Часть 1

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

Шифр: **21202616**

ID профиля: **254701**

Вариант 8

Чистовик

(1)

Дано

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

H

$\cos\alpha = \frac{3}{5}$

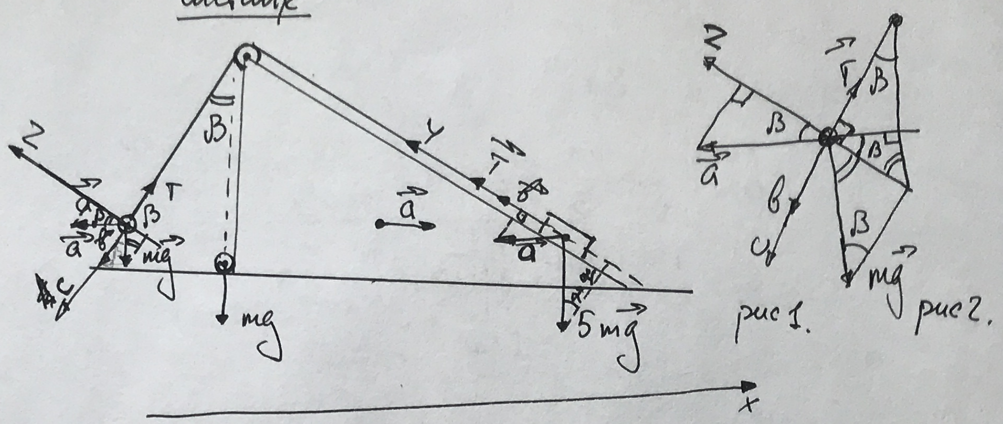
$g = 10\ \frac{м}{с^2}$

Найти

а) a

б) b

в) t



Решение

а)

OZ: (по рис 2)

$$mg\cdot\sin\beta - am\cdot\cos\beta = 0 \Rightarrow$$

$$\Rightarrow g\sin\beta = a\cos\beta \Rightarrow a = g\frac{\sin\beta}{\cos\beta} = g\frac{\sqrt{1-\cos^2\beta}}{\cos\beta} = 10\cdot\frac{12}{5} = 24\ \left(\frac{м}{с^2}\right)$$

$$\sin\beta = \sqrt{1-\cos^2\beta} = \frac{12}{13}$$

б) 1) OX:

$$\cancel{T\sin\beta = am \Rightarrow T = \frac{am}{\sin\beta}}$$

$$T\sin\beta - am = -bm\sin\beta \Rightarrow T = \frac{m(a - b\sin\beta)}{\sin\beta} = \frac{am}{\sin\beta} - bm$$

2) OY:

$$5am\cdot\cos\alpha + T - 5mg\sin\alpha = 5bm \quad) : 5m$$

из 1) $\Rightarrow T = \frac{am}{\sin\beta} = \frac{m(a - b\sin\beta)}{\sin\beta}$

$$\Rightarrow -\frac{b}{5} + \frac{a}{5\sin\beta} + a\cos\alpha - g\sin\alpha = b$$

из а) $\Rightarrow a = g\frac{\sin\beta}{\cos\beta}$ $\Rightarrow$

$$\Rightarrow b = \frac{5}{6}g\left(\frac{1}{5\cos\beta} + \frac{\cos\alpha\cdot\sin\beta}{\cos\beta} - \sin\alpha\right) = \cancel{\frac{5}{6}\cdot 10\cdot\left(\frac{13}{25} - \frac{\sqrt{25-9}}{5}\right)} = \frac{5}{6}\cdot 10\left(\frac{1}{5\cdot\frac{5}{13}} + \frac{\frac{3}{5}\cdot\frac{12}{13}}{\frac{5}{13}} - \frac{4}{5}\right) = \frac{50\cdot 29}{6\cdot 25} = \frac{29}{3}\ \left(\frac{м}{с^2}\right)$$

$$\sin\alpha = \sqrt{1-\cos^2\alpha} = \frac{4}{5}$$

в) OC:

$$l = v_0 t + \frac{bt^2}{2} = \frac{bt^2}{2} = H\cdot\left(\frac{1}{\cos\beta} - 1\right) \Rightarrow t = \sqrt{\frac{2H\cdot\left(\frac{1}{\cos\beta}-1\right)}{b}} = \sqrt{\frac{2H\cdot\left(\frac{1}{\cos\beta}-1\right)}{g\left(\frac{1}{5\cos\beta} + \frac{\cos\alpha\cdot\sin\beta}{\cos\beta} - \sin\alpha\right)}}.$$

