Часть 1

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

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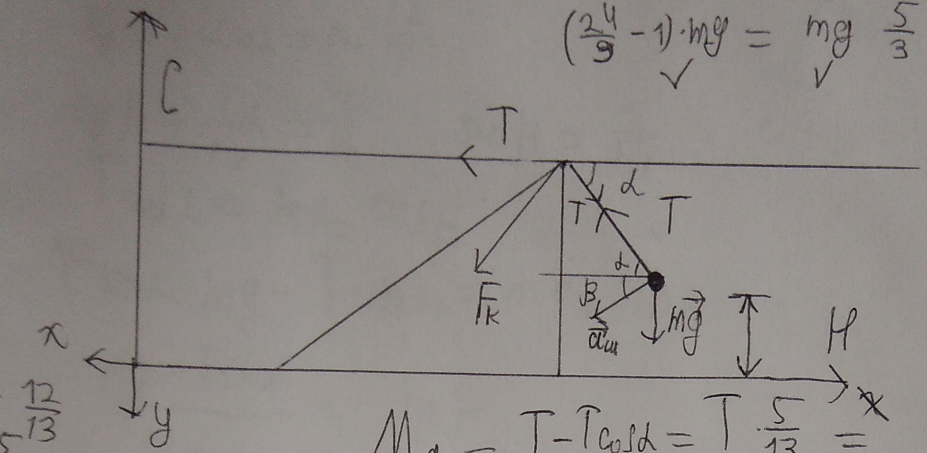
Вариант 3

1. Цилиндр



$mg\frac{26}{9}\cdot\frac{12}{13}T - mg = m\frac{5\sqrt{13}}{9}g\cdot\frac{3}{\sqrt{13}}$

$\left(\frac{24}{9}-1\right)\cdot mg = mg\frac{5}{3}$ ✓ ✓

$M = \frac{13}{8}m$

$\frac{1}{12}M = \frac{2}{39}m$

$M\cdot\frac{5}{12}g = \frac{10}{39}mg$

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

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

$S_m = H$

$M\cdot a_k = T - T\cos\alpha = T\frac{5}{13} = \frac{10}{39}mg$

$M\cdot a_k = \sqrt{(T-T\cos\alpha)^2 + T^2\sin^2\alpha} =$

$= \sqrt{T^2 + T^2\cos^2\alpha + T^2\sin^2\alpha - 2T^2\cos\alpha} =$

$= \sqrt{2T^2 - 2T^2\cos\alpha}$

$F_k = \sqrt{8^2+12^2} =$

ΔL

$\Delta H = \Delta L\sin\alpha = \Delta y$

$\Delta S = \Delta L\cos\alpha = \Delta x$

$M\cdot\frac{5}{12}g = \sqrt{2\cdot\frac{4}{9}m^2g^2\left(1-\frac{5}{13}\right)} =$

$M\cdot\frac{5}{12}g = \sqrt{\frac{8}{9}m^2g^2\cdot\frac{8}{13}}$

$Mg\cdot\frac{5}{12} = \frac{8}{3\sqrt{13}}mg$

$\Delta L = \Delta y + \Delta x$

$\frac{m}{M} = \frac{15\sqrt{13}}{3\cdot4\cdot8} = \frac{5\sqrt{13}}{32} < \frac{18}{32} = \frac{9}{16} < 0{,}5625$

$a_k = a_y + a_x$

$a_m = \frac{5}{3\sqrt{13}}$

$a_y = a_k\sin\alpha$

$a_x = a_k\cos\alpha$

$a_{my} = a_m\cdot\sin\beta = \frac{5\sqrt{13}}{9}g\cdot\frac{3}{\sqrt{13}} = \frac{5}{3}g$

$r_x = \Delta L - \Delta L\cos\alpha = \Delta L\frac{8}{13}$

$r_y = \Delta L\sin\alpha = \Delta L\frac{12}{13}$

$\frac{26}{9}mg\cdot\frac{5}{13} = ma_m\cos\beta$

$g\frac{10}{9} = a_m\cos\beta$

$\cos\beta = \frac{2}{\sqrt{13}}$

$\sin\beta = \frac{3}{\sqrt{13}}$

$tg\beta = \frac{r_y}{r_x} = \frac{3}{2}$

$C = \sqrt{13^2+12^2} = \sqrt{13}$

$\frac{10}{9}g = a_m\cdot\frac{2}{\sqrt{13}}$

$a_m = \frac{9\sqrt{13}}{9}g \approx 2g$

$mg = \frac{9}{26}T$

$T = \frac{26}{9}mg$

$m\vec{g} + \vec{T} = m\vec{a_m}$

$T\cos\alpha = ma_m\cos\beta$

$\frac{12}{13}\cdot T - mg = \frac{3}{2}$

$\sin\alpha\cdot T - mg = ma_m\sin\beta$

$T\cdot\frac{5}{13}$

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

$\frac{12}{13}\cdot T - mg = \frac{15}{26}T$

Черновик

1. 1) $r_x = \Delta l - \Delta l \cos\alpha = \Delta l \frac{5}{13}$ $\quad \sin\alpha = \frac{12}{13}$ $\quad \cos\alpha = \frac{5}{13}$

