

Часть 1

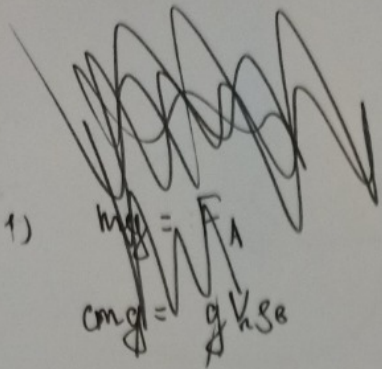
Олимпиада: **Физика, 9 класс (1 часть)**

Шифр: **21204325**

ID профиля: **383687**

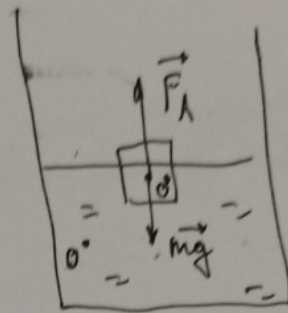
Вариант 3

Упробор



$$V = \frac{m}{\rho} = \frac{450}{0,9} \approx 500$$

$$\frac{450}{0,9} = 500$$



1)

$$mg = F_A$$

$$cmg = g \cdot V \cdot \rho$$

$$m = V_n \cdot \rho$$

$$V_n = \frac{m}{\rho} = \frac{0,45}{1000} = \frac{450}{1000} = 450 \text{ cm}^3$$

$$= 500 \text{ cm}^3 \quad V_n = 50 = \frac{m}{\rho_2} - \frac{m}{\rho_1} =$$

2)

$$t_1 = 30^\circ \text{C}$$

$$V_1 = 25 \text{ cm}^3 = \frac{m}{\rho_2 - \rho_1} = \frac{m}{\rho_2} - \frac{m}{\rho_1} = m \left(\frac{1}{\rho_2} - \frac{1}{\rho_1} \right) = 0,1111 m = 3$$

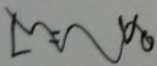
$$\Rightarrow m = 225 \text{ g}$$

$$m^2 = 450 - 225 = 225 \text{ g} = 0,225 \text{ kg}$$

$$m \cdot g \cdot 30 = 0,225 \cdot 3,36 \cdot 10^5$$

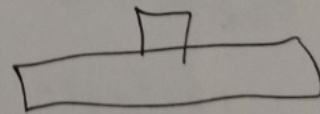
$$m = 0,6 \text{ kg}$$

~ 2



$$V_0 = at \Rightarrow t = 5 \text{ s}$$

$$L = V_0 t - \frac{at^2}{2} = 50 \text{ m} - \frac{2 \cdot 25}{2} = 25 \text{ m}$$



