



МОСКОВСКИЙ ГОСУДАРСТВЕННЫЙ УНИВЕРСИТЕТ
имени М.В.ЛОМОНОСОВА

Вариант 03

Место проведения Москва
город

ПИСЬМЕННАЯ РАБОТА

Олимпиада школьников РОБОФЕСТ
наименование олимпиады

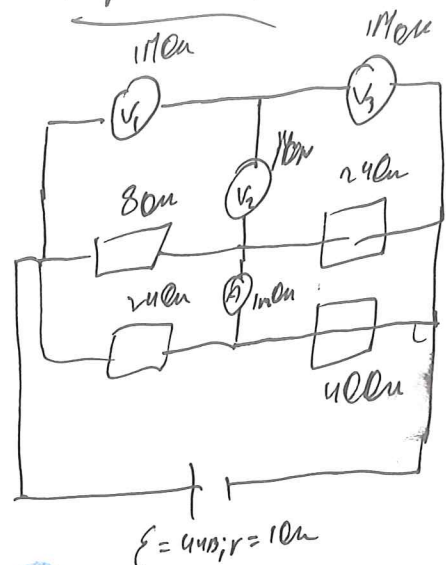
по физике
профиль олимпиады

Щелковского Станислава Степановича
фамилия, имя, отчество участника (в родительном падеже)

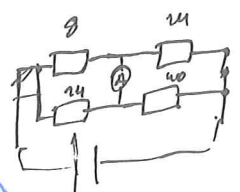
Дата
« 12 » апреля 2021 года

Подпись участника
С. Щелк

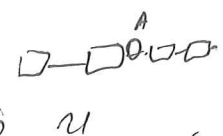
Черновик



7



$$U = I \cdot R = 2 \text{ MB}$$



$$\frac{8 \cdot 24}{3 \cdot 4} = 6$$

$$\frac{24 \cdot 10}{8 \cdot 4 \cdot 4} = 15$$

$$T = \frac{25R}{V}$$

$$a_3 = \frac{25}{5000}$$

$$W = \frac{25}{T} \cdot 48^2 R$$

$$\frac{24 \cdot 40}{64} = \frac{22 \cdot 2 \cdot 3 \cdot 4 \cdot 5 \cdot x}{2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2}$$

$$I = \frac{E}{R+r} = \frac{44}{22} = 2 \text{ A}$$

$$U = I \cdot R = 2 \cdot 22 = 44 \text{ V}$$

$$T = ?$$

$$T = \frac{25R}{V}$$

$$V = \frac{25R}{T}$$



$$F = \frac{mv^2}{R}$$

$$a = \frac{v^2}{R}$$

$$ma = F + mg$$

$$a = \frac{F + mg}{m}$$

$$a = \frac{E}{m} + g$$

$$mg = F + mg$$

$$\frac{mv^2}{R} = -\frac{mg}{f} + mg$$

$$\frac{v^2}{R} = -\frac{1}{f} + g$$

$$\left(\frac{20R}{f}\right)^2 = -\frac{1}{f} + g$$

$$\frac{4 \cdot 20^2 R^2}{f^2} = -\frac{1}{f} + g$$

Чистовик

68-99-34-86
(154.3)

W-2

I

Дано:

$$V_1 = V_2 = V$$

$$M_1 = M_2 = M$$

$$m_1 = 20 \text{ r}$$

$$m_2 = 15 \text{ r}$$

$$t_1 = 17^\circ \text{C}$$

$$t_2 = 57^\circ \text{C}$$

Решение:

$$T_1 = t_1 + 273 = 300 \text{ K}$$

$$T_2 = t_2 + 273 = 330 \text{ K}$$

$$\frac{P_2}{P_1} = \frac{m_2 R T_2 \frac{1}{V}}{m_1 R T_1 \frac{1}{V}} = \frac{m_2 T_2}{m_1 T_1} = 1,375$$

Ответ: 37,5%.