$r_y = \Delta l \sin\alpha = \Delta l \frac{12}{13}$

$tg\beta = \frac{r_y}{r_x} = \frac{3}{2}$ $\quad \sin\beta = \frac{3}{\sqrt{13}}$ $\quad \cos\beta = \frac{2}{\sqrt{13}}$

2) $T\cos\alpha = m a_w \cos\beta$

~~$T\sin\alpha$~~ $mg - T\sin\alpha = m a_w \sin\beta$

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

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

$mg = T(\frac{12}{13} + \frac{3}{2} \cdot \frac{5}{13}) = T(\frac{24}{26} + \frac{15}{26}) = T(\frac{39}{26}) = \frac{3}{2}T$

$T = \frac{2}{3}mg$

$\frac{2}{3}mg \cdot \frac{5}{13} = m a_w \cdot \frac{2}{\sqrt{13}}$

$\frac{5}{39}g = a_w \cdot \frac{1}{\sqrt{13}}$

$a_w = \frac{5}{3\sqrt{13}} g = 0{,}46\, g$

$a_{wy} = a_w \cdot \sin\beta = \frac{5}{13} g$

4) $H = \frac{a_{wy} \cdot t^2}{2}$

$t = \sqrt{\frac{2H}{a_{wy}}} = \sqrt{\frac{2H}{\frac{5}{13}g}} = \sqrt{\frac{26H}{5g}}$

$\frac{a_{wy} \cdot \Delta t^2}{2} = \Delta l \sin\alpha = \Delta l \frac{12}{13}$

$\frac{a_k \cdot \Delta t^2}{2} = \Delta l$

$\frac{a_{wy}}{a_k} = \frac{12}{13}$

$a_k = \frac{13}{12} a_{wy} = \frac{5}{12} g$

3) $M \cdot a_k = \sqrt{(T - T\cos\alpha)^2 + T^2 \sin^2\alpha}$

$\frac{m}{M} = \frac{5\sqrt{13}}{32} \approx \frac{9}{16} \approx 0{,}5 * 63$

Черновик

2. $C(T) = 3R\frac{T}{T_0}$ $\quad T_0, \nu, \frac{3}{5}T_0$

$M = \nu M_{He}$

$\Delta Q = cm\Delta T$

$Q_1 = \int_{\frac{3}{5}T_0}^{T_0} 3R\nu M_{He}\frac{dT \cdot T}{T_0} =$

$= \frac{3}{2}R\nu M_{He}\frac{T^2}{T_0}\Big|_{\frac{3}{5}T_0}^{T_0} =$

$= \frac{3}{2}R\nu M_{He}\left|\frac{T_0^2 - \frac{9}{25}T_0^2}{T_0}\right| =$

$= \frac{3}{2}R\nu M_{He}\frac{16}{25}T_0$

$= \frac{24}{25}\nu RT_0$

$\Delta V = \frac{3}{2}\nu R\Delta T$

$A = Q - \Delta V = \frac{3}{2}\nu R\left(\frac{T_0^2 - T^2}{T_0}\right| - \frac{3}{2}\nu R(T_0 - T) =$

$\frac{3}{2}\nu R\left(T_0 - \frac{T^2}{T_0} - T_0 + T\right) =$

$= \frac{3}{2}\nu R\left(T - \frac{T^2}{T_0}\right| = \frac{3}{2}\nu R\left(\frac{TT_0 - T^2}{T_0}\right)$

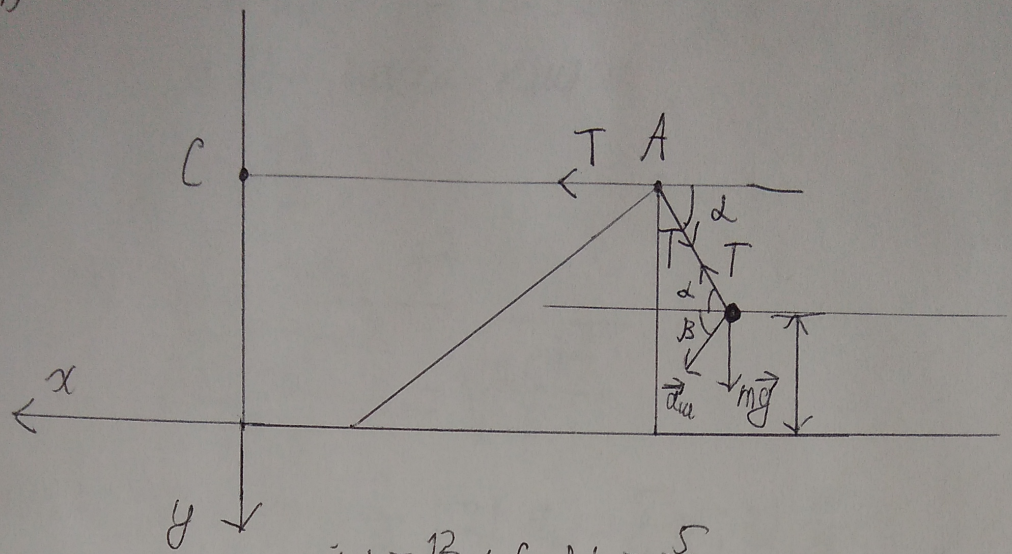
$\frac{dA}{dT} = \frac{3}{2}\nu R\left(T_0 - 2T\right) = 0$

