

Часть 1

Олимпиада: **Физика, 10 класс (1 часть)**

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Вариант 3

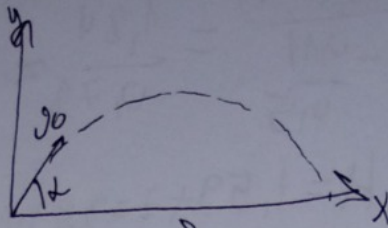
Мумокин

1)

$$\alpha = 60^\circ$$

$$S = 17 \text{ м}$$

- 1) $v_0 = ?$
- 2) $F_y = ?$



$$1) S = v_{0x} t$$

$$v_{0x} = v_0 \cos \alpha$$

$$t = \frac{2v_0 \sin \alpha}{g} = \frac{2v_0 \sin \alpha}{g}$$

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

$$v_0 = \sqrt{\frac{g \cdot S}{2 \sin \alpha \cos \alpha}} = \sqrt{\frac{10 \cdot 17}{2 \sin 60^\circ \cos 60^\circ}} \approx 14 \frac{\text{м}}{\text{с}}$$

$$2) m = 1 \text{ кг}$$

$$F = \frac{v_0}{t} = \frac{14}{4} = 3,5 \text{ м/с}^2$$

$$F_y = m g = 10 \text{ Н}$$



2,

$$\alpha = 30^\circ$$

$$H_1 = 2 \text{ м}$$

$$m_1 = 0,2 \text{ т}$$

$$m_2 = 0,1 \text{ т}$$

$$1) t = ?$$

$$2) H = ?$$

$$m g H = m_1 m g h_1 + m_2 m g h_2$$

$$h_1 + h_2 = \frac{m_1 h_1}{\sin \alpha} + \frac{m_2 h_2}{\sin \alpha}$$

$$H = h_1 \left(\frac{m_1}{\sin \alpha} - 1 \right) = h_2 \left(\frac{m_2}{\sin \alpha} - 1 \right)$$

$$h_2 = \frac{h_1 \left(\frac{m_1}{\sin \alpha} - 1 \right)}{\frac{m_2}{\sin \alpha} - 1} \quad H = h_1 + h_2 \quad \uparrow$$

Минимум

$$h_2 = \frac{2 \left(\frac{0,81}{0,5} - 1 \right)}{1 - \frac{0,11}{0,5}} = \frac{1,24}{0,78} \approx 1,59$$

$$H = 1,59 + 2 = 3,59 \text{ м}$$

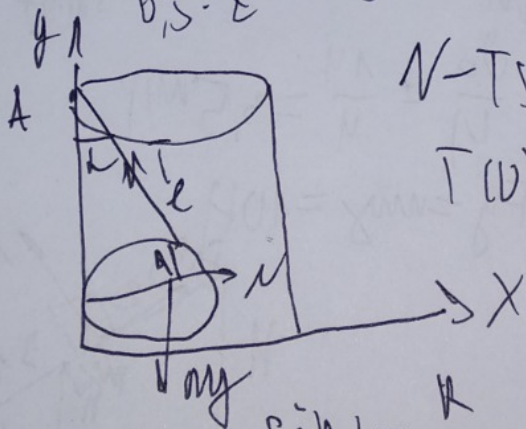
Коробку розпускаємо на кути α ($\mu_2 = 0,81$)

$$1 = \frac{a + z}{z} \quad \mu_2 = \mu_1 \sin \alpha - \mu_1 \cos \alpha$$

$$\mu_2 = \mu_1 \sin \alpha - \mu_1 \cos \alpha \quad a = g (\sin \alpha - \mu_1 \cos \alpha) =$$

$$t = \sqrt{\frac{2 \cdot 51}{a}} = \sqrt{\frac{2 \cdot h_1}{\sin \alpha \cdot a}} = 10 \left(0,5 - 0,81 \cdot \frac{\sqrt{3}}{2} \right) = -2$$

