Часть 1

Олимпиада: **Физика, 9 класс (1 часть)**

Шифр: **21204901**

ID профиля: **170058**

Вариант 2

Черновик

$$P_1 = \frac{\left(U_0 \frac{R}{R+3r}\right)^2}{R} = \frac{U_0^2 R^2}{R(R+3r)^2} = U_0^2 \frac{R}{(R+3r)^2}$$

$$P_2 = \frac{\left(U_0 \frac{R}{3R+r}\right)^2}{R} = \frac{U_0^2 R^2}{R(3R+r)^2} = U_0^2 \frac{R}{(3R+r)^2}$$

$$\frac{P_1}{P_2} = \left(\frac{3R+r}{R+3r}\right)^2$$

$$\sqrt{\frac{P_1}{P_2}} = \frac{3R+r}{R+3r}$$

$$3\sqrt{\frac{P_1}{P_2}}\, r + R\sqrt{\frac{P_1}{P_2}} = 3R+r$$

$$r\left(3\sqrt{\frac{P_1}{P_2}} - 1\right) = R\left(3 - \sqrt{\frac{P_1}{P_2}}\right)$$

$$R = r\,\frac{3\sqrt{\frac{P_1}{P_2}} - 1}{3 - \sqrt{\frac{P_1}{P_2}}} \approx 6,8874$$

$$P = I^2 R$$

$$\boxed{I_1 = \frac{P_1(R+3r)}{U_0 R} = 0,574 \qquad I_2 = \frac{P_2(3R+r)}{U_0 R} = 0,262}$$

$$\left(\frac{I_1}{I_2}\right)^2 = \frac{P_1}{P_2}$$

$$\boxed{\mathcal{E} = \frac{P_1(R+3r)}{\frac{U_0}{3} R} = \frac{3P_1(R+3r)}{U_0 R} = 1,723}$$

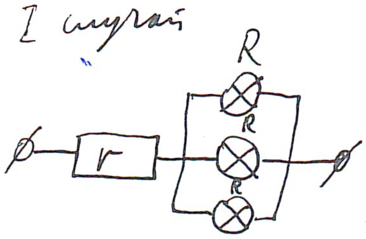
Чистовик лист 3

№3

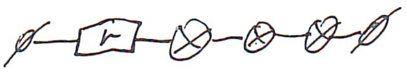
Пусть R - сопр-е лампочки

r - сопр-е источника напряжения

I случай



II случай



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

$$\begin{cases} P_1 = \frac{U_1^2}{R} \\ U_1 = U_0 \frac{\frac{R}{3}}{\frac{R}{3}+r} = U_0 \frac{R}{R+3r} \end{cases}$$

$$P_1 = \frac{U_0^2 R^2}{\cancel{R}(R+3r)^2} = \frac{U_0^2 R}{(R+3r)^2}$$

$$\begin{cases} P_2 = \frac{U_2^2}{R} \\ U_2 = U_0 \frac{R}{3R+r} \end{cases}$$

$$P_2 = \frac{U_0^2 R^2}{R(3R+r)} = \frac{U_0^2 R}{(3R+r)^2}$$

$\cancel{P_1 = U_0}$ $\cancel{P_2}$

$$\frac{P_1}{P_2} = \left(\frac{3R+r}{R+3r}\right)^2$$

$$\sqrt{\frac{P_1}{P_2}} = \frac{3R+r}{R+3r}$$

$$\sqrt{\frac{P_1}{P_2}}R + 3\sqrt{\frac{P_1}{P_2}}r = 3R+r$$

$\cancel{r(1-3}$ $r\left(3\sqrt{\frac{P_1}{P_2}}-1\right) = R\left(3-\sqrt{\frac{P_1}{P_2}}\right)$

$$r = R\frac{3-\sqrt{\frac{P_1}{P_2}}}{3\sqrt{\frac{P_1}{P_2}}-1} \cancel{\approx 0{,}1452} = kR$$

$$I_1 = \frac{P_1(R+3r)}{U_0 R} = \frac{P_1 R(1+3k)}{U_0 R} = \frac{P_1}{U_0}(1+3k) =$$

