Часть 1

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

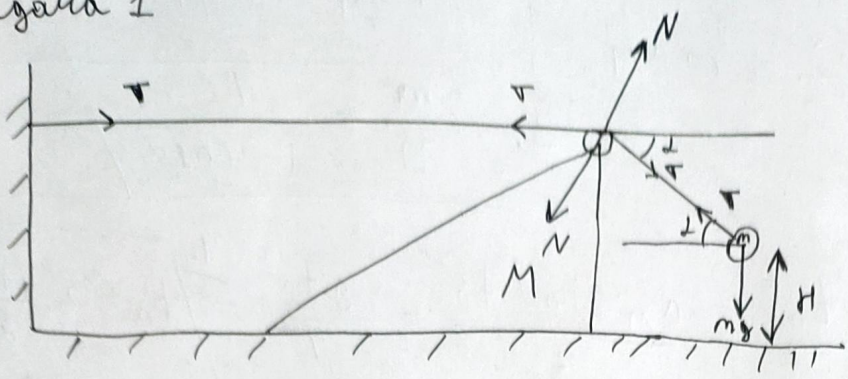
Шифр: **21202244**

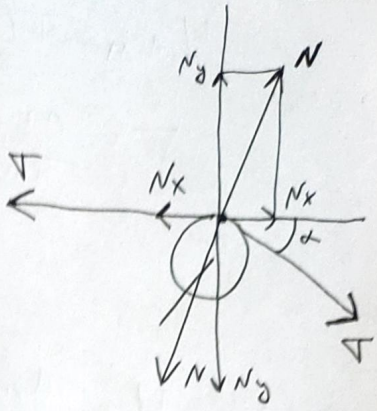
ID профиля: **322097**

Вариант 3

Чистовик

Задача 1



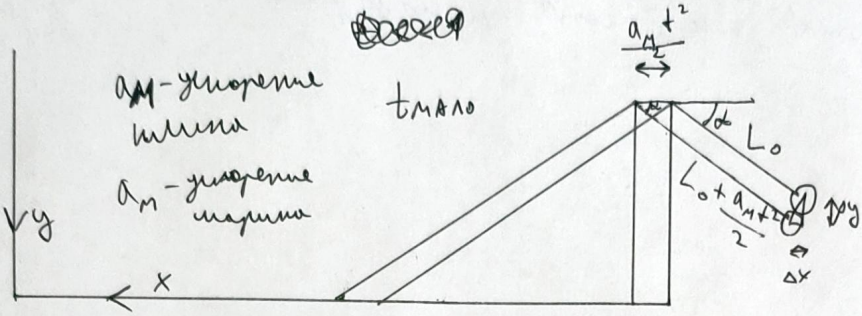


$T = T\cos\alpha + N_x$

$N_y = T\sin\alpha$

$N_x = M a_M$

(1) $M a_M = T(1-\cos\alpha)$



$$\Delta x = \frac{a_{mx} t^2}{2} = \left(L_0 + \frac{a_M t^2}{2}\right)\cos\alpha - L_0\cos\alpha \Rightarrow a_{mx} = a_M\cos\alpha$$

$$\Delta y = \frac{a_{my} t^2}{2} = \left(L_0 + \frac{a_M t^2}{2}\right)\sin\alpha - L_0\sin\alpha \Rightarrow a_{my} = a_M\sin\alpha$$

(2) $m a_{mx} = T\cos\alpha$

(3) $m a_{my} = mg - T\sin\alpha$

$T\cos\alpha = m \cdot a_M\cos\alpha$

$T\sin\alpha = mg - m a_M\sin\alpha$

$$\operatorname{tg}\alpha = \frac{g - a_M\sin\alpha}{a_M\cos\alpha} = \frac{g}{a_M\cos\alpha} - \operatorname{tg}\alpha$$

$$2\operatorname{tg}\alpha = \frac{g}{a_M\cos\alpha} = \frac{2\sin\alpha}{\cos\alpha}$$