$v_0 = 0$

$l = x_k - x_0 = H\left(\frac{1}{\cos\beta} - 1\right)$

$x_0 = H$

$x_k = H\cdot\frac{1}{\cos\beta}$

$\boxed{1}$

Чистовик

1

Ответ: а) $a = 24\,\frac{м}{с^2} = g \cdot \frac{\sin\beta}{\cos\beta}$

б) $b = \frac{29}{3}\,\frac{м}{с^2} = g\left(\frac{1}{5\cos\beta} + \frac{\cos\alpha \cdot \sin\beta}{\cos\beta} - \sin\alpha\right)$

в) $t = \sqrt{\frac{2 \cdot H \cdot}{g} \cdot \frac{\left(\frac{1}{\cos\beta} - 1\right)}{\left(\frac{1}{5\cos\beta} + \frac{\cos\alpha \cdot \sin\beta}{\cos\beta} - \sin\alpha\right)}}$.

Чистовик

(2)

Дано

$\alpha = 22{,}5^\circ$

$\beta = 15^\circ$

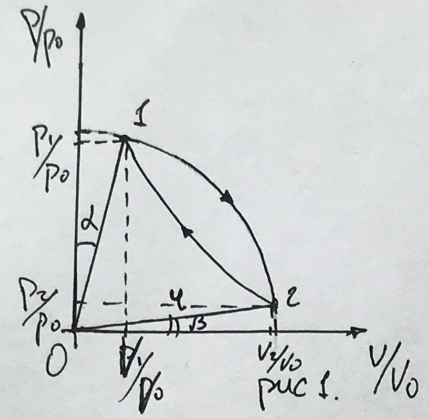
1-2 – окр.

Найти

а) $\dfrac{\Delta T_{12}}{T_2}$

б) $\sin\varphi, c=0$

в) η



Решение

а) 1)
$$\begin{cases} p_1V_1 = \nu RT_1 \Rightarrow T_1 = \dfrac{p_1V_1}{\nu R} \boxed{\Rightarrow} \\ p_2V_2 = \nu RT_2 \Rightarrow T_2 = \dfrac{p_2V_2}{\nu R} \Rightarrow \end{cases}$$

$p_1 = r\cdot\cos\alpha\cdot p_0$

$p_2 = r\cdot\sin\beta\cdot p_0$

$V_1 = r\cdot\sin\alpha\cdot V_0$

$V_2 = r\cdot\cos\beta\cdot V_0$

$$\boxed{\Rightarrow}\quad T_1 = \frac{r^2p_0V_0}{\nu R}\cdot\cos\alpha\sin\alpha = \frac{r^2p_0V_0}{2\nu R}\cdot\sin 2\alpha$$

$$\Rightarrow\quad T_2 = \frac{r^2p_0V_0}{\nu R}\cdot\cos\beta\cdot\sin\beta = \frac{r^2\cdot p_0V_0}{2\nu R}\cdot\sin 2\beta$$

$$\Rightarrow \frac{\Delta T_{12}}{T_2} = \frac{T_1 - T_2}{T_2} =$$

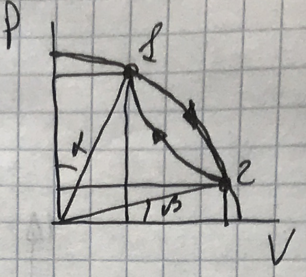
$$= \frac{\frac{r^2p_0V_0}{2\nu R}\left(\sin 2\alpha - \sin 2\beta\right)}{\frac{r^2p_0V_0}{2\nu R}\cdot\sin 2\beta} = \frac{\sin 2\alpha - \sin 2\beta}{\sin 2\beta} = \frac{\sin 2\alpha}{\sin 2\beta} - 1 = \frac{\sin 45^\circ}{\sin 30^\circ} - 1 =$$

$$= \sqrt{2} - 1.$$

Ответ: а) $\dfrac{\Delta T_{12}}{T_2} = \dfrac{\sin 2\alpha}{\sin 2\beta} - 1 = \sqrt{2} - 1.$

