

Часть 1

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

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Вариант 1

A diagram of a beam of length $2s$ supported at the left end by a pin and at the right end by a roller. A triangular load is applied to the beam, starting at zero at the left end and increasing linearly to a peak value s' at the right end. A cable is attached to the right end of the beam and extends downwards and to the left, where it is supported by a fixed point. The cable has a horizontal span of s and a vertical sag of h . The weight of the cable is represented by a downward arrow labeled W . The diagram is drawn on a grid background.

Смешивая блин влево на Δx и посмотрим, как смешиваются моды:

1) $\alpha = \beta$
 число совпадения Δx
 Δx (уменьша) $\uparrow$
 $\Rightarrow$ при добавлении y меняет на $\Delta x \Rightarrow$ равны

$$\beta = \frac{180 - \alpha}{2} = 90 - \frac{\alpha}{2}$$

$$\cos \beta = \cos \left(90 - \frac{\alpha}{2} \right) = \sin \frac{\alpha}{2}$$

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

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

$$= \sqrt{5/6}$$

$$\boxed{\cos \beta = \frac{\sqrt{5}}{5}}$$

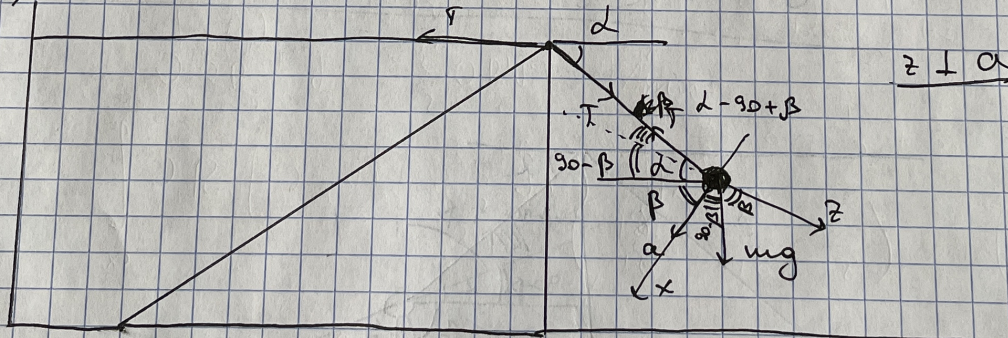
$$\sin \beta = \frac{2\sqrt{5}}{5}$$

угол
под которым
движется
матр (и пор)

$$\sin d = \frac{4}{5}$$

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

2)



Средств. на ось перпенд. условно

~~$$02: \quad 0 = -T \cos(\alpha - \beta) + mg \cos \beta$$~~

$$0 = -T \cos(\alpha + \beta - 90^\circ) + mg \cos \beta$$

$$T \cos (\alpha + (\beta - 90^\circ)) = mg \cos \beta$$

$$T(\cos \alpha \cdot \cos(\beta - 90) - \sin \alpha \cdot \sin(\beta - 90)) = mg \cos \beta$$

$$T \cdot (\cos d \cdot \cos(\beta - 90) - \sin d \cdot \sin(\beta - 90)) = mg \cos \beta \quad (2)$$

$$\begin{aligned}\cos \beta &= \frac{4}{5} \\ \sin \beta &= \frac{3}{5} \\ \sin d &= \frac{3}{5} \\ \cos d &= \frac{4}{5}\end{aligned}$$

$$T \left(\frac{3}{5} \cdot \frac{2\sqrt{5}}{5} - \frac{4}{5} \cdot \frac{\sqrt{5}}{5} \right) = mg \cdot \frac{\sqrt{5}}{5}$$

$$T \left(\frac{6\sqrt{5}}{25} - \frac{4\sqrt{5}}{25} \right) = mg \cdot \frac{\sqrt{5}}{5}$$

$$T \cdot \frac{2\sqrt{5}}{25} = mg \cdot \frac{\sqrt{5}}{5}$$

$$T \cdot \frac{2}{5} = mg \quad \boxed{T = \frac{5}{2} mg}$$

$$\begin{aligned}m a_m &= T \cos(d + \beta) + mg \cos(90 - \beta) = \\ &= \frac{5}{2} mg (\cos d \cdot \cos \beta - \sin d \cdot \sin \beta) + mg \cdot \sin \beta =\end{aligned}$$

$$a_m = \frac{5}{2} g \left(\frac{3}{5} \cdot \frac{4}{5} - \frac{4}{5} \cdot \frac{3}{5} \right) + g \cdot \frac{3}{5} =$$

$$= \frac{5}{2} g \left(\frac{12}{25} - \frac{12}{25} \right) + g \cdot \frac{3}{5} = \frac{5}{2} g \left(-\frac{3\sqrt{5}}{25} \right) + g \cdot \frac{2\sqrt{5}}{5} =$$

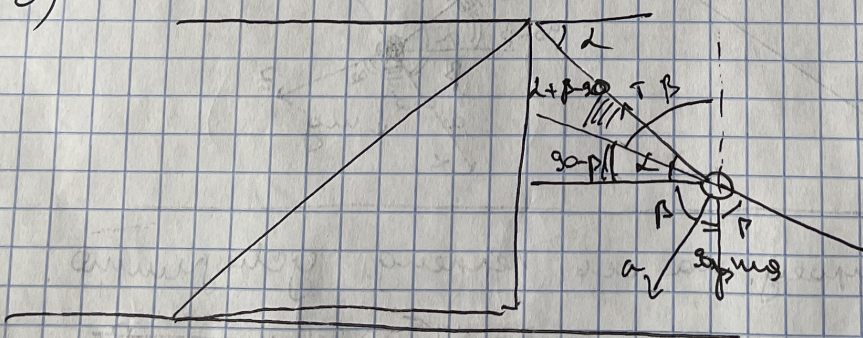
$$= -\frac{3}{2} g \cdot \frac{\sqrt{5}}{5} + \frac{2\sqrt{5}}{5} g = \frac{2\sqrt{5}}{5} g - \frac{3}{2} g = -\frac{\sqrt{5}}{2} g =$$

$$\text{or: } m a_m = -T \cos(d + \beta) + mg \sin \beta$$

$$a_m = \frac{5}{2} g \cos(d + \beta) + g \sin \beta$$

$$a_m = g \left(\frac{5}{2} \left(\frac{3}{5} \cdot \frac{4}{5} - \frac{4}{5} \cdot \frac{3}{5} \right) + \frac{3}{5} \right)$$

2)



$$T \cdot \frac{2}{5} = mg$$

$$T \cos(d + \beta - 90) = mg \cos \beta \quad \boxed{T = \frac{5}{2} mg}$$

$$T (\cos d \cdot \sin \beta - \sin d \cdot \cos \beta) = mg \cos \beta$$

$$T \left(\frac{3}{5} \cdot \frac{2\sqrt{5}}{5} - \frac{4}{5} \cdot \frac{\sqrt{5}}{5} \right) = mg \cdot \frac{\sqrt{5}}{5}$$

Kugel

$$m a_m = m g \sin \beta + T \cos (\alpha + \beta)$$

$$m a_m = m g \sin \beta + \frac{T}{2} m g (\cos \alpha \cdot \cos \beta - \sin \alpha \cdot \sin \beta)$$

$$a_m = g \frac{2\sqrt{5}}{5} + \frac{T}{2} g \left(0,6 \frac{3}{5} \cdot \frac{\sqrt{5}}{5} - \frac{4}{5} \cdot \frac{2\sqrt{5}}{5} \right)$$

$$a_m = g \cdot \frac{2\sqrt{5}}{5} + \frac{T}{2} g \left(\frac{3\sqrt{5}}{25} - \frac{8\sqrt{5}}{25} \right) = \frac{2\sqrt{5}}{5} g + \frac{T}{2} g \left(-\frac{5\sqrt{5}}{25} \right)$$

$$= \frac{2\sqrt{5}}{5} g - \frac{\sqrt{5}}{10} g$$

$$|a_m| = \frac{\sqrt{5}}{10} g$$

$$\frac{2}{\sqrt{5}} a_u = a_m = \frac{\sqrt{5}}{10} g$$

$$a_u = \frac{\sqrt{5} \cdot \sqrt{5}}{20} g = \frac{5}{20} g = \frac{1}{4} g$$

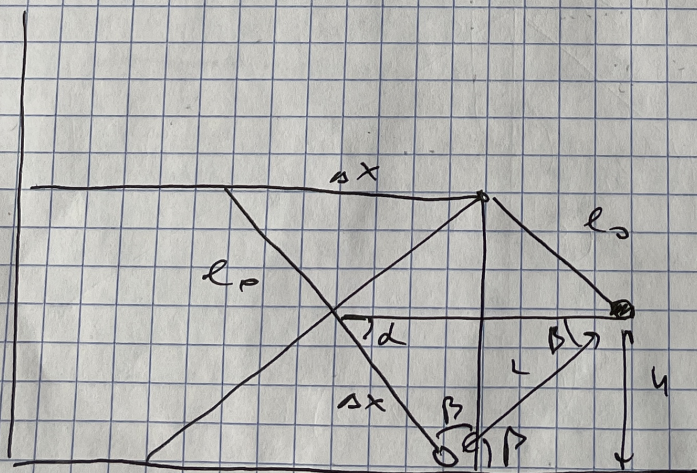
$$M a_u = T (1 - \cos \alpha)$$

$$M \cdot \frac{1}{4} g = \frac{T \cdot 4^2}{2} m g (1 - 0,6) \quad | : 4$$

$$M g = 10 m = 0,4$$

$$M = 4 m$$

$$\frac{m}{M} = \frac{1}{4}$$



$$L = \frac{h}{\sin \beta} = \frac{4 \cdot 5}{2\sqrt{5}} = \frac{5\sqrt{5}}{2} \text{ m}$$

$$L = 0 + \frac{a_u t^2}{2}$$

$$t_{\text{er}} = \sqrt{\frac{2L}{a_u}}$$

$$t = \sqrt{\frac{2 \cdot \frac{5\sqrt{5}}{2} \cdot 4 \cdot 10}{2 \cdot \frac{1}{4} g}} = \sqrt{\frac{100\sqrt{5}}{g}}$$

Antwort: 1) $\cos \beta = \frac{\sqrt{5}}{5}$ 2) $a_u = \frac{g}{4}$ 3) $\frac{m}{M} = \frac{1}{4}$ 4) $\sqrt{\frac{100\sqrt{5}}{g}}$

$$m a_m = m g \sin \beta + T \cos (\alpha + \beta)$$

~ 2.

