



**МОСКОВСКИЙ ГОСУДАРСТВЕННЫЙ УНИВЕРСИТЕТ  
имени М.В. ЛОМОНОСОВА**

**ОЛИМПИАДНАЯ РАБОТА**

Наименование олимпиады школьников: **«Ломоносов»**

Профиль олимпиады: **ФИЗИКА**

ФИО участника олимпиады: **Малютяк Тимофей Дмитриевич**

Класс: 9

Технический балл: **100**

Дата проведения: 24 февраля 2022 года

ШИФР РАБОТЫ 9969589

	1	2	3	4	$\Sigma$
Задача	25	25	25	25	<b><i>100</i></b>
Вопрос					

M1

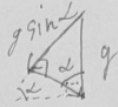
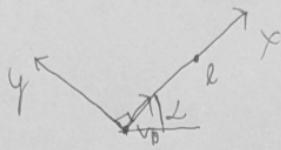
Lauo:

$$l = 0.6 \text{ m}$$

$$t_1 = 1 \text{ s}$$

$$t_2 = 2 \text{ s}$$

$$v_0 = ?$$



Microblux  
114

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

$$x(t_1) = x(t_2) = l$$

$$v_0 t_1 - \frac{g t_1^2 \sin \alpha}{2} = v_0 t_2 - \frac{g t_2^2 \sin \alpha}{2} = l$$

$$\textcircled{1} \quad v_0(t_1 - t_2) - \frac{g \sin \alpha}{2} (t_1 - t_2)(t_1 + t_2) = 0 \quad | : (t_1 - t_2) \neq 0$$

$$v_0 = \frac{g \sin \alpha}{2} (t_1 + t_2)$$

$$\textcircled{2} \quad v_0 t_2 - l = \frac{g t_2^2 \sin \alpha}{2}$$

$$\sin \alpha = \frac{2(v_0 t_2 - l)}{g t_2^2}$$

$$\Rightarrow v_0 = \frac{g \cdot (v_0 t_2 - l)}{2 g t_2^2} (t_1 + t_2) = \frac{v_0 t_2 - l}{t_2^2} (t_1 + t_2) \quad | \cdot t_2^2$$

$$v_0 t_2^2 = v_0 t_1 t_2 + v_0 t_2^2 - l t_1 - l t_2$$

$$v_0 t_1 t_2 = l (t_1 + t_2)$$

$$v_0 = l \frac{t_1 + t_2}{t_1 t_2} = \frac{0.6 \cdot (1 + 2)}{1 \cdot 2} = 0.9 \text{ m/s}$$

$$v_0 = 0.9 \text{ m/s}$$

N<sub>2</sub>λατφ<sub>1</sub>

$$m_1 = 0.1 \text{ κτ}$$

$$m_g = 0.005 \text{ κτ}$$

$$t_b = 0^\circ \text{C}$$

$$\rho_b = 1000 \frac{\text{κτ}}{\text{μ}^3}$$

$$\rho_u = 900 \frac{\text{κτ}}{\text{μ}^3}$$

$$\lambda_1 = 340000 \frac{\text{αττ}}{\text{κτ}}$$

$$\min(Q) = ?$$

$$\frac{P_T}{P_b} = 1 \quad (\text{ισοβαρική τακτική})$$

$$\Rightarrow P_T = P_b$$

$$P_T = P_{cp} = \frac{m_1 + m_g}{V_{u1}} = P_b$$

$$\Rightarrow V_{u1} = \frac{m_1 + m_g}{P_b} \cdot P_u$$

$$m_{u1} = \frac{(m_1 + m_g) P_u}{P_b}$$

$$\Rightarrow \Delta m_u = m_u - m_{u1} = m_1 - \frac{(m_1 + m_g) P_u}{P_b}$$

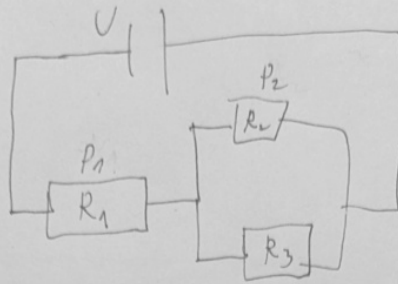
$$\lambda \Delta m_u = Q$$

$$\Rightarrow Q = \lambda \left( m_1 - (m_1 + m_g) \frac{P_u}{P_b} \right) = 340000 \left( 0.1 - (0.1 + 0.005) \frac{900}{1000} \right)$$

$$Q = 1870 \text{ αττ}$$

~ μισόβωρο  
214

$N_3$   
 Дано  
 $R_1 = 10 \text{ M}$   
 $R_2 = 20 \text{ M}$   
 $R_3 = 30 \text{ M}$   
 $P_1 = 25 \text{ Вт}$   
 $P_2 = ?$



