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(45.4)



МОСКОВСКИЙ ГОСУДАРСТВЕННЫЙ УНИВЕРСИТЕТ  
имени М.В.ЛОМОНОСОВА

Вариант \_\_\_\_\_

Место проведения Москва  
город

ПИСЬМЕННАЯ РАБОТА

Олимпиада школьников Ломоносов  
наименование олимпиады

по физике  
профиль олимпиады

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фамилия, имя, отчество участника (в родительном падеже)

Дата  
« 5 » марта 2023 года

Подпись участника



00-02-18-10  
(45.4)

Чистовик  
№1

$\square \updownarrow H = 148,5 \text{ м} \quad M_1 = 240 \text{ Т}$   
 $\rho_1$

$\square \updownarrow h = 50 \text{ см} = 0,5 \text{ м} \quad M_2 = ?$   
 $\rho_2 = \frac{\rho_1}{3} \Rightarrow \frac{\rho_1}{\rho_2} = 3$

~~Контрфорсы~~  
Контрфор. подобия  $K = \frac{H}{h}$

$\Rightarrow \frac{V_1}{V_2} = K^3 = \frac{H^3}{h^3} +$

$\frac{M_1}{M_2} = \frac{V_1 \cdot \rho_1}{V_2 \cdot \rho_2} = \left(\frac{H}{h}\right)^3 \cdot 3$

$\Rightarrow M_2 = \frac{M_1}{3} \cdot \left(\frac{h}{H}\right)^3 = 80 \cdot \left(\frac{0,5}{148,5}\right)^3 = 80 \cdot \left(\frac{1}{299}\right)^3 = \frac{80000000}{299^3} \approx$

$\approx 32.$

Ответ: 32. + 20

20  
 Броды  
 20  
 19  
 19  
 1  
 20 (составляет девять)  
 Броды  
 20



Частовак

$$C_1 m \Delta t = P \cdot \tau_1 + \text{теплоотдача}$$

$$C_1 \frac{m}{8} \Delta t = \frac{P}{4} \tau_2$$

$$C_2 m \Delta t = \frac{P}{4} \tau_2$$

*тогда  
большой  
кружки*

$$P \tau_1 = 2P \tau_2$$

$$\tau_1 = 2\tau_2 \Rightarrow \tau_2 = \frac{1}{2} \tau_1 = 30 \text{ с.}$$

Ответ: 30 с.

$$V_1 = V_2$$

$$\frac{V_1}{V_2} = 8 = k^3$$

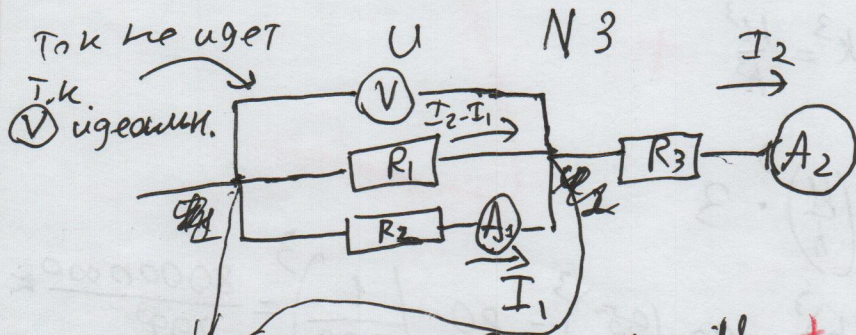
$\Rightarrow k = 2$  - коэффициент подобия

$$\frac{S_{\text{пол.т.ч.}}}{S_{\text{пол.т.ч.}}} = 4$$

$\downarrow$  205

$$\frac{P_1}{P_2} = 4$$

$$\Rightarrow P_2 = \frac{P_1}{4}$$



$$R_1 = R_3$$

$$I_1 = 0,2 \text{ A}$$

$$I_2 = 1,2 \text{ A}$$

$$U = 12 \text{ В}$$

$$U = R_1 \cdot (I_2 - I_1) \Rightarrow R_1 = \frac{U}{I_2 - I_1}$$

$$\Rightarrow R_3 = \frac{U}{I_2 - I_1}$$

$$P = I^2 R$$

$$\Rightarrow P_3 = I_2^2 \cdot R_3 = (1,2)^2 \cdot \frac{12}{1} = 1,44 \cdot 12 = 17,28$$

