Часть 1

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

Шифр: **21200839**

ID профиля: **836896**

Вариант 2

Чистовик
11-02

№1

Дано: СИ: Решение

α;

H

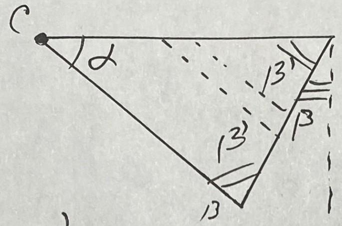
1) β - ?

2) a_K - ?

3) $\frac{m}{M}$ - ?

4) τ - ?

1) Представим, что вся нить „доехала" до стены (Пунктиром - разные положения ~~стекан~~ нити в разное время)



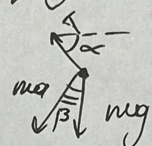
Из условия, что угол $\alpha = const$ и нить нерастяжима =>

$$=> 2\beta' = 180° - \alpha;$$

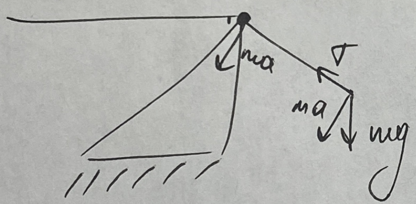
$$\beta' = 90° - \frac{\alpha}{2}; \quad \beta = \frac{\alpha}{2}$$

по ребру AB треугольника направлено ускорение

II З.Н.: $m\vec{a} = \vec{T} + m\vec{g}$



2)



$$a_K \sin\beta = a_ш$$

т. cos для шара:

$$\begin{cases} (ma)^2 = T^2 + (mg)^2 + 2Tmg\cos\beta \\ \text{II ЗН в проекции на ~~оси~~: гориз. ось} \\ T\cos\alpha = ma_ш \cdot \sin\beta \end{cases}$$

$$a^2 = a^2\frac{\sin^2\beta}{\cos^2\alpha} + g^2 - 2a\frac{\sin\beta\cos\beta}{\cos\alpha}$$

$$a^2\left(1 - \frac{\sin^2\beta}{\cos^2\alpha}\right) - g^2 + a\frac{\sin 2\beta}{\cos\alpha} = 0$$

$$D = \frac{\sin^2 2\beta}{\cos^2\alpha} - 4g^2\left(1 - \frac{\sin^2\beta}{\cos^2\alpha}\right); \quad a = \frac{-\frac{\sin 2\beta}{\cos\alpha} + \sqrt{D}}{2}$$

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Читовик 11-02

№2

Дано: СИ: Решение

ν; $C_v = \frac{3}{2}R$;

T_0;

$C(T) = \frac{5}{2}R\frac{T}{T_0}$

---

1) Q_1 - ?

2) T_1 - ?

3) A - ?

1) $Q_1 = \nu C(T) \cdot \Delta T$;

$\Delta T = (T_0 - \frac{1}{2}T_0) = \frac{1}{2}T_0$

т.к. $C(T)$ линейно, то $C_{средн} = \frac{C(T_0) + C(T_0/2)}{2}$

$C_{средн} = \frac{\left(\frac{5}{2}R\frac{T_0}{T_0} + \frac{5}{2}R\frac{T_0}{2T_0}\right)}{2} = \frac{5/2 R + \frac{5}{4}R}{2} =$

$= \frac{15 R}{8} = \frac{15}{8}R$

$Q_1 = \nu \cdot \frac{15}{8}R \cdot \frac{1}{2}T_0 = \frac{15}{16}\nu R T_0$

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

$A = Q - \Delta U$; $A = \nu C(T) \cdot (T_0 + T_1) - \nu C_v (T_0 + T_1)$

$A = \nu \cdot \frac{\left(\frac{5}{2}R\frac{T_0}{T_0} + \frac{5}{2}R\frac{T_1}{T_0}\right)}{2} \cdot (T_0 + T_1) - \nu C_v (T_0 + T_1)$

$A = \nu\left(\frac{\frac{5}{2}R + \frac{5}{2}R\frac{T_1}{T_0}}{2}\right) \cdot (T_0 + T_1) - \nu C_v (T_0 + T_1)$

$A = \nu\left(\frac{5}{4}R + \frac{5}{4}R\frac{T_1}{T_0}\right)(T_0 + T_1) - \nu C_v (T_0 + T_1)$