$\approx 0{,}574$ A

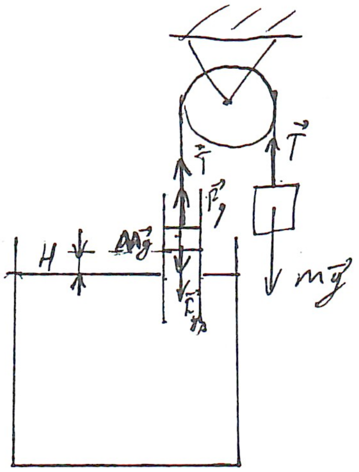
$\cancel{I_2 = \frac{P_2(3r+R)}{U_0 R} =}$

$$I_2 = \frac{P_2(3R+r)}{U_0 R} = \frac{P_2 R(3+k)}{U_0 R} = \frac{P_2}{U_0}(3+k) =$$

$\approx 0{,}262$ A

Чистовик Лист 2

№2



на пов-ти воды в сосуде давление p_A =>

=> при подъёме вверх на H давление будет равно $p_A - \rho g H = 98$ кПа

ОТН-но поршня:

$0 = T + F_g - Mg - F_{gA} = mg + S(p_A - \rho g H) - S \cdot p_A - Mg$

~~$0 = mg +$~~ $0 = mg - Mg - S\rho g H$

$M = m - SH\rho = 70$ г

при массе груза $\frac{m}{10}$ поршень опустится ниже уровня воды, т.к. $\frac{m}{10} < M$, поэтому

$0 = T' + F_g' - Mg - F_{gA} = \frac{mg}{10} + S(p_A + \rho g H') - Sp_A - Mg$

$0 = \frac{mg}{10} + S\rho g H' - Mg$

~~$S\rho g H' = \frac{mg}{...}$~~

$S\rho H' = M - \frac{m}{10}$

$H' = \frac{M - \frac{m}{10}}{S\rho} = 5$ см

Ответ: 1) 98 кПа; 2) 70 г; 3) 5 см.

Чистовик   Лист 1

№1

полная механическая энергия мячей в любой момент времени равна $E_k + E_p = \frac{mv^2}{2} + mgh = \frac{mv_0^2}{2}$

Поэтому на одной высоте модули скорости мячей по модулю равны

В момент столкновения:

$$\begin{cases} v_1 = g t_2 \\ v_1 = v_0 - g t_2 \\ v_0 = g t_1 \end{cases}$$

где t_2 – время от броска второго мяча до столкновения

t_1 – время от броска первого мяча до момента максимальной высоты

$$\begin{cases} v_0 = 2 g t_2 \\ v_0 = g t_1 \end{cases}$$

$$\begin{cases} t_1 = 2 t_2 \\ T = t_1 + t_2 \end{cases}$$

$$t_2 = \frac{T}{3}$$

$$t_1 = \frac{2T}{3}$$

$$\begin{cases} H_{max} = v_0 t_1 - \frac{g t_1^2}{2} \\ v_0 = g t_1 \end{cases}$$