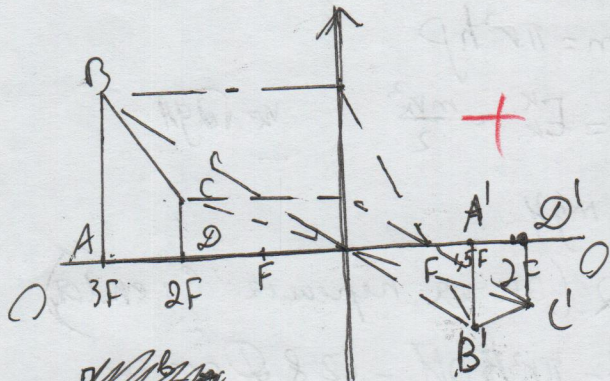
Объем работы  
Ответ: 17,28 Дж/с +

195



00-02-18-10  
(45.4)

№4



$$AB = 0,2F$$

$$CD = 0,1F$$

$$AO = \Gamma$$

$$\frac{1}{a} + \frac{1}{b} = \frac{1}{F}$$

$$\frac{1}{3F} + \frac{1}{b_B} = \frac{1}{F}$$

$$b_B = \frac{3}{2}F$$

$$\frac{1}{2F} + \frac{1}{b_C} = \frac{1}{F}$$

$$b_C = 2F$$

подобие:

$$\frac{A'B'}{AB} = \frac{1,5F}{3F} = \frac{1}{2}$$

$$\Gamma = \frac{C'D'}{CD} = \frac{2F}{2F} = 1$$

$$A'D' = 2F - 1,5F = 0,5F$$

$\Rightarrow A'B' = \frac{1}{2} AB = 0,1F \Rightarrow A'B' = C'D'$   
 $C'D' = CD = 0,1F$   
 $B'A' \perp OO'$   
 $C'D' \perp OO'$

$A'B'C'D'$  - прямоуголь.  
 $\Rightarrow S_{A'B'C'D'} = A'D' \cdot C'D' = 0,5F \cdot 0,1F = 10 \cdot 2 = 20 \text{ см}^2$

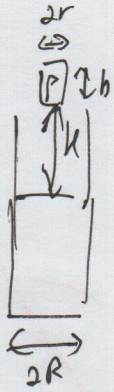
Ответ:  $20 \text{ см}^2$

объем вез?

198



Чистовик  
№5



$$m = \pi r^2 h \rho$$

$$3 \text{ сд: } mgH = E_k = \frac{mv_k^2}{2}$$

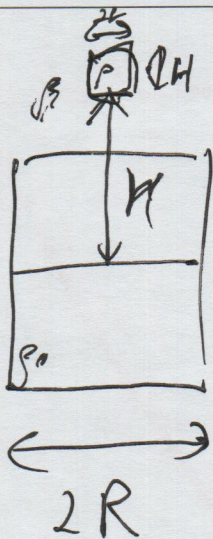
$$v_k = \sqrt{2gH}$$

$$\Rightarrow E_k = mgH$$

$E_k \rightarrow Q$  (эки-ия переиша в тепло)

$$\Rightarrow Q = mgH = \pi r^2 h \rho g = 628 \text{ Дж}$$





N5 Черкавук

$$V_0 = 0 \Rightarrow V_k = gt \Rightarrow t = \frac{V}{g}$$

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

$$H = g \frac{\frac{V^2}{g^2}}{2} = \frac{V^2}{2g}$$

$$\Rightarrow V^2 = 2Hg$$

$$V = \sqrt{2gH}$$

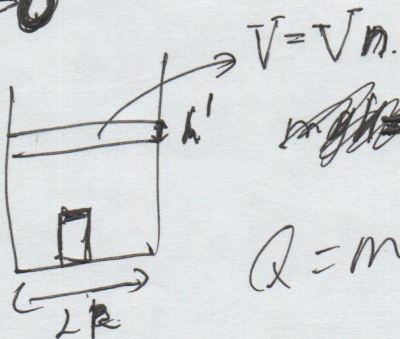
$$E_k = \frac{mV^2}{2} = \frac{2gHm}{2} = mgH$$

$$V_k = h \cdot \pi r^2 \rho$$

$$m = \rho V_k = \rho \pi r^2 h$$

$$E_k \rightarrow Q$$

$$V \rightarrow 0$$



$$Q = mgh'$$

$$Q = mgh' = \rho \cdot \pi r^2 \cdot h' \cdot g \cdot h'$$

$$3,14 \cdot 25 \cdot 2 = 314 \cdot 50 = 15700$$

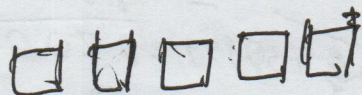
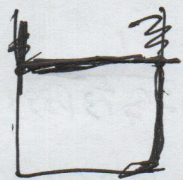
$$15700 \cdot 4 \cdot g = 15740 = 628$$

$$\begin{array}{r} \times 157 \\ 4 \\ \hline 400 \\ 200 \\ 28 \\ \hline 628 \end{array}$$