$A = \nu T_0 \cdot \frac{5}{4}R + \nu T_1^2 \cdot \frac{5}{4}\frac{R}{T_0} + \nu C_v T_0 + \nu C_v T_1$

$A = + T_1^2 \cdot \nu \cdot \frac{5}{4}\frac{R}{T_0} + T_1 \cdot \frac{3}{2}\nu R + \nu T_0 \cdot \frac{5}{4}R + \nu \cdot \frac{3}{2}RT_0$

~~Парабола ветви вверх~~; Парабола, ветви вверх,

Работа минимальна при $T_1 = T_{вершины}$; $T_1 = \frac{\frac{3}{2}R\nu}{\frac{5}{2}\frac{R}{T_0}\nu} = \frac{3}{5}T_0$

$= \frac{3}{5}T_0$

11-02. Черновик

1. Дано: СИ: Решение

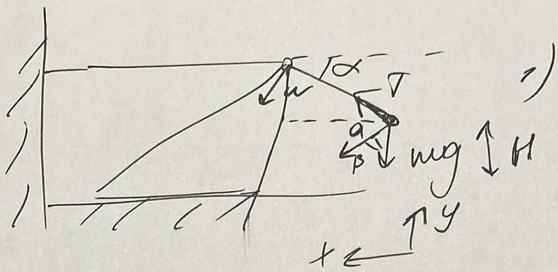
$\alpha; H;$

1) β - ?

2) $a_к$ - ?

3) $\frac{H_m}{H}$ - ?

4) T - ?



II з-н

1) $Ox: T\cos\alpha = ma\sin\beta$

$Oy: T\sin\alpha - mg = ma\cos\beta$

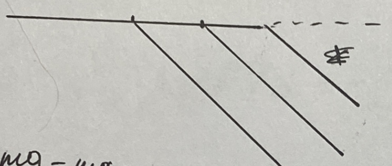
$$\frac{T\cos\alpha}{T\sin\alpha - mg} = -tg\beta$$

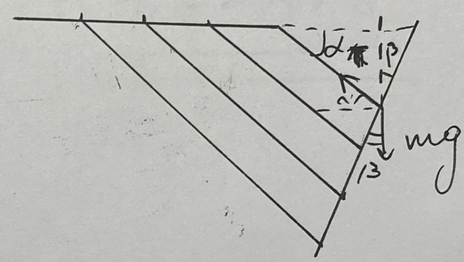
$$ctg\beta = \frac{-T\sin\alpha + mg}{T\cos\alpha}$$

$$ctg\beta = -tg\alpha + \frac{mg}{T\cos\alpha}$$

$mg =$

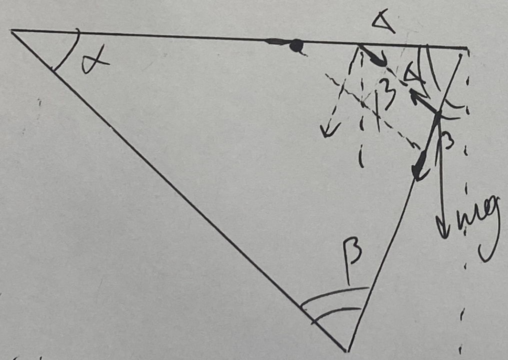
1)





$Ox: ma = mg\cos\beta - T\cos(\beta + 90° - \alpha)$

$0 = mg\sin\beta -$

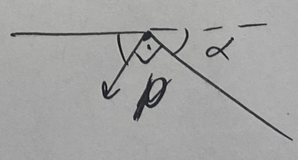


$\cancel{\beta = 180°}$

$\alpha + 2\beta = 180° = 2\pi$

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

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



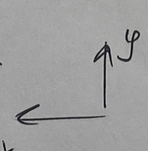
$180° - \alpha - 90° = \gamma$

$\gamma = 90° - \alpha$

2) $P\cos(90° - \alpha) = Ma_к$

$P\sin(90° - \alpha) = 0$

$T\cos(90° - \alpha) =$



$\cancel{Ox: T\sin\beta = Ma}$

$Oy:$

$mg\cos\beta$

$a_к = a_ш \sin\beta$

$\cancel{T\cos\alpha = ma\sin\beta}$

$\cancel{T\sin\alpha + mg = -ma\cos\beta}$

$T\cos\alpha = ma\sin\beta$

~~macos~~

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

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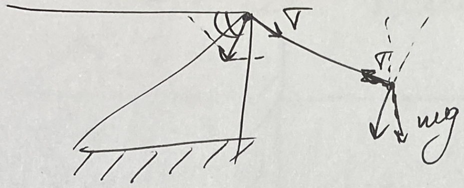
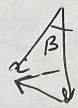