(2)

$\alpha = 22{,}5^\circ \quad \beta = 15^\circ$



$\frac{\Delta T_{12}}{T_2}$

$pV = \nu R T$

$p^2 + V^2 = r^2 = const$

$(r \cdot \sin\alpha \cdot p_0)^2 + (r \cdot \cos\alpha \cdot V_0)^2 = r^2 \;/ : r^2$

$\sin^2\alpha \cdot p_0^2 + \cos^2\alpha \, V_0^2 = 1$

$\begin{cases} p_1 V_1 = \nu R T_1 \Rightarrow T_1 = \frac{p_1 V_1}{\nu R} = \frac{r^2 p_0^2 \cos\alpha \sin\alpha}{\nu R} \boxed{=} \\ p_2 V_2 = \nu R T_2 \Rightarrow T_2 = \frac{p_2 V_2}{\nu R} = \frac{r^2 p_0^2 \cos\beta \sin\beta}{\nu R} \ominus \end{cases}$

$p_1 = r \cdot \cos\alpha \cdot p_0$

$p_2 = r \cdot \sin\beta \cdot p_0$

$V_1 = r \cdot \sin\alpha \cdot p_0$

$V_2 = r \cdot \cos\beta \cdot p_0$

$\boxed{=} \; \frac{r^2 p_0^2 \sin 2\alpha}{2\nu R}$

$\ominus \; \frac{r^2 p_0^2 \sin 2\beta}{2\nu R}$

$\Rightarrow \frac{\Delta T_{12}}{T_2} = \frac{(T_1 - T_2)}{T_2} = \frac{\frac{r^2 p_0^2}{2\nu R} \cdot (\sin 2\alpha - \sin 2\beta)}{\frac{r^2 p_0^2}{2\nu R} \cdot \sin 2\beta} =$

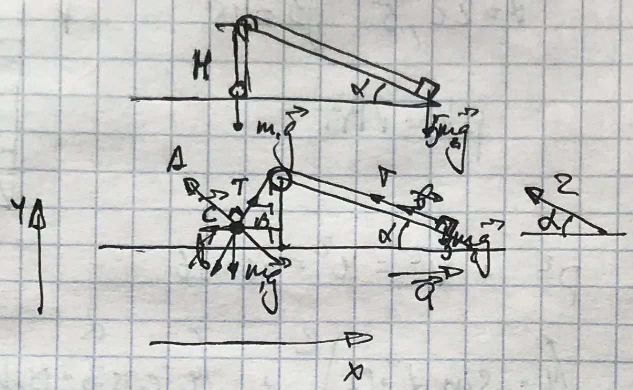
$= \frac{\sqrt{2} - 1}{2 \cdot \frac{1}{2}} = \sqrt{2} - 1$

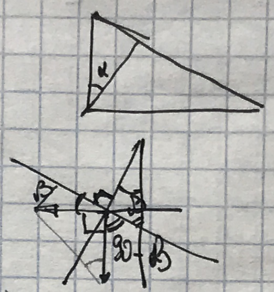
$c = \frac{Q = 0}{\nu \Delta T} = 0$

$\Delta U = -A'$

$\Delta U = \frac{i}{2} \nu R \Delta T = \frac{i}{2} \Delta p \Delta V$

$\cancel{A}$ $\quad \Delta p \Delta V = \nu R \Delta T$





OX :

$$T\sin\beta = -cm = am \Rightarrow T = \frac{am}{\sin\beta}$$

$a = c$

1) OA :