$$= \sqrt{\frac{2 \cdot 2}{0,5 \cdot 2}} = 2 \text{ с}$$



$$N - T \sin \alpha = 0$$

$$T \cos \alpha - mg = 0$$

$$T = \frac{mg}{\cos \alpha}$$

$$N = mg \cdot \tan \alpha$$

$$\sin \alpha = \frac{R}{R + l} = \frac{0,05}{0,05 + 0,15} = 0,25$$

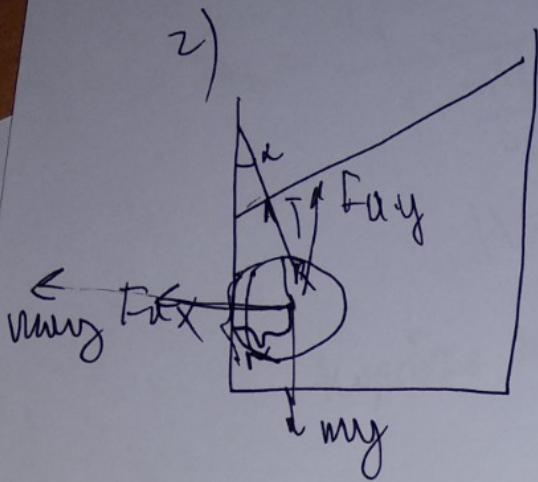
$$\cos \alpha = \sqrt{1 - 0,25^2} = \frac{\sqrt{15}}{4}$$

$$\tan \alpha = \frac{\sqrt{15}}{15}$$

$$N = 0,8 \cdot 10 \cdot \frac{\sqrt{15}}{15} = 2,07 \text{ Н}$$

3.
 $R = 0,05$
 $l = 0,15$
 $m = 0,8 \text{ кг}$
 $\mu = 10 \text{ Н/л}$
 1) $N = ?$
 2) $\alpha = ?$

Умножить



$$v=0$$

$$\vec{F}_{ax} + \vec{T} + \vec{F}_A + m\vec{g} = m\vec{a}_{ax}$$

$$ax \left\{ \begin{aligned} m a_{ax} &= F_{ax} + T \sin \alpha \\ 0 &= T \cos \alpha + F_{ay} + m g \end{aligned} \right.$$

$$T \cos \alpha = m g - F_{ay}$$

$$T \sin \alpha = m \omega^2 R - F_{ax}$$

$$\tan \alpha = \frac{m \omega^2 R - F_{ax}}{m g - F_{ay}} = \frac{m \omega^2 R - g a V}{m g - g y V}$$

$$r = (l+R) \sin \alpha$$

$$\tan \alpha = \frac{m \omega^2 (l+R)}{g(l+R)}$$

$$\tan \alpha = (l+R) \frac{\omega^2}{g} \sin \alpha$$

$$\frac{1}{\cos \alpha} = \frac{\omega^2 (l+R)}{g}$$

$$\Rightarrow \frac{\sin \alpha (l+R)}{\cos \alpha} = \frac{\omega^2 (l+R)}{g} \sin \alpha$$

$$\cos \alpha = \frac{g}{\omega^2 (l+R)}$$

$$\cos \alpha = \frac{10}{10^2 (0,05 + 0,15)} = 0,5$$

$$L = 600$$

3

Memorandum

1.

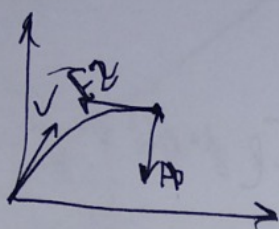
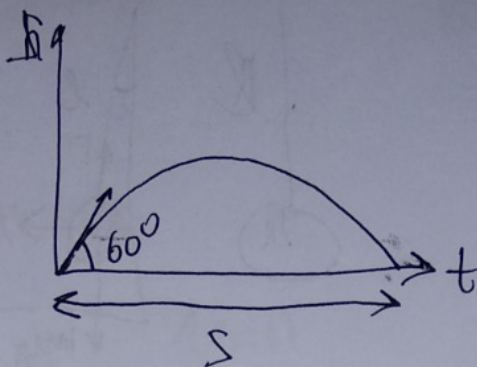
$\alpha = 60^\circ$