Черновик

N2



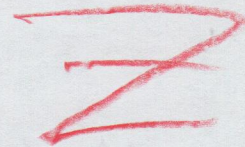
$$cm \Delta t = P \cdot \tau_1$$

$$cm \frac{\Delta t}{8} = P \cdot 8 \tau_2$$

$$P \tau_1 = P 8 \tau_2$$

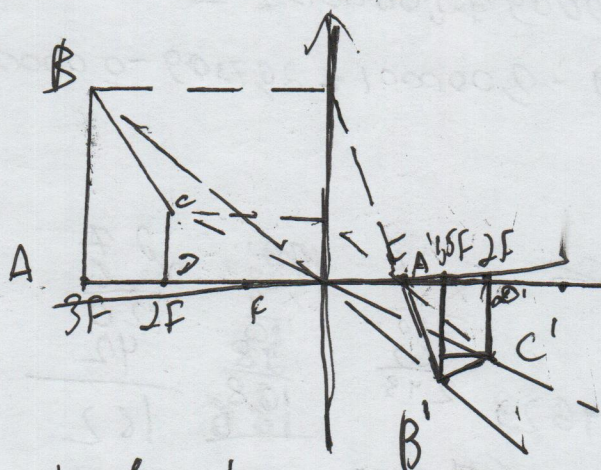
$$\tau_1 = 8 \tau_2$$

$$\tau_2 = \frac{\tau_1}{8} = 7,5c$$



$$\begin{array}{r} 1 \text{ мм} \\ 60c \cdot \frac{1}{7,5} \\ - \frac{56}{40} \end{array}$$

N4



$$AB = 0,2F \quad F = 20 \text{ см}$$

$$CD = 0,1F$$

$$AD = F$$

$$\frac{D'C'}{D'E} = \frac{2F}{2F} = 1$$

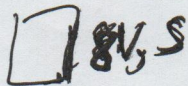
$$A'D' = 0,5F$$

$$\frac{A'B'}{AB} = \frac{1,5F}{3F} = \frac{1}{2}$$

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

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

$$\frac{1}{3F} = \frac{2}{3F} \Rightarrow F = \frac{2}{3}F$$



$$\Rightarrow D'C' = DC = 0,1F$$

$$AD = 0,5F$$

$$A'B' = 0,5AB = 0,1F$$

$$\Rightarrow D'C' = A'B' \Rightarrow A'B'C'D' \text{ n/y}$$

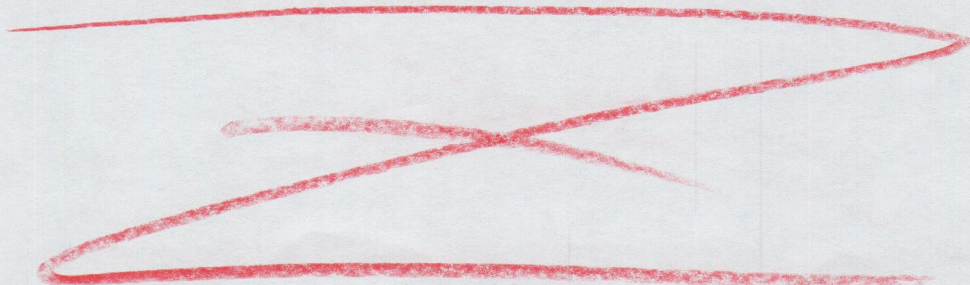
$$\Rightarrow S_{A'B'C'D'} = A'D' \cdot C'D' = 0,5F \cdot 0,1F =$$

$$= 10 \cdot 2 \cdot 20 \text{ см}^2$$

$$cm \Delta t = P \tau_1$$

$$cm \frac{\Delta t}{8} = P \cdot 8 \tau_2 \quad S \downarrow = k^2 = 4$$

$$cm \Delta t = 8P \tau_2 \geq 2P \tau_2$$





Черновик N1

$$M_2 = \frac{M_1}{3} \cdot \left(\frac{h}{H}\right)^3 = \frac{M_1}{3} \cdot \left(\frac{1}{299}\right)^3 = 80 \cdot \frac{1}{26,730899} \approx$$