$$F_{\text{тр.}} = mg \mu$$

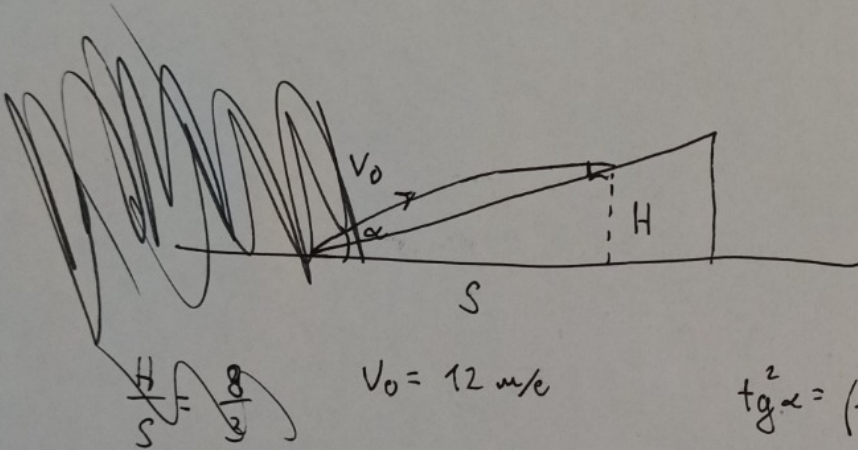
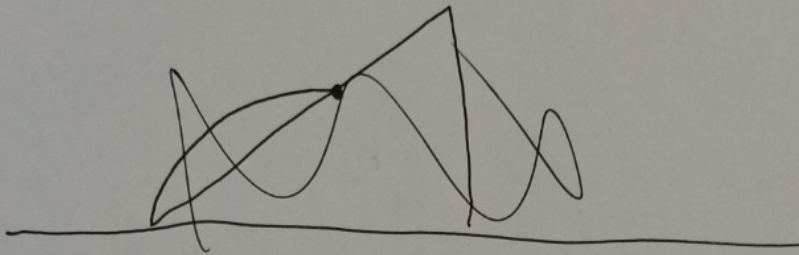
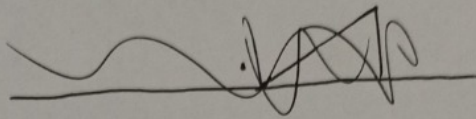
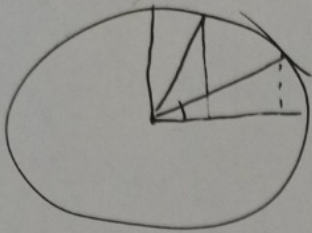
$$mg \mu = m \sqrt{100^2} = m \cdot 10,2$$

$$10 m \mu = m \cdot 10,2$$

$$\mu = 1,02$$

Черновик

~3



$$\frac{H}{S} = \frac{8}{3}$$

$$v_0 = 12 \text{ м/с}$$

$$\text{tg}^2 \alpha = \left(\frac{8}{3}\right)^2 = \frac{\sin^2 \alpha}{\cos^2 \alpha} = \frac{\sin^2 \alpha}{1 - \sin^2 \alpha}$$

$$v_x = \cos \alpha \cdot 12 \approx 4,212 \text{ м/с} = \frac{\sin^2}{1 - \sin^2} \Rightarrow 64 - 64 \sin^2 = 3 \sin^2$$

$$v_y = 11,232 \text{ м/с}$$

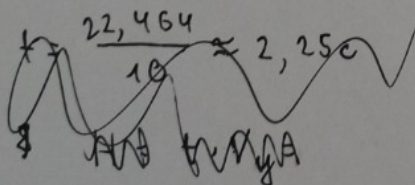
$$64 \sin^2 = 64$$

$$\text{Над } 11,232 \text{ м/с} \quad \alpha = \frac{gt^2}{2}$$

$$43 \sin^2 = 64$$

$$\sin^2 = \frac{64}{43}; \quad \cos^2 = \frac{9}{43}$$

$$\sin \approx 0,938 \quad \cos \approx 0,351$$

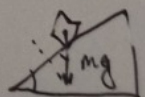


$$H = gt = v_y \Rightarrow t = 1,123 \text{ с}$$

$$H = v_y \cdot 1,123 - \frac{gt^2}{2} = v_y \cdot 1,123 - 6,306 = 6,308 \text{ м}$$

$$\text{tg} \beta = \frac{H}{S} = \frac{6,308}{1,123} \approx 1,334$$

21204325 (U383687M1283548)



Чистовик

Задача ~ 1

Дано:

лёд

$$M = 0,45 \text{ кг}$$

система в

тепловом рав-

новесии,

$$t_1 = 30^\circ\text{C}; V_1 = 25 \text{ см}^3$$

Найти:

1) $V_{\text{нагв.}} - ?$

2) $m - ?$

1) лёд плавает $\Rightarrow F_A = Mg$

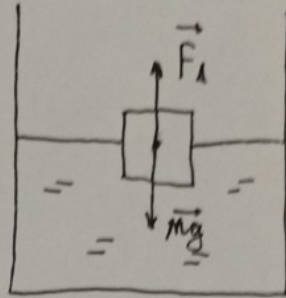
$$Mg = F_A$$

$$Mg = \rho_B \cdot V_{\text{погр.}} \cdot g$$

$$V_{\text{погр.}} = \frac{M}{\rho_B} = \frac{0,45 \text{ кг}}{1 \text{ г/см}^3} = \frac{450 \text{ г}}{1 \text{ г/см}^3} = 450 \text{ см}^3$$

$$V_{\text{весь}} = \frac{M}{\rho_{\text{л}}} = \frac{450 \text{ г}}{0,9 \text{ г/см}^3} = 500 \text{ см}^3$$

$$V_{\text{нагв.}} = V_{\text{весь}} - V_{\text{погр.}} = \underline{50 \text{ см}^3}$$