$S = 17$

$V_0 = ?$

$m = 1 \text{ kg}$

$V = V_0 / 4$



$S = v_0 \cdot \cos \alpha \cdot t$

$H = v_0 \cdot \sin \alpha \cdot t - \frac{g \cdot t^2}{2}$

$v_0 = \frac{S}{\cos \alpha \cdot t}$

$H = \frac{S \cdot \sin \alpha}{\cos \alpha} - \frac{g \cdot t^2}{2}$

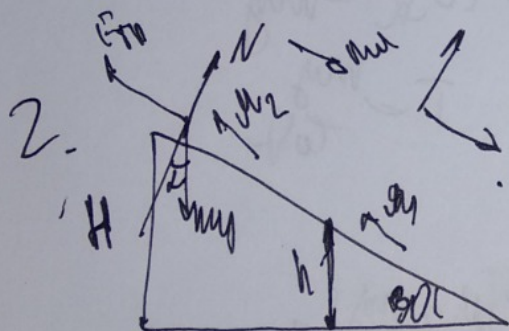
$t = \frac{2 \cdot v_0 \cdot \sin \alpha}{g}$

~~$v_0 = \frac{S \cdot g}{2 \cdot \sin \alpha \cdot \cos \alpha \cdot t}$~~

~~$v_0 = \frac{S \cdot g}{\cos \alpha \cdot 2 \cdot \sin \alpha}$~~

$v_0 = \sqrt{\frac{S \cdot g}{2 \cdot \cos \alpha \cdot \sin \alpha}} = \sqrt{\frac{17 \cdot 10}{2 \cdot \frac{\sqrt{3}}{2} \cdot \frac{1}{2}}} = \sqrt{\frac{17 \cdot 20}{\sqrt{3}}} = \sqrt{\frac{340}{\sqrt{3}}} = \sqrt{\frac{340 \cdot \sqrt{3}}{3}} = \sqrt{\frac{340 \sqrt{3}}{3}}$

2.



$m \cdot a_1 = m_1 g \sin \alpha - m_2 N$

$N = m_2 g \cos \alpha$

$a_1 = g \sin \alpha - m_2 g \cos \alpha = 4.065$

$a_2 = g \sin \alpha - m_1 g \cos \alpha = 6.1055$

$g \cdot t - ?$

$S = S_1 + S_2 =$

$g \cdot t^2$

$\sin \alpha = \frac{h}{S_1}$

$t = \frac{v_0^2}{2a_2}$

$v_0 = \sqrt{2a_2 S}$

~~$v_0 = \sqrt{2a_2 \cdot \frac{h}{\sin \alpha}}$~~

~~$S_2 = \frac{v_0^2}{2a_1}$~~

~~$S_2 = \frac{2a_2 \cdot \frac{h}{\sin \alpha}}{2a_1} = \frac{a_2 \cdot h}{a_1 \cdot \sin \alpha} = \frac{6.1055 \cdot h}{4.065 \cdot \frac{1}{2}} = \frac{6.1055 \cdot 2 \cdot h}{4.065} = \frac{12.211 \cdot h}{4.065} = 3.004 \cdot h$~~

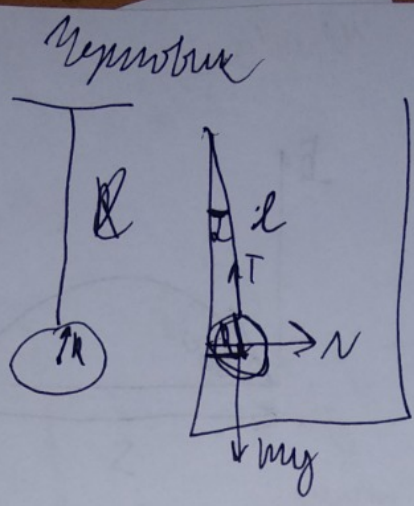
$H = \sin \alpha \cdot (S_2 + S_1)$

$0.25 = 1 - \frac{1}{4}$
 $0.25 = \frac{3}{4}$

3.