универсальн (4)

$$T_{\text{норм}} \quad T_0 \quad C(T) = 2R \frac{T}{T_0}$$

$$1) \quad \Delta Q = \Delta U + \Delta A$$

$$dQ = D C(T) dT$$

$$dQ = 0 - 2R \frac{T}{T_0} dT$$

$$\int_0^Q dQ = \frac{2DR}{T_0} \int_{\frac{T_0}{6}}^{\frac{T_0}{2}} T dT$$

$$Q_A = \frac{2DR}{T_0} \frac{T^2}{2} \Big|_{\frac{T_0}{6}}^{\frac{T_0}{2}} = \frac{2DR}{T_0} \left(\frac{T_0^2}{2} - \frac{25}{36} \frac{T_0^2}{2} \right) =$$

$$= \frac{2DR}{T_0} \cdot \frac{1}{2} \left(T_0^2 - \frac{25}{36} T_0^2 \right) = \frac{DR}{T_0} \left(\frac{36 - 25}{36} \right) T_0^2 =$$

$$= \frac{11DR T_0}{36} \approx 0,306 DR T_0$$

$$2) \quad \Delta Q = \Delta U + \Delta A$$

$$D C(T) dT = \frac{3}{2} DR dT + p dV = dA_{\text{кин}}$$

$$D C(T) dT - \frac{3}{2} DR dT = dA_{\text{кин}}$$

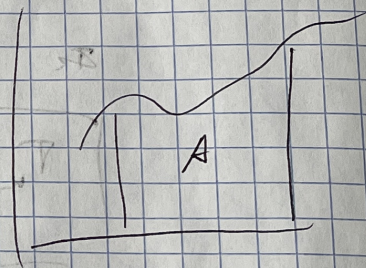
$$\int_{\frac{T_0}{6}}^{\frac{T_0}{2}} 2R \frac{T}{T_0} dT - \frac{3}{2} DR dT = dA_{\text{кин}}$$

$$\int_{\frac{T_0}{6}}^{\frac{T_0}{2}} DR \left(\frac{2T dT}{T_0} - \frac{3}{2} dT \right) = \int_0^A dA_{\text{кин}}$$

$$DR \left(\int_{\frac{T_0}{6}}^{\frac{T_0}{2}} \frac{2T dT}{T_0} - \int_{\frac{T_0}{6}}^{\frac{T_0}{2}} \frac{3}{2} dT \right) = |A|$$

$$DR \left(\frac{2}{T_0} \int_{\frac{T_0}{6}}^{\frac{T_0}{2}} T dT - \frac{3}{2} \int_{\frac{T_0}{6}}^{\frac{T_0}{2}} dT \right) = |A|$$

DR



$$\partial R \left(\frac{2}{T_0} \cdot \frac{T^2}{2} \Big|_T^{T_0} - \frac{3}{2} (T_0 - T) \right) = |A|$$

$$\partial R \left(\frac{2}{T_0} \left(\frac{T_0^2}{2} - \frac{T^2}{2} \right) - \frac{3}{2} (T_0 - T) \right) = |A|$$

$$\partial R \left(\frac{2}{T_0} \cdot \frac{1}{2} (T_0^2 - T^2) - \frac{3}{2} (T_0 - T) \right) = F(T)$$

OR нам нужно найти $\max F(T) = |A|$, чтобы

$$\partial R \left(\frac{T_0^2 - T^2}{T_0} - \frac{3}{2} (T_0 - T) \right) = F_2(T) \quad \text{огранич.}$$

$$\Rightarrow \text{max} \quad \frac{T_0^2 - T^2}{T_0} - \frac{3}{2} (T_0 - T) = F_2^*(T) \quad \text{on system min } A.$$

$$T_0 - \frac{T^2}{T_0} - \frac{3}{2} T_0 + \frac{3}{2} T = F_2^*(T)$$

$$-\frac{T^2}{T_0} + \frac{3}{2} T - \frac{1}{2} T_0 = F_2(T)$$

OR нахождение ее экстремума в T

$$\boxed{T_k = \frac{-\frac{3}{2} T_0}{-2 \frac{1}{T_0}} = \frac{3}{4} T_0} \quad \text{— min } A.$$

$$F_2(T_k) = -\frac{9}{16} \frac{T_0^2}{T_0} + \frac{3}{2} \cdot \frac{3}{4} T_0 - \frac{1}{2} T_0 =$$

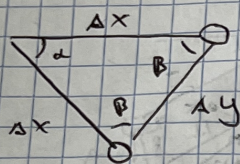
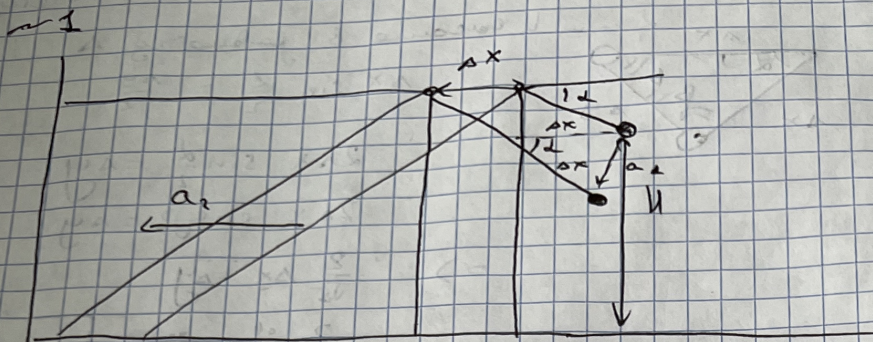
$$= -\frac{9}{16} T_0 + \frac{9}{8} T_0 - \frac{1}{2} T_0 =$$

$$= T_0 \left(\frac{18}{16} - \frac{9}{16} - \frac{1}{2} \right) = T_0 \left(\frac{9}{16} - \frac{1}{2} \right) = \frac{1}{16} T_0$$

$$\boxed{|A| = \partial R \cdot \frac{1}{16} T_0 = + \frac{\partial R T_0}{16}}$$

$$\boxed{A = - \frac{\partial R T_0}{16}}$$

Ответ: 1) $\frac{11}{36} \partial R T_0$ 2) $\frac{3}{4} T_0$ 3) $-\frac{\partial R T}{16}$



$$180^\circ = \alpha + 2\beta$$

$$\beta = (180 - \alpha) \cdot \frac{1}{2} = 90 - \frac{\alpha}{2}$$

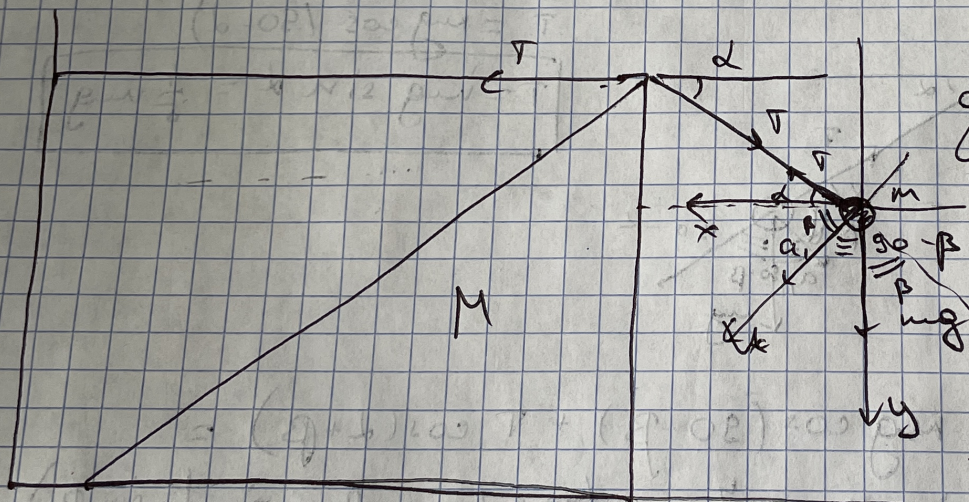
$$\cos \beta = \sin \frac{\alpha}{2}$$

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

$$\sin^2 \frac{\alpha}{2} = \frac{1 - \cos \alpha}{2} = \frac{1 - \frac{3}{5}}{2} = \frac{1}{5}$$

$$\sin \frac{\alpha}{2} = \sqrt{\frac{1}{5}} = \cos \beta$$

$$\begin{cases} \sin \alpha = \frac{4}{5} \\ \sin \beta = \frac{2}{\sqrt{5}} \end{cases}$$



$$Ox: m a_x = m g \sin \beta + T \cos(\alpha + \beta)$$

$$\begin{aligned} \cos(\alpha + \beta) &= \\ &= \cos \alpha \cos \beta - \sin \alpha \sin \beta \\ &= \frac{3}{5} \cdot \frac{1}{\sqrt{5}} - \frac{4}{5} \cdot \frac{2}{\sqrt{5}} \end{aligned}$$

$$Ox: m a_x = T \cos \alpha$$

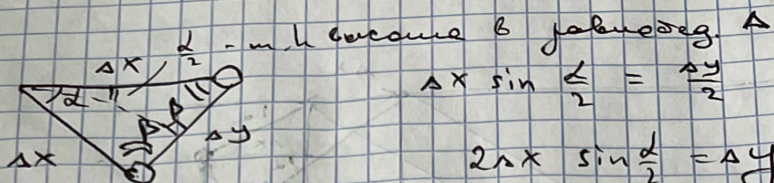
$$m a_y = m g$$

$$T = m g \cos \beta$$

$$Ox: m a_x = T - T \cos \alpha = T(1 - \cos \alpha)$$

$$m a_x = m g \cos \beta (1 - \cos \alpha)$$

1)



$$\Delta x \sin \frac{\alpha}{2} = \frac{\Delta y}{2}$$

$$2\Delta x \sin \frac{\alpha}{2} = \Delta y$$

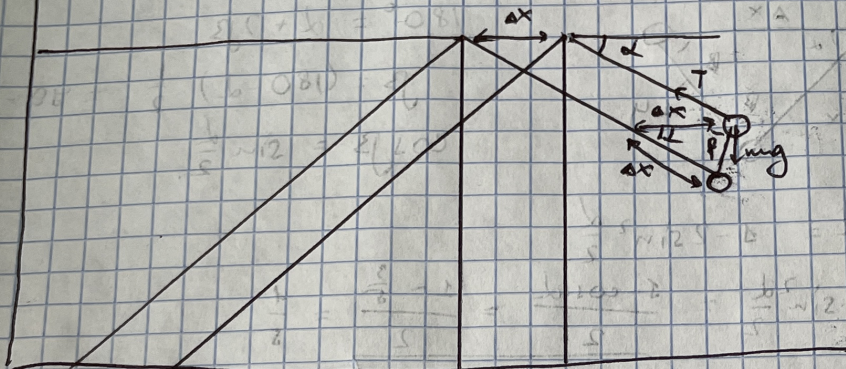
$$2\Delta x \cos \beta = \Delta y$$

$$\Rightarrow \frac{2}{\sqrt{5}} \Delta x = \Delta y$$

$$\frac{2}{\sqrt{5}} \ddot{x} = \ddot{y}$$

$$\boxed{\frac{2}{\sqrt{5}} a_n = \frac{2}{\sqrt{5}} a}$$

2)



