Часть 1

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

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Вариант 2

Черновик

2. $h_{max} \Rightarrow E_{max} = \frac{1}{5} \cdot \frac{5}{13} mg \cdot \frac{1}{13} \cdot \frac{5}{\sqrt{2}} g = \frac{5}{13\sqrt{2}} g$

$\Rightarrow E_{k1} = \frac{5}{65} mg \Rightarrow a_{k1} = \frac{5}{13\sqrt{2}} g$

$a_m = \frac{4 \cdot 5}{13 \cdot 5} g = \frac{20}{65} = \frac{4}{13} g$

$\frac{R}{\sin\beta} = a_2 \frac{T^2}{2} \Rightarrow T = \sqrt{\frac{2R}{a_2 \sin\beta}} = \sqrt{\frac{13\sqrt{2}R}{2g}}$

$Q = \frac{1}{2T_0} \cdot V \cdot \frac{5}{2} R \int_{T_0}^{T_0} \frac{dT}{T_0} = \frac{5}{4} \frac{VR}{T_0} \int_{\frac{T_0}{2}}^{T_0} T\,dT = \frac{5}{2} \frac{VR}{T_0} \left(\frac{T}{2}\right)^2 \Big|_{\frac{T_0}{2}}^{T_0}$

$= \frac{1}{2} \cdot \ldots$

$C = \frac{dQ}{\nu dT} = \frac{dA + dU}{\nu dT}$

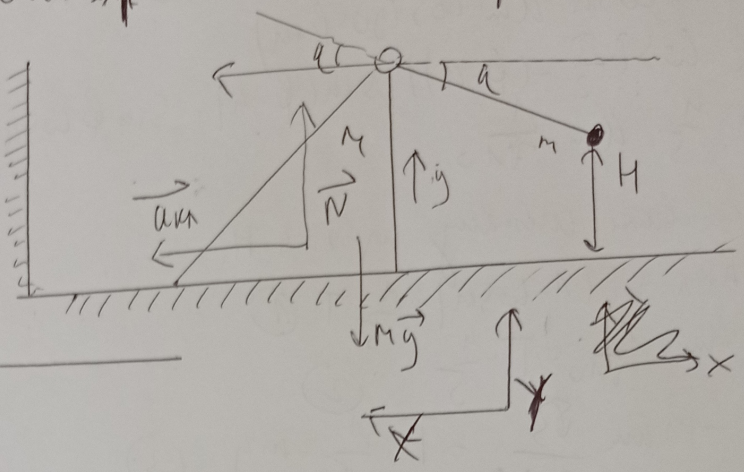
Чистовик

Вар. 11-02

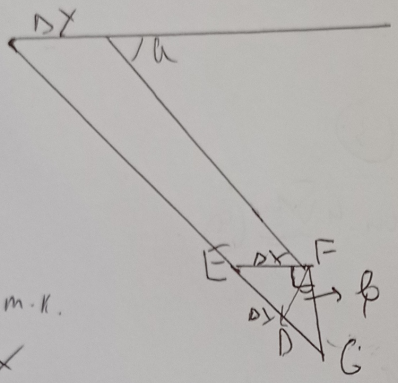
1.

Дано:

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



1) β - ?



1. $\triangle EFD$ - равнобедренный.

$EF = EG = \Delta x$

$\triangle EFG$ - ~~равнобедренный~~ $\angle EFG$ - прямой

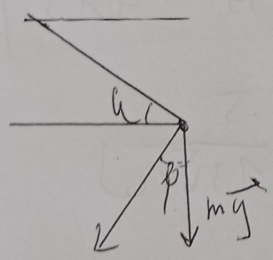
$\Rightarrow \angle EFD = \frac{180° - \alpha}{2}$

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

$\cos\alpha = \frac{4^2}{5} \Rightarrow \cos^2\frac{\alpha}{2} - \sin^2\frac{\alpha}{2} = 2\cos^2\frac{\alpha}{2} - 1 \Rightarrow 2\cos^2\frac{\alpha}{2} = \frac{9}{5} \Rightarrow$