$R = 5 \text{ cm}$
 $l = 15 \text{ cm}$
 $m = 0.8 \text{ kg}$

1) $N = ?$



$$\sin \alpha = \frac{R}{R+l}$$

$$\begin{aligned}
 & T \cdot \cos \alpha + N = 0 \\
 & mgy + N = 0 \\
 & mgy = N \quad T \cdot \cos \alpha = mgy \\
 & T = \frac{mgy}{\cos \alpha}
 \end{aligned}$$

~~2) $l = ?$~~

2.

$$mgy H = \mu_1 mgy s_1 + \mu_2 mgy s_2$$

$$h_1 + h_2 = \mu_1 \frac{h_1}{\sin \alpha} + \mu_2 h_2$$

$$H = 1.59 + 2 = 3.59$$

$$h_1 \left(1 - \frac{\mu_1}{\sin \alpha} \right) = h_2 \left(\frac{\mu_2}{\sin \alpha} - 1 \right)$$

$$\begin{aligned}
 & 2 \left(\frac{0.11}{0.5} - 1 \right) = 1.24 h_2 = \\
 & = \frac{1 - 0.11}{0.5} = \frac{0.89}{0.5} = 1.78 = \frac{1.59 + 2}{1.59}
 \end{aligned}$$

Корпуска погружена на глубину z ($m_1 = 0,8$)

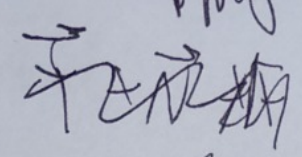
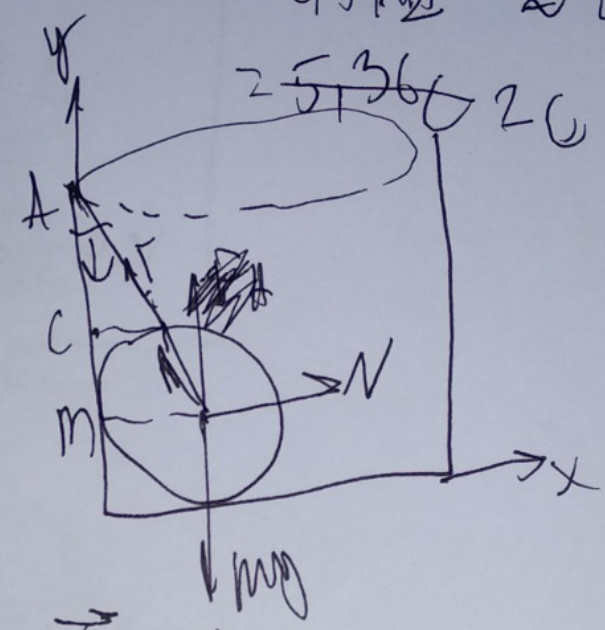
$$s = \frac{at^2}{2}$$

$$ma = mg \sin \alpha - m_1 g \cos \alpha$$

$$|a| = g (\sin \alpha - m_1 \cos \alpha) =$$

$$t = \sqrt{\frac{2 \cdot s_1}{a}} = \sqrt{\frac{2 \cdot h_1}{\sin \alpha \cdot a}} = 10 \left(\frac{1}{2} - 0,8 \cdot \frac{5}{12} \right) = \frac{\sqrt{2 \cdot 21}}{0,5 \cdot 1000} \approx 2$$

- 3.
- $R = 0,05$
- $l = 4,15$
- $m = 0,9 \text{ кг}$
- $W = 10 \text{ П/л}$
- 1) $N = ?$
- 2) $\alpha = ?$



$$\sin \alpha = \frac{R}{R+l} = \frac{0,05}{0,05+4,15}$$

$$\cos \alpha = \sqrt{1 - 0,025^2} \approx 0,999$$

$$t_{y\alpha} = \frac{\sqrt{15}}{15} = 1 - \frac{1}{4} = \frac{\sqrt{15}}{4}$$

Часть 2

Олимпиада: **Физика, 10 класс (2 часть)**

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Вариант 3

Условие

4

$m = 5,5 \text{ г}$

$t_0 = 0^\circ \text{C}$

$S = 500 \text{ см}^2$

$P_0 = 1 \cdot 10^5 \text{ Па}$

1) $Q_1 - ?$

2) $H - ?$

1) $Q = cm\Delta T = 4130 \cdot 5,5 \cdot 10^{-3} \cdot 100 = 2299,5 \text{ Дж}$

После начала испарения вода начинает испаряться и воздушной пар поднимает поршень

