# Часть 1

Олимпиада: **Физика, 11 класс (1 часть)**

Шифр: **21200064**

ID профиля: **846489**

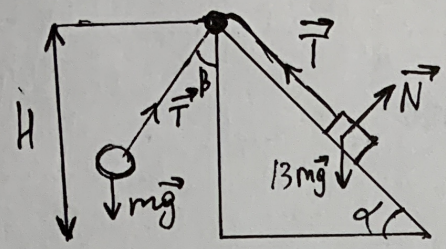
Вариант 5

Чистовик



№1

а)




Брусок: $ma\cos\alpha = 13mg\sin\alpha - T$

Шарик: $ma\sin\beta = T - mg\cos\beta$

$T = 13mg\sin\alpha - ma\cos\alpha$

$ma\sin\beta = 13mg\sin\alpha - ma\cos\alpha - mg\cos\beta$

$a(\sin\beta + \cos\alpha) = g(13\sin\alpha - \cos\beta)$

$a = g\dfrac{13\sin\alpha - \cos\beta}{\sin\beta + \cos\alpha} = 10\dfrac{13\cdot\frac{5}{13} - \frac{4}{5}}{\frac{3}{5} + \frac{12}{13}} =$

$\approx \dfrac{4{,}2}{1{,}52} \approx 10 \cdot 2{,}76 \approx \boxed{27{,}6\ \frac{м}{с^2}}$

$\cos\alpha = \frac{12}{13} \Rightarrow$

$\Rightarrow$ по осн. тригон. тожд:

$\sin\alpha = \sqrt{1 - \frac{144}{169}} = \frac{5}{13}$

$\cos\beta = \frac{4}{5} \Rightarrow$

$\Rightarrow \sin\beta = \sqrt{1 - \frac{16}{25}} = \frac{3}{5}$

б) Введём $\tilde{a}$ в систему относительно бруска.

Брусок: $m\tilde{a} = 13mg\sin\alpha + T$

Шарик: $m\tilde{a} = mg\cos\beta - T$

$T = -13mg\sin\alpha + m\tilde{a}$

$m\tilde{a} = mg\cos\beta + 13mg\sin\alpha - ma$

$2m\tilde{a} = mg\cos\beta + 13mg\sin\alpha$

$\tilde{a} = \dfrac{g}{2}(\cos\beta + 13\sin\alpha)$

$\tilde{a} = 5\left(\frac{4}{5} + 13\cdot\frac{5}{13}\right) = 4 + 25 = \boxed{29\ \frac{м}{с^2}}$

в) Для шарика

ЗСЭ: $mgH = \dfrac{mV_к^2}{2}$

$gH = \dfrac{V_к^2}{2}$

$V_к = \sqrt{2gH}$

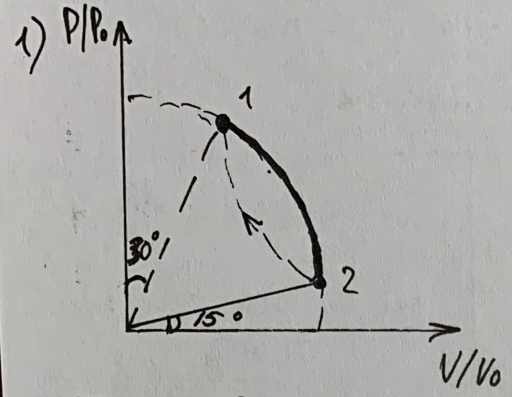
$\tilde{a} = \dfrac{V_к - V_0}{t}$, $V_0 \to 0$

$t = \dfrac{V_к}{\tilde{a}} = \boxed{\dfrac{\sqrt{2gH}}{29}}$

Чистовик

(2)

N2

1) 


$$\frac{T_1}{T_2} = \frac{P_1 V_1}{P_2 V_2}$$

$P_1 = \cos 30° \cdot P_0$

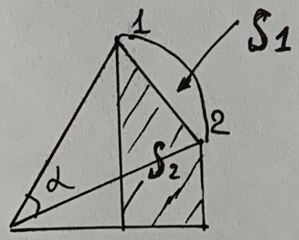
$P_2 = \sin 15° \cdot P_0$

$V_1 = \sin 30° \cdot V_0$

$V_2 = \cos 15° \cdot V_0$

$$\frac{T_1}{T_2} = \frac{\cos 30° \cdot \sin 30°}{\cos 15° \cdot \sin 15°} = 2\cos 30° = 2 \cdot \frac{\sqrt{3}}{2} = \boxed{\sqrt{3}}$$

2) Такая точка не существует. Теплоемкость равна нулю только при нулевой температуре или когда $Q = 0$.