$\cos^2\frac{\alpha}{2} = \frac{9}{10} \Rightarrow \cos\frac{\alpha}{2} = \cos\beta = \frac{3}{\sqrt{10}}$

2) +3)



2 З.Н. для М:

$\begin{cases} OX: Ma_{кл} = T - T\cos\alpha \\ OY: N = Mg + T\sin\alpha \end{cases}$

2 З.Н. для m:

$\begin{cases} OX: ma_m \cdot \sin\beta = T\cos\alpha \\ OY: -ma_m \cdot \cos\beta = T\sin\alpha - mg \end{cases}$

$\Rightarrow \operatorname{tg}\beta \cdot (-1) = \frac{T\cos\alpha}{T\sin\alpha - mg}$

Чистовик 2 Задача 11-02

$\Rightarrow a_{кл}\cos\alpha = a_m\cos(90-\beta+\alpha)$

$= a\cos(\frac{\pi}{2}-(\beta-\alpha)) = \sin(\beta-\alpha) = \sin\beta\cos\alpha - \sin\alpha\cos\beta \Rightarrow \frac{1}{\sqrt{10}}\cdot\frac{4}{5} - \frac{3}{5}\frac{3}{\sqrt{10}} =$

$= -\frac{1}{\sqrt{10}}$

$a_{кл}\cdot\frac{4}{5} = a_m\cdot\frac{1}{\sqrt{10}}$

Составим систему из 2.3.Н

$$\begin{cases} M_{акл} = T(1-\cos\alpha) = \frac{1}{5}T \quad (1) \\ m a_m = \frac{1}{\sqrt{10}} = T\cdot\frac{4}{5} \quad (2) \\ -m a_m\cdot\frac{3}{\sqrt{10}} = T\cdot\frac{1}{5} - mg \quad (3) \\ a_{кл} = \frac{4}{5} = a_m\cdot\frac{1}{\sqrt{10}} \Rightarrow a_m = a_{кл}\cdot\frac{4\sqrt{10}}{5} \quad (4) \end{cases}$$

$\frac{(2)}{(3)} = -\frac{1}{3} = \frac{\frac{4}{5}T}{\frac{1}{5}T - mg} \Rightarrow -\frac{1}{15}T + \frac{1}{3}mg = \frac{4}{5}T \Rightarrow T\cdot\frac{13}{15} = \frac{1}{3}mg \Rightarrow$

$T = \frac{5}{13}mg$

$\Rightarrow M_{акл} = \frac{1}{5}\cdot\frac{5}{13}mg \quad ((1)) \Rightarrow$

$(2)+(4): \frac{M_{акл}}{M_{акл}} = \frac{a_{кл}\sqrt{10}}{5} = \frac{\frac{4}{5}T}{\frac{1}{5}T} \Rightarrow \boxed{\frac{m}{M} = \frac{5}{\sqrt{10}}}$ - ответ на п. 3)

$M_{акл} = \frac{1}{5}\cdot\frac{5}{13}mg \Rightarrow a_{кл} = \frac{1}{13}\cdot\frac{5}{\sqrt{10}}\cdot g = \frac{5}{13\sqrt{10}}g$

$\Rightarrow a_m = \frac{4}{5}\cdot\frac{5}{13}g = \frac{4}{13}g$

4) $\frac{H}{\sin\beta} = a_m\frac{T^2}{2} \Rightarrow T = \sqrt{\frac{2H}{a_m\sin\beta}} = \sqrt{\frac{13\sqrt{10}H}{2g}}$

Ответ: 1) $\cos\beta = \frac{3}{\sqrt{10}}$ 2) $a_{кл} = \frac{5}{13\sqrt{10}}g$ 3) $\frac{m}{M} = \frac{5}{\sqrt{10}}$

4) $T = \sqrt{\frac{13\sqrt{10}H}{g}}$

3. Источник 3 Вар 11-02

№2

Дано:

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

1) $Q = \Delta U \cdot VC(T) \Delta T$

$Q = \int_{\frac{T_0}{2}}^{T_0} V \frac{5}{2} R \frac{T}{T_0} dT = -\frac{5}{2} \frac{VR}{T_0} \int_{\frac{T_0}{2}}^{T_0} T dT =$