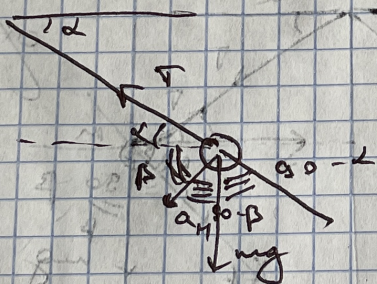
1) 2) H gne murula

$$\cos \beta = \frac{1}{\sqrt{5}}$$

$$\sin \beta = \frac{2}{\sqrt{5}}$$

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

$$\sin \alpha = \frac{4}{5}$$



$$T = mg \cos (90 - \alpha)$$

$$\boxed{T = mg \sin \alpha = \frac{4}{5} mg}$$

$$m a_n = mg \cos (90 - \beta) + T \cos (\alpha + \beta) =$$

$$= mg \sin \beta + \frac{4}{5} mg (\cos \alpha \cos \beta - \sin \alpha \sin \beta)$$

$$a_n = g \left(\sin \beta + \frac{4}{5} \left(\frac{3}{5} \cdot \frac{1}{\sqrt{5}} - \frac{4}{5} \cdot \frac{2}{\sqrt{5}} \right) \right) =$$

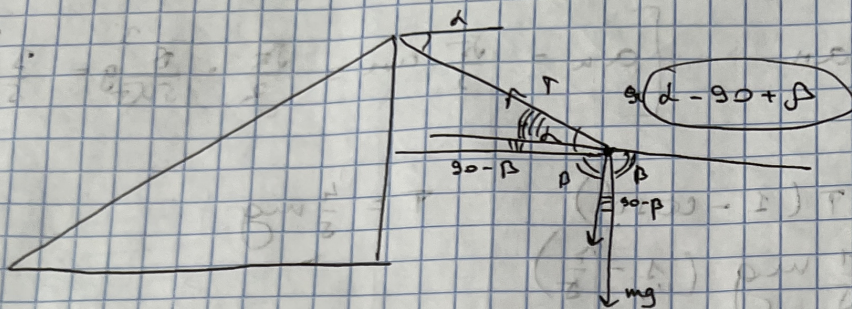
$$= g \left(\frac{2}{\sqrt{5}} + \frac{4}{5} \left(\frac{3}{5\sqrt{5}} - \frac{8}{5\sqrt{5}} \right) \right) =$$

$$= g \left(\frac{2}{\sqrt{5}} + \frac{4}{5} \cdot \left(-\frac{5}{5\sqrt{5}} \right) \right) = g \left(\frac{2}{\sqrt{5}} + \frac{4}{5} \cdot \left(-\frac{1}{\sqrt{5}} \right) \right)$$

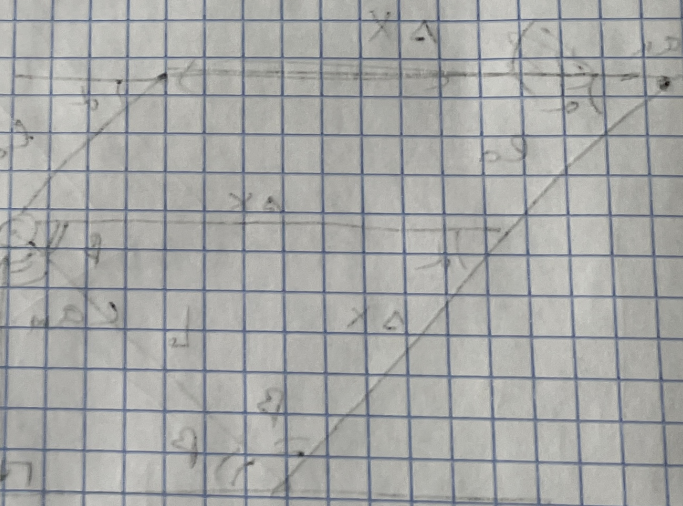
$$= g \left(\frac{2}{\sqrt{5}} - \frac{4}{5\sqrt{5}} \right) = g \frac{10 - 4}{5\sqrt{5}} =$$

результа

результа



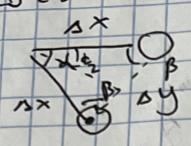
$$\frac{61}{8} = \frac{14}{11}$$



Упробули (2)

$$\cos \beta = \sqrt{\frac{1}{5}} \approx 0,45$$

$$\cos^2 \beta = 0,2025$$



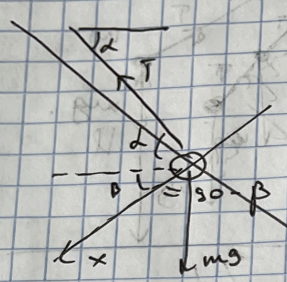
$$\sin \beta = \sqrt{1 - \cos^2 \beta} \approx 0,9$$

$$\sin \beta = \sqrt{1 - \frac{1}{5}} = \frac{2}{\sqrt{5}} \approx 0,9$$

$$\Delta x \cdot \sin \frac{\alpha}{2} = \frac{\Delta y}{2} \quad (2)$$

$$Ox: m a = m g \cos(90 - \beta) \quad (3)$$

$$a = g \sin \beta = 0,9g$$



$$(2): \Delta y = 2 \Delta x \sin \frac{\alpha}{2} = 2 \Delta x \cos \beta = 0,8 \Delta x$$

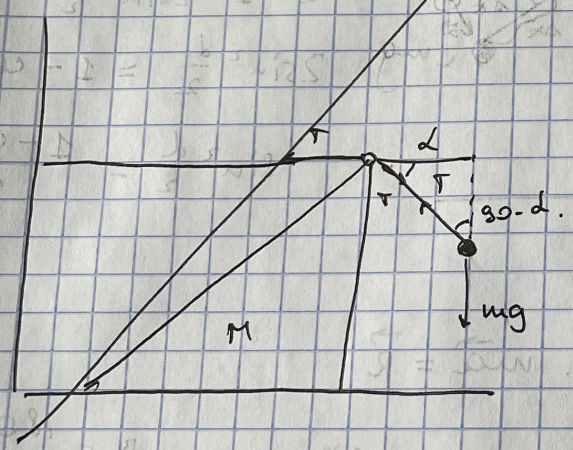
$$\Rightarrow \ddot{y} = 0,8 \ddot{x}$$

$\ddot{x}$ - ychopenne kune (uare no na x igbenyan)

$\ddot{y}$ - ychopenne mapa

$$\ddot{y} = a \quad (\text{ug } (1))$$

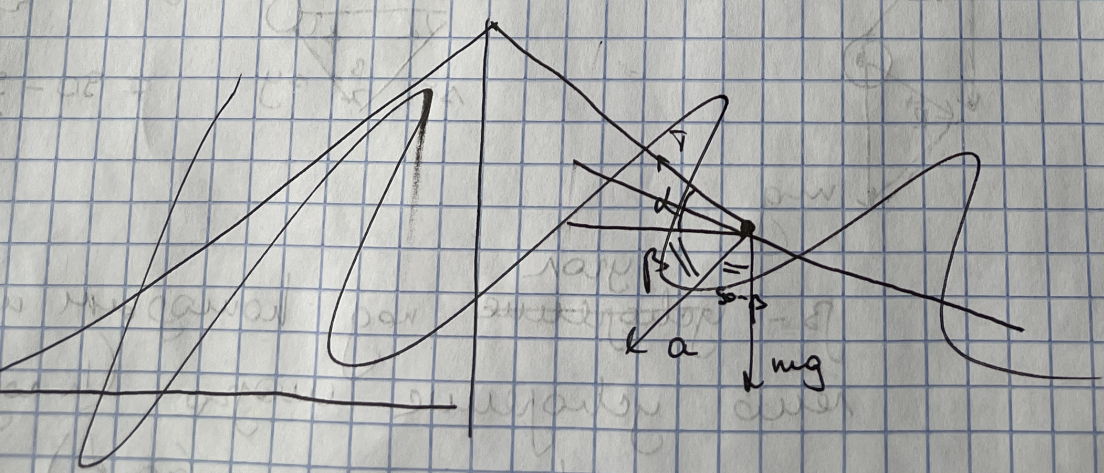
$$0,9g = 0,8\ddot{x} \quad \boxed{\ddot{x} = g}$$



$$m \ddot{x} = T - T \cos \alpha$$

$$mg = T(1 - \cos \alpha) = T \cdot \frac{2}{5}$$

$$\boxed{T = \frac{5}{2} mg}$$



Черновик (1)