$Ma\cancel{\cos} \sin\beta = T\cos(\beta + 90° - \alpha)$ черновик

$\cancel{ma \sin\beta = T\cos(\beta + 90° + \alpha)}$



$(ma)^2 = T^2 + (mg)^2 - 2Tmg\cos\beta$

$$\begin{cases} a_к \cdot \cancel{\ } \sin\beta = a_ш; \\ -T\sin\alpha + mg = ma_ш \cdot \cos\beta \\ T\cos\alpha = ma_ш \cdot \sin\beta \\ T = ma\dfrac{\sin\beta}{\cos\alpha} \end{cases}$$

$(ma)^2 = \left(ma\dfrac{\sin\beta}{\cos\alpha}\right)^2 + (mg)^2 -$

$-2 \cdot ma\dfrac{\sin\beta}{\cos\alpha} mg\cos\beta$

$a^2 = a^2\dfrac{\sin^2\beta}{\cos^2\alpha} + g^2 - 2a\dfrac{\sin\beta\cos\beta}{\cos\alpha}$

$a^2\left(1 - \dfrac{\sin^2\beta}{\cos^2\alpha}\right) - g^2 + a\dfrac{\sin 2\beta}{\cos\alpha} = 0$

$D = \dfrac{\sin^2 2\beta}{\cos^2\alpha}$

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Чистовик 11-02

№2

2) $T_1 = \frac{3}{5} T_0$

3) $A = \left(\frac{3}{5} T_0\right)^2 \cdot \nu \frac{5}{4} \frac{R}{T_0} - \frac{3}{5} T_0 \cdot \frac{3}{2} \nu R - \nu T_0 \cdot \frac{5}{4} R +$

$+ \nu \cdot \frac{3}{2} R T_0$

$A = \frac{9}{25} \cdot \frac{5}{4} \cdot \nu R T_0 - \frac{9}{10} \nu R T_0 - \nu R T_0 \cdot \frac{5}{4} +$

$+ \nu R T_0 \cdot \frac{6}{4}$

$A = \frac{9}{20} \nu R T_0 - \frac{9}{10} \nu R T_0 + \frac{1}{4} \nu R T_0$

$A = \left(-\frac{9}{20} + \frac{5}{20}\right) \nu R T_0 = -\frac{4}{20} \nu R T_0 = -\frac{1}{5} \nu R T_0$

21200839 (U836896 M1266171)

Часть 2

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

Шифр: **21200839**

ID профиля: **836896**

Вариант 2

№4

Ильяковск
11-02

Дано: СИ: Решение

$m; R;$

$\frac{m}{2}; 4R;$

$L; B$

v_0

1) a_2 - ?

2) u - ?

3) ΔS - ?

1) $\mathcal{E} = BLv_0$

$J = \frac{\mathcal{E}}{5R} = \frac{BLv_0}{5R}$

$a = F \cdot \frac{1}{\frac{m}{2}} = \frac{2F}{m} = \frac{2 \cdot JLB}{m}$

$= \frac{2(BL)^2 v_0}{5mR}$

2) по ЗСИ:

$mv_0 = \frac{3}{2}mu$; $u = \frac{2}{3}v_0$; перемычку едут с равными скор. (силы ~~трения~~ нет; $v_{отн} = 0$; контур едет поступательно)

3) ЗСЭ:

$\frac{mv_0^2}{2} = \frac{m}{2 \cdot 2} \frac{4}{9} v_0^2 + \frac{m}{2} \cdot \frac{4}{9} v_0^2 + A$; где $\frac{4}{9} v_0^2 = u^2$

$A = 3mv_0^2$

$A = F\Delta S$; $F_{ср} = \frac{1}{2} \cdot \frac{(BL)^2 v_0}{5R}$ (т.к. сила линейна по скорости)