$$am\cos\beta = mg\sin\beta \Rightarrow a = g\frac{\sin\beta}{\cos\beta}$$

2) OZ :

$$T - 5mg\sin\alpha = 5bm$$

$$T\sin\beta - b\sin\beta \quad \frac{am}{\sin\beta} - 5mg\sin\alpha = \cancel{5}bm \quad \Big| :5m$$

$$T\sin\beta - am = b_m\sin\beta \Rightarrow T = \frac{m(a+b\sin\beta)}{\sin\beta} = \frac{am}{\sin\beta} + bm$$

$$\frac{a}{5\sin\beta} - \cancel{5mg}\sin\alpha = b = g\left(\frac{1}{5\cos\beta} - \sin\alpha\right)$$

3) OB:

$x_0 = H$

$x_k = \frac{H}{\cos\beta}$

$$\frac{1}{5\cdot\frac{5}{13}} - \frac{4}{5} = \frac{13-20}{25} = -\frac{7}{25}$$

$$L = H\left(\frac{1}{\cos\beta} - 1\right)$$

$$L = v_0 t + \frac{bt^2}{2} = \frac{bt^2}{2}$$

$v_0 = 0$

$$\Rightarrow t = \sqrt{\frac{2L}{b}} = \sqrt{\frac{2H\left(\frac{1}{\cos\beta} - 1\right)}{g\left(\frac{1}{5\cos\beta} - \sin\alpha\right)}}$$

Часть 2

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

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Вариант 8

Чистовик

4

Дано
m
d
υ_0
R
B

Найти
а) a_0
б) υ_1
в) υ_2

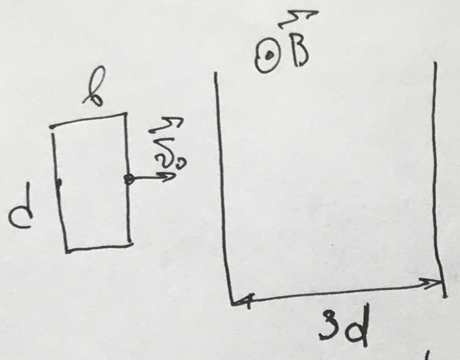

рис 1.

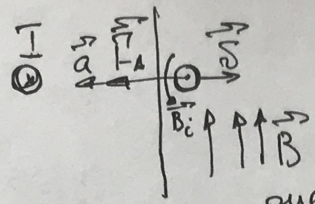

рис 2.

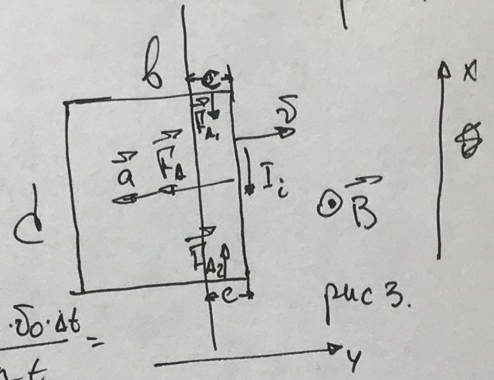

рис 3.

Решение

а) $\cdot\ \mathcal{E}_i = \left|\frac{\Delta\Phi}{\Delta t}\right| = \frac{\Delta S\cdot B}{\Delta t} = \frac{d\cdot B\cdot\upsilon_0\cdot\Delta t}{\Delta t} =$

$= \upsilon_0\cdot d\cdot B$

$\circ\ F_A = BI_i l = a_0 m \Rightarrow a_0 = \frac{B\,\mathcal{E}_i\, l}{mR} = \boxed{\frac{B^2 d^2 \upsilon_0}{mR}}$

$I_i = \frac{\mathcal{E}_i}{R}$

$l = d$

б) $\cdot$ OX: $\vec{F}_{A_1} + \vec{F}_{A_2}$ (рис 3.) $\vec{F}_A$ R $= F_{A_1} - F_{A_2} = BI_i\cdot c - BI_i c = 0 \Rightarrow$

$F_{A_1} = BI_i\cdot c$

$F_{A_2} = BI_i\cdot c$

$\Rightarrow\ am = F_A = BI_i l \Big| \Rightarrow a = \frac{B^2 d^2 \upsilon}{mR}$ (1) $\Rightarrow a\sim\upsilon;\ \underline{\upsilon(t)\downarrow}$

из 1) ...