$= -\frac{5}{2} \frac{VR}{T_0} \left[\frac{T^2}{2}\right] \Big|_{\frac{T_0}{2}}^{T_0} = \frac{5}{4} \frac{VR}{T_0} \cdot \frac{3}{4} T_0^2 = \frac{15}{16} VRT_0$

2) $C = \frac{dQ}{V dT} = \frac{dA + dU}{V dT} = \frac{dA + \frac{3}{2} VR dT}{V dT} \Rightarrow C = \frac{1}{V} \frac{dA}{dT} + \frac{3}{2} R$

$dA = VC(T) dT - \frac{3}{2} VR dT$

$A(T) = \int V \cdot \frac{5}{2} R \frac{T}{T_0} dT = \int \frac{3}{2} VR dT$

$A(T) = \frac{5}{2} \frac{VR}{T_0} \frac{T^2}{2} - \frac{3}{2} VRT + C$

$\frac{dA(T)}{dT} = \frac{5}{2} \frac{VRT}{T_0} - \frac{3}{2} VR$

$\frac{d(A(T))}{dT} = 0 \Rightarrow \frac{\frac{5}{2} VRT_{Amin}}{T_0} = \frac{3}{2} VR \Rightarrow T_{Amin} = \frac{3}{5} T_0$

3) $A_{min} = \underbrace{\frac{5}{2} \frac{VR}{T_0} \left[\frac{T_0^2}{2}\right]_{T_0}^{\frac{3}{5}T_0}}_{\text{ур. 1}} - \frac{3}{2} VR [T]_{T_0}^{\frac{3}{5}T_0} =$

$= \frac{5}{4} \frac{VR}{T_0} \left(\frac{9}{25} T_0^2 - T_0^2\right) - \frac{3}{2} VR \left(\frac{3}{5} T_0 - T_0\right) = -\frac{5}{4} \frac{VR}{T_0} \cdot \frac{16}{25} T_0^2$

$+ \frac{3}{2} VR \cdot \frac{2}{5} T_0 = -\frac{4}{5} VRT_0 + \frac{3}{5} VRT_0 = -\frac{1}{5} VRT_0$

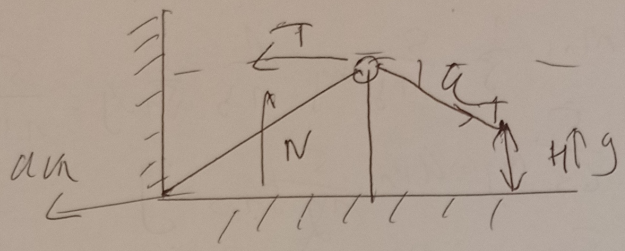
Ответ: 1) $Q_1 = \frac{15}{16} VRT_0$

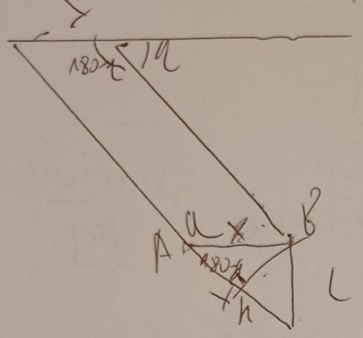
2) $T_{Amin} = \frac{3}{5} T_0$

3) $A_{min} = -\frac{1}{5} VRT_0$

Черновик

1





АВС - р/б
Д. п. ВН
$\angle ABH = \frac{a}{2}$

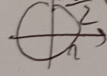
$\cos 2a = \cos^2 a - \sin^2 a = 2\cos^2 a - 1 = 2\cdot\frac{9}{5} - 1 =$
$2\cos^2 a = 1 + \frac{4}{5} = \frac{9}{5} \Rightarrow \cos a = \frac{3}{\sqrt{10}}$

для M
2) ox: $Ma_1 = T - T\cos a$
oy: $N = Mg + T\sin a$

для m
$ma_2 \cdot \sin\beta = T\cos a$
$ma_2\cos\beta = T\sin a - mg$

$\Rightarrow \operatorname{tg}\beta = \frac{T\cos a}{T\sin a - mg}$ $\quad a_{\text{кл}}\cos a = a_m\cos(a + 90 - \beta)$

