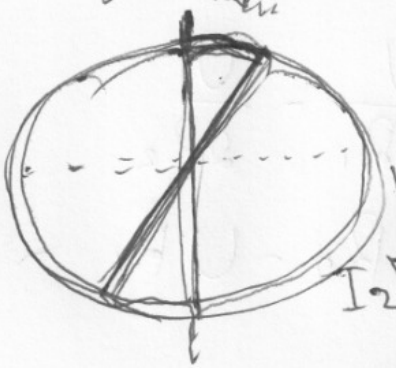
$$R_1 = \frac{\frac{R}{2} \cdot \frac{R}{2}}{\frac{2R}{2}} = \frac{\frac{R^2}{4}}{R} = \frac{R}{4} = 18 \text{ (Ом)}$$

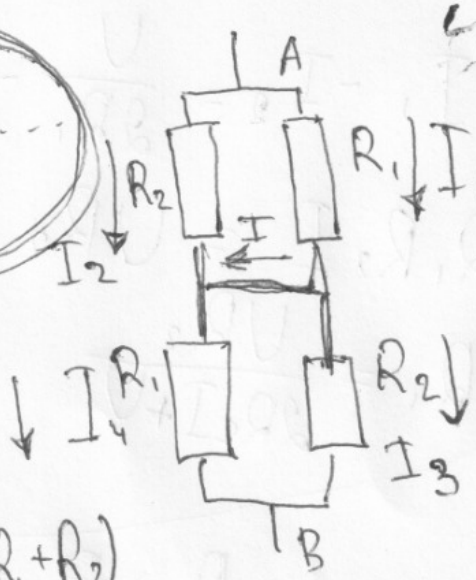


$$P = UI = \frac{U^2}{R} = \frac{24^2}{18} =$$

$$= 32 \text{ (Вт)}$$

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





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

$\frac{(R_1+R_2)^2}{2R_1+2R_2} =$

$= R_1 + R_2$

$I = \frac{U(R_1+R_2)}{2R_1R_2}$

$I_1 + I_2 = I_3 + I_4$

$I_1 = I_3 + I$

$I_4 = I_2 + I$

$I = I_3 + I_1$

4 Зад. (2 пункт) Орловск

$$\begin{cases} R_1 = \dfrac{24R_2}{R_2+24} \\ R_1 + R_2 = 36 \end{cases}$$

$R_1 = 36 - R_2$

$36 - R_2 = \dfrac{24R_2}{R_2+24}$

$(36-R_2)(R_2+24) = 24R_2$

$36R_2 - R_2^2 - 24R_2 + 36\cdot 24 - 24R_2 = 0$

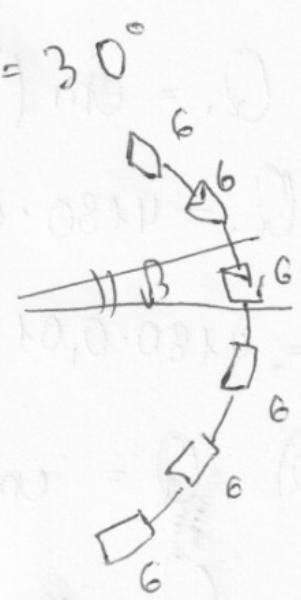
$-R_2^2 - 12R_2 + 864 = 0$

$D = 144 - 4(-1)\cdot 864 = 60^2$

$R_{2_{1,2}} = \dfrac{12 \pm 60}{-2}$; $R_2 = 36$

$R_1 = 12$

$R_2 = 24$



в) $P = \dfrac{U^2}{2\cdot \frac{12}{24}} = \dfrac{U^2}{16} = \dfrac{24^2}{16}$

$U = 24$ В ; P - ?

18 (Вт)

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4) 1) $Q = cm(T_к - T_0)$

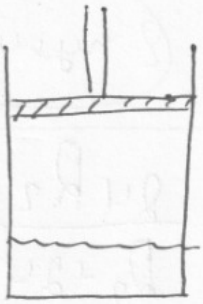
Черновик

$\rho = \frac{m}{V}$

$Q_1 = cm(T_к - T_0)$

$Q_1 = 4180 \cdot 0{,}01 \cdot (373 - 293) =$

$= 4180 \cdot 0{,}01 \cdot 80 = 3344$ (Дж)



$2{,}26 \cdot 1000000 =$

$= 2260000$

2) $Q = cm\Delta(T_к - T_0) + rm = 3344 + 22600 = 25944$

$Q = cm\, c_p m(T_к' - T_к) = 2200 \cdot 0{,}01 \cdot (T_к' - 373)$

$7056 = 22T_к' - 8206$

$22T_к' = 15262$

$T_к' = 693{,}72$ (К)

$pV = \nu RT$

$pV = \frac{m}{M} RT_к'$

$V = \frac{mRT_к'}{Mp_0} = \frac{\nu RT_к'}{p_0} = \frac{p_0 m}{\rho RT_0} \cdot \frac{RT_к'}{p_0} =$

$= \frac{mT_к'}{\rho T_0} = \frac{0{,}01 \cdot 693{,}72}{1000 \cdot 293} \approx 0{,}0000237$ ($м^3$)

$\nu = \frac{V}{V_м}$

$\nu = \frac{m}{M}$

$pV = \frac{m}{M} RT$

$\nu = \frac{pV}{M}$

$\rho = \frac{m}{V}$

0,000001

$\nu = \frac{p_0 m}{\rho RT_0}$

$M = \frac{Ri}{2c_p}$ $C_p = \frac{i}{2} \frac{R}{M}$

$\nu = \frac{0{,}01 \cdot 2 \cdot 2200}{8{,}31 \cdot \frac{3}{2}} = \frac{44}{} \approx 3{,}52$

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