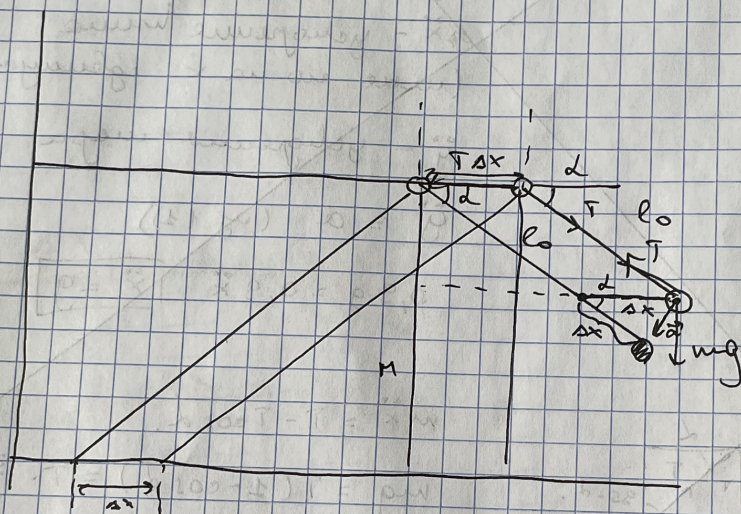
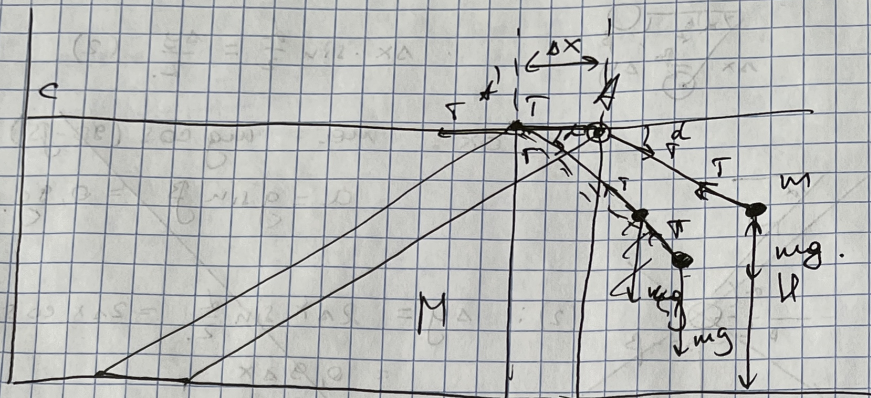
Размах.

 $\sim I$

Dans :

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

$$\cos \alpha = \text{const}$$



$$\cos^2 \frac{d}{2} = 1 - \sin^2 \frac{d}{2}$$

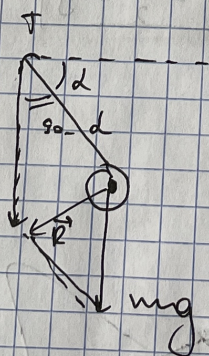
$$\cos(90^\circ - d) = \sin d.$$

$$\cos^2 \frac{d}{2} = \cos^2 \frac{d}{2} - \sin^2 \frac{d}{2} =$$

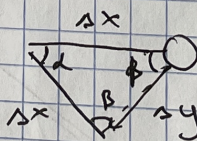
$$= 1 - 2\sin^2 \frac{\alpha}{2}$$

$$2\sin^2 \frac{d}{2} = 1 - \cos d$$

$$\sin^2 \frac{d}{2} = \frac{1 - \cos d}{2}$$



$$m\vec{a} = \vec{R}$$



$$\beta = \frac{180 - \alpha}{2} =$$

$$= 90 - \frac{2}{2}$$

β - ускорение ^{упр} под некоторым направ-
лено ускорение ^{шар} (и пружины)

$$\beta = 90 - \frac{\alpha}{2}$$

$$\cos \beta = \cos \left(90 - \frac{\alpha}{2} \right) = \sin \frac{\alpha}{2}$$

$$\cos \beta = \sqrt{\frac{1 - \frac{1}{\gamma^2}}{2}} = \sqrt{\frac{\frac{4}{\gamma^2}}{2}} = \sqrt{\frac{1}{\gamma^2}} \quad \cos \beta = \sqrt{\frac{1 - \cos \alpha}{2}}$$

~2.

monom T_0 $C(T) = 2R \frac{T}{T_0}$

1) $\Delta Q = \Delta U + \Delta A$

$dQ = C(T) dT$

$dQ = 2R \frac{T}{T_0} dT$

$\int_0^{T_0} dQ = \frac{20R}{T_0} \int_{\frac{1}{6}T_0}^{T_0} T dT$

$Q_1 = \frac{20R}{T_0} \left[\frac{T^2}{2} \right]_{\frac{1}{6}T_0}^{T_0} = \frac{20R}{T_0} \left(\frac{T_0^2}{2} - \frac{25}{36} \frac{T_0^2}{2} \right) =$

$= \frac{20R}{T_0} \cdot \frac{1}{2} \left(T_0^2 - \frac{25}{36} T_0^2 \right) = \frac{20R}{T_0} \left(\frac{36-25}{36} \right) T_0^2 =$

$= \frac{110R T_0}{36} \approx 0,306 0R T_0$

2) $\Delta Q = \Delta U + \Delta A$ ~~ΔQ~~

$C(T) dT = \frac{3}{2} 0R dT + p dV$

$C(T) dT - \frac{3}{2} 0R dT = dA$

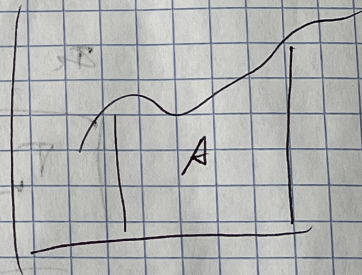
$2R \frac{T}{T_0} dT - \frac{3}{2} 0R dT = dA$

$\int_{\frac{1}{6}T_0}^{T_0} 2R \left(\frac{2T dT}{T_0} - \frac{3}{2} dT \right) = \int_0^T dA$

$2R \left(\int_{\frac{1}{6}T_0}^{T_0} \frac{2T dT}{T_0} - \int_{\frac{1}{6}T_0}^{T_0} \frac{3}{2} dT \right) = |A|$

~~$2R$~~ $2R \left(\frac{2}{T_0} \int_{\frac{1}{6}T_0}^{T_0} T dT - \frac{3}{2} \int_{\frac{1}{6}T_0}^{T_0} dT \right) = |A|$

~~$2R$~~



$$m a_m = m g \sin \beta + T \cos(\alpha + \beta)$$

$$m a_m = m g \sin \beta + \frac{T}{2} m g (\cos \alpha \cdot \cos \beta - \sin \alpha \cdot \sin \beta)$$

$$a_m = g \cdot \frac{2\sqrt{5}}{5} + \frac{T}{2} g \left(0,6 \cdot \frac{3}{5} - \frac{\sqrt{5}}{5} - \frac{4}{5} \cdot \frac{2\sqrt{5}}{5} \right)$$

$$a_m = g \cdot \frac{2\sqrt{5}}{5} + \frac{T}{2} g \left(\frac{3\sqrt{5}}{25} - \frac{8\sqrt{5}}{25} \right) = \frac{2\sqrt{5}}{5} g + \frac{T}{2} g \left(-\frac{5\sqrt{5}}{25} \right)$$

$$= \frac{2\sqrt{5}}{5} g - \frac{\sqrt{5}}{10} g$$

$$|a_m| = \frac{\sqrt{5}}{10} g$$

$$\frac{2}{\sqrt{5}} a_u = a_m = \frac{\sqrt{5}}{10} g$$

$$a_u = \frac{\sqrt{5} \cdot \sqrt{5}}{20} g = \frac{5}{20} g = \frac{1}{4} g$$

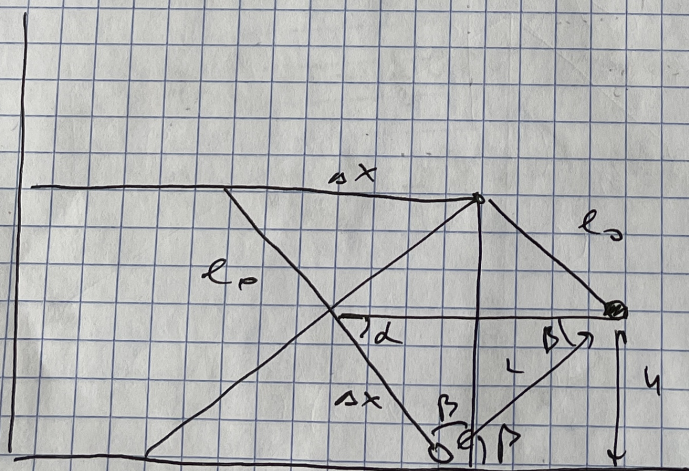
$$M a_u = T(1 - \cos \alpha)$$

$$M \cdot \frac{1}{4} g = \frac{T \cdot 4^2}{2} m g (1 - 0,6) \quad | \cdot 4$$

$$M g = 10 m = 0,4$$

$$M = 4 m$$

$$\frac{m}{M} = \frac{1}{4}$$



$$L = \frac{4}{\sin \beta} = \frac{4 \cdot 5}{2\sqrt{5}} = \frac{10\sqrt{5}}{2}$$

$$L = 0 + \frac{a_u t^2}{2}$$

$$t_{\text{tot}} = \sqrt{\frac{2L}{a_u}}$$

$$t = \sqrt{\frac{2 \cdot \frac{10\sqrt{5}}{2} \cdot 10}{2 \cdot \frac{1}{4} g}} = \sqrt{\frac{100\sqrt{5}}{g}}$$

Answer: 1) $\cos \beta = \frac{\sqrt{5}}{5}$ 2) $a_u = \frac{g}{4}$ 3) $\frac{m}{M} = \frac{1}{4}$ 4) $\sqrt{\frac{100\sqrt{5}}{g}}$

$$T \cdot (\cos d \cdot \cos(\beta - 90) - \sin d \cdot \sin(\beta - 90)) = mg \cos \beta$$

(2)