$\cos\alpha = \frac{5}{13}$

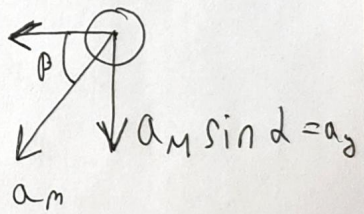
$\Downarrow$

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

2. $\boxed{a_M = \frac{g}{2\sin\alpha}}$

$\boxed{a_M = \frac{13g}{24}}$

$a_M\cos\alpha = a_x$



β - угол к горизонту

$\operatorname{tg}\beta = \frac{a_y}{a_x} = \frac{\sin\alpha}{\cos\alpha} = \operatorname{tg}\alpha$

1. $\boxed{\beta = \alpha \quad (\operatorname{tg}\beta = \operatorname{tg}\alpha)}$

$\cos\beta = \frac{5}{13} = \cos\alpha$

Человек, задача 1

$$M a_M = T(1-\cos\alpha)$$

$$T = \frac{m a_{mx}}{\cos\alpha} = m a_M$$

$$\Rightarrow M a_M = m a_M (1-\cos\alpha)$$

3. $$\frac{m}{M} = \frac{1}{1-\cos\alpha} \qquad \frac{m}{M} = \frac{13}{8}$$

$$H = \frac{a_{my} t_0^2}{2} = \frac{a_M \sin\alpha\, t_0^2}{2} = \frac{g t_0^2}{4}$$

4. $$\Rightarrow t_0 = 2\sqrt{\frac{H}{g}}$$

$a_{my} = const$, т.к $T = const$, $a_M = const$, $\alpha = const$

Чистовик

Задача 2

$C(T) = 3R\frac{T}{T_0}$ — Не $\Rightarrow i = 3$

$dQ = dU + pdV = C(T)\nu\,dT$

$$\int_0^{Q_1} dQ = \left|\int_{T_0}^{\frac{3}{5}T_0} C(T)\nu\,dT\right| = \left|\frac{3R\nu}{T_0}\,\frac{T^2}{2}\Big|_{T_0}^{\frac{3}{5}T_0}\right| = \frac{3R\nu T_0^2}{2T_0}\left(1-\frac{9}{25}\right) =$$

$$= \frac{24R\nu T_0}{25} \overset{1.}{=} \boxed{\frac{24}{25}R\nu T_0 = 0{,}96R\nu T_0 = Q_1}$$

$$dQ = \frac{3}{2}R\nu\,dT + \underbrace{p\,dV}_{dA} = 3R\nu\frac{T}{T_0}dT$$

$pV = R\nu T$

$R\nu\,dT = p\,dV + V\,dp$

$$\int_0^A dA = \int_{T_0}^{T_1} 3R\nu\left(\frac{T\,dT}{T_0} - \frac{dT}{2}\right)$$

$$\frac{dA}{dT} = 3R\nu\left(\frac{T_1}{T_0} - \frac{1}{2}\right) = 0$$

уст. минимум A

$$\overset{2.}{\boxed{T_1 = \frac{T_0}{2}}}$$

$$A = 3R\nu\left(\frac{1}{T_0}\,\frac{T_1^2 - T_0^2}{2} - \frac{T_1 - T_0}{2}\right) = \frac{3R\nu}{2}(T_1 - T_0)\left(\frac{T_1 + T_0}{T_0} - 1\right) =$$

$$= \frac{3R\nu T_1(T_1 - T_0)}{2T_0} = [\text{illegible}] = -\frac{3R\nu\frac{T_0^2}{4}}{2T_0} \overset{3.}{=} \boxed{-\frac{3R\nu T_0}{8} = A}$$

[illegible]

$A < 0$, т.к. работа совершена над газом, а $|A| = \frac{3R\nu T_0}{8}$

Именно $A = -\frac{3}{8}R\nu T_0$ минимальна, и это вполне, если брать модуль, то это максимальная работа, но работа над газом.