3) 


$$S_1 = \frac{\pi R^2 \alpha}{360} - \frac{1}{2}\pi R^2 \sin\alpha = R^2\left(\frac{\pi}{8} - \frac{\sqrt{2}}{4}\right) = \frac{R^2}{8}\left(\pi - 2\sqrt{2}\right)$$

$$S_2 = \frac{P_1 + P_2}{2}(V_2 - V_1) = \frac{R^2}{2}(\cos 30° + \sin 15°) \cdot (\cos 15° - \sin 30°)$$

$$A_{1-2} = S_1 + S_2 = \frac{R^2}{8}\left(\left(\pi - 2\sqrt{2}\right) + 4(\cos 30° + \sin 15°)(\cos 15° - \sin 30°)\right)$$

$$A_{2-1} = -\Delta U = \int_{V_1}^{V_2} \frac{\nu RT}{V} = \nu RT \ln\frac{V_2}{V_1} = \nu RT \ln\frac{\cos 15°}{\cos 30°}$$

$$\frac{A_{1-2} - A_{2-1}}{A_{1-2}} = \frac{\frac{R^2}{8}\left(\left(\pi - 2\sqrt{2}\right) + 4(\cos 30° + \sin 15°)(\cos 15° - \sin 30°)\right) - \nu RT \ln\frac{\cos 15°}{\cos 30°}}{\frac{R^2}{8}\left(\left(\pi - 2\sqrt{2}\right) + 4(\cos 30° + \sin 15°)(\cos 15° - \sin 30°)\right)}$$

N2

Черновик

1) 2-1: $Q=0$

$$\frac{T_1}{T_2} = \frac{p_1 V_1}{p_2 V_2}$$

$p_1 = 4\cos 30^\circ \cdot p_0$

$p_2 = 4\sin 15^\circ \cdot p_0$

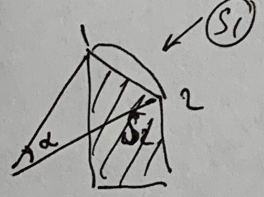
$V_1 = 4\sin 30^\circ \cdot V_0$

$V_2 = 2\cos 15^\circ \cdot V_0$

$$\frac{T_1}{T_2} = \frac{\cos 30 \cdot \sin 30}{\cos 15 \cdot \sin 15} = 2\cos 30^\circ = 2 \cdot \frac{\sqrt{3}}{2} = \sqrt{3}$$

2) Такой точки нет, теплоемкость = 0 может быть только при нулевой температуре или когда $Q=0$

3)




$$S_1 = \frac{\pi R^2 \alpha}{360} - \frac{1}{2}\pi R^2 \sin\alpha = R^2\left(\frac{\pi}{8} - \frac{\sqrt{2}}{4}\right) =$$

$$= \frac{R^2}{8}(\pi - 2\sqrt{2})$$

$$S_2 = \frac{p_1 + p_2}{2}(V_2 - V_1) = \frac{R^2}{2}(\cos 30 + \sin 15) \cdot$$

$$\cdot (\cos 15 - \sin 30)$$

$$A_{12} = S_1 + S_2 = \frac{R^2}{8}\left((\pi - 2\sqrt{2}) + 4(\cos 30 + \sin 15)(\cos 15 - \sin 30)\right).$$

$$A_{21} = -\Delta U = \int_{V_1}^{V_2} \frac{\nu R T}{V} = \nu R T \ln\frac{V_2}{V_1} = \nu R T \ln\frac{\cos 15}{\cos 30}$$

$$\frac{A_{12} - A_{21}}{A_{12}}$$

б) Введем $\tilde{a}$ в систему отсчета относительно бруска.