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

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

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

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

$$T \left(\frac{3}{5} \cdot \frac{2\sqrt{5}}{5} - \frac{4}{5} \cdot \frac{\sqrt{5}}{5} \right) = mg \cdot \frac{\sqrt{5}}{5}$$

$$T \left(\frac{6\sqrt{5}}{25} - \frac{4\sqrt{5}}{25} \right) = mg \cdot \frac{\sqrt{5}}{5}$$

$$T \cdot \frac{2\sqrt{5}}{25} = mg \cdot \frac{\sqrt{5}}{5}$$

$$T \cdot \frac{2}{5} = mg \quad \boxed{T = \frac{5}{2} mg}$$

$$m a_m = T \cos(d + \beta) + mg \cos(90 - \beta) =$$

$$= \frac{5}{2} mg (\cos d \cdot \cos \beta - \sin d \cdot \sin \beta) + mg \cdot \sin \beta =$$

$$a_m = \frac{5}{2} g \left(\frac{3}{5} \cdot \frac{\sqrt{5}}{5} - \frac{4}{5} \cdot \frac{2\sqrt{5}}{5} \right) + g \cdot \frac{2\sqrt{5}}{5} =$$

$$= \frac{5}{2} g \left(\frac{3\sqrt{5}}{25} - \frac{8\sqrt{5}}{25} \right) + g \frac{2\sqrt{5}}{5} = \frac{5}{2} g \left(-\frac{5\sqrt{5}}{25} \right) + g \frac{2\sqrt{5}}{5} =$$

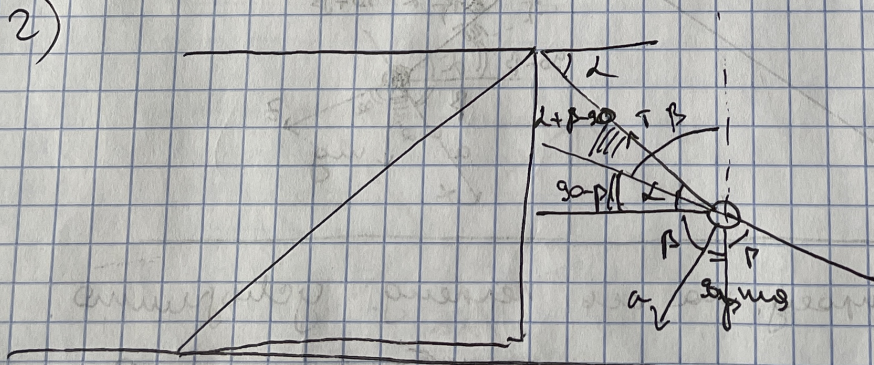
$$= -\frac{5}{2} g \frac{\sqrt{5}}{5} + \frac{2\sqrt{5}}{5} g = \frac{2\sqrt{5}}{5} g - \frac{\sqrt{5}}{2} g =$$

$$\text{or: } m a_m = -T \cos(d + \beta) + mg \sin \beta$$

$$a_m = \frac{5}{2} g \cos(d + \beta) + g \sin \beta$$

$$a_m = g \left(\frac{5}{2} \cdot \frac{3}{5} \right)$$

2)



$$T = \frac{2}{5} mg$$

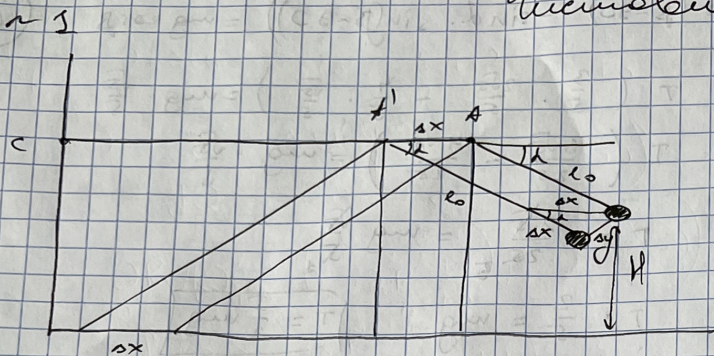
$$T \cos(d + \beta - 90) = mg \cos \beta$$

$$\boxed{T = \frac{5}{2} mg}$$

$$T (\cos d \cdot \sin \beta - \sin d \cdot \cos \beta) = mg \cos \beta$$

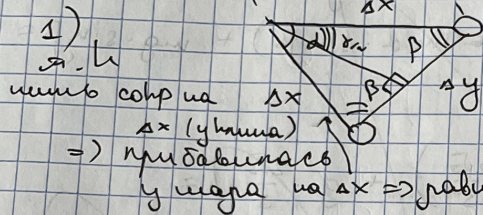
$$T \left(\frac{3}{5} \cdot \frac{2\sqrt{5}}{5} - \frac{4}{5} \cdot \frac{\sqrt{5}}{5} \right) = mg \cdot \frac{\sqrt{5}}{5}$$

Умножение



1

соединим точку верха на Δx и посмотрим, как соединимся между:



$$\beta = 180 - \frac{\alpha}{2} = 90 - \frac{\alpha}{2}$$

$$\cos \beta = \cos \left(90 - \frac{\alpha}{2} \right) = \sin \frac{\alpha}{2}$$

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

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

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

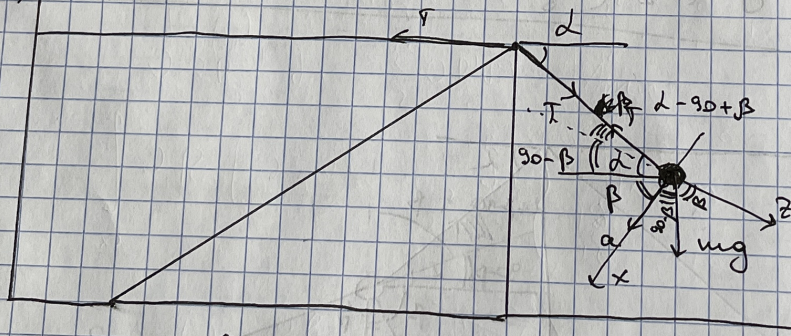
$$\sin \beta = \frac{2\sqrt{5}}{5}$$

$$\sin \alpha = \frac{4}{5}$$

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

угол
под которым
глядим
между (и нпр)

2)



$z \perp \alpha$

Силы, на ось перпенд. уклоняемо.

$$OZ: \quad 0 = -T \cos(\alpha - \beta) + mg \cos \beta$$

$$0 = -T \cos(\alpha + \beta - 90) + mg \cos \beta$$

$$T \cos(\alpha + (\beta - 90)) = mg \cos \beta$$

$$T (\cos \alpha \cdot \cos(\beta - 90) - \sin \alpha \cdot \sin(\beta - 90)) = mg \cos \beta$$

$$T \cdot (\cos d \cdot \cos(\beta - 90) - \sin d \cdot \sin(\beta - 90)) = mg \cos \beta \quad (2)$$

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

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

$$\sin d = \frac{4}{5}$$

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

$$T \left(\frac{3}{5} \cdot \frac{2\sqrt{5}}{5} - \frac{4}{5} \cdot \frac{\sqrt{5}}{5} \right) = mg \cdot \frac{\sqrt{5}}{5}$$

$$T \left(\frac{6\sqrt{5}}{25} - \frac{4\sqrt{5}}{25} \right) = mg \cdot \frac{\sqrt{5}}{5}$$

$$T \cdot \frac{2\sqrt{5}}{25} = mg \cdot \frac{\sqrt{5}}{5}$$

$$T \cdot \frac{2}{5} = mg \quad \boxed{T = \frac{5}{2} mg}$$

$$m a_m = T \cos(d + \beta) + mg \cos(90 - \beta) =$$

$$= \frac{5}{2} mg (\cos d \cdot \cos \beta - \sin d \cdot \sin \beta) + mg \cdot \sin \beta =$$

$$a_m = \frac{5}{2} g \left(\frac{3}{5} \cdot \frac{\sqrt{5}}{5} - \frac{4}{5} \cdot \frac{2\sqrt{5}}{5} \right) + g \cdot \frac{2\sqrt{5}}{5} =$$

$$= \frac{5}{2} g \left(\frac{3\sqrt{5}}{25} - \frac{8\sqrt{5}}{25} \right) + g \frac{2\sqrt{5}}{5} = \frac{5}{2} g \left(-\frac{5\sqrt{5}}{25} \right) + g \frac{2\sqrt{5}}{5} =$$

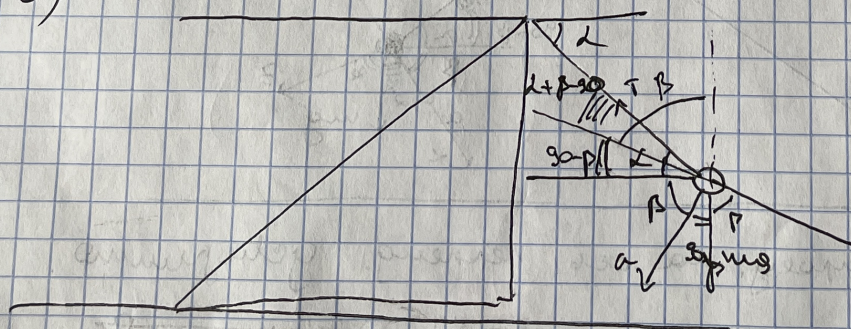
$$= -\frac{5}{2} g \frac{\sqrt{5}}{5} + \frac{2\sqrt{5}}{5} g = \frac{2\sqrt{5}}{5} g - \frac{\sqrt{5}}{2} g = -\frac{\sqrt{5}}{2} g =$$

$$\text{or: } m a_m = -T \cos(d + \beta) + mg \sin \beta$$

$$m a_m = \frac{5}{2} g \cos(d + \beta) + g \sin \beta$$

$$a_m = g \left(\frac{5}{2} \cdot \frac{3}{5} \right)$$

2)



$$T = \frac{2}{5} mg$$

$$T \cos(\alpha + \beta - 90) = mg \cos \beta \quad \boxed{T = \frac{5}{2} mg}$$

$$T (\cos \alpha \cdot \sin \beta - \sin \alpha \cdot \cos \beta) = mg \cos \beta$$

$$T \left(\frac{3}{5} \cdot \frac{2\sqrt{5}}{5} - \frac{4}{5} \cdot \frac{\sqrt{5}}{5} \right) = mg \cdot \frac{\sqrt{5}}{5}$$