$\cos\left(\frac{\pi}{2} + (\beta - a)\right) = \sin(\beta - a) = \sin\beta\cos a - \sin a\cos\beta = \frac{4}{5\sqrt{10}} - \frac{3\cdot 3}{5\sqrt{10}} = \frac{1}{\sqrt{10}}$



$M a_1 = T(1 - \cos a) = \frac{1}{5}T$ 1

$ma_2 \cdot \frac{1}{\sqrt{10}} = 0{,}8T$ 2

$-ma_m \cdot \frac{3}{\sqrt{10}} = T\cdot 0{,}2 - mg$ 3

$a_{\text{кл}} \cdot \frac{4}{5} = a_2 \frac{1}{\sqrt{10}} \Rightarrow a_2 = a_1 \cdot \frac{4\sqrt{10}}{5}$ 4

$\frac{2}{3} - \frac{1}{3} = \frac{0{,}8T}{0{,}2T - mg} \Rightarrow -\frac{1}{15}T + \frac{1}{3}mg = \frac{4}{5}T + T = \frac{5}{13}mg$

$P_{1A_1} = \frac{1}{5}\cdot\frac{5}{13}mg$ (1)

2+1: $\frac{Ma_1(1)}{ma_2(2)} \cdot \frac{4\sqrt{10}}{5} = \frac{0{,}8T}{0{,}4T} \Rightarrow \frac{M}{m} = \frac{5}{\sqrt{10}}$

Часть 2

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

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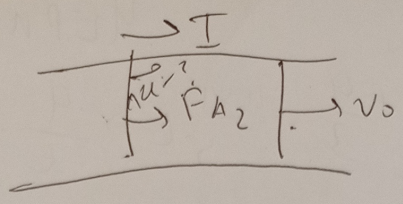
Вариант 2

Черновик 2 Вариант-02

2.



$ma_2 = F_{A_2} \rightarrow X$

$ma_2 = IBL$

$|\xi_i| = \frac{\Delta\Phi}{\Delta t} = \frac{B \cdot \Delta x \cdot L}{\Delta t} = BLv_0$

$\xi_i = I(R+4R) \Rightarrow I = \frac{\xi}{5R} = \frac{BLv_0}{5R}$

$ma_2 = B_4 I B L_2 = \frac{BLv_0}{5R} \cdot BL = \frac{B^2L^2v_0}{5mR}$

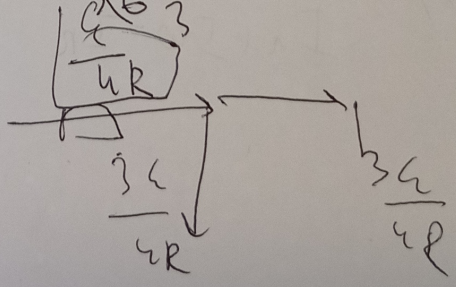
3) $\begin{cases} ma_1 = IBL \\ I = \frac{BVL}{5R} \end{cases} \quad -m\frac{\Delta V}{\Delta t} = BIL$

$\Rightarrow -m\frac{\Delta V}{\Delta t} = \frac{B^2VL^2}{5R} \Rightarrow -m\frac{\Delta V}{V} = \frac{BL\Delta t}{5R}$

$\Rightarrow -m\int dV = \frac{B^2L^2}{5R}\int V dt \Rightarrow mv_0 = \frac{B^2L^2}{5R} \Rightarrow L_1 = \frac{mv_0 \cdot 5R}{(BL)^2}$

№3 $f = \frac{Fd}{d-F}$

$x = a + f = a + \frac{Fd}{d-F} = 24 + \frac{12 \cdot 48}{36} = 24 + 16 = 40$



$I(C_2) = I_0 = \frac{3\xi}{4R}$

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

2·3·4

Черновик Вариант-02

7. №1

до зам.