$$H_{max} = g t_1^2 - \frac{g t_1^2}{2}$$

$$H_{max} = \frac{g t_1^2}{2} = \frac{2 g T^2}{9}$$

$$v_0 = g t_1 = \frac{2 g T}{3}$$

Ответ: 1) $\frac{T}{3}$; 2) $\frac{2gT^2}{9}$, 3) $\frac{2gT}{3}$

Черновик

$t_1 = \frac{v_0}{g}$

$t_2 =$

$h = v_0 t_2 - \frac{g t_2^2}{2}$

$h = H_{max} - \frac{g t'^2}{2}$

$H_{max} = v_0 t_2 = v_0 t_1 - \frac{g t_1^2}{2}$

$v' = v_0 - t_2 g$

$v' = t_2 g$

$v_0 = 2 t_2 g$

$v_0 = t_1 g$

$t_1 = 2 t_2$

$t_1 + t_2 = T$

$3 t_2 = T$

1) $\boxed{t_2 = \frac{T}{3}}$

$H_{max} = v_0 t_1 - \frac{g t_1^2}{2}$

$v_0 = g t_1$

2) $\boxed{H_{max} = \frac{g t_1^2}{2} = \frac{2gT^2}{9}}$

3) $v_0 = g t_1 = \frac{2gT}{3}$

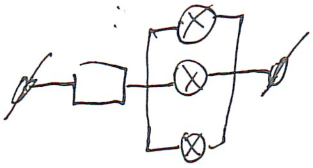
$P = \frac{U_л^2}{R}$

$P_2 = 4$

$I_1 = \frac{P_1}{U}$ 0,4 A

$I_2 = \frac{3P_2}{U} = \frac{0,8}{3} \approx$ ~~0,266 A~~ 0,26

~~II~~ I



$I_1 = \frac{P_1}{U_0 \frac{\frac{R}{3}}{\frac{R}{3} + r}} = \frac{P_1}{\frac{U_0 R}{R+3r}} = \frac{P_1(R+3r)}{U_0 R}$

$I_2 = \frac{P_2}{U_0 \frac{R}{3R+r}} = \frac{P_2(3R+r)}{U_0 R}$

$\frac{I_1}{I_2} = \frac{P_1(R+3r)}{P_2(3R+r)}$

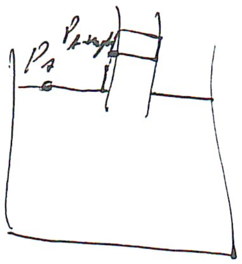
Черновик

$m_п = 70$ г

1) $P_A = \rho g H = 98000$ Па $= 98$ кПа

2) 70 г

3) 5 см



$$I' = \frac{P_1(R+3r)}{\frac{U_0}{3}R} = \frac{3P_1(R+3r)}{U_0 R} = \frac{3P_1 R(1+3k)}{U_0 R} = \frac{3P_1}{U_0}(1+3k) \approx 1{,}723\,A$$

Ответы: 1) 0,574 A; 2) 0,262 A; 3) 1,723 A.

Часть 2

Олимпиада: **Физика, 9 класс (2 часть)**

Шифр: **21204901**

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Вариант 2

Черновик лист 2
№ 8

$\cancel{t = \sqrt{10gH}}$

$\cancel{0{,}5 H + 3H - 0{,}5 H}$

$x^2 - 3x + 2$

$\cancel{0{,}25\pi}$

$\frac{3+1}{2} = 2$

$0{,}0625\pi H^3 = V$

$\frac{3-1}{2} = 1$

$v = \sqrt{2{,}5gH}\,S$

1) $t = \frac{V}{v} = \frac{0{,}0625\pi H^3}{\sqrt{2{,}5gH}\,S} = \sqrt{\frac{0{,}25\pi^2 H^6}{2{,}5 g H S^2}} = \sqrt{\frac{\pi^2 H^5}{10 g H S^2}} = \cancel{\frac{\pi H^2}{S\sqrt{10g}}}\ \frac{\pi H^2}{S}\sqrt{\frac{H}{10g}}$