W-2 II

Дано:

$$V = \text{const}$$

$$P_0 = 200 \text{ kPa}$$

$$m_0 = 1 \text{ кг}$$

$$m_2 = 3 \text{ кг}$$

$$T(m) = \frac{T_0}{4} \left(1 + 3 \frac{m^2}{m_0^2}\right)$$

$$T(3) = \frac{T_0}{4} \left(1 + 3 \frac{1}{9}\right)$$

$$T(3) = \frac{T_0}{3}$$

$$PV = \frac{m}{M} RT \quad \text{const} = C$$

$$p = m \cdot \frac{RT}{MV}$$

$$p = C m T$$

$$m_3 = 3 \text{ кг}$$

$$m_2 = 2 \text{ кг}$$

$$m_1 = 1 \text{ кг}$$

Pmin-?

mmin-?

$$T(1) = \frac{T_0}{4} \left(1 + 3 \frac{1}{1}\right)$$

$$T(1) = T_0$$

$$\begin{cases} P_0 = C m_0 T_0 \\ P_1 = C m_1 T(1) \end{cases}$$

$$\begin{cases} P_0 = C m_0 T_0 \\ P_1 = C m_1 T_0 \end{cases} \Rightarrow \frac{P_0}{P_1} = \frac{m_0}{m_1} \Rightarrow P_1 = P_0 = 200 \text{ kPa}$$

$$\frac{P_0}{P_1} = \frac{m_0}{m_1} \cdot 3$$

$$P_1 = \frac{P_0 m_1}{m_0 \cdot 3} = \frac{200 \text{ kPa} \cdot 3}{1 \cdot 3} = 200 \text{ kPa}$$

$$T(2) = \frac{T_0}{4} \left(1 + 3 \frac{1}{4}\right)$$

$$T(2) = \frac{7}{16} T_0$$

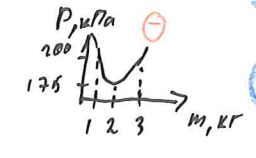
$$\begin{cases} P_0 = C m_0 T_0 \\ P_2 = C m_2 T(2) \end{cases}$$

$$\begin{cases} P_0 = C m_0 T_0 \\ P_2 = C m_2 \frac{7}{16} T_0 \end{cases} \Rightarrow \frac{P_0}{P_2} = \frac{m_0 \cdot 16}{m_2 \cdot 7} \Rightarrow P_2 = \frac{7 P_0 m_2}{16 m_0} = \frac{7 \cdot 200 \text{ kPa} \cdot 2 \text{ кг}}{16 \cdot 1 \text{ кг}} = 175 \text{ kPa}$$

$$P_{\min} = 175 \text{ kPa}$$

$$m_{\min} = 2 \text{ кг}$$

Ответ: 175 kPa; 2 кг



7

7

Чистовик

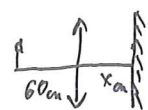
№ 4 (I)



Ответ: собирающая; действительное; 40 см

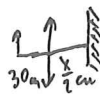
65

№ 4 (II)



$$V_1 = 2V_2$$

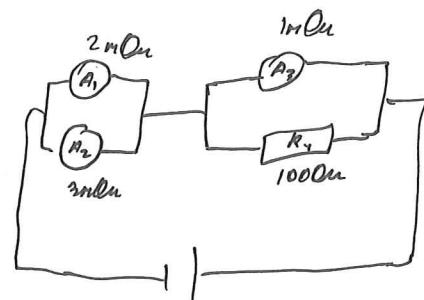
$$V_2 = \frac{V_1}{2} = \frac{4 \text{ мм/с}}{2} = 2 \text{ мм/с}$$



Ответ: 2 мм/с

25

№ 3 (I)



$$R_{12} = \frac{R_1 \cdot R_2}{R_1 + R_2} = 1,2 \text{ Ом}$$

$$R_{34} = \frac{R_3 \cdot R_4}{R_3 + R_4} = 1 \text{ Ом}$$

$$R = 1,2 \text{ Ом} + 1 \text{ Ом} = 2,2 \text{ Ом} = 0,0022 \text{ Ом}$$

$$I = \frac{E}{r + R} = \frac{5 \text{ В}}{1,0022 \text{ Ом}} \approx 5 \text{ А} = I_1 = I_{34}$$

$$U_{12} = I_{12} \cdot R_{12} = 5 \text{ А} \cdot 1,2 \text{ Ом} = 6 \text{ В} = U_1 = U_2$$

$$I_1 = \frac{U_1}{R_1} = \frac{I_{12} \cdot R_{12}}{R_1} = \frac{5 \text{ А} \cdot 1,2 \text{ Ом}}{2 \text{ Ом}} = 3,00 \text{ А}$$