$\cdot$ OY: (рис 3) $\upsilon_1 = \upsilon_k = \upsilon_0 - \Delta\upsilon$, где υ_k - υ при входе л. стор. рамки в область МП;

$\Delta\upsilon$ - изменение υ за t полного "вхождения" рамки в МП.

$\Delta\upsilon = \int_{t_k=t}^{t_0=0} a(t)$

1

Чистовик

1

$$\cancel{a = v_0 \cdot \frac{B^2 \cdot d^2}{mR}}$$ $\cancel{\Delta v}$

$\cancel{v_2 \; v = v_0}$

из 1 $\Rightarrow$ $a_k = \frac{B^2 d^2}{mR} \cdot v_1 \Rightarrow$ $\boxed{v_1 = 0}$ $\Rightarrow v_2 = 0$.

$a_k = 0$

Ответ: а) $a_0 = \frac{B^2 d^2 v_0}{mR}$;

б) $v_1 = 0$;

в) $v_2 = 0$.

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Чистовик

5

Дано

$\dfrac{|D_1|}{|D_2|} = 5$

$D_{1,2} < 0$

$D_1 < D_2$

$d_1 \gg f$

$|D_1| > |D_2|$

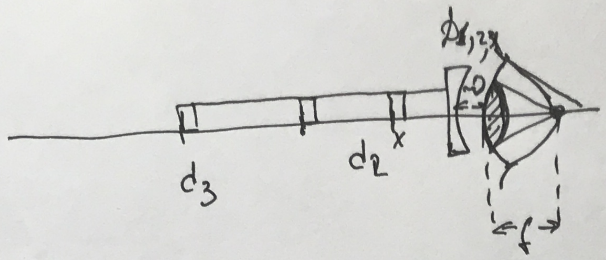
f - const

$d_2 = 25 \cdot 10^{-2}$ м

Найти

а) x, D_1

б) D_3, $d_3 = 50 \cdot 10^{-2}$ м



Решение

а)
$$\begin{cases} D_0 = \dfrac{1}{f} + \dfrac{1}{x} \\ D_0 + D_2 = \dfrac{1}{f} + \dfrac{1}{25 \cdot 10^{-2}} = \dfrac{1}{f} + 4 \\ D_0 + D_1 = \dfrac{1}{f} + \dfrac{1}{d_1} \\ d_1 \gg f \end{cases} \Rightarrow D_0 + D_1 \approx \dfrac{1}{f} \Rightarrow$$

$$\Rightarrow \begin{cases} \dfrac{1}{x} = -D_1 \Rightarrow x = -\dfrac{1}{D_1} = 0{,}2\ (\text{м}) \\ D_2 = D_1 + 4 = \dfrac{D_1}{5} \Rightarrow D_1 = -5\ (\text{м}^{-1}) \end{cases}$$

б) $D_3 + D_0 = \dfrac{1}{f} + \dfrac{1}{50 \cdot 10^{-2}} = D_0 + D_1 + 2 \Rightarrow$