$Q_{\text{исп}} = \mu m = 12430 \text{ Дж}$

$Q_2 > Q_{\text{исп}}$

Учитывая: $Q = Q_2 - Q_{\text{исп}} = 17430 - 12430 = 5000 \text{ Дж}$

$Q = m \cdot c_p \cdot \Delta T = 5,5 \cdot 10^{-3} \cdot 2200 \cdot \Delta T$

$\Delta T = \frac{5000}{5,5 \cdot 10^{-3} \cdot 2200} = 413 \text{ К}$

$A = \int R \Delta T = p \Delta V$

$\frac{m}{M} R \Delta T = p_0 \cdot S \cdot H$

$H = \frac{m \cdot R \cdot \Delta T}{M \cdot p_0 \cdot S} = \frac{5,5 \cdot 10^{-3} \cdot 8,31 \cdot 413}{18 \cdot 10^{-3} \cdot 10^5 \cdot 500 \cdot 10^{-4}} = 0,2 \text{ м}$

Ответ: 1) $2299,5 \text{ Дж}$ 2) $0,2 \text{ м} = 20 \text{ см}$

5.

$R = 240 \text{ Ом}$

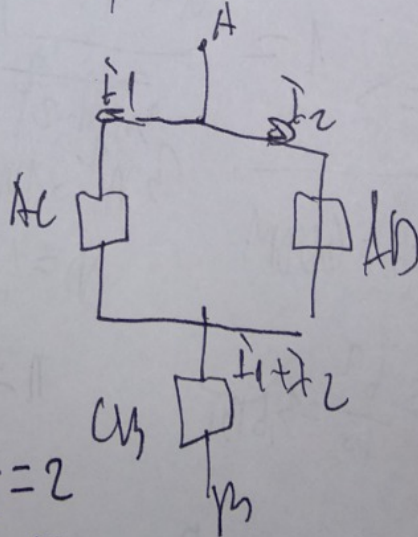
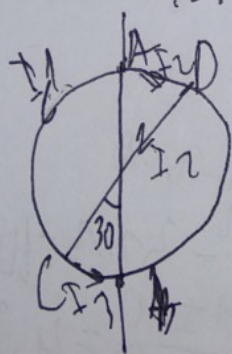
$U = 6 \text{ В}$

1) $I_1 = I_2 = 30$

2) $I = \frac{2}{3} \text{ А}$

$R_1 - ?$ $R_2 - ?$

$H - ?$



$R_{AD} = R_{CB} = \frac{R}{12} = 2$

$R_{AC} = \frac{R}{2} - \frac{R}{12} = \frac{5R}{12} = 100 \text{ Ом}$

1

$$R_{\text{os}} = \frac{R_{\text{ac}} \cdot R_{\text{ad}}}{R_{\text{ac}} + R_{\text{ad}}} + R_{\text{cs}} = \frac{10 \cdot 2}{12} + 2 = \frac{11}{3} \Omega \quad \text{memotok}$$

$$P_1 = \frac{U^2}{R_{\text{os}}} = \frac{36 \cdot 3}{11} = 9,81 \text{ Вт}$$

2) сунтот хэргэ хэрэглэнэ $I = \frac{2}{3} \text{ А} \Rightarrow I_1 = \frac{2}{3}$

$$\begin{cases} U_1 = (I_1 + I_2) R_{\text{cs}} + I_2 \cdot R_{\text{ad}} \\ I_1 \cdot R_{\text{ac}} = I_2 \cdot R_{\text{ad}} \end{cases}$$

$$R_{\text{ad}} = R_{\text{cs}} = \frac{R}{n} \quad R_{\text{ac}} = \frac{R}{2} - \frac{R}{n} = R \left(\frac{1}{2} - \frac{1}{n} \right)$$

$$\begin{cases} 6 = \left(I_1 + \frac{2}{3} \right) \frac{R}{n} + \frac{2}{3} \frac{R}{n} \\ I_1 R \left(\frac{1}{2} - \frac{1}{n} \right) = \frac{2}{3} \frac{R}{n} \end{cases} \Rightarrow \begin{cases} I_1 = \frac{2}{3n \left(\frac{1}{2} - \frac{1}{n} \right)} = \frac{4n}{3n(n-2)} \\ = \frac{4n}{3n(n-2)} = \frac{4}{3(n-2)} \end{cases}$$

$$U = \left(\frac{4}{3(n-2)} \right) \cdot \frac{R}{n} + \frac{2R}{3n} \quad 6 = \frac{4 \cdot 24}{3n(n-2)} + \frac{2 \cdot 24}{3n}$$