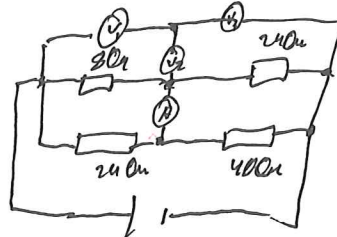
$$I_2 = \frac{U_2}{R_2} = \frac{I_{12} \cdot R_{12}}{R_2} = \frac{5 \text{ А} \cdot 1,2 \text{ Ом}}{3 \text{ Ом}} = 2,00 \text{ А}$$

$$U_{34} = I_{34} \cdot R_{34} = 5 \text{ А} \cdot 1 \text{ Ом} = 5 \text{ В} = U_3$$

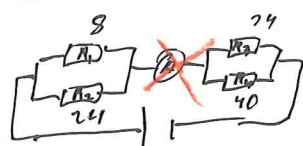
$$I_3 = \frac{U_3}{R_3} = \frac{I_{34} \cdot R_{34}}{R_3} = \frac{5 \text{ А} \cdot 1 \text{ Ом}}{1 \text{ Ом}} = 5,00 \text{ А}$$

Ответ: 3,00 А; 2,00 А; 5,00 А

№ 3 (II)



E = 44 В r = 1 Ом



$$R_{12} = 6 \text{ Ом}$$

$$R_{34} = 15 \text{ Ом}$$

$$R = 21 \text{ Ом}$$

$$I = \frac{E}{r + R} = \frac{44 \text{ В}}{1 \text{ Ом} + 21 \text{ Ом}} = 2 \text{ А}$$

$$A_1 = 2 \text{ А}$$

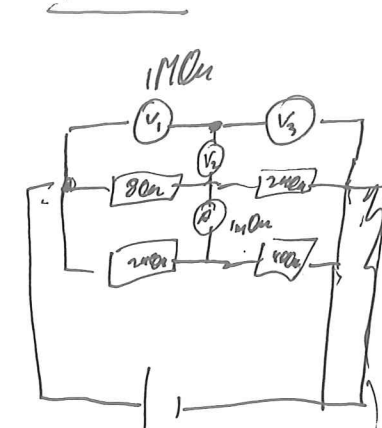
$$U_1 = U_3 = 2 \text{ МВ}$$

$$U_2 = 0 \text{ В}$$

2 Ответ: 2 А; 2 МВ; 0 В

Черновик

I-2

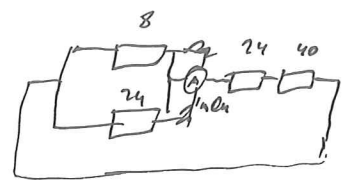
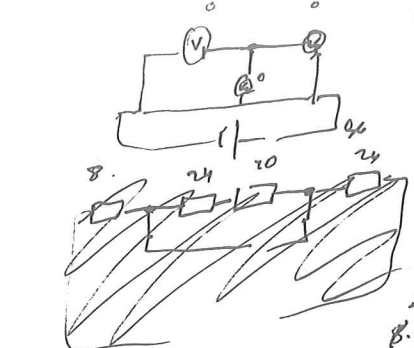


E = 44 В, r = 1 Ом

$$A = 0,6 \text{ А}$$

$$6 \text{ А}$$

$$U = 5 \text{ В}$$



$$70 \text{ Ом}$$

$$I = \frac{E}{r + R} = \frac{44}{1 + 70} = \frac{44}{71} = 0,619 \text{ А}$$

$$\frac{m}{100} \cdot 1000 = \frac{m}{100} \cdot 1000$$

$$F = -\frac{\Delta m}{\Delta t} u ; d = \frac{\Delta m}{\Delta t}$$

$$qU = mg ; U = \frac{mg \cdot 1000}{q \cdot 25} = 10000 \text{ В}$$

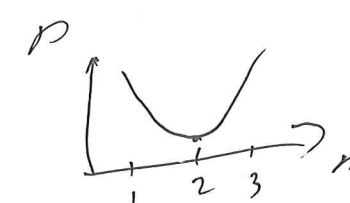
$$F = -qU ; -\frac{\Delta m}{\Delta t} u = mg ; -qU = mg$$

$$F = mg ; -\frac{\Delta m}{\Delta t} u = mg$$

$$q = \frac{m}{1000}$$

$$\frac{P_0}{P} = \frac{m_0 \cdot 16}{m \cdot 7}$$

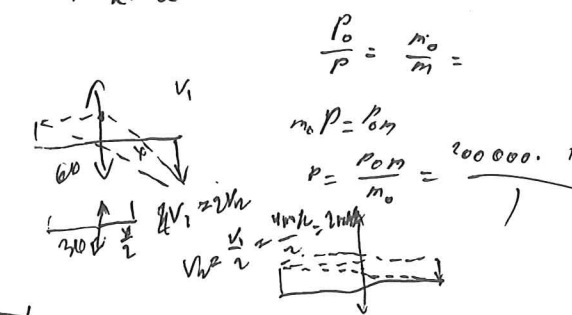
$$16 P_0 m_0 = 7 P_0 m ; P = \frac{7 P_0 m}{16 m_0} = \frac{7 \cdot 2 \cdot 1000000}{16 \cdot 84} = \frac{20160000}{1344} = 15000$$