4

$0{,}5H = v_x t$

$H = v_y t - \frac{gt^2}{2}$

$v_x^2 + v_y^2 = v^2$

$v_x = \sqrt{v^2 - v_y^2}$

$t = \frac{0{,}5H}{\sqrt{v^2 - v_y^2}}$

$\frac{v^2}{2} = gh$

$\cancel{v = \sqrt{2gh}}$

$v_x = \sqrt{v_0^2 - v_y^2}$

$v_x = \sqrt{2{,}5gh - 2gh} = \sqrt{0{,}5gh}$

$\operatorname{tg}\alpha = \frac{v_y}{v_x} = \sqrt{\frac{2}{0{,}5}} = 2$

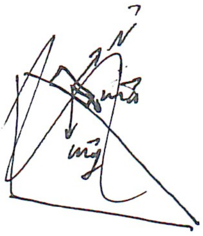
$H = \frac{0{,}5Hv_y}{\sqrt{v^2 - v_y^2}} - g\frac{0{,}25H^2}{2(v^2 - v_y^2)} = \frac{0{,}5Hv_y}{\sqrt{v^2 - v_y^2}} - \frac{\cancel{0{,}25H^2}\ H^2 \cdot 0{,}125}{(v^2 - v_y^2)}$

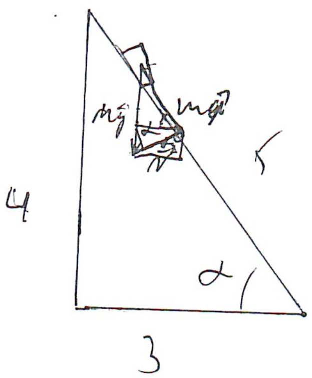
$1 = \frac{0{,}5v_y}{\sqrt{v^2 - v_y^2}} - \frac{gH \cdot 0{,}125}{v^2 - v_y^2} = \frac{0{,}5v_y\sqrt{v^2 - v_y^2} - 0{,}125Hg}{v^2 - v_y^2}$

$v^2 - v_y^2 = 0{,}5v_y\sqrt{v^2 - v_y^2} - 0{,}125Hg$

$v_x^2 = 0{,}5v_x v_y - 0{,}125Hg \qquad v_x(v_x - 0{,}5v_y) = -0{,}125gH$

Черновик лист 1





$\frac{4}{5}g$

$\frac{3}{5}mg$

$\frac{12}{25}mg$

$\frac{6}{25}g$

$\cancel{mg=}$ $ma=mg\sin\alpha$

$a=g\sin\alpha$

$l=\frac{H}{\sin\alpha}$

$l=\frac{at^2}{2}$ $\frac{H}{\sin\alpha}$

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

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

$t=\sqrt{\frac{2H}{\sin^2\alpha\, g}}$

$a_ш=g\sin\alpha\cancel{\cos\alpha}$

$a_к=\frac{g\sin\alpha\cos\alpha\, tg\alpha}{2}=\frac{g\sin^2\alpha}{2}$

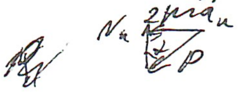
$\cancel{a=g\sin\alpha\cos\alpha\left(1+\frac{tg\alpha}{2}\right)=g\sin\alpha\left(\cos\alpha+\frac{\sin\alpha}{2}\right)}$

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

$H=\frac{at^2}{2}$

$H=\frac{g\sin\alpha\cos\alpha\left(1+\frac{tg\alpha}{2}\right)t^2}{2}$

$t^2=\frac{2H}{g\sin\alpha\cos\alpha\left(1+\frac{tg\alpha}{2}\right)}$



$2ma_к=P\cdot\sin\alpha$

$2ma_к=N\sin\alpha$

$2ma_к=mg\cos\alpha\sin\alpha$

$a_к=\frac{g\cos\alpha\sin\alpha}{2}$

$a'_{к}=\frac{g\cos^2\alpha\sin\alpha}{2}$

$a=a_ш+a_к'=$

$=g\sin\alpha\left(1+\frac{\cos^2\alpha}{2}\right)=$

$=1{,}5g\sin\alpha$

$\cancel{l=\frac{at^2}{2}}$

$l=\frac{at^2}{2}$

$a_ш'=g\sin\alpha\cdot\cos\alpha$

$a_к'=\frac{g\cos\alpha\sin\alpha\, tg\alpha}{2}$

$a=g\sin\alpha\cos\alpha\left(1+\frac{tg\alpha}{2}\right)$

$H=\frac{at^2}{2}$

$H=\frac{g\sin\alpha\cos\alpha\left(1+\frac{tg\alpha}{2}\right)t^2}{2}$

$t^2=\frac{2H}{g\sin\alpha\cos\alpha\left(1+\frac{tg\alpha}{2}\right)}$

$\frac{H}{\sin\alpha}=\frac{g\sin\alpha\left(1+\frac{\cos^2\alpha}{2}\right)t^2}{2}$