Часть 2

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

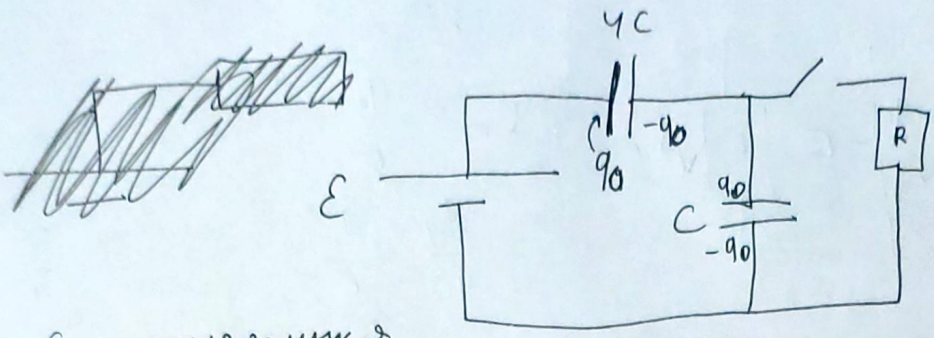
Шифр: **21202244**

ID профиля: **322097**

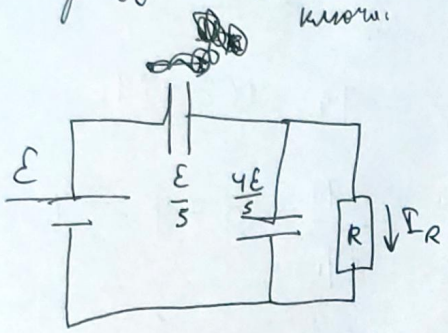
Вариант 3

Чистовик

Задача 3



Сразу после замык-я ключа:



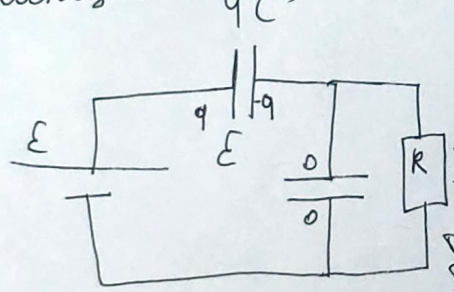
$$\mathcal{E} = \frac{q_0}{4C} + \frac{q_0}{C} = \frac{5q_0}{4C} \Rightarrow q_0 = \frac{4C\mathcal{E}}{5}$$

$$U_4 = \frac{q_0}{4C} = \frac{\mathcal{E}}{5} \qquad U_1 = \frac{q_0}{C} = \frac{4\mathcal{E}}{5}$$

После замыкания ключа: $U_1 = I_R R = \frac{4\mathcal{E}}{5}$

1. $\boxed{I_R = \frac{4\mathcal{E}}{5R}}$

Конечная ситуация ($t \to \infty$)



т.к. если $I_R \neq 0$, то C_1 зарядится, а заряд $C_2 \neq 0$

$$\frac{q}{4C} = \mathcal{E}$$

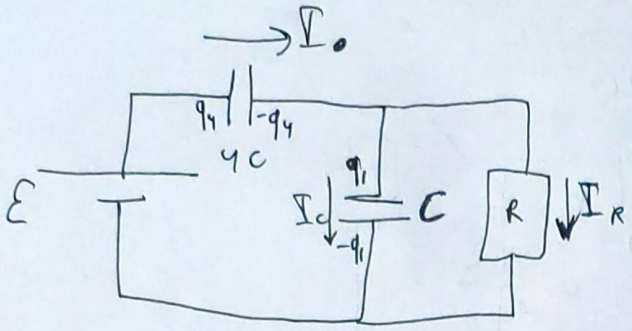
$$q = 4C\mathcal{E}$$

ЗСЭ: $\frac{4C \cdot \mathcal{E}^2}{50} + \frac{C \cdot 16\mathcal{E}^2}{50} + \mathcal{E}\left(\underbrace{4C\mathcal{E}}_{q} - \underbrace{\frac{4C\mathcal{E}}{5}}_{q_0}\right) =$ (Ашт)

