Место для скобы

ОРМО

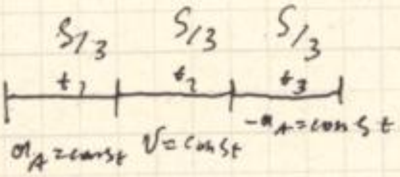
Открытая региональная межвузовская олимпиада

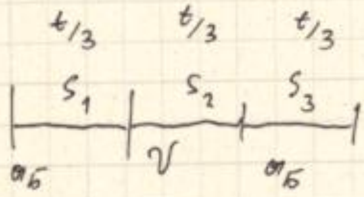
Общий балл	Дата	Ф.И.О. Жюри	Подпись
51	16.03.25	Соломатин К.В	

Шифр 01102

20

№1





A) $\frac{S}{3} = \frac{a t_1^2}{2}$ $t_1^2 = \frac{2}{3}\frac{S}{a_A}$ $a_A = \frac{v-0}{t_1}$ $t_1 = \frac{2}{3}\frac{S}{v} = t_3$

$t_2 = \frac{S}{3v}$

$t_A = t_1 + t_2 + t_3$ $t_A = \frac{2}{3}\frac{S}{v} + \frac{2}{3}\frac{S}{v} + \frac{1}{3}\frac{S}{v} = \frac{5}{3}\frac{S}{v}$ 8

Б) $S_1 = S_3 = \frac{a_Б t^2}{18}$ $a_Б = \frac{3v}{t}$ $S_1 = S_3 = \frac{vt}{6}$

$S_2 = \frac{vt}{3}$

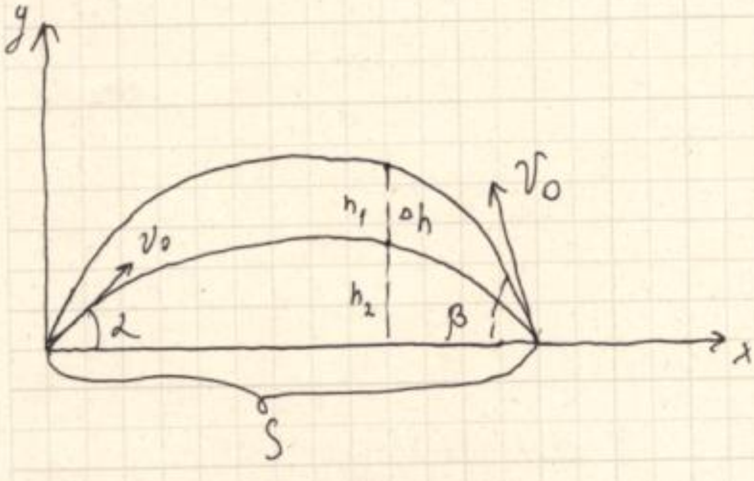
$S = S_1 + S_2 + S_3$ $S = \frac{vt}{6} + \frac{vt}{3} + \frac{vt}{6} = \frac{4vt}{6} = \frac{2}{3} vt$ $t_Б = \frac{3}{2}\frac{S}{v}$ 8

$t_Б < t_A$ – Борис будет первым 2

$\Delta t = \cancel{t_Б - t_A = \frac{3}{2}\frac{S}{v} - \frac{5}{3}\frac{S}{v}}$ $t_A - t_Б = \frac{5}{3}\frac{S}{v} - \frac{3}{2}\frac{S}{v} = \frac{1}{6}\frac{S}{v}$ 2

Ответ: Борис первый; $\Delta t = \frac{1}{6}\frac{S}{v}$

№2



Δh - минимальное расстояние

~~$h_1 h_2$~~

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

$\sin 2\alpha = \sin 2\beta$ 2

$\beta = 90 - 2$

$\beta > 45^0$ $\alpha < 45^0$

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$h_1 = -v_0 t \sin\beta - \frac{gt^2}{2}$ $\quad h_2 = v_0 t \sin\alpha - \frac{gt^2}{2}$

$gt^2 + 2v_0 t \sin\beta + 2h_1 = 0$

$D = 4v_0^2 \sin^2\beta - 8gh_1$

$t_1 = \frac{-\cancel{2}v_0 \sin\beta - \cancel{2}\sqrt{v_0^2 \sin^2\beta - 2gh_1}}{\cancel{2}g}$