номерок 3/4

$$R_{23} = \frac{R_2 R_3}{R_2 + R_3}$$

$$R_c = R_1 + \frac{R_2 R_3}{R_2 + R_3}$$

$$\Rightarrow I_{R1} = I_c = \frac{U}{R_1 + \frac{R_2 R_3}{R_2 + R_3}} = I_{R_2 R_3} \quad (\text{покл. соедин.})$$

$$P_1 = \frac{U^2}{\left(R_1 + \frac{R_2 R_3}{R_2 + R_3}\right)^2} \cdot R_1 = I_{R1}^2 R_1$$

$$\Rightarrow U = \left(R_1 + \frac{R_2 R_3}{R_2 + R_3}\right) \sqrt{\frac{P_1}{R_1}}$$

$$\Rightarrow I_c = \sqrt{\frac{P_1}{R_1}}$$

$$\Rightarrow I_{R_2 R_3} = \sqrt{\frac{P_1}{R_1}}, \quad R_{23} = \frac{R_2 R_3}{R_2 + R_3}$$

$$\Rightarrow U_{R_2 R_3} = \frac{R_2 R_3}{R_2 + R_3} \sqrt{\frac{P_1}{R_1}} = U_{R_2} = U_{R_3} \quad (\text{// соедин.})$$

$$\Rightarrow P_2 = \frac{U_{R_2}^2}{R_2} = \frac{R_2 R_3^2 \cdot P_1}{(R_2 + R_3)^2 R_1 \cdot R_2}$$

$$P_2 = P_1 \frac{R_2 R_3^2}{(R_2 + R_3)^2 R_1} = 25 \cdot \frac{2 \cdot 3^2}{(2+3)^2 \cdot 1}$$

$$P_2 = 18 \text{ Вт}$$

рисовки 4/4

ны

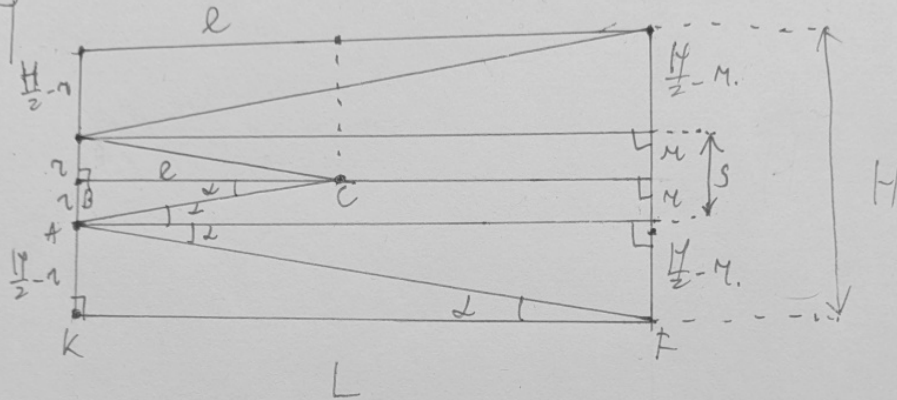
дано:

$$H = 3 \text{ м}$$

$$e = 2 \text{ м}$$

$$L = 5 \text{ м}$$

$$s = ?$$



$$\begin{aligned} & (\triangle ABC) \quad (\triangle AKF) \\ & \frac{r}{L} = \frac{r}{e} = \frac{\frac{H}{2} - r}{L} \quad | \cdot eL \end{aligned}$$

$$rL = \frac{He}{2} - rL$$

$$r = \frac{He}{2(l+L)} \Rightarrow s = 2r$$

$$s = \frac{He}{l+L} = \frac{3 \cdot 2}{2+5}$$

$$s = \frac{6}{7} \text{ м}$$

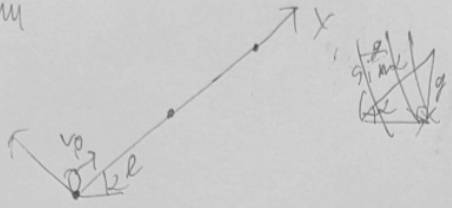
$$l = 0.6 \text{ m}$$

$$t_1 = 1 \text{ s}$$

$$t_2 = 2 \text{ s}$$

$$v_0 = ?$$

mm



$$\frac{1.8}{2} = \frac{1.8}{2.0} = \frac{1}{1.1} \approx 0.9$$

перевик  
1/3

$$y(t) = 0$$

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

$$x(t_1) = x(t_2) = l$$

$$v_0 t_1 - \frac{g t_1^2 \sin \alpha}{2} = v_0 t_2 - \frac{g t_2^2 \sin \alpha}{2} = l$$