$$= Q + \frac{4C\mathcal{E}^2}{2}$$

$$Q = C\mathcal{E}^2\left(\frac{2}{5} + 4 - \frac{4}{5} - 2\right) =$$

$$= C\mathcal{E}^2\left(2 - \frac{2}{5}\right) = \frac{C\mathcal{E}^2 \cdot 8}{5} = Q$$



$$I_0 = I_C + I_R$$

$$R I_R = \frac{q_1}{C}$$

$$\mathcal{E} = \frac{q_4}{4C} + \frac{q_1}{C} \qquad q_1 = \mathcal{E}C - \frac{q_4}{4}$$

$$I_0 = \frac{dq_4}{dt}$$

$$I_C = \frac{dq_1}{dt}$$

$$\frac{dq_4}{dq_1} = \frac{I_0}{I_C} \Rightarrow I_C = I_0 \frac{dq_1}{dq_4}$$

$$q_4 = 4C\mathcal{E} - 4q_1$$

$$\frac{dq_4}{dq_1} = 0 - 4 = -4$$

$$\frac{dq_1}{dq_4} = -\frac{1}{4}$$

$$I_0 = -\frac{I_0}{4} + I_R$$

$$5I_0 = I_R$$

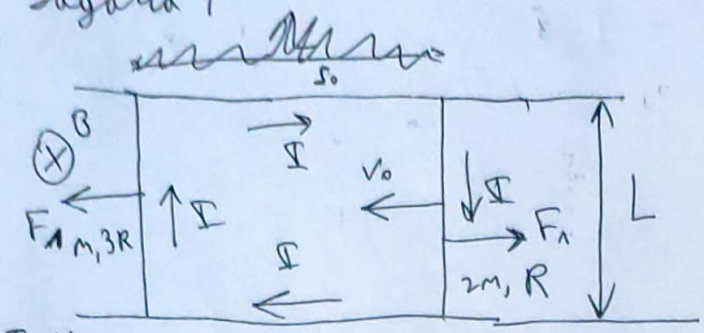
$$I_R = 5I_0 R$$

$$I_R = \frac{5I_0}{4}$$

3. $$U_R = R I_R = \frac{5 I_0 R}{4}$$

Чиповик

Задача 4



$$\mathcal{E} = \frac{d\Phi}{dt} = \frac{B \cdot LV dt}{dt} = VBL$$

$$\mathcal{E} = I \cdot 4R \Rightarrow I = \frac{\mathcal{E}}{4R} = \frac{V_0 BL}{4R}$$

$$F_A = [\bar{I} \times \bar{B}]\, L = IBL = \frac{V_0 (BL)^2}{4R}$$

II ЗН:

$2m\, a_0 = F_A$ →

1. $$a_0 = \frac{V_0 (BL)^2}{8mR}$$

a_0 противонаправлено V_0

ЗСИ, ох: $2mV_0 = 3mV_{10}$ ⇒

2. $$V_{10} = \frac{2V_0}{3}$$

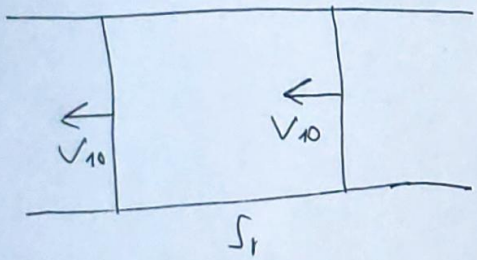
$$a_1 = \frac{F_A}{2m} \quad a_1 = \frac{a_2}{2}$$