Часть 2

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

Шифр: **21201990**

ID профиля: **348139**

Вариант 1

- Dimensions :
- 1) $x = 36 \text{ cm}$
 - 2) $R = 2,25 \text{ cm}$
 - 3) $z = 12 \text{ cm}$

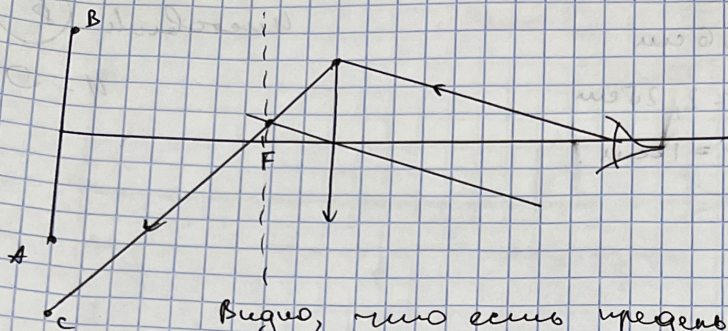
Microbiology (P)

4-5/

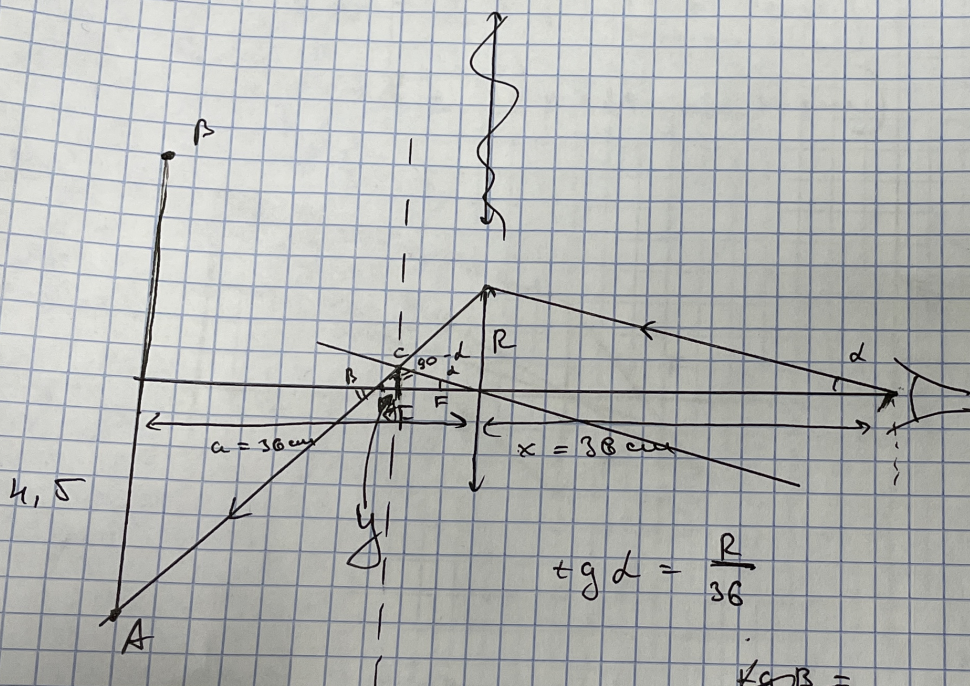
Исходные

(7)

4-01



Видно, что если предмет упол под которым
пройдет луч - если бы в м с была бы
и А. Это был бы наш диаметр при
каждом источнике света углубить картину



$$\tan \alpha = \frac{R}{36}$$

$$\tan \beta =$$

$$\tan \beta = \frac{R}{y+F}$$

$$\frac{y}{y+F} = \frac{\tan \alpha \cdot F}{R}$$

$$\frac{R}{y+F} =$$

$$\frac{y}{y+F} = \frac{R \cdot F}{R \cdot 36} = \frac{9}{36} = \frac{1}{4}$$

$$4y = y+F$$

$$3y = F = 9$$

$$\tan \beta = \frac{(4,5+R)}{a}$$

$$\frac{4,5+R}{36} = \frac{R}{y+9}$$

$$\frac{4,5+R}{36} = \frac{R}{3+9}$$

$$36R = 12 \cdot 4,5 + 12R$$

$$\left[z = y + F = 3 + 9 = 12 \text{ cm} \right] 24R = 54$$

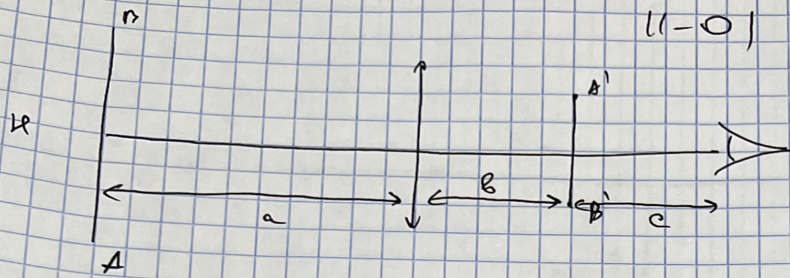
$$R = 2,25 \text{ cm}$$

$$y = 3 \text{ cm}$$

5

микрометр (6)
[1-0]

$h = 3 \text{ cm}$
 $a = 36 \text{ cm}$
 $F = 3 \text{ cm}$
 $c = 24 \text{ cm}$



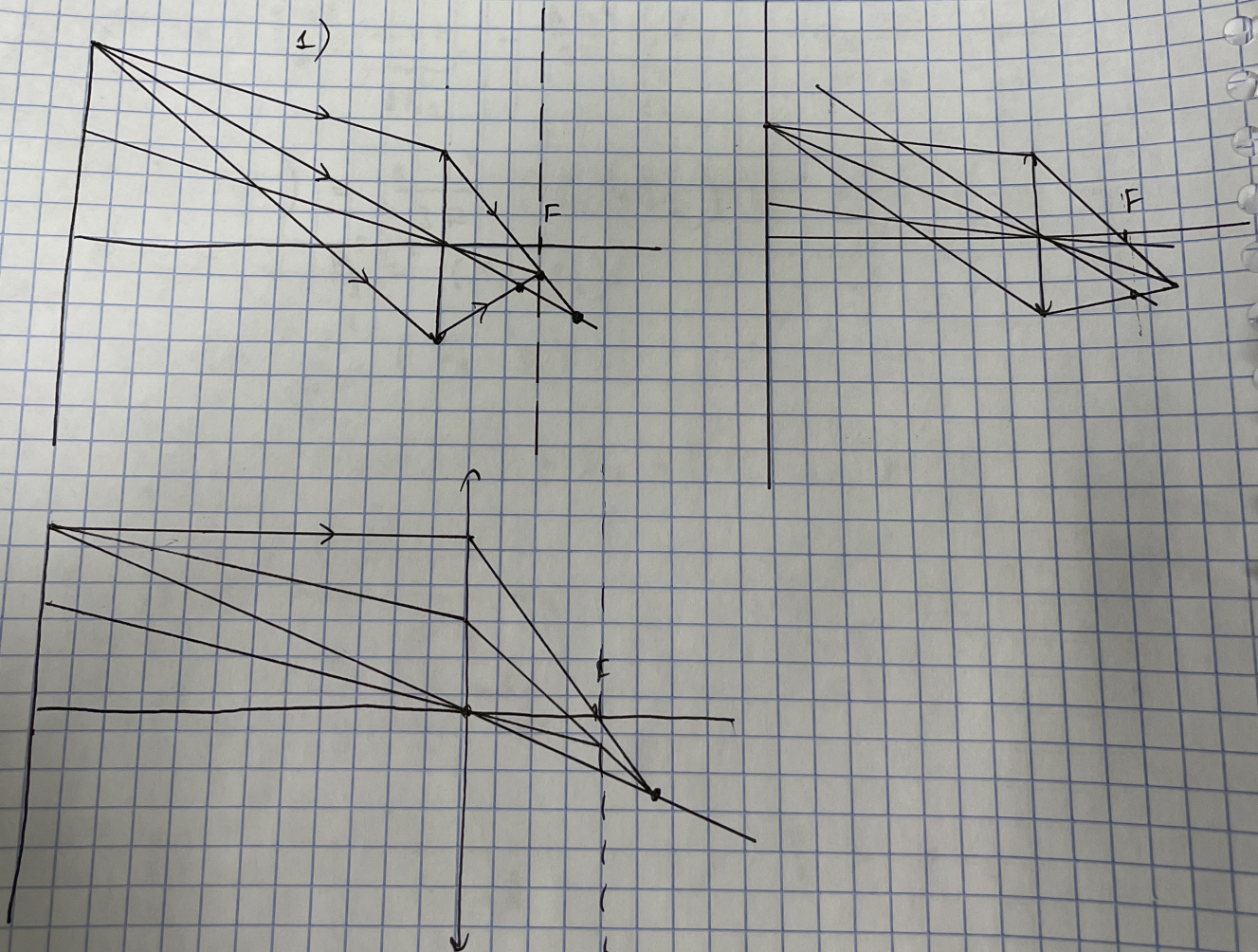
$$\frac{1}{F} = \frac{1}{a} + \frac{1}{b}$$

$$\frac{1}{b} = \frac{1}{F} - \frac{1}{a} = \frac{a-F}{Fa}$$

$$b = \frac{Fa}{a-F} = \frac{3 \cdot 36}{36-3} = \boxed{12 \text{ cm}}$$

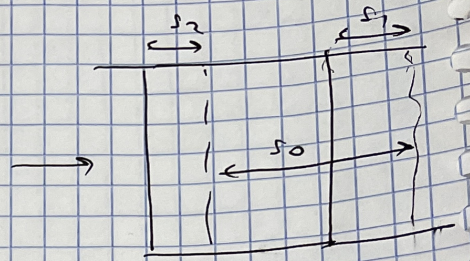
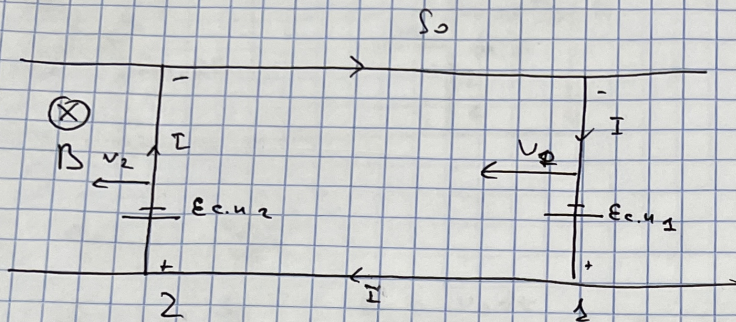
$$\Gamma = \frac{b}{a} = \frac{1}{3} = \frac{h}{H} \quad \boxed{h = 3 \text{ cm}}$$

$$(x = c + b = 12 \text{ cm} + 24 \text{ cm} = 36 \text{ cm})$$



3)