2) По условию система в тепловом равновесии. Значит и вода, и лёд имеют $t = 0^\circ\text{C}$. Тогда вся энергия добавленной воды (при $t_1 = 30^\circ\text{C}$) пойдёт на плавление льда. По условию лёд не расплавился во полностью \Rightarrow энергии добавленной воды не хватило. Значит добавленная вода остыла до 0°C и теплообмен закончился.

найдем массу расплавленной части льда (m_p)

$$V_{\text{н}}' = V_{\text{нагв.}} - V' = 50 \text{ см}^3 - 25 \text{ см}^3 = 25 \text{ см}^3 = \cancel{M} V_{\text{весь}}' - V_{\text{н}}' =$$

$$= \frac{M'}{\rho_{\text{л}}} - \frac{M'}{\rho_B} = M' \left(\frac{1}{0,9} - 1 \right) \Rightarrow M' = \frac{V_{\text{н}}' \cdot \rho_{\text{л}}}{\frac{1}{0,9} - 1} = \frac{25 \cdot 0,9}{0,9 - 1} = 225 \text{ г}$$

$$m_p = M - M' = 450 \text{ г} - 225 \text{ г} = 225 \text{ г} = 0,225 \text{ кг}$$

уравн-ие теплового баланса:

$$m_p \cdot \lambda = m \cdot c \cdot \Delta t = m \cdot c \cdot (30^\circ\text{C} - 0^\circ\text{C})$$

$$0,225 \text{ кг} \cdot 3,36 \cdot 10^5 \frac{\text{Дж}}{\text{кг}} = m \cdot 4200 \frac{\text{Дж}}{\text{кг} \cdot ^\circ\text{C}} \cdot 30^\circ\text{C}$$

$$\text{Отсюда } m = 0,6 \text{ кг} = 600 \text{ г}$$

Ответ: 1) $V_{\text{нагв.}} = 50 \text{ см}^3$

2) $m = 0,6 \text{ кг}$

Чистовик
Задача №3

Дано:

$$V_0 = 12 \text{ м/с}$$

$$\text{tg } \alpha = \frac{8}{3}$$

Найти:

1) H

2) $\text{tg } \beta$

3) T

4) μ

$$1) \text{tg } \alpha = \frac{8}{3}$$

$$\text{tg}^2 \alpha = \frac{64}{9} = \frac{\sin^2 \alpha}{\cos^2 \alpha} =$$

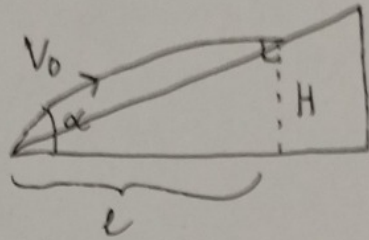
$$= \frac{\sin^2 \alpha}{1 - \sin^2 \alpha};$$

$$64 - 64 \sin^2 \alpha = 9 \sin^2 \alpha \Rightarrow \sin^2 \alpha = \frac{64}{73}$$

$$\cos^2 \alpha = 1 - \sin^2 \alpha = \frac{9}{73}$$

$$\sin \alpha \approx 0,936; \cos \alpha \approx 0,351$$

$$V_x = V_0 \cdot \cos \alpha \approx 4,212 \text{ м/с}$$



$$V_y = V_0 \cdot \sin \alpha \approx 11,232 \text{ м/с.}$$

По условию перед столкновением мячик движется горизонтально. Значит его V_y' в этот момент равно 0,