$\mathcal{E} = V_1 + V_2 = \frac{q}{3C} + \frac{q}{3} = \frac{4q}{3C} \Rightarrow \frac{q}{C} = \frac{3}{4}\mathcal{E} = V_2 \Rightarrow$

$q = \frac{3}{4}\mathcal{E}C$

После зам.

$V_2(0-1) = V_2'(0+1) = \frac{3}{4}\mathcal{E}$

$\Rightarrow I \cdot R = V_2 \Rightarrow I = \frac{3\mathcal{E}}{4R}$

2) $q_1 = V_1' \cdot C_1 = 3\mathcal{E}C$

$\Delta q = \Delta q_1 + \Delta q_2 = |3\mathcal{E}C - \frac{3}{4}\mathcal{E} \cdot 3C| + \frac{3}{4}\mathcal{E}C =$

$= 3\mathcal{E}C - \frac{6}{4}\mathcal{E}C = \frac{3}{2}\mathcal{E}C$

ЗСЭ: $Q_1 + Q_2 + A_{вн} = Q_3 + Q$

$\Rightarrow Q = \frac{3C}{2}\left(\frac{4}{4}\right)^2 + \frac{C}{2}\left(\frac{3}{4}\mathcal{E}\right)^2 + \mathcal{E} \cdot \left(\frac{3}{4}\mathcal{E}C\right) - \frac{3C\mathcal{E}^2}{2} =$

$CE: \left(\frac{3}{2 \cdot 16} + \frac{4}{32} + \frac{3}{4} - \frac{3}{2}\right)$

$\frac{3}{2} \cdot \frac{1}{16} + \frac{1 \cdot 9}{2 \cdot 16} + \frac{7}{4} - \frac{3}{2} = \frac{3}{8} + \frac{7}{4} - \frac{3}{2} = \frac{9}{8} + \frac{7}{4} =$

$= \frac{56 - 22}{24} = \boxed{\frac{24}{24}}$ ✓

3) $\mathcal{E} = V_1(t) + V_2(t)$

$I_1 + I_2 = I_R$

$\mathcal{E} = \frac{1}{3C}\int i_1(t)dt + \frac{1}{C}\int I_2(t)dt$

$\Rightarrow \frac{1}{3C} i_1 = \frac{1}{C} \cdot i_2 \Rightarrow i_1 = 3i_2$

Чистовик Вар. 11-02

4. $\Rightarrow I_R = 4I_0 \Rightarrow V_R = 4I_0R$

Ответ: 3) $4I_0R$

Чистовик 3 Вар. 11-02

3 №3

Дано:
$F = 12\,см$
$H = 9\,см$
$d = 48\,см$
$a = 24\,см$

1) $\frac{1}{d} + \frac{1}{f} = \frac{1}{F} \Rightarrow \frac{1}{f} = \frac{d-F}{Fd} \Rightarrow f = \frac{Fd}{d-F}$

$x = a + f = a + \frac{Fd}{d-F} = 24\,см + \frac{12\,см \cdot 48\,см}{48\,см - 12\,см} =$

$= (24 + 16)\,см = 40\,см$

Ответ: 1) 40 см

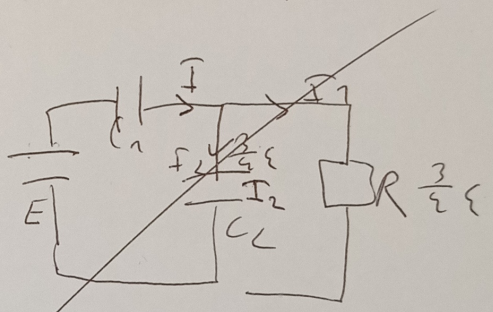
№2 (продолжение 1 с. 3)

~~$I(R_2 t) - I_0 = \frac{3\mathcal{E}}{4R}$~~

по 2 закону Кирхгофа

~~$\mathcal{E} = V(R_1 t) + V(R_2 t) = \frac{3\mathcal{E}}{4}$~~

$\Rightarrow V(R_1)$



$I = I_1 + I_2 \Rightarrow I_1 = I - I_2 \Rightarrow V(R) = (I - I_2)R =$

$= \left(I - \frac{3\mathcal{E}}{4R}\right)R$

$I = \frac{\mathcal{E}}{R} \Rightarrow V(R) = \frac{\mathcal{E}}{4R} \cdot R = \frac{\mathcal{E}}{4}$