$$a_2 = \frac{F_A}{m}$$

$$V_0 - a_1 t = a_2 t$$

$$3a_1 t = V_0$$

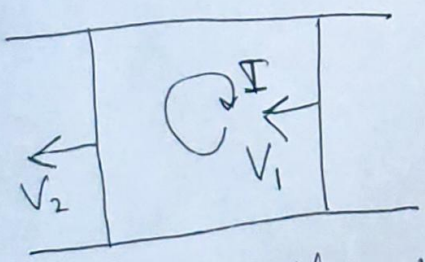
$$a_1 t = \frac{V_0}{3}$$



$$dx_1 = V_1 dt$$

$$dx_2 = V_2 dt$$

$$\int dx_2 + S_0 - \int dx_1 = S_1$$



$$\mathcal{E} = BL(V_1 - V_2)$$

$$F_A = \frac{(BL)^2 (V_1 - V_2)}{4R} = \frac{m\, dV_2}{dt}$$

$$dx = dx_1 - dx_2 =$$

$$= (V_1 - V_2)\, dt =$$

$$= (V_1 - V_2) \cdot \frac{m\, dV_2 \cdot 4R}{(BL)^2 (V_1 - V_2)} =$$

$$= \frac{4mR}{(BL)^2} dV_2$$

$$mV_2 + 2mV_1 = 2mV_0$$

$$ma_2 = 2ma_1 = F_A$$

$$m\frac{dV_2}{dt} = 2m\frac{dV_1}{dt} \qquad dV_2 = 2dV_1$$

$$S_0 + \int dx = S_1$$

$$\int dx = \int dx_1 - \int dx_2$$

Чиновек, задача 4

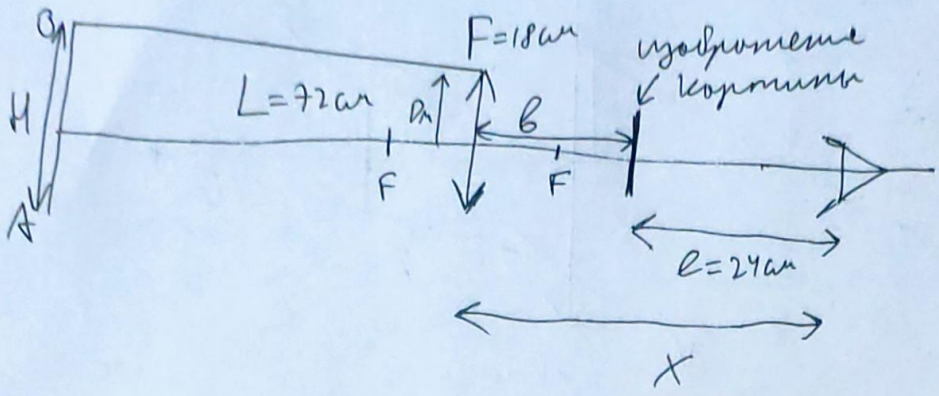
4

$$S_0 \cdot \frac{4mR}{(BL)^2} \int_0^{V_{10}} dV_2 = S_1 = S_0 \cdot \frac{4mR}{(BL)^2} \cdot \frac{2V_0}{3} = \boxed{S_0 \cdot \frac{8mRV_0}{3(BL)^2} = S_1}$$

3.

Чистовик

Задача 5

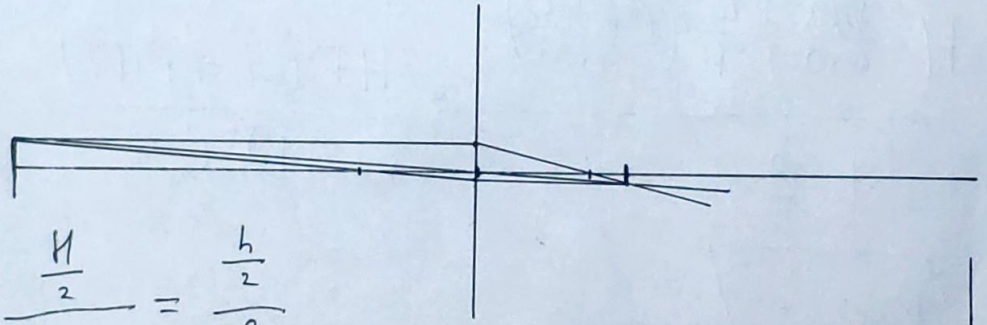


$$\frac{1}{L} + \frac{1}{в} = \frac{1}{F} \Rightarrow в = \frac{F \cdot L}{L - F} = 24\text{см}$$

$$x = в + f = \frac{F \cdot L}{L - F} + f = \frac{18 \cdot 72}{54} + 24\text{см} =$$