$$= 80000 \cdot \frac{1}{26,731} = \frac{80000000}{26,730899} = 27000000$$

$$(3 \cdot 001)^3 = 27 - 0,27 + 0,0009 - 0,000001 =$$

$$= 27 - 0,27 + 0,0009 - 0,000001 =$$

$$= 26,73 + 0,0009 - 0,000001 = 26,7309 - 0,000001 =$$

$$= 26,730899$$

~~80000000~~

800000000 | 27  
~~84~~  
~~260~~  
~~243~~  
~~170~~  
~~148~~  
 80

~~27~~  
~~180~~  
~~62~~  
~~243~~

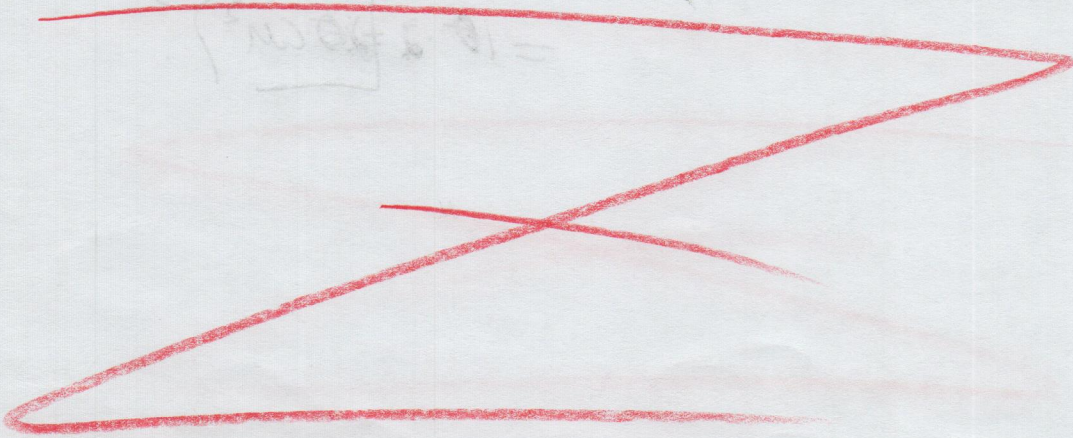
27  
~~27~~  
~~4~~  
~~108~~  
~~108~~  
 162

27  
~~6~~  
~~120~~  
~~42~~  
 162

8000 | 2671  
~~6000~~  
~~180~~  
~~21~~  
 7913

~~118~~  
~~97~~  
~~2671~~  
~~3000~~

$$M_2 = \frac{M_1}{3} \cdot \left(\frac{h}{H}\right)^3 = 80 \cdot \left(\frac{1}{299}\right)^3 \approx 32$$





Черновик М

$K = 148,5 \text{ м}$   $\rho_1$   $M_1 = 240 \text{ т.}$

$h = 50 \text{ см} = 0,5 \text{ м}$   $M_2 = ?$   
 $\rho_2 = \frac{\rho_1}{3}$   $\frac{\rho_1}{\rho_2} = 3$

$$\begin{array}{r} 299 \\ \times 299 \\ \hline 1800 \\ 2691 \\ 81 \\ \hline 2691 \end{array}$$

$$\begin{array}{r} 299 \\ \times 299 \\ \hline 2691 \\ 2691 \\ 81 \\ \hline 89501 \end{array}$$

$$\begin{array}{r} 299 \\ \times 299 \\ \hline 400 \\ 1700 \\ 18 \\ \hline 538 \end{array}$$

коэф. ср. погодия  $K = \frac{H_1}{H_2}$   $\frac{0,5}{148,5} = \frac{5}{1485} = \frac{1}{297}$

$$\Rightarrow \frac{V_1}{V_2} = K^3 = \left(\frac{H_1}{H_2}\right)^3 = \frac{1}{297}$$

$$\begin{array}{r} 299 \\ \times 299 \\ \hline 1000 \end{array}$$

$$\frac{M_1}{M_2} = \frac{V_1 \cdot \rho_1}{V_2 \cdot \rho_2} = \frac{V_1}{V_2} \cdot \frac{\rho_1}{\rho_2} = \left(\frac{H_1}{H_2}\right)^3 \cdot 3 = 3 \frac{H_1^3}{H_2^3}$$

$$\begin{array}{r} 299 \\ \times 299 \\ \hline 89501 \\ 299 \\ \hline 45 \end{array}$$