$$V_y' = V_y - gt = 0$$

$$t = \frac{V_y}{g} \approx 1,123 \text{ с}$$

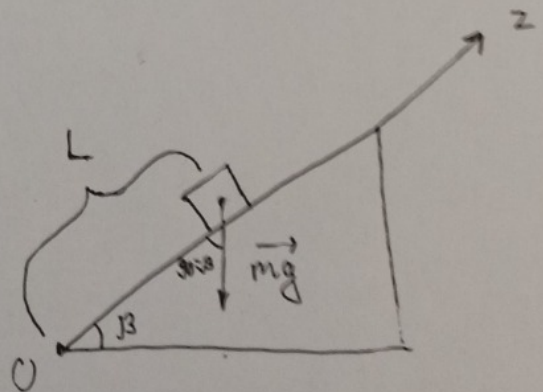
$$H = V_y \cdot t - \frac{gt^2}{2} = 11,232 \cdot 1,123 - \frac{10 \cdot (1,123)^2}{2} \approx 6,308 \text{ м}$$

$$2) \text{tg } \beta = \frac{H}{l} = \frac{6,308}{V_x \cdot t} \approx 1,334$$

3) рассмотрим ось OZ:

$$g_z = g \cdot \cos(90 - \beta)$$

$$\text{tg}^2 \beta \approx 1,78 = \frac{\sin^2 \beta}{\cos^2 \beta}$$



2

Чистовик

$$\operatorname{tg} \beta^2 = 1,78 = \frac{\sin^2 \beta}{1 - \sin^2 \beta}$$

$$1,78 - 1,78 \sin^2 \beta = \sin^2 \beta$$

$$2,78 \sin^2 \beta = 1,78 \Rightarrow \sin^2 \beta = 0,64 \Rightarrow \sin \beta = 0,8$$

$$\cos^2 \beta = 0,36 \Rightarrow \cos \beta = 0,6$$

$$g_z = -g \cdot \overset{\cos}{\sin}(90 - \beta) = -g \cdot \overset{\sin}{\cos} \beta = -8 \text{ м/с}^2$$

$$L^2 = H^2 + L_z^2 \quad (\text{по т. Пифагора})$$

$$L^2 = 39,49 + (v_x \cdot t)^2 \approx 62,164$$

$$L \approx 7,884 \quad \& \quad L_z = -L$$

$$L_z = 0 + \frac{g_z T^2}{2} = \frac{-6 \cdot T^2}{2} = -7,884$$

$$-8 T^2 = -15,468$$

$$T \approx 1,62 \text{ с} \quad T \approx 1,404 \text{ с}$$

4) $F_{\text{тр}} = N \mu$

$N = mg_f$ (проекция mg на of)

~~$mg_f = mg \cdot \cos \beta$~~

$mg_f = mg \cdot \sin(90 - \beta) = mg \cdot \cos \beta = mg \cdot 0,6$

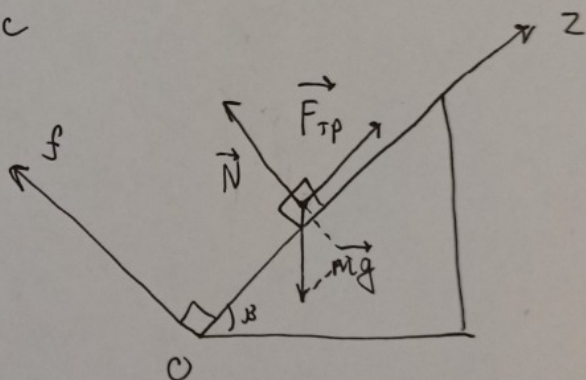
$F_{\text{тр}} = 0,6 mg \mu$

тело не движется $\Rightarrow F_{\text{тр}} = mg_{\parallel z}$

$mg_z = mg \cdot \cos(90 - \beta) = 0,8 mg$

$0,8 mg = 0,6 \mu mg \mu$

$\mu = \frac{0,8}{0,6} = \frac{4}{3}$



Ответ: 1) $H = 6,308 \text{ м}$

2) $\operatorname{tg} \beta = 1,334$

3) $T = 1,404 \text{ с}$

4) $\mu = \frac{4}{3}$

3

Чистовик

Задача № 2

Дано:

$$V_0 = 10 \text{ м/с}$$

$$a = 2 \text{ м/с}^2$$

$$S = 12 \text{ м}$$

Найти:

1) L

2) μ

3) T

4) U_{\max}

1) ~~по~~

по оси Ox ;

$$L = V_0 \cdot t - \frac{at^2}{2}$$

Вывод

машина останавливается $\Rightarrow V_0 - at = 0$

$$t = \frac{V_0}{a} = 5 \text{ с}$$

$$L = 10 \text{ м/с} \cdot 5 \text{ с} - \frac{2 \text{ м/с}^2 \cdot 5^2 \text{ с}^2}{2} = 25 \text{ м}$$

2) $F_{\text{тр}} = \mu N = \mu mg$

по закону Ньютона:

$$\sum F = ma \Rightarrow F_{\text{тр}} = ma$$

$$\mu mg = ma \quad 10 \mu = 2 \Rightarrow \mu = \frac{1}{5}$$

3) $S = 12 \text{ м} = V_0 t - \frac{at^2}{2} = 10t - \frac{2t^2}{2} = 10t - t^2$

$$t^2 - 10t + 12 = 0$$

$$D = 100 - 48 = 52$$

$$t = \frac{10 + \sqrt{52}}{2} \approx 8,6 \text{ с}$$

Движение представляет собой параболу. Значит
(график скорости)
первую половину t скорость роста (T), а потом умень-
шается,

$$T = \frac{t}{2} = 4,3 \text{ с}$$

Ответ: 1) $L = 25 \text{ м}$

2) $\mu = \frac{1}{5}$

3) $T = 4,3 \text{ с}$

4) -

Часть 2

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

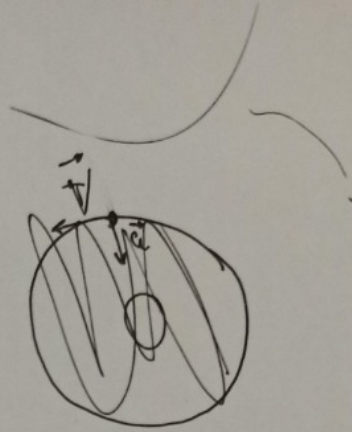
Шифр: **21204325**

ID профиля: **383687**

Вариант 3

Черновик

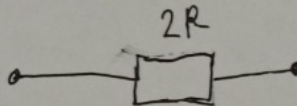
~~$\frac{U^2}{R^2} \cdot R$~~



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$$I^2 R^2 = U \cdot R = \frac{U^2}{I}$$

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



$$36 \text{ Ом} \cdot I = 6 \text{ В}$$

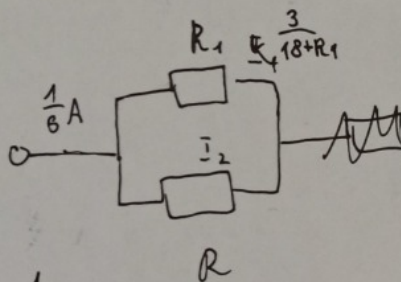
$$I = \frac{36}{2R} = \frac{18}{R} \Rightarrow R = 180 \text{ Ом}$$

$$I = \frac{1}{6} \text{ А}$$

~~$\frac{U^2}{R^2}$~~

$$I_1 R_1 = 18 I_2$$

$$I_1 + I_2 = \frac{1}{6} \Rightarrow I_2 = \frac{1}{6} - I_1$$



$$I_2 = \frac{1}{6} - I_1$$

$$\frac{1}{6} R_1 - I_2 R_1 = 18 I_2$$

$$I_1 R_1 = \frac{18}{6} - 18 I_1 = 3 - 18 I_1$$

$$18 I_1 + I_1 R_1 = 3$$

$$I_1 = \frac{3}{18 + R_1}$$

$$P_{\max} = I^2 R = \frac{9 R_1}{(18 + R_1)^2} = \frac{9 R_1}{324 + 36 R_1 + R_1^2}$$