- брусок: $m\tilde{a} = 13mg\sin\alpha + T$
- шарик: $m\tilde{a} = mg\cos\beta - T$

Черновик

$T = -13mg\sin\alpha + m\tilde{a}$

$m\tilde{a} = mg\cos\beta + 13mg\sin\alpha - m\tilde{a}$

$2m\tilde{a} = mg\cos\beta + 13mg\sin\alpha$

$\tilde{a} = \frac{g}{2}(\cos\beta + 13\sin\alpha)$

$\tilde{a} = \frac{5}{5}\left(\frac{4}{5} + 13\cdot\frac{5}{13}\right) = 4 + 25 = 29\ \frac{м}{с^2}$

в) Для шарика

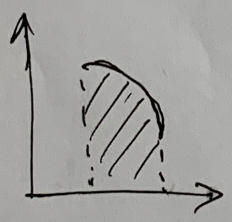
ЗСЭ: $mgH = \frac{mv^2}{2}$ $\quad gH = \frac{v^2}{2}$

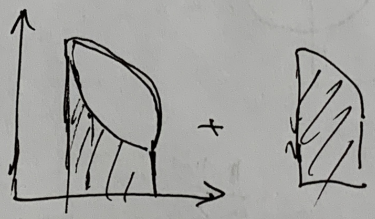
$V_к = \sqrt{2gH}$

$\tilde{a} = \frac{V_к - V_0}{t}$ →

→ $t = \frac{V_к - V_0}{\tilde{a}} = \frac{\sqrt{2gH}}{29}$

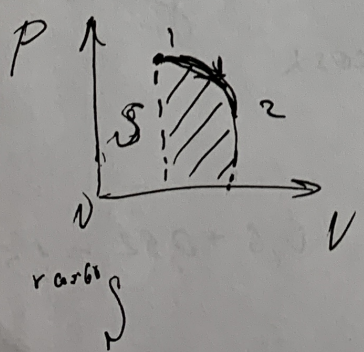
$A = V\uparrow$



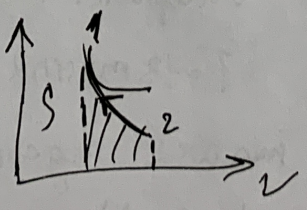


A за цикл =

$A = \frac{i}{2}(\nu R\Delta T)$




+




$\frac{A_{цикл}}{A_{1-2}} = \frac{A_{1+2} + A_{2-1}}{A_{1-2}}$

$r\cos\beta$

Черновик

N1

$\cos\alpha = \frac{12}{13}$

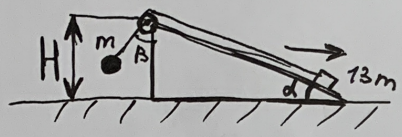
$1 - \frac{144}{169} = \sin^2\alpha$

$\sin = \frac{5}{13}$

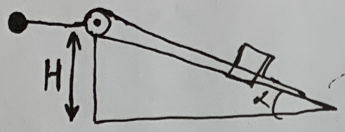
$\cos\beta = \frac{4}{5}$

$1 - \frac{16}{25} = \sin^2\beta$

$\sin\beta = \frac{3}{5}$



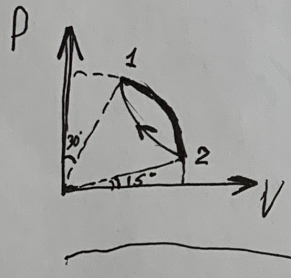

В начале:



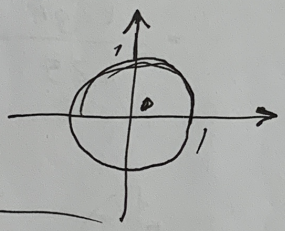

N2

$pV = \nu RT$

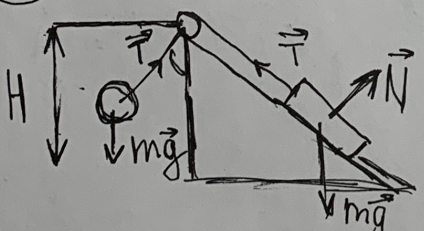
$p\Delta V = \nu R\Delta T$




Чтобы найти $\frac{T_1}{T_2} \Rightarrow \frac{p_2 V_1}{p_2 V_2}$




N1




Брусок: $ma\cos\alpha = 13mg\sin\alpha - T$

Шарик: $ma\sin\beta = T - mg\cos\beta$

$T = 13mg\sin\alpha - ma\cos\alpha$

$ma\sin\beta = 13mg\sin\alpha - ma\cos\alpha - mg\cos\beta$

$a(\sin\beta + \cos\alpha) = g(13\sin\alpha - \cos\beta)$

$a = g\frac{13\sin\alpha - \cos\beta}{\sin\beta + \cos\alpha} = g\frac{13\cdot\frac{5}{13} - \frac{4}{5}}{\frac{3}{5} + \frac{12}{13}} =$