⇓

$\Delta S = \frac{3mv_0^2 \cdot 5R \cdot 2}{(BL)^2 \cdot v_0} \Rightarrow \frac{30 m v_0 R}{(BL)^2}$

21200839 (U836896 M1266172)

Черновик

$\cancel{\frac{m}{2}}$ $mv_0 = (M+m)u$

$$u = \frac{mv_0}{m+M} = \frac{mv_0}{\frac{3}{2}m} = \frac{2}{3}v_0$$

$$\frac{mv_0^2}{2} = \frac{m}{4}\cdot\frac{4}{9}v_0^2 + \frac{m}{2}\cdot\frac{4}{9}v_0^2 + A$$

$$\frac{mv_0^2}{2} = \frac{m}{9}v_0^2 + \frac{2m}{9}v_0^2 + A \quad |\cdot 18$$

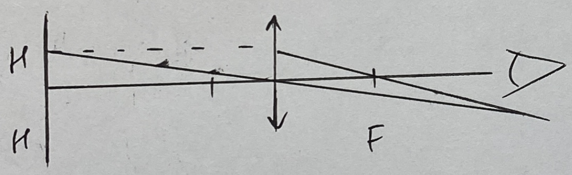
$$9mv_0^2 - 2mv_0^2 - 4mv_0^2 = A$$

$$3mv_0^2 = A;$$

$$3mv_0^2 = F\Delta S; \quad F_{cp} = \frac{(BL)^2\cdot v_0}{5R\cancel{z}}\cdot\frac{1}{2}$$

$$\Delta S = \frac{3mv_0^2\, 5R\cdot 2}{(BL)^2 v_0\cancel{z}} = \cancel{3m}\ \frac{30\, mv_0 R}{(BL)^2}$$