$\frac{2H}{g\sin^2\alpha\left(1+\frac{\cos^2\alpha}{2}\right)}=t^2$

$l=\frac{at^2}{2}$ $\frac{H}{\sin\alpha}=\frac{1{,}5g\sin\alpha\, t^2}{2}$

$\frac{2H}{1{,}5\sin^2\alpha\, g}=t^2$

Чистовик лист 2

$$\begin{cases} V = S \cdot H = 0{,}625\pi H^3 \\ \upsilon_V = \sqrt{2{,}5gH} \cdot S \\ t = \frac{V}{\upsilon_V} \end{cases}$$

$$t = \frac{0{,}625\pi H^3}{\sqrt{2{,}5gH}} = \frac{\pi H^2}{S}\sqrt{\frac{H}{10g}}$$

$$H = \upsilon_{y0} t - \frac{gt^2}{2}$$

$$0{,}5H = \upsilon_x t$$

$$H = \frac{\upsilon_{y0} \cdot 0{,}5H}{\upsilon_x} - \frac{gH^2}{8\upsilon_x^2}$$

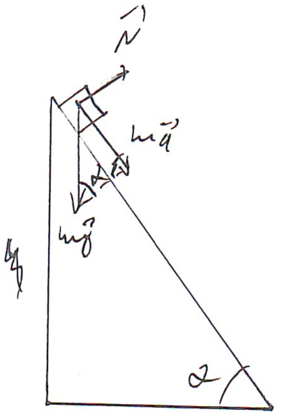
$$\frac{gH}{8\upsilon_x^2} = \frac{\upsilon_{y0}}{2\upsilon_x} - 1$$

Ответ 1) $\frac{\pi H^2}{S}\sqrt{\frac{H}{10g}}$

Чистовик лист 1

№4

Д) I



$ma = mg\sin\alpha$

$a = g\sin\alpha$

$a_y = a\sin\alpha = g\sin^2\alpha$

$t = \sqrt{\frac{2H}{a}}$

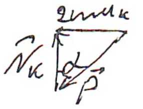
$t = \sqrt{\frac{2H}{g\sin^2\alpha}}$

II

$a_Ш = g\sin\alpha$

для клина:

$2m\vec{a}_к = \vec{P} + \vec{N}_к$



$2ma_к = P\sin\alpha$

$2ma_к = N\sin\alpha$

$2ma_к = mg\cos\alpha\sin\alpha$

$a_к = \frac{g\sin\alpha\cos\alpha}{2}$

Если клин сдвинется на l, а шайбу будут удерживать так, чтобы её ~~горизонтально~~ X-координата отн-но стола не менялась, то шайба опустится на $\mathrm{tg}\alpha\, l$

$$\begin{cases} a_{к_Ш} = a_к\,\mathrm{tg}\alpha = \frac{g\sin\alpha\cos\alpha\,\mathrm{tg}\alpha}{2} = \frac{g\sin^2\alpha}{2} \\ a_{Ш_y} = a_Ш\cdot\sin\alpha = g\sin^2\alpha \\ a = a_{кш} + a_{шy} \end{cases}$$

$$\begin{cases} a = g\sin^2\alpha\cdot 1{,}5 \\ t = \sqrt{\frac{2H}{a}} \end{cases}$$