Ответ: 2) $\frac{\mathcal{E}}{4}$

№3 В (продолжение)

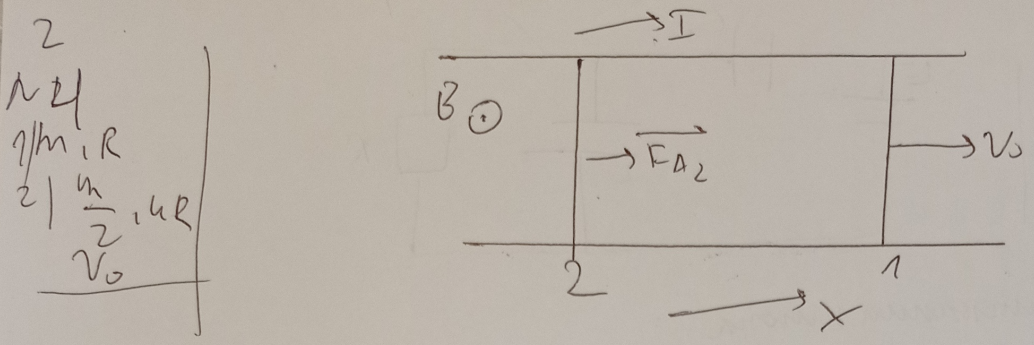
(1) $\begin{cases} \mathcal{E} = V_1(t) + V_2(t) \\ V_2(t) = V \\ I_2 + I_0 = I_R \Rightarrow \end{cases}$ Законы Кирхгофа:

(2)

(+) $\mathcal{E} = \frac{1}{2C}\int i_1(t)dt + \frac{1}{C}\int i_2(t)dt \Rightarrow$

$\frac{1}{2C} i_1 = \frac{1}{C} \cdot i_2 \Rightarrow i_1 = 2 i_2$

Чистовик 2 Зад. 11 02



1) 2 з.к. для перемычки 2

$m\vec{a}_2 = \vec{F}_{A_2}$

OX: $ma_2 = IBL$

$|\mathcal{E}_i| = -\Phi' = \frac{B\,dS}{dt} = \frac{B\,L\,dx}{dt} = BLV_0$

$\mathcal{E}_i = I(R+4R) = 5IR \Rightarrow I = \frac{\mathcal{E}}{5R} = \frac{BV_0L}{5R}$

$\Rightarrow ma_2 = BL\cdot\frac{BV_0L}{5R} \Rightarrow \boxed{a_2 = \frac{B^2L^2V_0}{5mR}}$

2) Поскольку в цепи присутствует сопротивление, то через длительный промежуток времени $V_1 = V_2 = 0$

3) 2 з.к для 1

$\begin{cases} ma_1 = IBL \\ -m\frac{dV}{dt} = BIL \end{cases} \Rightarrow \begin{cases} I = \frac{BVL}{5R} \text{ (из п.1)} \\ -m\frac{dV}{dt} = \frac{B^2mVL^2}{5R} \end{cases} \Rightarrow -m\frac{dV}{V} = \frac{BL\,dt}{5R} \Rightarrow$

$-m\int_{V_0}^{0} \frac{dV}{V} = \frac{B^2L^2}{5R}\int_0^{t} dt \Rightarrow -m(0-V_0) = \frac{B^2L^2}{5R}L_1 \Rightarrow \boxed{L_1 = \frac{mV_0\,5R}{B^2L^2}}$

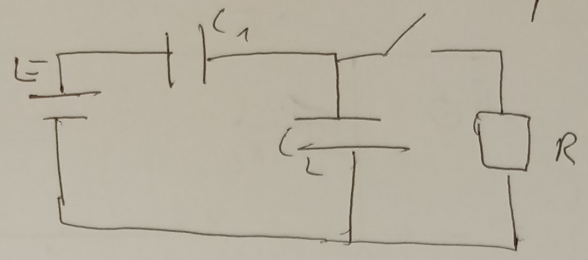
Ответ: 1) $\frac{B^2L^2V_0}{5mR}$ 2) 0 ($V_1 = V_2 = 0$) 3) $\frac{mV_0\,5R}{B^2L^2}$