кучинский (5)
11-91



$$I = \frac{\epsilon_{cu1} - \epsilon_{cu2}}{3R} = \frac{Bv_{uL} - Bv_{uL}}{3R} = \frac{B L (v_1 - v_2)}{3R}$$

$$-m \frac{dV_1}{dt} = + IBL = + \frac{B^2 L^2 (v_1 - v_2)}{3R}$$

$$-m dv_1 = + \frac{B^2 L^2}{3R} \underbrace{v_1 dt}_{ds_1} - \frac{B^2 L^2}{3R} \underbrace{v_2 dt}_{ds_2}$$

Судимирский

$$m(v_0 - \frac{v_0}{3}) = \frac{\rho^2 L^2}{3R} (S_1 - S_2)$$

$$\frac{2m v_0}{3} = \frac{\beta^2 L^2}{3R} (s_1 - s_2)$$

$$2mV_0 = \frac{\beta^2 L^2}{R} (S_1 - S_2)$$

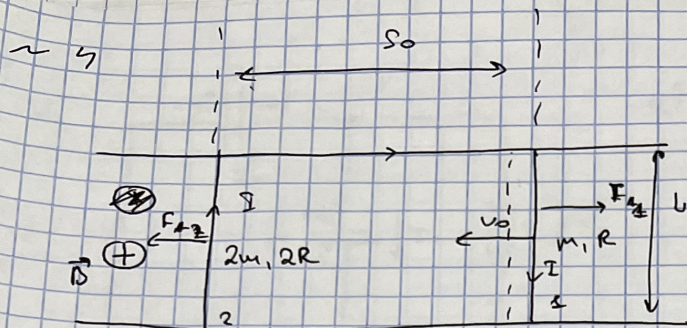
$$S_n = S_0 - S_1 + S_2 = S_0 - (S_1 - S_2)$$

$$S_1 - S_2 = \frac{B^2 L^2}{2m v_0 R}$$

$$P_n = S_0 - \frac{\beta^2 L^2}{2m v_0 R}$$

Orbital: 1) $\frac{R^2 L^2 v_0}{6 m R}$ 2) $\frac{v_0}{3} = v_1 = v_2$

$$3) S_n = S_0 - \frac{\beta^2 L^2}{2m\nu_0 R}$$



Условие (4)
 $u=0$

$$1) \quad \mathcal{E}_{c.u.} = - \frac{d\Phi}{dt}$$

$$|\mathcal{E}_{c.u.}| = \frac{B dS}{dt} = \frac{B \cdot L \cdot v_0 dt}{dt} = B v_0 L \quad - \text{ в момент времени } t=0.$$

$$I = \frac{\mathcal{E}_{c.u.}}{3R} = \frac{B v_0 L}{3R}$$

$$2ma_2 = IBL = \frac{v_0 B^2 L^2}{3R}$$

$$a_2 = \frac{B^2 L^2 v_0}{6mR}$$

- ускорение перемещения 2 в нач. момент.

$$2) \quad 1: \quad m \frac{dv_1}{dt} = -IBL$$

$$v_1(0) = v_0$$

$$v_{2u} = V$$

$$2m \frac{dv_2}{dt} = IBL$$

$$v_2(0) = 0$$

$$v_{2u} = V$$

$$-m \frac{dv_1}{dt} = 2m \frac{dv_2}{dt}$$

$$-dv_1 = 2dv_2$$

$$v_0 - V = 2V$$

$$3V = v_0$$

$$V = \frac{v_0}{3}$$

(т.к. перемещение не сбалансировано)
 и \mathcal{E}_{c.u.} пропадет, когда $v_1 = v_2$

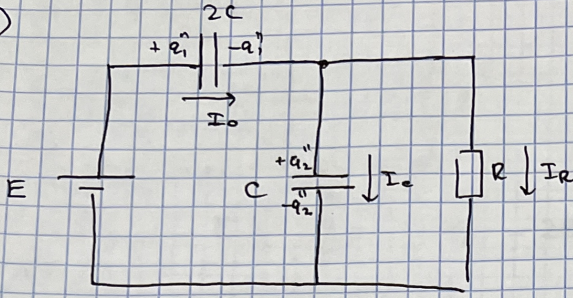
- скорость
 обеих перемещений
 через проволочку
 одинакова
 в момент

$$3) \quad \mathcal{E}_{c.u.1} = \frac{B \cdot L \cdot v_1 \cdot dt}{dt} = BLv_1$$

$$\mathcal{E}_{c.u.2} = \frac{BLv_2 \cdot dt}{dt} = BLv_2$$

$$|\mathcal{E}| = |\mathcal{E}_{c.u.1} - \mathcal{E}_{c.u.2}| = |BL(v_1 - v_2)|$$

8)



1) $I_0 = I_c + I_R$

(3)

U=0

$$E = \frac{q_1''}{2C} + \frac{q_2''}{C}$$

$$0 = \underbrace{\frac{dq_1''}{dt}}_{I_0} \cdot \frac{1}{2C} + \underbrace{\frac{dq_2''}{dt}}_{I_c} \cdot \frac{1}{C} \quad | \cdot 2C$$

$$0 = I_0 \cdot 1 + I_c \cdot 2$$

$$I_0 = -2I_c$$

$$I_c = -\frac{I_0}{2}$$

$$I_0 = -2I_c = I_c + I_R$$

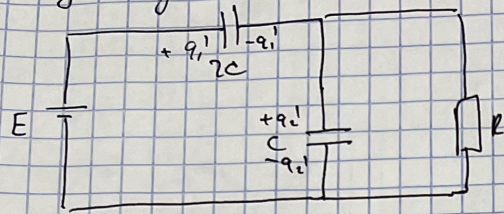
$$-3I_c = I_R$$

$$I_R = +3 \frac{I_0}{2} = \frac{3}{2} I_0$$

Answers: 1) $I_R = \frac{2E}{3R}$ 2) $Q = \frac{2}{3} E^2 C$ 3) $\frac{3}{2} I_0$

6. yem. pismenne $I = 0$ bygge

hvorabuh



$$\frac{q_2'}{C} = I_R \cdot R = 0$$

$$q_2' = 0$$

(2) 4-01

$$E = \frac{q_1^*}{2C} \quad q_1' = 2EC$$

2) 3C3:

$$W_0 = \frac{q_1'^2}{2C} + \frac{q_1'^2}{2 \cdot 2C}$$

$$A_{\text{um}} = E \cdot q_1^*$$

$$W_u = \frac{q_1'^2}{2 \cdot 2C}$$

$$q_1^* = q_1' - q_1 = 2EC - \frac{2EC}{3} =$$

$$= \frac{6EC - 2EC}{3} =$$

$$= \frac{4EC}{3}$$

$$\frac{q_1'^2}{2C} + \frac{q_1'^2}{4C} + \frac{4E^2C}{3} = \frac{4E^2C}{3} + Q$$

$$\frac{2q_1'^2 + q_1'^2}{4C} + \frac{4E^2C}{3} = E^2C + Q$$

$$\frac{3q_1'^2}{4C} + \frac{4E^2C}{3} = E^2C + Q$$

$$\frac{3 \cdot 4E^2C}{4 \cdot 3} + \frac{4E^2C}{3} = E^2C + Q$$

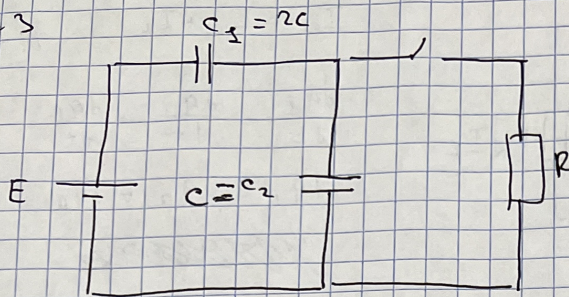
$$\frac{E^2C}{3} + \frac{4E^2C}{3} = E^2C + Q$$

$$\frac{5E^2C}{3} - E^2C = Q$$

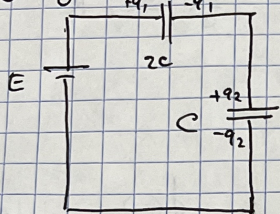
$$\boxed{\frac{2E^2C}{3} = Q}$$

13/11

~3



1) go замкнуто



$$E = \frac{q_1}{2C} + \frac{q_2}{C}$$

$$q_1 = q_2 \quad \left(\begin{array}{l} \text{незав.} \\ \text{в запале. C} \end{array} \right)$$

$$-q_1 + q_2 = 0$$

$$q_1 = q_2$$

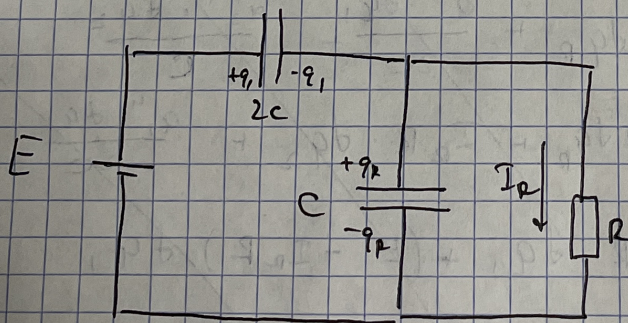
$$E = \frac{q_1}{2C} + \frac{q_1}{C} = \frac{q_1 + 2q_1}{2C} = \frac{3q_1}{2C}$$

$$q_1 = \frac{2EC}{3}$$

$$q_2 = \frac{2EC}{3}$$

2) сразу после замыкания:

$U_C \sim \text{зарядом}$ не меняется.



$$E = \frac{2E}{3} + I_R \cdot R$$

$$U_C$$

$$E = \frac{q_1}{2C} + I_R \cdot R$$

$$E = \frac{2EC}{3 \cdot 2C} + I_R \cdot R$$

$$\frac{2E}{3} = I_R \cdot R$$

$$\frac{2E}{3R} = I_R$$

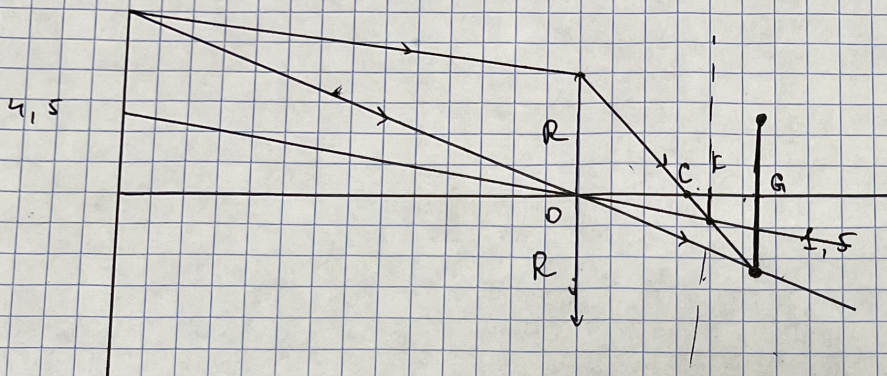
$$\frac{R}{r} = \frac{R}{b-r}$$

$$\frac{R}{r} = \frac{a}{2} = 3$$

$$R = 3r$$

$$\frac{4,5-r}{a} = \frac{1,5-r}{b}$$

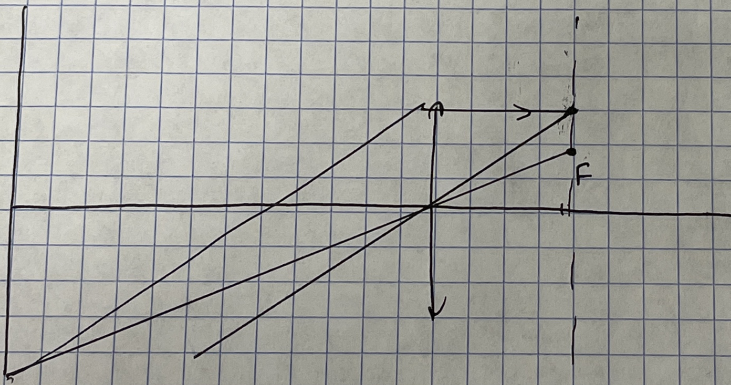
$$\frac{4,5-r}{3r} = \frac{1,5-r}{1,2}$$



$$\frac{OC}{CG} = \frac{R}{1,5}$$

$$OC + CG = b$$

$$OC = b - CG$$



$$\cancel{S_k = S_0 + A}$$

$$dS = v_1 dt + v_2 dt$$

$$m \frac{dv_1}{dt} = -IBL$$

$$I = \frac{\mathcal{E}_{e.m.}}{3R} = \frac{BL(v_1 - v_2)}{3R}$$

$$\int_{v_0}^{v_1} m dv_1 = - \int_0^t IBL dt$$

$$(m(v_1 + v_0)) = IBL$$

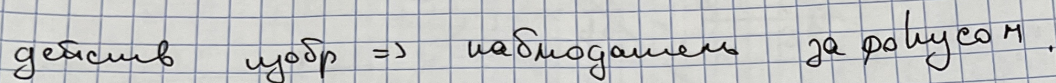
$$m \frac{dv_1}{dt} = - \frac{B^2 L^2 (v_1 - v_2)}{3R}$$

$$2m \frac{dv_2}{dt} = \frac{B^2 L^2 (v_1 - v_2)}{3R}$$

$$2m \frac{dv_2}{dt} = IBL$$

$$m \frac{dv_1}{dt} = - \frac{B^2 L^2 (v_1 - v_2)}{3R}$$

$$2m \frac{dv_2}{dt} = - \frac{B^2 L^2}{3R} v_2 + \frac{B^2 L^2}{3R} v_1$$

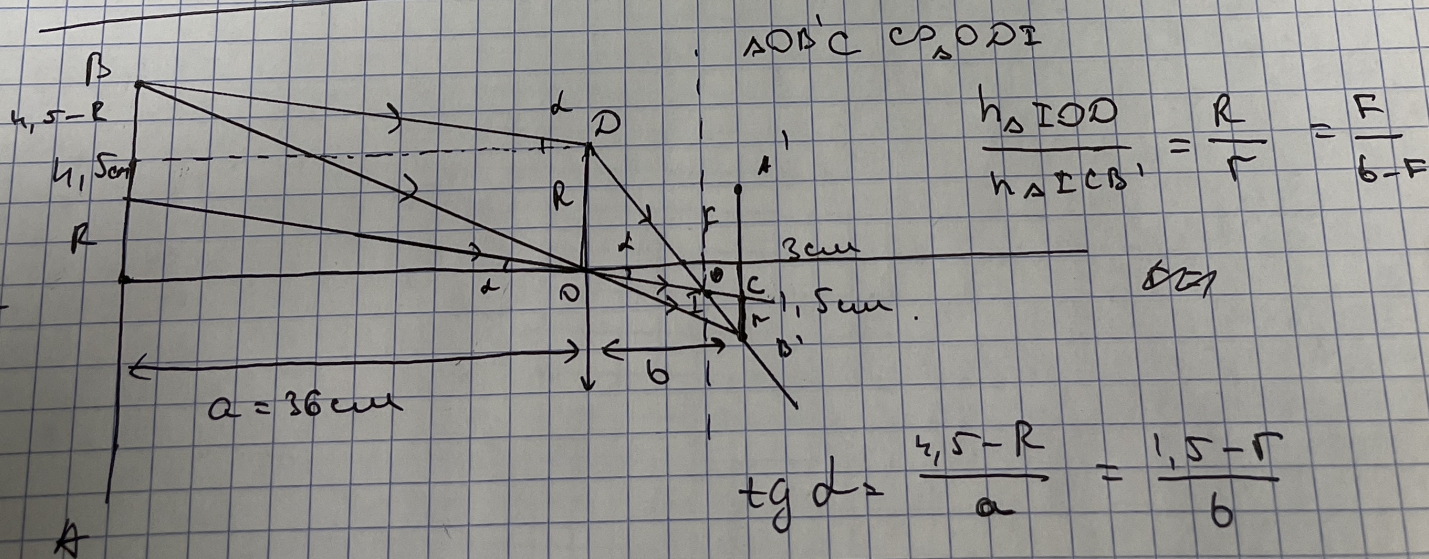


$$\frac{1}{F} = \frac{1}{a} + \frac{1}{b}$$

$$\frac{1}{b} = \frac{1}{p} - \frac{1}{a} = \frac{a-p}{ap} \Rightarrow b = \frac{ap}{a-p} = \frac{36 \cdot 9}{36-9} = \frac{324}{27} = 12 \text{ cm}$$

$$\Gamma = \frac{6}{a} = \frac{12}{36} = \frac{1}{3}$$

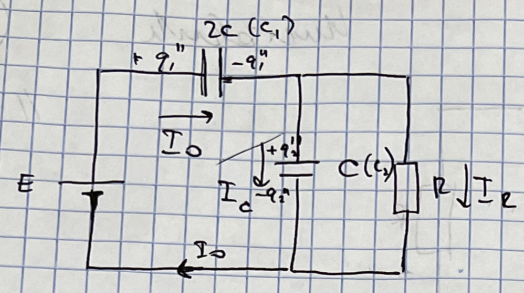
$$x = 6 + c = 12 \text{ cm} + 24 = 36 \text{ cm}$$



$$\frac{R}{r} = \frac{R}{b-F}$$

$$\frac{R}{r} = \frac{a}{z} = 3 \quad z = 3r$$

3)



Кепсүлүк ①

$$I_0 = I_C + I_R \quad u = 0$$

$$\frac{dq_1}{dt} = \frac{dq_2}{dt} + \frac{dq_R}{dt}$$

$$dq_1 = dq_2 + dq_R$$

~~ИЗМЕНЕНИЕ~~

$$I_0 = \frac{dq_1}{dt}$$

$$E = \frac{q_1''}{2C} + I_R \cdot R$$

$$\frac{q_2''}{C} = I_R R$$

$$E = \frac{q_1''}{2C} + \frac{q_2''}{C}$$

~~ИЗМЕНЕНИЕ~~ ~~dq_1 = I_0 dt~~ ~~dq_2 = I_R dt~~ ~~dq_R = I_R dt~~

$$dq_1 = I_0 dt$$

$$dq_R = I_R \cdot R \cdot dq_R$$

~~$$E \cdot dq_1 + \frac{q_1''^2}{2C} + \frac{q_2''^2}{2C} = I_R \cdot R \cdot dq_R + \frac{(q_1'' + dq_1)^2}{2C} + \frac{(q_2'' + dq_2)^2}{2C}$$

$$E \cdot dq_1 + \frac{q_1''^2}{2C} + \frac{q_2''^2}{2C} = I_R \cdot R \cdot dq_R + \frac{q_1''^2}{2C} + \frac{2q_1'' \cdot dq_1}{2C} + \frac{q_2''^2}{2C} + \frac{2dq_2 \cdot q_2''}{2C} + \frac{dq_2^2}{2C}$$

$$E \cdot dq_1 = I_R \cdot R \cdot dq_R + \frac{q_1'' \cdot dq_1}{C} + \frac{q_2'' \cdot dq_2}{C}$$

$$E \cdot dq_1 = I_R \cdot R \cdot dq_R + I_R R \cdot dq_2 + \frac{q_1'' \cdot dq_1}{C}$$

$$E \cdot dq_1 = I_R \cdot R \cdot dq_1 + (E - I_R R) \cdot dq_1$$~~

$$E = \frac{q_1''}{2C} + I_R \cdot R$$

$$\phi = \frac{I_0}{2C} + \frac{dq_2}{dt^2} R$$