№5

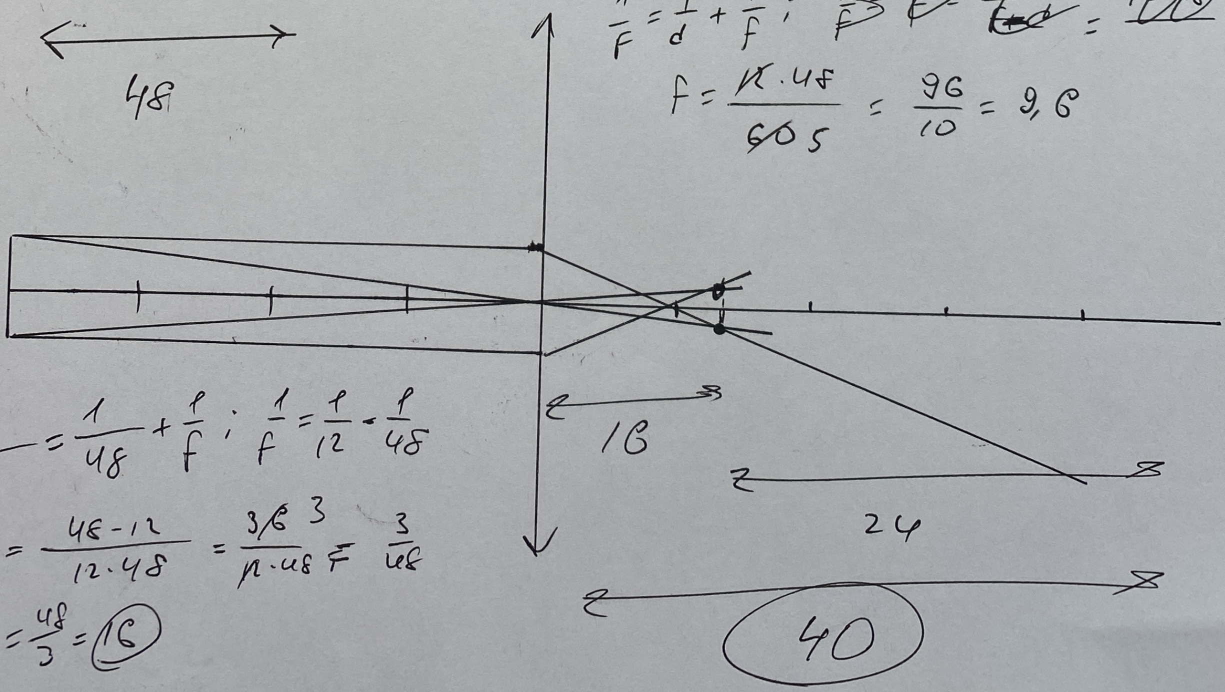


$$\frac{1}{12} = \frac{1}{48} + \frac{1}{f}$$

$$f = \frac{Fd}{F-d}$$

$$\frac{1}{F} = \frac{1}{d} + \frac{1}{f}; \quad \cancel{\frac{1}{f}} \quad \cancel{f = \frac{Fd}{F-d}} = \cancel{12\cdot 48}$$

$$f = \frac{12\cdot 48}{60} = \frac{96}{10} = 9{,}6$$



$$\frac{1}{12} = \frac{1}{48} + \frac{1}{f}; \quad \frac{1}{f} = \frac{1}{12} - \frac{1}{48}$$

$$\frac{1}{f} = \frac{48-12}{12\cdot 48} = \frac{36}{12\cdot 48} = \frac{3}{48}$$

$$f = \frac{48}{3} = 16$$

Чистовик

№3:

11-02

Дано: СИ: Решение

$C_2 = C$;
$C_1 = 3C$;
$\mathcal{E}$; R

1) J - ?
2) Q - ?
3) U_R - ?

1) Сразу после ~~разм~~. зам. заряды конд. не успели измениться

$\Rightarrow q_1 = q_2$

$C_1 U_1 = C_2 U_2$

$3U_1 = U_2$

по правилу Кирхгофа для контура без R

$\mathcal{E} - U_2 - U_1 = 0$

$\mathcal{E} = 4U_1$

$U_1 = \frac{\mathcal{E}}{4}$; $U_2 = \frac{3}{4}\mathcal{E} \Rightarrow J = \frac{3/4\,\mathcal{E}}{R} = \underline{\underline{\frac{3}{4}\frac{\mathcal{E}}{R}}}$

2) ЗСЭ: (В конечном сост: $U_1 = \mathcal{E}$; $U_2 = 0$, тока нет)

$\mathcal{E}\Delta q = \Delta W_1 + \Delta W_2 + Q$

$\Delta q = \Delta q_1 + \Delta q_2 = (3C\mathcal{E} - \frac{3}{4}C\mathcal{E}) + (0 - \frac{3}{4}C\mathcal{E}) =$
$= \frac{3}{2}C\mathcal{E}$

$\Downarrow$

$\frac{3}{2}C\mathcal{E}^2 = \left(\frac{3C\mathcal{E}^2}{2} - \frac{3C\mathcal{E}^2}{32}\right) + \left(0 - \frac{C\cdot 9\mathcal{E}^2}{32}\right) + Q$

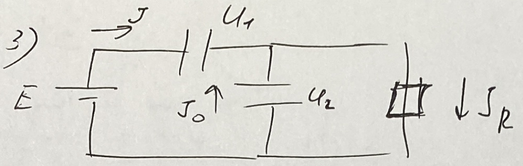
$\Rightarrow Q = 3C\mathcal{E}^2 + 9C\mathcal{E}^2 = \underline{\underline{12C\mathcal{E}^2}}$

3) В этот момент, ~~раз~~ C_1 уже зарядился, ток течет только в правом контуре

$U_C = U_R = \underline{\underline{J_0 R}}$

Черновик
11-07

3)



$q = CU$

$$\begin{cases} E - U_1 - U_2 = 0 \\ E - U_1 = J_R \cdot R \\ U_2 = J_R \cdot R \\ E - U_1 - J_R R = 0 \\ U = E - J_R R \end{cases}$$

$J_0 + J = J_R$

$\frac{E - U_1}{R} = J_R$;

$U_1 = E - U_2$; $U_1 = E - J_R R$

$U_2 = J_R R$

$$\begin{cases} J_R = J_0 + J, \\ E - U_1 - U_2 = 0 \\ E - U_1 = J_R R \\ U_2 = J_R R \end{cases}$$