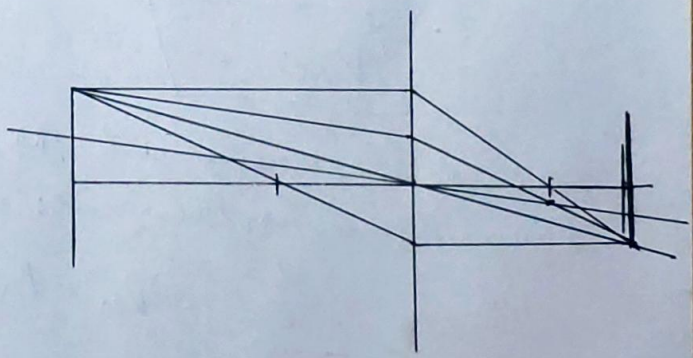
h - размер картины - изображения

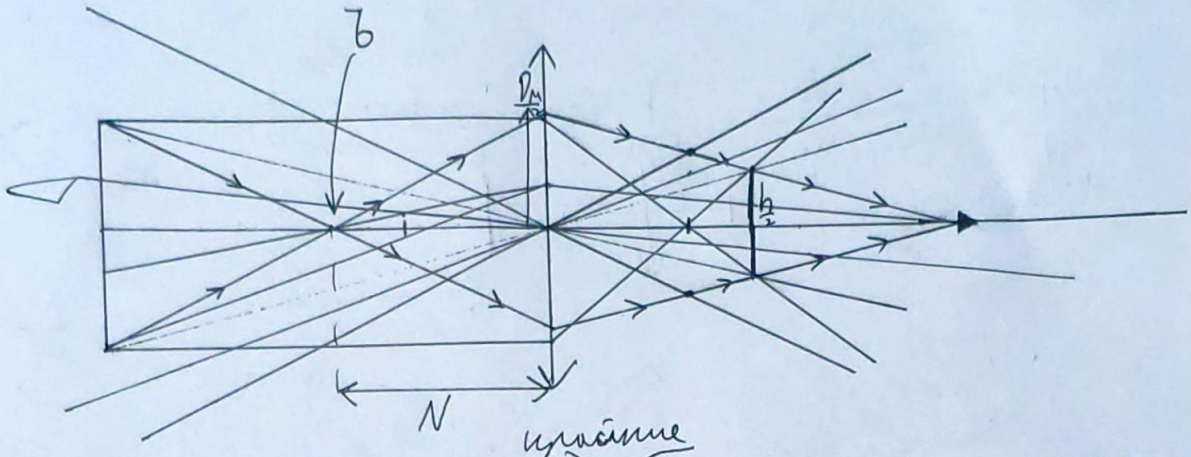
1. = 48 см = x



$$\frac{\frac{H}{2}}{L} = \frac{\frac{h}{2}}{в}$$

$$h = \frac{H \cdot в}{L} = \frac{9 \cdot 24}{72} = 3\text{см}$$





Стрелочками отмечены лучи, создающие для глаза изображение картины ⇒ они должны проходить через самый край линзы для создания полного изображения

$$\frac{\frac{h}{2}}{l} = \frac{\frac{D_м}{2}}{б+l} \Rightarrow D_м = \frac{h(б+l)}{l} = \frac{H б (б+l)}{L l} =$$

$$= \frac{H \cdot \frac{FL}{L-F}\left(l + \frac{FL}{L-F}\right)}{Ll} = \frac{HF(lL - lF + FL)}{(L-F)^2 l} = \frac{3.48_{см}}{24} = 6см$$

2. $D_м = 6$ см

Все лучи, приходящие в глаз, пересекаются в одной точке (б), в ней и нужно разместить экран.

$$\frac{\frac{D_м}{2}}{N} = \frac{\frac{H}{2}}{L-N} \Rightarrow D_м L - D_м N = HN \Rightarrow N = \frac{D_м L}{H + D_м} = \frac{6 \cdot 72}{9+6} =$$

$= 28{,}8$ см

из хода крайних лучей

3. $N = 28{,}8$ см