$$M_2 = \left( \frac{M_1 \cdot h^3}{3H^3} \right) = \frac{M_1}{3} \left(\frac{h}{H}\right)^3 = 80 \cdot (0,33)^3 =$$

$$= 80 \cdot 27 = 2160$$

$$\begin{array}{r} 299 \\ \times 299 \\ \hline 89501 \\ 299 \\ \hline 45 \end{array}$$

$$\begin{array}{r} 27 \\ \times 8 \\ \hline 160 \\ 56 \\ \hline 216 \end{array}$$

$$(300 - 1)^3 = 27 + 27 \cdot 0,0001 = 27,001$$

$$27 + 3 \cdot 0,0009 = 27 + 0,0027 = 27,0027$$

$$= 27,0027 - 0,0027 = 26,731$$

$$26,73$$

$$(a-b)^3 = (a-b)(a-b)(a-b) = a^3 + b^3 - 3a^2b - 3ab^2 + 3a^2b + 3ab^2 = a^3 + b^3 - 3a^2b - 3ab^2$$

$$\begin{array}{r} \times 26731 \\ 88 \\ \hline \end{array}$$

$$80 \cdot 80 \cdot (2,99)^3 = 80 \cdot 26,731 = 2138,48 = 2139 \text{ т.}$$

$$\begin{array}{r} 16000 \\ 24 \\ 56 \\ 48 \\ \hline 213848 \end{array}$$



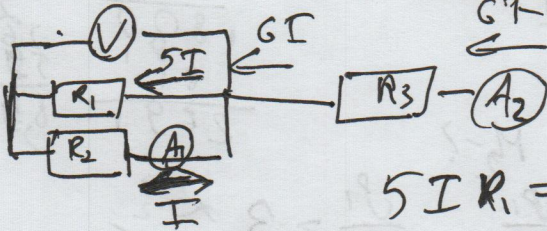
Черновик

N 3

$R_1 = R_3$

$I_2 = 6I = 6 \cdot 0,2 = 1,2 \text{ A}$

$I = 0,2 \text{ A}$



$5I R_1 = I R_2 = U_V = 12 \text{ В}$

$5 \cdot 0,2 \cdot 12$

$R_3 = R_1 = 12 \Omega$

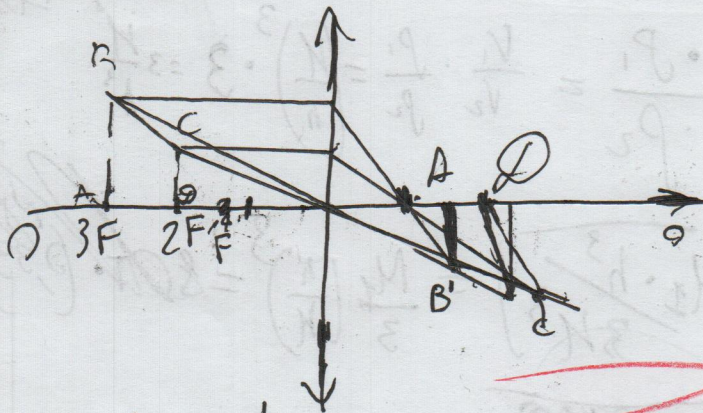
$R_3 = 12 \Omega$

$P = U_3 I_2 = 1,2 \cdot 12 = 144 \cdot 12 = 1728 \text{ Вт}$

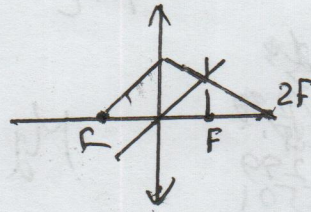
$$\begin{array}{r} \times 144 \\ 12 \\ \hline 288 \\ 144 \\ \hline 1728 \end{array}$$

$P_3 = 1728 \frac{\text{Вт}}{\text{с}}$

$$\begin{array}{r} \times 144 \\ 12 \\ \hline 288 \\ 144 \\ \hline 1728 \end{array}$$



$F = 20 \mu\text{с}$



$\frac{1}{a} + \frac{1}{b} = \frac{1}{F}$

$\frac{1}{2F} + \frac{1}{6} = \frac{1}{F}$

$\frac{1}{6} = \frac{2-1}{2F} = \frac{1}{2F} \Rightarrow 6 = 2F$

$\frac{1}{3F} + \frac{1}{6} = \frac{1}{F} \Rightarrow \frac{1}{6} = \frac{3F-1}{3F} = \frac{2}{3F}$

$6 = \frac{3}{2} F = 1,5 F$