$$1 = \frac{24 + 8(n-2)}{3n(n-2)} \quad 3n^2 - 6n = 24 + 8n - 16$$

$$R_{\text{os}} = \frac{6 \cdot 12}{6 + 12} = 4 \Omega \quad U_1 = 100 \text{ мВ}$$

$$P_2 = \frac{U^2}{R_{\text{os}}} = \frac{6^2}{4} = 9 \text{ Вт}$$

$$3n^2 - 14n - 8 = 0$$

$$D = 14^2 - 4 \cdot 3 \cdot (-8) = 100$$

$$n = \frac{14 \pm 10}{6} = 4, \frac{2}{3}$$

$$n = 4, \text{ к } n > 1$$

$$R_{\text{ad}} = R_{\text{cs}} = \frac{24}{4} = 6 \Omega \quad R_{\text{ac}} = 24 \left(\frac{1}{2} - \frac{1}{4} \right) = 12 \Omega$$

Дүнжени: 1) 9,81 Вт 2) 4 3) 9 Вт

репробук

ММ/А-03

4.

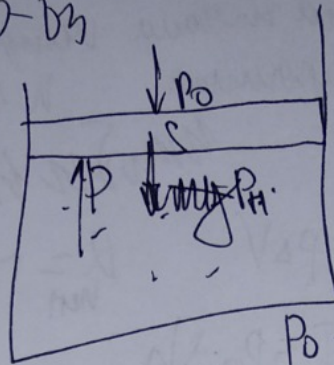
$$m = 5,52$$

$$t_0 = 0^\circ C$$

$$S = 500 \text{ cm}^2$$

$$P_0 = 1 \cdot 10^5 \text{ Па}$$

$$Q_1 = ?$$



$$v_1 = \frac{m}{\rho}$$

$$P_0 + P_1 - P_2 = 0$$

$$Q = cmt$$

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

$$P_2 = \frac{F}{S} = \frac{mg}{S}$$

$$Q = 4200 \cdot 5,5 \cdot 10^{-3} \cdot 2 = 2310$$

$$P_2 = P_1 - P_0$$

$$P = \frac{mg}{S} - P_0$$

$$v_2 = \frac{P_2 \cdot V_1}{P_1} = \frac{P_2 \cdot m}{\rho P_1}$$

$$Q_2 = 17930 \text{ J}$$

$$P_1 = \frac{mg}{S} - P_0$$

$$P_2 = \frac{mRT}{V_2 M}$$

$$V = S \cdot h$$

$$h = \frac{V}{S}$$

$$\Delta h = h_2 - h_1 = \frac{V}{S}$$

$$= \frac{P_2 V_1}{P_1} = \frac{P_2 m}{\rho P_1}$$

$$Q_2 = Q_k + Q_{\text{н}} =$$

$$= \mu m + cm(t_2 - t_0) = \frac{m}{S} \left(\frac{P_2}{P_1} - 1 \right) =$$

$$\frac{Q_2 - \mu m}{cm} + 100 = t_2$$

$$P_1 V_1 = \frac{m}{M} RT_1$$

$$P_2 V_2 = \frac{m}{M} RT_2$$

методом

$$1) Q_1 = c m \Delta t = 4180 \cdot 5,5 \cdot 10^{-3} \cdot 100 = 2299 \text{ Дж}$$

После нагрева температура воды максимум
уменьшилась и вода еще продолжает нагреваться
модель без воды уменьшилась:

$$A = \int R \Delta T = p \Delta V \quad Q_2 = r m = 12430 \text{ Дж}$$

$$\frac{m}{M} R \Delta T = p_0 \cdot S h$$

$$\eta = \frac{m p_0 S}{M p_0 S} = \frac{m}{M}$$

$$\frac{5,5 \cdot 10^{-3} \cdot 9,31 \cdot 4113}{18 \cdot 10^{-3} \cdot 10^5 \cdot 500 \cdot 10^{-4}}$$