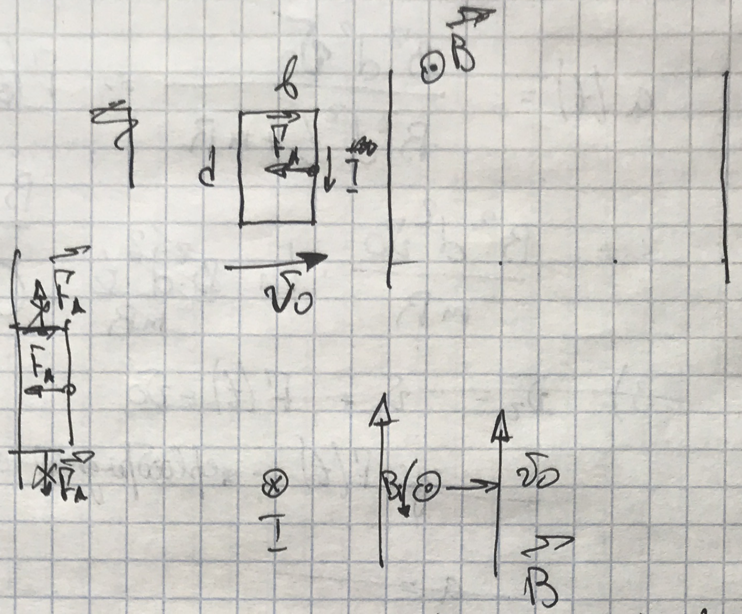
$\Rightarrow D_3 = D_1 + 2 = -3\ (\text{м}^{-1})$

$$\boxed{\text{Ответ: а) } x = 0{,}2 \text{ м}; \ D_1 = -5 \text{ дптр}; \quad \text{б) } D_3 = -3 \text{ дптр}.}$$

Черновик 11-08

4

Дано
m
d
v_0
R
B



1)

$\Delta v = v_0 - v_1$

$a_k = 0$

$$\mathcal{E}_i = \left|\frac{\Delta\Phi}{\Delta t}\right| = \left|\frac{\Delta S \cdot B}{\Delta t}\right| = \left|\frac{d \cdot v_0 \cancel{t} \cdot B}{\cancel{\Delta t}}\right| = |d \cdot v_0 B|$$

$$F_A = B I l = am \Rightarrow a = \frac{B \mathcal{E}_i l}{mR} = \frac{B^2 d^2 v_0}{mR}$$

$$I = \frac{\mathcal{E}_i}{R}, \quad l = d$$

2)

$$v_2 = v_1 + \int_{t_{k_2}}^{t_k} a(t)$$

$$v_1 = v_0 - \int_{t_0}^{t_k} a(t)$$

~~$F(t)$ - первообр. $a(t)$~~ $t_0 = 0$

$t_k =$

$$\frac{v_2 - v_1}{t} = a \Rightarrow v = v_1 + at$$

$$a = \frac{B^2 d}{mR} \cdot d \cdot v = \frac{B^2 d^2}{mR} \cdot v \qquad v = \frac{v_0 - v}{t}$$

$$at = \frac{B^2 d^2}{mR} v_1 + at \frac{B^2 d^2}{mR}$$

$$l = d + v t$$

$$v = v_0 - at$$

~~$v = v_0 - at$~~

$$a = \frac{B^2 d^2 v_1}{mR - B^2 d^2 t}$$

$$a = \frac{B^2 d^2}{mR} v_0 - a t \cdot \frac{B^2 d^2}{mR}$$

$$a\left(1 + t \cdot \frac{B^2 d^2}{mR}\right) = \frac{B^2 d^2 \cdot v_0}{mR}$$

$$a = \frac{B^2 d^2 \cdot v_0 \cdot \cancel{mR}}{\cancel{mR}(mR + B^2 d^2 t)} = \frac{B^2 d^2 \cdot v_0}{mR + B^2 d^2 t}$$

Черновик

$$a(t) = \frac{B^2 d^2 v_0}{B^2 d^2 t + mR} \Rightarrow F(t) = \cancel{\log} B^2 d^2 v_0 \cdot \log_e \frac{B^2 d^2}{mR} t =$$

$$= \frac{B^2 d^2 v_0}{mR} \cdot \ln \frac{\cancel{B^2 d^2 t}}{mR} + C^{\frac{B^2 d^2}{mR} + t}$$