$t_1 = t_2$

$gt^2 - 2v_0 t \sin\alpha + 2h_2 = 0$

$D = 4v_0^2 \sin^2\alpha - 8gh_2$

$\beta = 90 - \alpha \Rightarrow \sin\beta = \sin(90 - \cancel{\alpha}) = \cos\alpha$

$t_2 = \frac{\cancel{2}v_0 \sin\alpha + \cancel{2}\sqrt{v_0^2 \sin^2\alpha - 2gh_2}}{\cancel{2}g}$

$-v_0 \sin\beta - \sqrt{v_0^2 \sin^2\beta - 2gh_1} = v_0 \sin\alpha + \sqrt{v_0^2 \sin^2\alpha - 2gh_2}$

$-\left(\sqrt{v_0^2 \sin^2\beta - 2gh_1} + \sqrt{v_0^2 \sin^2\alpha - 2gh_2}\right) = v_0 (\sin\alpha + \underset{\cos\alpha}{\sin\beta})$

$-\left(\sqrt{\frac{v_0^2 \sin^2\beta - 2gh_1}{v_0^2 \sin 2\alpha}} + \sqrt{\frac{v_0^2 \sin^2\alpha - 2gh_2}{v_0^2 \sin 2\alpha}}\right) = 1$

$\left(\sqrt{\frac{v_0^2 \sin^2\beta - 2gh_1}{v_0^2 \sin 2\alpha}}\right)^2 = \left(\sqrt{\frac{v_0^2 \sin^2\alpha - 2gh_2}{v_0^2 \sin 2\alpha}}\right)^2$

$\frac{v_0^2 \sin^2\beta - 2gh_1}{\cancel{v_0^2 \sin 2\alpha}} = \frac{v_0^2 \sin^2\alpha - 2gh_2}{\cancel{v_0^2 \sin 2\alpha}}$

$v_0^2 \sin^2\beta - 2gh_1 = v_0^2 \sin^2\alpha - 2gh_2$

$v_0^2 \sin^2\beta - v_0^2 \sin^2\alpha = 2gh_1 - 2gh_2$

$\Delta h = h_1 - h_2$

№ 2

$$v_0^2(\sin^2\beta - \sin^2\alpha) = 2g\Delta h \qquad \sin^2\beta = \cos^2\alpha$$

$$\Delta h = \frac{v_0^2(\sin^2\beta - \sin^2\alpha)}{2g}$$

$$\Delta h = \frac{v_0^2}{2g}(\cos^2\alpha - \sin^2\alpha); \quad \Delta h = \frac{v_0^2}{2g}\cos 2\alpha$$

$$S = \frac{v_0^2 \sin 2\alpha}{g} \qquad \sin 2\alpha = \frac{Sg}{v_0^2} \qquad 2\alpha = \arcsin\left(\frac{Sg}{v_0^2}\right)$$

$$\Delta h = \frac{v_0^2}{2g}\cos\left(\arcsin\left(\frac{Sg}{v_0^2}\right)\right)$$

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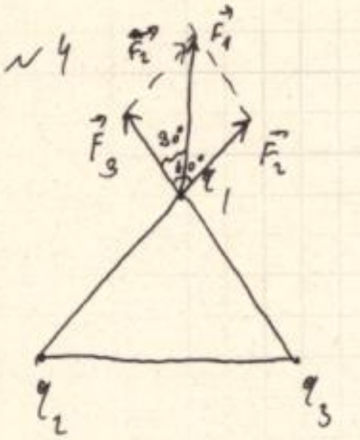
Ответ: $\frac{v_0^2}{2g}\cos\left(\arcsin\left(\frac{Sg}{v_0^2}\right)\right)$

№ 4



$$F_2^2 = F_3^2 + F_1^2 - 2F_3F_1\cos 30°$$

$$F_2^2 = F_3^2 + F_1^2 - \sqrt{3}F_1F_3$$

$$\varphi_1 = \frac{kq_1}{a} \qquad \varphi_2 = \frac{kq_2}{a} \qquad \varphi_3 = \frac{kq_3}{a}$$ 3

$$q_1 = \frac{\varphi_1 a}{k} \qquad q_2 = \frac{\varphi_2 a}{k} \qquad q_3 = \frac{\varphi_3 a}{k}$$

$$F_2 = \frac{kq_1q_2}{a^2} = \frac{\cancel{k}\frac{\varphi_1 \cancel{a}}{\cancel{k}} \cdot \frac{\varphi_2 \cancel{a}}{k}}{\cancel{a^2}} = \frac{\varphi_1\varphi_2}{k}$$