$$y = \frac{9x}{(x+18)^2}$$

$$\frac{P_{\max} (18 + R_1)^2}{9 R_1} = 1$$

$$\frac{36}{9x} + \frac{4}{18x} + \frac{x^2}{9x} = \frac{1}{y} \quad | \cdot x$$

$$x^2 - 9x \left(\frac{1}{y} - 4\right) + 36 = 0$$

$$36 + 4x + \frac{x^2}{9} = \frac{x}{y}$$

$$D = 81 \left(\frac{1}{y}\right)^2$$

$$\frac{x^2}{9} - \frac{x}{y} + x \left(\frac{1}{y} - 4\right) + 36 = 0$$

Чепробник

$$y - P_{max}$$

$$x - R_1$$

$$D = 81 \left(\frac{1}{y} - 4 \right)^2 - 144 \geq 0$$

$$x^2 - 9x \left(\frac{1}{y} - 4 \right) + 36 = 0$$

$$D = 81 \left(\frac{1}{y} - 4 \right)^2 - 144 \geq 0$$

$$\frac{81}{y^2} - \frac{81 \cdot 8}{y} + 1296 - 144 \geq 0$$

$$\frac{81}{y^2}$$

$$81 - 648y + 1152y^2 \geq 0$$

$$D = 479904 = 324^2$$

∴ ∴

$$P = I^2 R^2 = \frac{3 \cdot R_1^2}{18 + R_1} = \frac{3 R_1^2}{18 R_1 + R_1^2}$$

$$y = \frac{3x^2}{18+x}$$

$$= \frac{3}{18+x}$$

$$3x^2 - yx - 18y = 0$$

$$D = y^2 + 216y$$

$$x = \frac{y \pm \sqrt{D}}{6} = \frac{y}{6} + \frac{\sqrt{D}}{6} > 0$$

$$\frac{3}{18+x} \leq \frac{1}{6}$$

$$\frac{18}{18+x} \leq 1$$

$$18 \leq 18+x$$

$$x \geq 0$$

$$I_1 \in \left[0, \frac{1}{6} \right] \quad x > \frac{18}{8}$$

$$y = \frac{9x}{(18+x)^2}$$

$$9x > 18+x$$

$$8x > 18$$

$$x > \frac{18}{8}$$

$$1) P = I^2 R^2 = UR = 1 = 6R \Rightarrow R = \frac{1}{6}$$

$$P = I^2 R$$

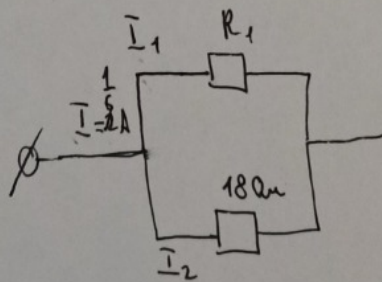
$$\begin{cases} I_1 + I_2 = \frac{1}{6} \\ I_1 R_1 = I_2 R_2 = 18 I_2 \end{cases}$$

$$I_1 R_1 = I_2 R_2 = 18 I_2$$

$$I_2 = \frac{1}{6} - I_1 \quad I_1 R_1 = 300 \dots$$

$$I_1 R_1 = 3 - 18 I_1$$

$$I_1 = \frac{3}{18 + R_1}$$



$$\frac{9x}{P} = 324x + 36x^2$$

$$P = R_1 \frac{9R_1}{(18+R_1)^2}$$

$$\frac{1}{P} = \frac{(18+R_1)^2}{9R_1} = \frac{R_1}{9} + 4 + \frac{36}{R_1}$$

Черно Вух

$$\begin{cases} \bar{I}_1 + \bar{I}_2 = \frac{1}{6} \\ \bar{I}_1 R_1 = 18 \bar{I}_2 \end{cases}$$

$$\bar{I}_2 = \frac{\bar{I}_1 R_1}{18} = \left(\frac{1}{6} - \bar{I}_2\right) R_1$$