$= 10\frac{4,2}{1,52} = 10\cdot 2,76 = 27,6\ \frac{м}{с^2}$

$0,6 + 0,92 = 1,52$

# Часть 2

Олимпиада: **Физика, 11 класс (2 часть)**

Шифр: **21200064**

ID профиля: **846489**

Вариант 5

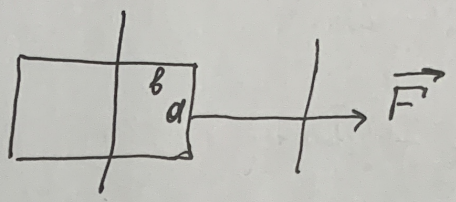
Чистовик



№4 Рамка ускоряется при изменении площади

1) Рассмотрим время от входа правой стороны в магнит. поле до выхода.

$$\mathcal{E} = \frac{\Delta\Phi}{\Delta t} = \frac{B\Delta S}{\Delta t}$$




$S = ab \qquad \Delta S : a\Delta b = d\Delta B$

$$\mathcal{E} = \frac{Bd\Delta B}{\Delta t} \to V_0$$

$$I = \frac{\mathcal{E}}{R} = \frac{BdV_0}{R}$$

$$F = BId = \frac{B^2d^2V_0}{R} = ma$$

$$a = \frac{B^2d^2V_0}{Rm}$$

3) $\Delta V_2 = \Delta V_1 =$

$$= -\frac{B^2d^2}{3mR}$$

2) $$\mathcal{E} = \frac{Bd\Delta b}{\Delta t} = V$$

$$\Delta B_{max} = \frac{d}{3}$$

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

$$F = ma = -m\frac{\Delta V}{\Delta t} \quad | \cdot \Delta t$$

$$BVd\Delta t = -m\Delta V$$

$$\frac{B^2d^2\Delta S}{R} = -m\Delta V$$

$$\Delta V_1 = -\frac{B^2d^2\Delta S}{mR} = -\frac{B^2d^2}{3mR}$$

# Чистовик



N5

1) $\begin{cases} \frac{1}{d_0} + \frac{1}{f} = D_{лин.} \\ \frac{1}{d} + \frac{1}{f} = D_{л.} - D_{оч.} \\ \frac{1}{\infty} + \frac{1}{f} = D_{л.} - 2D_{оч} \end{cases}$

$\frac{1}{f} = D_л - \frac{1}{d_0}$

$\begin{cases} \frac{1}{0{,}25} + D_л - \frac{1}{d_0} = D_л - D_{оч} \\ \frac{1}{\infty} + D_{л.} - \frac{1}{d_0} = D_л - 2D_{оч.} \end{cases}$

$\begin{cases} 4 - \frac{1}{d_0} = -D_{оч.} \\ -\frac{1}{d_0} = -2D_{оч} \end{cases}$

$4 - 2D_{оч} = -D_{оч}$

$4 = D_{оч}$

$D_{оч} = 4D_{пр}$ (близ.)

$\frac{1}{d_0} = 2D_{оч}$

$d_0 = \frac{1}{2D_{оч}} = \frac{1}{8} = 0{,}125м$ (расст.)

$D = 2D_{оч} = 8D_{пр}$ (дальн.)

2) $\begin{cases} \frac{1}{d_0} + \frac{1}{f} = D_л \\ \frac{1}{d} + \frac{1}{f} = D_{л.} - D_{оч} \end{cases}$

$D_л - \frac{1}{f} = \frac{1}{d_0} \quad \left\{ \frac{1}{d} = \frac{1}{d_0} - D_{оч.} \right.$

$D_{оч.} = \frac{1}{d_0} - \frac{1}{d} = \frac{1}{0{,}125} - \frac{1}{0{,}5} =$

$= 8 - 2 = 6$

Ответ: $-6D_{пр}$.