$$-175 \text{ кПа}$$

$$\tau(1) = \frac{\tau_0}{4} \left(1 + 3 \frac{1}{1}\right)$$

$$\tau(1) = \tau_0$$



Черновик

$\nu^{-2} \text{ (I)}$
 $V_1 = V_2 = V$
 $m_1 = 20r$
 $T_1 = 27^\circ C$
 $m_2 = 25r$
 $T_2 = 57^\circ C$
 $\frac{P_2}{P_1} = ?$

$T_1 = t_1 + 273 = 300K$
 $T_2 = t_2 + 273 = 330K$

$PV = \frac{m}{M} RT$
 $P = \frac{mRT}{MV}$

$\frac{P_2}{P_1} = \frac{\frac{m_2 RT_2}{MV_2}}{\frac{m_1 RT_1}{MV_1}} = \frac{m_2 RT_2 MV_1}{MV_2 m_1 RT_1} = \frac{m_2 T_2}{m_1 T_1} = \frac{0,25r \cdot 330K}{0,20r \cdot 300K} = 1,375$

$\nu^{-2} \text{ (II)}$
 $V = const$
 $P_0 = 700kPa$
 $m_0 = 1kr$
 $m_1 = 3kr$

$P = \frac{m}{M} RT$
 $P = C m T$
 $T(m) = \frac{T_0}{4} \left(1 + 3 \frac{m^2}{m^2} \right)$

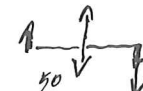
$T = \frac{P}{Cm}$

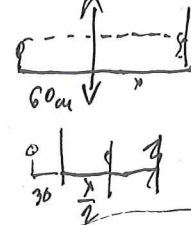
$PV = \frac{m}{M} RT$

$P = \frac{mRT}{MV}$

$mRT = PMV$
 $T = \frac{PMV}{mR}$

$T(3) = \frac{T_0}{4} \left(1 + \frac{9}{3} \right) = \frac{T_0}{4} \cdot 4 = T_0$
 $T(2) = \frac{T_0}{3}$

ν^{-4}


$\nu^{-4} \text{ (II)}$
 $V_1 = 4 \text{ mm/c}$
 $V_2 = 2 \text{ mm/c}$


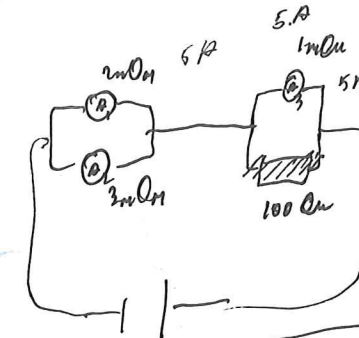
$\frac{P}{Cm} = \frac{T_0}{4} \left(1 + 3 \frac{m^2}{m^2} \right)$

$\frac{1}{R_{12}} = \frac{1}{R_1} + \frac{1}{R_2}$
 $R_{12} = \frac{R_1 R_2}{R_1 + R_2}$

$I = \frac{U}{R}$
 $U = I \cdot R$

$R_{12} = \frac{R_1 \cdot R_2}{R_1 + R_2} = \frac{2 \text{ mOh} \cdot 3 \text{ mOh}}{2 \text{ mOh} + 3 \text{ mOh}} = \frac{6}{5} = 1,2 \text{ mOh}$

ν^{-3}



$R = R_{12} + R_3 = 1,2 \text{ mOh} + 1 \text{ mOh} = 2,2 \text{ mOh}$

$I = \frac{E}{r + R} = \frac{5A}{1 + 2,2 \cdot 10^{-3}} = \frac{5A}{1,0022} \approx 5A$

$E = 10B$
 $r = 1 \text{ Oh}$

$\frac{100 \cdot 1}{100} = 1 \quad q = \frac{m}{1000}$

$\frac{P_2}{P_1} = 1,375$

$P_2 = 1,375 P_1$

$\frac{137,5}{100} = 1,375\%$