$E - U_1 = J_R R$

$E - U_1 = J_0 R + J R$

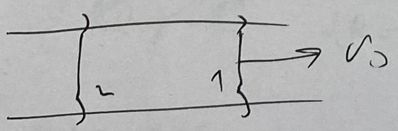
$U_R = J_0 R$

№4

$\mathcal{E} = B\ell v$; $F_A = BJL$; $F_A = qvB$;

$F_A = IB\ell$

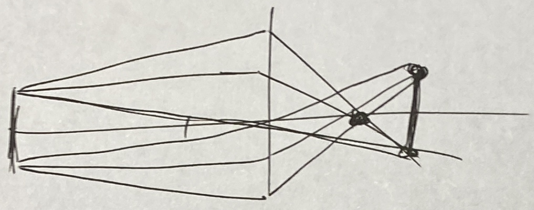
$\mathcal{E} = B \cdot \ell \cdot v_0$

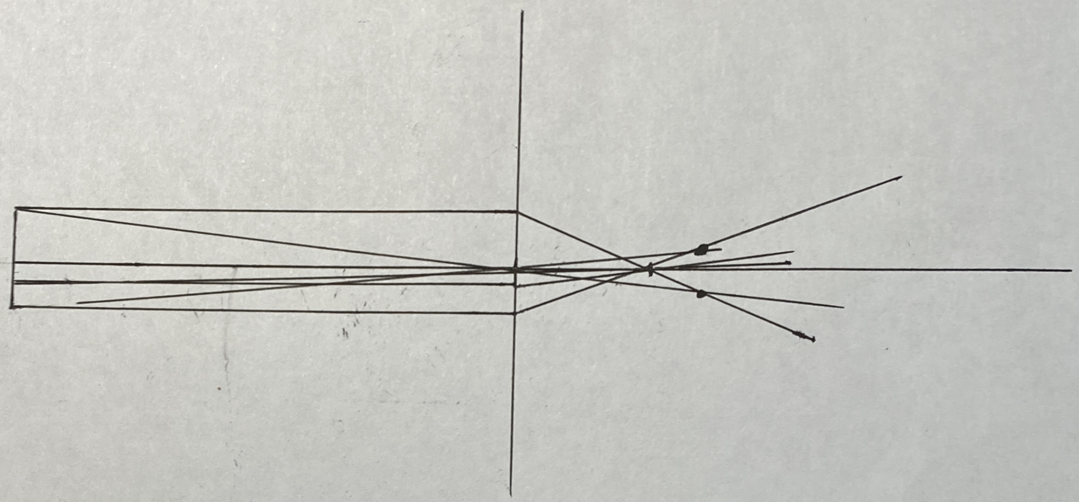


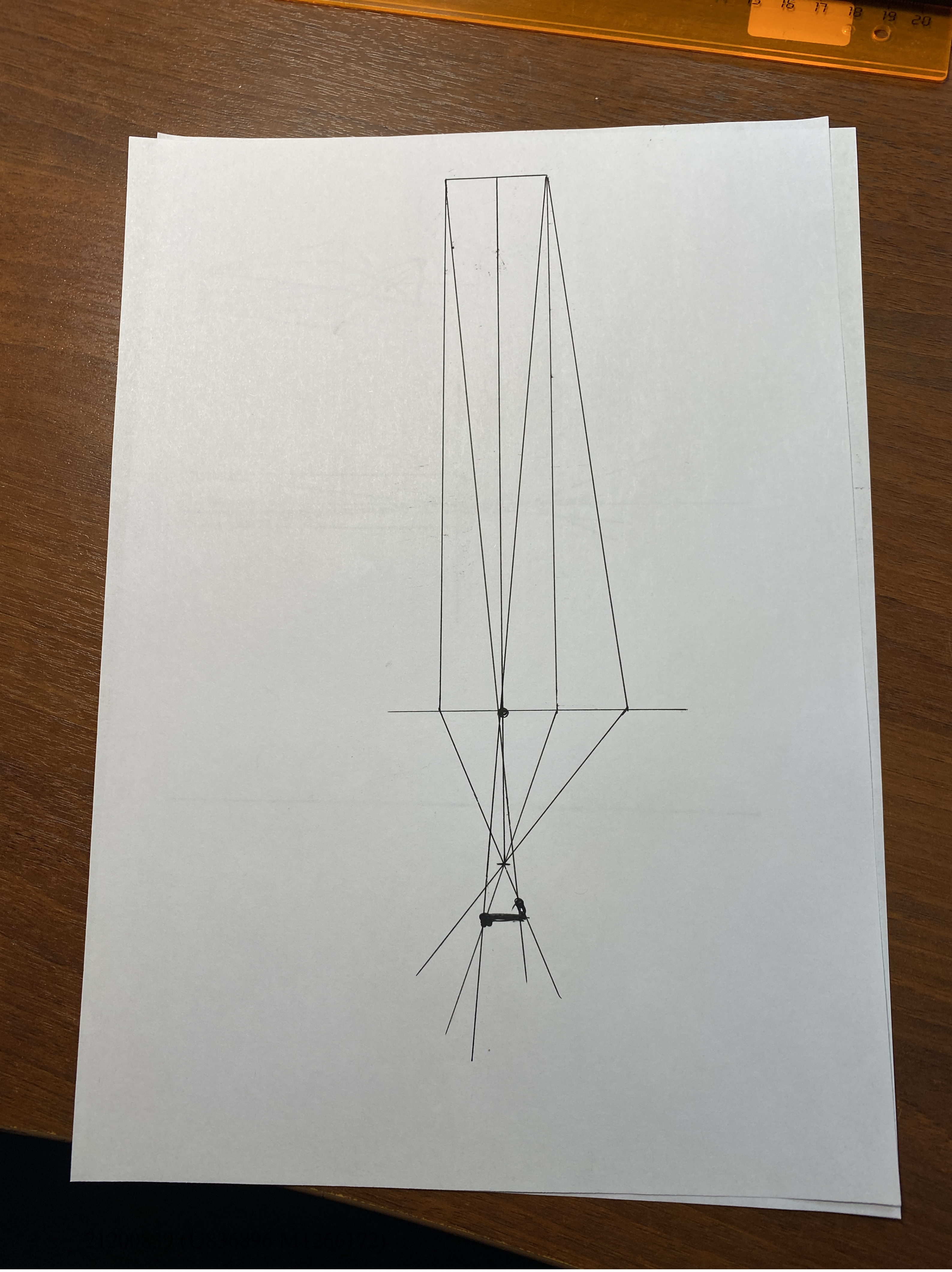
$J = \frac{\mathcal{E}}{5R} = \frac{B\ell v_0}{5R}$

$a = \frac{2F}{m} = \frac{2 \cdot JLB}{m} = \frac{2B\ell v_0 \ell B}{m5R}$

$$a = \frac{2(BL)^2 v_0}{5mR}$$






15 16 17 18 19 20

2) $F_1 = BR$; $F_2 =$ Черновик

$F_1 =$ $a = \frac{F}{m}$

$F = \frac{B e v_0}{5R}$. $Be = \frac{(BL)^2 v_0}{5R}$