$$v_0 t_1 - l = \frac{g t_1^2 \sin \alpha}{2}$$

$$\frac{1}{\sin \alpha} = \frac{g t_1^2}{2(v_0 t_1 - l)}$$

$$v_0 = \frac{l}{t_2} + \frac{g t_2}{2 \sin \alpha}$$

$$v_0 = \frac{l}{t_2} + \frac{g t_2 (v_0 t_1 - l)}{2 g t_1^2} = \frac{l}{t_2} + \frac{g t_2 (v_0 t_1 - l)}{2 g t_1^2}$$

$$v_0 (t_1 - t_2) - \frac{g \sin \alpha}{2} (t_1^2 - t_2^2) = 0 \quad | : t_1 - t_2$$

$$v_0 = \frac{g \sin \alpha}{2} (t_1 + t_2)$$

$$v_0 t_2 - l = \frac{g t_2^2}{2 \sin \alpha}$$

$$v_0 = \frac{g (t_1 + t_2) (v_0 t_1 - l)}{2 g t_1^2} = \frac{(t_1 + t_2) (v_0 t_1 - l)}{t_1^2}$$

$$v_0 t_1^2 - v_0 t_1^2 - l t_1 + v_0 t_1 t_2 - l t_2 = 0$$

$$v_0 t_1 t_2 = l (t_1 + t_2)$$

$$v_0 = \frac{l (t_1 + t_2)}{t_1 t_2}$$

$m_d = 0.1 \text{ кг} = m$   
 $m_g = 5 \text{ г} = 0.005 \text{ кг} = M$   
 $t_B = 0^\circ \text{C} = t_u$   
 $\min(Q) = ?$



$\frac{P_T}{P_B} = \text{нон. н.}$   
 $\Rightarrow \frac{P_T}{P_B} = 1$   
 $0.105 \cdot 0.9 - 0.1$   
 $\frac{0.105}{0.9} = \frac{0.105}{0.9}$   
 $0.1 - 0.0945 = -0.0055$

$P_T = \frac{m_g + m_d}{V_1} = P_B \Rightarrow V_1 = \frac{m_g + m_d}{P_B} = \frac{m + M}{P_B}$   
 $m = pV$

$\Delta V_1 = \frac{m + M}{P_B} - \frac{m}{P_B} \quad | \cdot P_B$

$\Delta m_1 = (m + M) \frac{P_u}{P_B} - m$

$c_p m_B (0 - t_B) + c_u m_d (0 - t_u) + \lambda \Delta m_1 = Q$

$\lambda \Delta m_1 = Q$   
 $Q = \lambda \left( (m + M) \frac{P_u}{P_B} - m \right)$

$\frac{2.3}{2.5} \cdot 1 = 2.9$

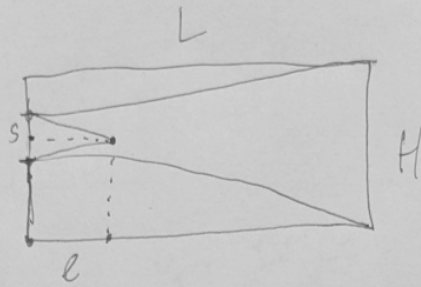
0.0055 · 140000  
 55.34  
 $\frac{2}{39} \quad 55$   
 $\frac{170}{34}$   
 $\frac{170}{1870}$   
 $Q = 1870 \text{ Дж}$



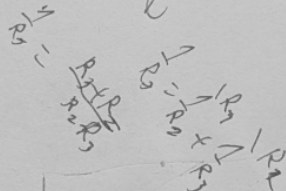
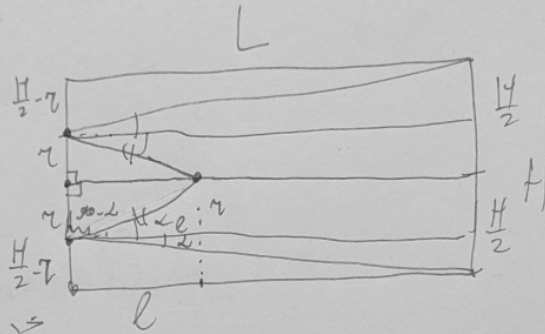
340  $\frac{dy}{dx}$  - 340000  $\frac{dy}{dx}$  | переносим

переносим 3/3

$L = 5 \text{ м}$   
 $H = 3 \text{ м}$   
 $l = 2 \text{ м}$   
 $s = ?$



$s = 2 \text{ м}$



$$\frac{3-2}{2+5} = \frac{6}{7}$$



340000  $\frac{dy}{dx}$  - 340000  $\frac{dy}{dx}$  | переносим  
 $340 - 340000 \frac{dy}{dx} = 340000 \frac{dy}{dx}$

$$\frac{340}{925} = 0.367$$

$$\frac{1.5}{2.5} = 0.6$$

55.34  
 55