$$Q_2 > Q_{\text{max}}$$

$$Q_2 - Q_{\text{max}} = 17430 - 12430 = 5000 \text{ Дж}$$

$$Q = m \cdot c_p \cdot \Delta T = 5,5 \cdot 10^{-3} \cdot 2200 \cdot \Delta T$$

$$\Delta T = \frac{5000}{5,5 \cdot 10^{-3} \cdot 2200} = 413 \text{ К}$$

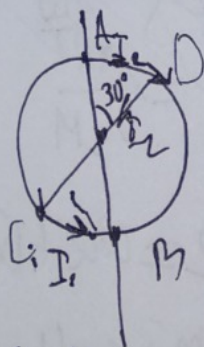
интервалу, 1) 2299 Дж

5:

$$R = 24$$

$$U = 6$$

$$1) P = ?$$



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

$$\frac{30}{360} = \frac{1}{12} R$$

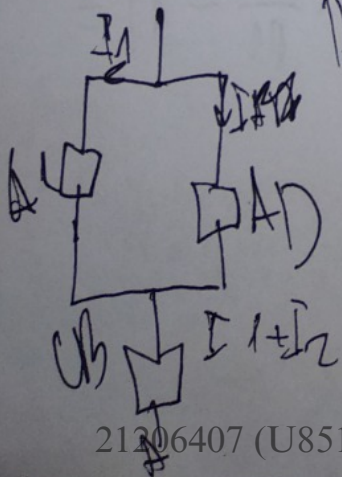
$$R_{AB} = R_{CB} = \frac{R}{12} = 2$$

$$R_{AC} = \frac{R}{2} = 12 = 5 \text{ A}$$

$$R_{05} = \frac{R_{AC} \cdot R_{AB}}{R_{AC} + R_{AB}} + R_{CB} = \frac{10 \cdot 2}{10 + 2} + 2 = \frac{20}{12} + 2 = 2 \frac{2}{3} + 2 = 4 \frac{2}{3}$$

$$F = I R L \cdot \sin \alpha$$

$$P = U \cdot I \cdot \sin \alpha = U I \sin \alpha$$



рекурсия

2) Если не брать рекурсию $I = \frac{2}{3}A \Rightarrow I_1 = \frac{2}{3}A$

$$\begin{cases} U_1 = (I_1 + I_2)R_{CB} + I_2 \cdot R_{AD} \\ I_1 \cdot R_{AC} = I_2 \cdot R_{AD} \end{cases}$$

$$R_{AD} = R_{CB} = \frac{R}{2} \quad R_{AC} = \frac{R}{2} - \frac{R}{n} = R\left(\frac{1}{2} - \frac{1}{n}\right)$$

$$\begin{cases} 6 = \left(I_1 + \frac{2}{3}I_1\right) \frac{R}{n} + \frac{2}{3}I_1 \frac{R}{n} \\ I_1 R\left(\frac{1}{2} - \frac{1}{n}\right) = \frac{2}{3}I_1 \frac{R}{n} \end{cases} \quad \left\{ \begin{aligned} I_1 &= \frac{2}{3n\left(\frac{1}{2} - \frac{1}{n}\right)} = \frac{4}{3n(n-2)} \\ &= \frac{4}{3(n-2)} \end{aligned} \right.$$

$$6 = \left(\frac{4}{3(n-2)}\right) \frac{R}{n} + \frac{2}{3} \frac{4}{3(n-2)} \frac{R}{n} \Rightarrow 6 = \frac{4 \cdot 24}{3n(n-2)} + \frac{2 \cdot 24}{3n}$$

$$1 = \frac{24}{3n(n-2)} + \frac{8}{3n} \Rightarrow$$

$$1 = \frac{24 + 8(n-2)}{3n-2} \quad 3n^2 - 6n = 24 + 8n - 16$$

$$3n^2 - 14n - 8 = 0$$

$$D = 14^2 + 4 \cdot 8 \cdot 3 = 100$$

$$n = \frac{14 \pm 10}{6} = \frac{4}{3} \cdot 2 = 3$$

$$n = 4 \quad \text{т.к. } n > 1$$

$$R_{AD} = R_{CB} = \frac{24}{4} = 6 \text{ Ом}$$

$$R_{AC} = 24\left(\frac{1}{2} - \frac{1}{4}\right) = 12 \text{ Ом}$$

$$R_{00} = \frac{6+12}{6+12} + b =$$

$$= 100 \text{ м}$$

$$r_2 = \frac{U_2}{R_{00}} = \frac{6^2}{10} = 3,6 \text{ В}$$