$F(v_0) = \frac{(BL)^2 v_0}{5R}$

$F_1 = \frac{(BL)^2 \cdot v}{5R}$;

$m v_0 = m u + \frac{m}{2} v$

$\frac{m v_0^2}{2} = \frac{m u^2}{2} + \frac{m v^2}{4}$

$a_2 = \frac{(BL)^2 v_2 \cdot 2}{5R\, m}$

$a_1 = \frac{(BL)^2 \cdot v_1}{5Rm}$

$\begin{cases} 2v_0^2 = 2u^2 + v^2 \\ 2v_0 = 2u + v \end{cases}$

$\begin{cases} 2v_0^2 - 2u^2 = v^2 \\ 2v_0 - 2u = v \end{cases}$ $\begin{cases} 2v_0^2 - 2u^2 = v^2 \\ 4v_0^2 + 4u^2 - 8v_0 u = v^2 \end{cases}$

$\cancel{2v_0^2 - 2u^2 = 4v_0^2 + 4u^2 - 8v_0 u}$

относит:

$a_{отн} = \frac{(BL)^2}{5Rm}(2v_2 - v_1)$

$F_1 = \frac{(BL)^2 \cdot v_{отн}}{5R} = \frac{(BL)^2 \cdot (v_1 - \frac{v_2}{2})}{5R}$