$$18 \bar{I}_2 = \frac{1}{6} R_1 - \bar{I}_2 R_1$$

$$\bar{I}_2 = \frac{\frac{1}{6} R_1}{18 + R_1} = \frac{R_1}{6R_1 + 108}$$

$$P = R_1 \bar{I}_2^2 = R_1 \cdot \frac{R_1^2}{(6R_1 + 108)^2} = \frac{R_1^3}{(6R_1 + 108)^2} = \frac{9R_1}{(18 + R_1)^2}$$

$$R_1 \cdot (18 + R_1) = 3 \cdot (6R_1 + 108)$$

$$R_1^2 + 18R_1 = 18R_1 + 324$$

$$R_1 = 18$$

$$R_{sub} = 18 + \frac{1}{\frac{1}{18} + \frac{1}{R_1}} = 18 + \frac{1}{\frac{1}{18R_1}}$$

$$= 18 + \frac{18R_1}{R_1 + 18} = 18 \left(1 + \frac{R_1}{R_1 + 18}\right) = 18 \left(\frac{2R_1 + 18}{R_1 + 18}\right)$$

$$\bar{I} = \frac{U}{R_{sub}} = \frac{6 \cdot (R_1 + 18)}{18 \cdot \frac{2R_1 + 18}{R_1 + 18}} = \begin{cases} \frac{R_1 + 18}{6R_1 + 54} = \bar{I}_1 + \bar{I}_2 \\ \bar{I}_1 R_1 = \bar{I}_2 \cdot 18 \end{cases}$$

$$H = \frac{H_{max}^2 R_1^2}{u^2 u^2}$$

$$a = \frac{u}{e} = \frac{H \cdot u^2}{u^2} \cdot \frac{H}{u} \bar{I}_2 = \frac{6(R_1 + 18)}{18(2R_1 + 18)} = \bar{I}_1$$

$$= \frac{H}{u} = \frac{H \cdot u^2}{u^2} \cdot \frac{u}{u}$$

$$\frac{6(R_1 + 18)}{2R_1 + 18} - 18 \bar{I}_1 = \bar{I}_1 R_1$$

$$\bar{I}_1 = \frac{6(R_1 + 18)}{(2R_1 + 18)(18 + R_1)} = \frac{6}{2R_1 + 18}$$

$$P = R_1 \bar{I}_1^2 = \frac{36R_1}{(2R_1 + 18)^2}$$

$$y = \frac{36x}{(2x + 18)^2}$$

$$\frac{4x}{36x} + \frac{72x}{36x} + \frac{9}{x} = \frac{1}{y}$$

$$\frac{x}{9} + \frac{9}{x} + 2 = \frac{1}{y}$$

$$\frac{x}{9} = \frac{x^2 + 9 + 2x}{9}$$

$$2x = x^2 + 18x + 81$$

$$x^2 - x + 81 = 0$$

$$x^2 + 9x(2 - \frac{1}{y}) + 81 = 0$$

$$D = 81(2 - \frac{1}{y})^2 - 324 \geq 0$$

$$81(2 - \frac{1}{y})^2 \geq 324$$

$$4(2 - \frac{1}{y})^2 \geq 4$$

$$2 - \frac{1}{y} \geq 1$$

$$\frac{1}{y} \leq 1$$

$$y \geq 1$$

$$y = \frac{36x}{(2x + 18)^2} \rightarrow \max$$

$$36x = (2x + 18)^2$$

$$4x^2 + 36x + 324 = 0$$

$$36x \geq 2x + 18$$

$$34x \geq 18$$

$$x \geq \frac{9}{17}$$

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$$\frac{4x^2 + 72x + 324}{x} \cdot \frac{36x}{(2x + 18)^2}$$

$$\frac{36x - 648 + 2916}{24} \cdot \frac{9}{x}$$

Чистовик
Загара ~ 4

$$F = G \cdot \frac{m_1 \cdot m_2}{R^2}$$

$$a = G \cdot \frac{M_3}{R^2}$$

Дано:

$$R = 2R_3 = 2 \cdot 6400 \text{ км}$$

$$g = 10 \text{ м/с}^2$$

Найти:

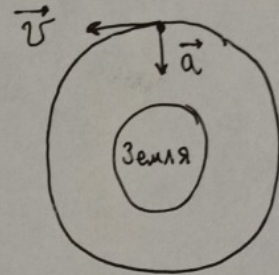
T

$$g = G \frac{M_3}{R_3^2}$$

$$a = G \cdot \frac{M_3}{(2R_3)^2} = G \cdot \frac{M_3}{4R_3^2} = \frac{g}{4} = \frac{10}{4} \text{ м/с}^2$$

$$l = 2\pi R = 4\pi R_3$$

$$a = \frac{10}{4} \text{ м/с}^2$$



1

Үнембүү Зогарал 5

Дүнэ:
 $U = 6B$
 $P = 1BТ$

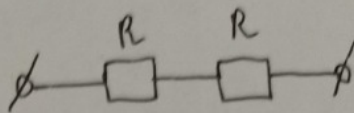
Хайгуу:

- 1) R
- 2) R_1
- 3) P_{max}

1) $R_{sub.} = 2R$

$$P = R_{sub.} \bar{I}^2 = U \cdot \bar{I} =$$

$$= \frac{U^2}{2R} = 1BТ \Rightarrow R = \frac{U^2}{2 \cdot 1BТ} = \frac{36B}{2BТ} = 18Om$$



2) $\bar{I} = \frac{U}{R_{sub.}} = \frac{6B}{36Om} = \frac{1}{6}A$

$$R_{sub.} = R \rightarrow \frac{1}{\frac{1}{R} + \frac{1}{R_1}} =$$

$$= 18 + \frac{1}{\frac{1}{18} + \frac{1}{R_1}} = 18 \left(\frac{2R_1 + 18}{R_1 + 18} \right)$$

$$\bar{I} = \frac{U}{R_{sub.}} = \frac{6(R_1 + 18)}{18(2R_1 + 18)} = \bar{I}_1 + \bar{I}_2$$

$$\left\{ \begin{aligned} \bar{I} &= \bar{I}_1 + \bar{I}_2 = \frac{6(R_1 + 18)}{18(2R_1 + 18)} \\ \bar{I}_1 R_1 &= \bar{I}_2 R_2 = 18 \bar{I}_2 \end{aligned} \right.$$

$$\bar{I}_2 = \frac{6(R_1 + 18)}{18(2R_1 + 18)} - \bar{I}_1$$

$$18 \bar{I}_2 = \frac{6(R_1 + 18)}{(2R_1 + 18)} - 18 \bar{I}_1 = \bar{I}_1 R_1$$

$$\bar{I}_1 = \frac{6(R_1 + 18)}{(2R_1 + 18)(18 + R_1)} = \frac{6}{2R_1 + 18}$$

$$P = \bar{I}_1^2 R_1 = \frac{36R_1}{(2R_1 + 18)^2}$$

$$4R_1^2 R + 36R_1(2P - 1) + 324P = 0$$

~~$$D = 1296 R_1^2 P + 9R_1(2P - 1) + 81P = 0$$~~

$$D = 81(2P - 1)^2 - 4P \cdot 81P = 4P^2 \cdot 81 - 4 \cdot 81P + 81 - 4 \cdot 81P^2 \geq 0$$

$$-324P + 81 \geq 0 \Rightarrow 324P \leq 81 \Rightarrow P \leq 0,25$$

(2)

Чистовик

Значит $P_{\max} = \frac{1}{4}$

Найдём, при каком R_1 это достигается

$$\frac{1}{4} = \frac{36R_1}{(2R_1+18)^2}$$

$$36R_1 = R_1^2 + 18R_1 + 81$$

$$R_1^2 - 18R_1 + 81 = (R_1 - 9)^2 = 0 \Rightarrow \boxed{R_1 = 9}$$

Ответ: 1) $R = 18 \text{ Ом}$

2) $R_1 = 9 \text{ Ом}$

3) $P_{\max} = \frac{1}{4} \text{ Вт}$,