Чистовик

(3)

(N3)

$\mathcal{E}_c = L\frac{\Delta I}{\Delta t}$

$\frac{\Delta I}{\Delta t} = \frac{\mathcal{E}_c}{L}$

До замыкания: $C_0 = \frac{C_1 C_2}{C_1 + C_2} = \frac{2c^2}{3c} = \frac{2c}{3}$

$U = E$

$q = \frac{2}{3} EC$

1) После замыкания:

$\frac{\Delta I}{\Delta t} = \frac{\mathcal{E}_i}{L}$

В момент замыкания:

$\mathcal{E}_i = E \Rightarrow \boxed{V_c = \frac{E}{L}}$

2) $C_\Sigma = 3C$

$q_0 = 3EC$

$W = \frac{CE^2}{2}$

$\boxed{Q_R = \Delta W = \frac{\frac{7}{3}CE^2}{2}}$

3) ЗСЭ:

$\frac{CU^2}{2} = \frac{LI^2}{2}$

Черновик

N5

1) $\begin{cases} \frac{1}{d_0} + \frac{1}{f} = D_{глаза} \\ \frac{1}{d} + \frac{1}{f} = D_{глаза} - D_{оч.} \\ \frac{1}{\infty} + \frac{1}{f} = D_{л.} - 2D_{оч.} \end{cases}$

2)

$\frac{1}{f} = D_{л.} - \frac{1}{d_0}$

$\begin{cases} \frac{1}{0,25} + D_{л} - \frac{1}{d_0} = D_{л} - D_{оч.} \\ \frac{1}{\infty} + D_{л.} = \frac{1}{d_0} = D_{л} - 2D_{оч.} \end{cases}$

$\begin{cases} 4 - \frac{1}{d_0} = -D_{оч} \\ -\frac{1}{d_0} = -2D_{оч} \end{cases}$

$4 - 2D_{оч} = -D_{оч}$

$4 = D_{оч}$

$D_{оч} = 4D_{пр.}$ (близ.)

$\frac{1}{d_0} = 2D_{оч}$

$d_0 = \frac{1}{2D_{оч}} = \frac{1}{8} = 0,125$ м (расст.)

$D_{доп} = 2D_{оч} = 8D_{пр.}$

2) $\begin{cases} \frac{1}{d_0} + \frac{1}{f} = D_{глаза} \\ \frac{1}{d} + \frac{1}{f} = D_{л} - D_{оч} \end{cases}$

$D_{л} = \frac{1}{f} = \frac{1}{d_0}$

$\frac{1}{d} = \frac{1}{d_0} - D_{оч}$

$D_{оч} = \frac{1}{d_0} - \frac{1}{d} = \frac{1}{0,125} - \frac{1}{0,15} =$

$= 8 - 2 = 6$

Ответ: $-6$ Дптр.

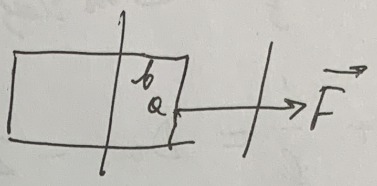
До замыкания: $C_0 = \frac{C_1 C_2}{C_1 + C_2} = \frac{2C^2}{3C} = \frac{2C}{3}$

N4 Черновик

Рамка ускоряется при изменении площади.

1) Рассмотрим время от входа правой стороны в магнитн. поле до выхода

$$\mathcal{E} = \frac{\Delta \Phi}{\Delta t} = \frac{B \Delta S}{\Delta t}$$




$S = a \cdot b \Rightarrow \Delta S = a \Delta B = d \Delta b$

$$\mathcal{E} = \frac{Bd\Delta b}{\Delta t} \to V_0$$

$$I = \frac{\mathcal{E}}{R} = \frac{BdV_0}{R}$$

$$F = BId = \frac{B^2 d^2 V_0}{R} = ma$$

$$a = \frac{B^2 d^2 V_0}{Rm}$$

2) $\mathcal{E} = \frac{Bd\Delta b}{\Delta t} = v$

$\Delta B_{max} = \frac{d}{3}$

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

$$F = ma = -m\frac{\Delta V}{\Delta t} \quad | \cdot \Delta t$$

$$BVd\Delta t = -m\Delta V$$

$$\frac{B^2 d^2 \Delta S}{R} = -m\Delta V$$

$$\Delta V_1 = -\frac{B^2 d^2 \Delta S}{mR} = -\frac{B^2 d^2}{3mR}$$

3) $\Delta V_2 = \Delta V_1$