$a_{отн} = \frac{(BL)^2 \cdot (v_{отн})}{5mR}$

$\mathcal{E} = BLv_{отн} = BL(v_1 - v_2)$

$F = \frac{BLv_{отн} \cdot BL}{5R} = \frac{(BL)^2 \cdot v_{отн}}{5R}$

$\frac{(BL)^2}{5Rm}$

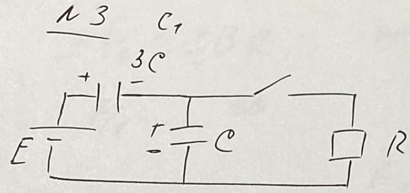
$a_1 = \frac{(BL)^2 v_{отн}}{5Rm}$;

$a_2 = \frac{(BL)^2 v_{отн}}{5Rm} \cdot 2$

$\cancel{\frac{(BL)^2 v_{отн}}{5Rm}}$ $\frac{(BL)^2 v_{отн}}{5Rm} = \frac{(BL)^2 \cdot v_0}{5Rm} \cdot 2$

$v_{отн} = 2v_0$; $v_1 - v_2 = 2v_0$

№ 3



1) $q_1 = q_2$

$C_1U_1 = C_2U_2$

$3CU_1 = CU_2$

$3U_1 = U_2$;

$\frac{1}{3C} + \frac{1}{C} = \frac{1}{C'} \Rightarrow C' = \frac{3C^2}{4C} = \frac{3}{4}C$

1) $\mathcal{E} - \frac{\mathcal{E}}{4} = JR$

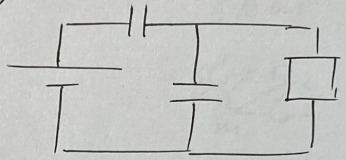
$J = \frac{3\mathcal{E}}{4R}$

$\mathcal{E} - 3U_1 - U_1 = 0$

$\mathcal{E} = 4U_1$;

$U_1 = \frac{\mathcal{E}}{4}$; $U_2 = \frac{3}{4}\mathcal{E}$

2)



$\mathcal{E}(q_2 - q_1) = \frac{3C\mathcal{E}^2}{2} + Q$

$q_1 = 3CU_1 + CU_2 = 3C\cdot\frac{\mathcal{E}}{4} + C\cdot\frac{3}{4}\mathcal{E} = \frac{3}{2}C\mathcal{E}$

$q_2 = 3C\cdot\mathcal{E}$

$\mathcal{E}(3C\cdot\mathcal{E} - \frac{3}{2}C\mathcal{E}) = \frac{3}{2}C\mathcal{E}^2 + Q$

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

$J = J_1 + J_2$

$J_2R = \frac{3}{4}\mathcal{E}$

2) $\cancel{Q\,4\,U}$ $J_2R = 0 \Rightarrow U_2 = 0$

$\mathcal{E}\Delta q = \Delta W_1 + \Delta W_2 + \Delta Q$; $\Delta q = \Delta q_1 + \Delta q_2 = (3C\mathcal{E} - 3C\frac{\mathcal{E}}{4}) + (0 - \frac{3}{4}C\mathcal{E}) = (3C\mathcal{E} - \frac{3}{2}C\mathcal{E}) = \frac{3}{2}C\mathcal{E}$

$\frac{3}{2}C\mathcal{E}^2 = \left(\frac{3C\cdot\mathcal{E}^2}{2} - \frac{3C\cdot\mathcal{E}^2}{32}\right) + \left(0 - \frac{C\cdot 9\mathcal{E}^2}{32}\right) + Q \quad |\cdot 32$

$\cancel{48C\mathcal{E}^2} = \cancel{48C\mathcal{E}^2} - 3C\mathcal{E}^2 - 9C\mathcal{E}^2 + Q$; $Q = 12C\mathcal{E}^2$

Чистовик

№5

Дано: СИ: Решение

$F = 12 см;$

$H = 9 см;$

$d = 48 см;$

$L = 24 см$

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1) $x - ?$

2) $D_м - ?$

3) $x' - ?$

1) $\frac{1}{F} = \frac{1}{d} + \frac{1}{f};$

$\frac{1}{f} = \frac{48-12}{12 \cdot 48} см^{-1} = \frac{3}{48} см^{-1}$

$f = 16 см;$

$x = f + L;$

$x = 16 + 24 = 40 см$

2) $D_м = H = 9 см$

3) На расст $F = 12 см$, где пересекаются все лучи;

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