~~3) $v_2 = v_1 + F(t) = v_0$~~

~~где $F(t)$ – первообразная $a(t)$~~

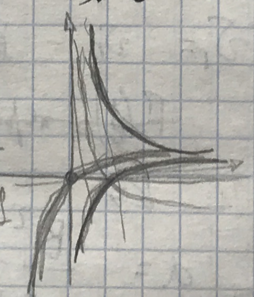
~~$a =$~~

$$\left.\cancel{\frac{B^2 d^2 v_0}{mR} \cdot \ln \frac{B d}{R}}\right|_{t_0 = 0}^{t_k} = \frac{B^2 d^2 v_0}{mR}\left(-\ln \frac{B^2 d^2}{mR} + t_k + \ln \frac{B^2 d^2}{mR} + t_0\right) =$$

$$= \frac{B^2 d^2 v_0}{mR}\left(\ln \frac{\cancel{B^2 d^2} \cdot t_k \cdot \cancel{mR}}{\cancel{B^2 d^2} \cdot t_0 \cancel{mR}}\right) = \frac{B^2 d^2 v_0}{mR} \cdot \ln \frac{t_0}{t_k}$$

~~$(\ln x)' = \frac{1}{x}$~~

$$\frac{b}{kx + a} = \frac{b}{a} \cdot \frac{1}{\frac{k}{a}x + 1}$$



↓

ln осн

$\cancel{\log}$ $\ln x + C$

$$\frac{b}{a} \ln\left(\frac{k}{a} x\right)$$

$$\frac{b}{a}$$

Черновик

$$\frac{D_2}{D_1} = 5 = \frac{F_1}{F_2} \Rightarrow F_1 = 5F_2$$

$$\cancel{F = 25\text{ см} = \frac{1}{D_2 + D_0}} \Rightarrow D_2 + D_0 = \frac{1}{25 \cdot 10^{-2}} = 4$$

$D_{1,2} < 0$

$D_1 < D_2$ $\quad |D_1| > |D_2|$

уд. $\quad$ 25

$$D_0 = \frac{1}{f} + \frac{1}{x}$$

f - const

$$D_0 = \frac{1}{f} + \frac{1}{x} \Rightarrow \frac{1}{f} = D_0 - \frac{1}{x}$$

$$D_2 + D_0 = \frac{1}{f} + \frac{1}{25 \cdot 10^{-2}} \Rightarrow$$

$$D_2 + D_0 = \frac{1}{f} + \frac{1}{25} = \cancel{4} \Rightarrow \frac{1}{f} = \cancel{4} - \frac{1}{25}$$

$D_2 + D_0$

$$\Rightarrow D_2 = 4 - D_0 + \frac{1}{f}$$

$$\cancel{D_0} - \frac{1}{x} = D_2 + \cancel{D_0} - \frac{1}{25 \cdot 10^{-2}}$$

$$D_1 + D_0 = \frac{1}{f} + \frac{1}{d}$$

$d \gg f$

$$D_2 - 4 = \frac{1}{x}$$

$$\Rightarrow D_1 + D_0 \approx \frac{1}{f} = \frac{1}{F} \Rightarrow$$

$$D_0 + D_1 = \frac{1}{f} + \frac{1}{d} \approx \frac{1}{f}$$

$d \gg f$

$$\Rightarrow D_0 = \frac{1}{F} - D_1 = \frac{1}{F} - 5D_2$$

$$D_1 = \frac{5D_2}{\cancel{5}}$$

$$D_1 = D_0 - \frac{1}{x} = 5D_2 = \frac{5}{x} + 20$$

$$D_0 = \frac{6}{x} + 20$$

$$D_0 = \frac{1}{f} + \frac{1}{x}$$

$$D_1 + \frac{1}{f} + \frac{1}{x} = \frac{1}{f}$$

$$\cancel{D_0} = \cancel{D_0} + D_1 + \frac{1}{x} \qquad \frac{1}{x} = -D_1 = \frac{5}{f} + 20$$

$$D_2 = D_1 + 4 = \frac{D_1}{5}$$

$$\frac{1}{x} = -D_1 \qquad D_1 = 5D_2 = \frac{5}{f} + 5 \cdot 4$$

$$D_1 = -5$$