4 2 4

$$F_3 = \frac{kq_1q_3}{a^2} = \frac{k\frac{\varphi_1 a}{k} \cdot \frac{\varphi_3 a}{k}}{a^2} = \frac{\varphi_1\varphi_3}{k}$$

$$F_2^2 = F_3^2 + F_1^2 - \sqrt{3}F_1F_3$$

$$F_1^2 - \sqrt{3}F_1F_3 + F_3^2 - F_2^2 = 0$$

№4

$$D = 3F_3^2 - 4F_3^2 + 4F_2^2 = 4F_2^2 - F_3^2$$

$$F_1 = \frac{\sqrt{3}F_3 \pm \sqrt{4F_2^2 - F_3^2}}{2}$$

$$F_1 = \frac{\frac{\sqrt{3}\varphi_1\varphi_3}{k} \pm \sqrt{4\frac{\varphi_1^2\varphi_2^2}{k^2} - \frac{\varphi_1^2\varphi_3^2}{k^2}}}{2} =$$

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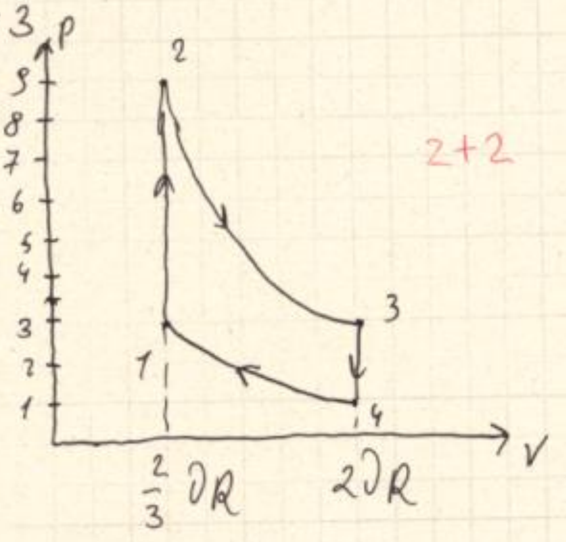
$$= \frac{\frac{\varphi_1}{k}\sqrt{3}\varphi_3 \pm \frac{\varphi_1}{k}\sqrt{4\varphi_2^2 - \varphi_3^2}}{2} = \frac{\varphi_1}{2k}\left(\sqrt{3}\varphi_3 \pm \sqrt{4\varphi_2^2 - \varphi_3^2}\right)$$

~~Если $\varphi_2 > \varphi_3$~~

$$F_1 = \frac{\varphi_1}{2k}\left(\sqrt{3}\varphi_3 \pm \sqrt{4\varphi_2^2 - \varphi_3^2}\right)$$

Ответ: $\frac{\varphi_1}{2k}\left(\sqrt{3}\varphi_3 + \sqrt{4\varphi_2^2 - \varphi_3^2}\right)$

№3



2+2

$$P_1V_1 = \nu R T_1$$

$$9V_1 = \nu R\, 6$$

$$V_1 = \frac{2}{3}\nu R$$

$$P_3V_3 = \nu R T_3$$

$$3V_3 = \nu R\, 6$$

$$V_3 = 2\nu R$$

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$\eta = \frac{A}{Q_1}$ $\quad A = A_{23} + A_{41}$

$Q_1 = Q_{12} + Q_{23} = \Delta U_{12} + A_{23} + \Delta U_{23} = A_{23} + \Delta U_{13} =$

$= A_{23} + \Delta U_{13}$

$\eta = \frac{A_{23} + A_{41}}{A_{23} + \Delta U_{13}}$ $\quad \Delta U_{13} = \frac{3}{2}\nu R(T_3 - T_1) = 6\nu R$

$A_{23} = \ln \frac{\Delta V_{23}}{\Delta P_{23}}$ $\quad A_{41} = \ln \frac{\Delta V_{41}}{\Delta P_{41}}$ $\quad$ 12

$A_{23} = \cancel{\frac{2}{3}\nu R} \ln \frac{2/3}{6} \nu R = \ln \frac{1}{9} \nu R = -2,2\,\nu R$

$A_{41} = \ln \frac{2/3}{2} \nu R = \ln \frac{1}{3} \nu R = -1,1\,\nu R$

$\eta = \frac{3,3\,\nu R}{\cancel{9}\,7,1\,\nu R} = 0,46 \; (46\%)$

Ответ: 46%