$t = \sqrt{\frac{2H}{1{,}5g\sin^2\alpha}}$

Ответ: $\sqrt{\frac{2H}{g\sin\alpha}}$; $\frac{g\sin\alpha\cos\alpha}{2}$; $\sqrt{\frac{2H}{1{,}5g\sin^2\alpha}}$

Чернетки Лист 4

$$\frac{1}{v_x} = \frac{v_{y0} + \sqrt{v_{y0}^2 - 2gH}}{0{,}5gH}$$

$$\frac{0{,}5gH}{v_x} - v_{y0} = \sqrt{v_{y0}^2 - 2gH}$$

$$\cancel{\frac{0{,}25g^2H^2}{v_x^2} - \frac{gHv_{y0}}{v_x} + v_{y0}^2 = v_{y0}^2 - 2gH}$$

$$H = v_{y0}t - \frac{gt^2}{2}$$

$$0{,}5H = v_x t$$

$$t = \frac{0{,}5H}{v_x}$$

$$H = \frac{v_{y0} \cdot 0{,}5H}{v_x} - \frac{gH^2}{8v_x^2}$$

$$1 = \frac{v_{y0}}{2v_x} - \frac{gH}{8v_x^2}$$

$$\frac{gH}{8v_x^2} - \frac{v_{y0}}{2v_x} + 1 = 0$$

$$\frac{gH}{8}k^2 - \frac{v_{y0}}{2}k + 1 = 0$$

$$\frac{v_{y0}}{2} - \frac{gH}{2}$$

$$k_1 k_2 = 1 \cdot \frac{8}{gH}$$

$$k_1 + k_2 = \frac{v_y 8}{2gH} = \frac{4v_y}{gH}$$

Черновик Лист 3

$$\frac{v_{y_0}^2}{2} = \frac{v_y^2}{2} + gH$$

$$v_y = v_{y0} - gt$$

$$\cancel{t = \frac{l}{v_x}} \quad t = \frac{0{,}5H}{v_x}$$

$$v_y = v_{y0} - \frac{0{,}5Hg}{v_x}$$

$$v_{y0}^2 = v_y^2 + 2gH$$

$$v_{y0}^2 = v_{y0}^2 - \frac{v_{y0}gH}{v_x} + \frac{0{,}25H^2g^2}{v_x^2} + 2gH$$

$$\frac{v_{y0}}{v_x} = \frac{0{,}25gH}{v_x^2} + 2$$

$$\frac{0{,}25gH}{v_x^2} - \frac{v_{y0}}{v_x} + 2 = 0$$

$$\cancel{v_{y0}^2 - 2\frac{gH}{v_x}}$$

$$v_{y0} \pm \sqrt{v_{y0}^2 - 2gH}$$

$$\overline{0{,}5gH}$$

$$\cancel{\frac{1}{v_{x_1}} + \frac{1}{v_{x_2}} = -\frac{2}{0{,}25gH} = -\frac{8}{gH}}$$

$$\cancel{\frac{1}{v_{x_1}v_{x_2}} = -\frac{v_y}{v_x 0{,}25gH}}$$

$$\frac{1}{v_{x_1}} + \frac{1}{v_{x_2}} = \frac{v_{y0}}{0{,}25gH} = \frac{4v_{y0}}{gH} \qquad \frac{1}{v_{x_2}} = \frac{4v_{y0}}{gH} - \frac{1}{v_{x_1}}$$

$$\frac{1}{v_{x_1}v_{x_2}} = \frac{8}{gH}$$

$$\cancel{\frac{H}{v_{x1}}}$$

$$\frac{1}{v_{x_2}} = \frac{8v_{x_1}}{gH}$$

$$\frac{1}{v_{x_1}} + \frac{v_{x_1}8}{gH} = \frac{4v_{y0}}{gH} \qquad \frac{gH}{v_{x_1}} + 8v_{x_1} = 4v_{y0}$$

$$gH + 8v_{x_1}^2 = 4v_{y0}v_{x_1}$$