Чистовик 1 Стар. 11-02

1

Дано: №3

$C_2 = C_1 C_1 = 3C$



1) до замыкания ключа

(1) $\mathcal{E} = V_1 + V_2 = \frac{q}{3C} + \frac{q}{3} \Rightarrow \mathcal{E} = \frac{4q}{3C} \Rightarrow \frac{q}{C} = \frac{3}{4}\mathcal{E} = V_2 \Rightarrow$

$q = \frac{3}{4}\mathcal{E}C$

2) После замыкания:

$V_2(0-) = V_2(0+) = \frac{3}{4}\mathcal{E}$ (закон коммутации)

(2) $I(R_0) \cdot R = V_2 = \frac{3}{4}\mathcal{E} \Rightarrow I(R_0) = \frac{3\mathcal{E}}{4R}$

3) В установившемся режиме:

$\mathcal{E} = V_1' \Rightarrow V_1' = \mathcal{E} \Rightarrow q_1 = V_1' \cdot C_1 = 3\mathcal{E}C$

$\Delta Q = \Delta q_1 + \Delta q_2 = (3\mathcal{E}C - \frac{3}{4}\mathcal{E} \cdot 3C) + (\frac{3}{4}\mathcal{E}C) = 3\mathcal{E}C - \frac{9}{4}\mathcal{E}C + \frac{3}{4}\mathcal{E}C =$

$= 3\mathcal{E}C - \frac{6}{4}\mathcal{E}C = 3\mathcal{E}C - \frac{2}{3}\mathcal{E}C = \frac{7}{3}\mathcal{E}C \Rightarrow (\frac{7}{3}\mathcal{E}C)$

~~$3\frac{CV_1^2}{2} + \frac{CV_2^2}{2} = 3C(\frac{1}{3}\mathcal{E})^2 = \frac{7}{3}$~~

ЗСЗ: $\frac{3CV_1^2}{2} + \frac{CV_2^2}{2} + A_{ист} = 3\frac{CV_1^2}{2} + Q \Rightarrow Q = \frac{3C}{2} \cdot (\frac{\mathcal{E}}{4})^2 +$

$+ \frac{C}{2}(\frac{3}{4}\mathcal{E})^2 + \mathcal{E} \cdot (\frac{2}{3}\mathcal{E}C) - 3\frac{C\mathcal{E}^2}{2} \Rightarrow Q = C\mathcal{E}^2(\frac{3}{2} \cdot \frac{1}{16} + \frac{1}{2} \cdot \frac{9}{16} +$

$+ \frac{2}{3} - \frac{3}{2}) = \frac{29}{24}C\mathcal{E}^2 \rightarrow (\frac{29}{24}C\mathcal{E}^2)$

Ответ: 1) $\frac{3\mathcal{E}}{4R}$ 2) $\frac{29}{24}C\mathcal{E}^2$

Чистовик 5 №5 (строение) Вариант 1-02

2) $\frac{H}{h} = \frac{f}{d} \Rightarrow h = \frac{Hd}{f}$

$\frac{h + D_{min}}{2} \cdot f + \frac{D_{min}}{2} \cdot f = \frac{h + H}{2}(f + d)$

$\frac{D_{min}}{2} \cdot f + \frac{hf}{2} + \frac{D_{min} d}{2} + \frac{hd}{2} = \frac{hf}{2} + \frac{hd}{2} + \frac{Hf}{2} + \frac{Hd}{2}$

$\Rightarrow D_{min} = \frac{hd + Hf}{f + d}$

$\Rightarrow D_{min} = \frac{\frac{Hd}{f} + Hf}{f + d} = \frac{9.24 + 9.24}{7 \cdot 2} = \frac{18}{3} = 6$ см

Ответ: 2) 6 см.