$T = \frac{T_0}{2}$

$A = \frac{3}{2}\nu R\left(\frac{\frac{T_0}{2}\cdot T_0 - \frac{T_0^2}{4}}{T_0}\right| = \frac{3}{2}\nu R\frac{T_0}{4} = \frac{3}{8}\nu RT_0$

Условие

1. 1)



$\sin\alpha = \frac{12}{13}$; $\cos\alpha = \frac{5}{13}$

пусть клин сдвинулся на Δl, тогда, т.к. нить нерастяжима:

$r_x = \Delta l - \Delta l\cos\alpha = \Delta l \frac{8}{13}$

$r_y = \Delta l \sin\alpha = \Delta l \frac{12}{13}$

$tg\beta = \frac{r_y}{r_x} = \frac{3}{2}$; $\sin\beta = \frac{3}{\sqrt{13}}$; $\cos\beta = \frac{2}{\sqrt{13}}$

2) $\begin{cases} T\cos\alpha = m a_ш \cos\beta \\ mg - T\sin\alpha = m a_ш \sin\beta \end{cases}$

где m – масса шара, $a_ш$ – ускорение шара, β – угол между ускорением шара и горизонтом

$T = \frac{2}{3} mg$

$\frac{2}{3} mg \cdot \frac{5}{13} = m a_ш \cdot \frac{2}{\sqrt{13}}$

$a_ш = \frac{5}{3\sqrt{13}} \cdot g$

$a_{шy} = a_ш \cdot \sin\beta = \frac{5}{13} g$

$\begin{cases} \frac{a_{шy} \cdot \Delta t^2}{2} = \Delta l \sin\alpha \\ \frac{a_к \cdot \Delta t^2}{2} = \Delta l \end{cases}$

где $a_к$ – ускорение клина

$a_к = \frac{5}{12} g$

(1)

Чистовик

1. 3) $M \cdot a_к = T - T\cos\angle = T\frac{5}{13} = \frac{10}{39} mg$

где M – масса клина

$\frac{m}{M} = \frac{13}{8}$

4) $H = \frac{a_{шу} \cdot t^2}{2}$

$t = \sqrt{\frac{2H}{a_{шу}}} = \sqrt{\frac{26H}{5}}$

Ответ: 1) $tg\beta = \frac{3}{2}$; 2) $a_к = \frac{5}{12}g$; 3) $\frac{m}{M} = \frac{13}{8}$; 4) $t = \sqrt{\frac{26H}{5}}$

Чистовик

2. 1) $dQ_1 = C\nu\, dT$

$$Q_1 = \int_{\frac{3}{5}T_0}^{T_0} C\nu\, dT = \int_{\frac{3}{5}T_0}^{T_0} 3R\nu \frac{dT \cdot T}{T_0} =$$

$$= \frac{3}{2} R\nu \frac{T^2}{T_0} \Big|_{\frac{3}{5}T_0}^{T_0} = \frac{24}{25} \nu R T_0$$

2) $\Delta V = \frac{3}{2} \nu R \Delta T$

$$A = Q - \Delta V = \frac{3}{2} \nu R \left(\frac{T_0^2 - T^2}{T_0} \right) - \frac{3}{2} \nu R (T_0 - T) =$$

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

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

$$T = \frac{1}{2} T_0$$

3) $A_{min} = \frac{3}{2} \nu R \left(\frac{\frac{T_0}{2} \cdot T_0 - \frac{T_0^2}{4}}{T_0} \right) = \frac{3}{8} \nu R T_0$

Ответ: 1) $Q_1 = \frac{24}{25} \nu R T_0$; 2) $T = \frac{T_0}{2}$; 3) $A_{min} = \frac{3}{8} \nu R T_0$.

Часть 2

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

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Вариант 3

Черновик

4. $\varepsilon = BLv_0$

$I = \frac{\varepsilon}{4R} = \frac{BLv_0}{4R}$

$F_A = BIL = \frac{B^2L^2v_0}{4R}$

$a_1 = \frac{F_A}{2m} = \frac{B^2L^2v_0}{8mR}$

$a_2 = \frac{B^2L^2v_0}{4mR}$

$\Delta 2\Delta v_1 = \Delta v_2$

$v_0 - \Delta v_1 = \Delta v_2$

$v_0 = 3\Delta v_1$

$\Delta v_1 = \frac{v_0}{3}$

$v_1 = v_2 = \frac{2}{3}v_0$

$E_0 = \frac{2mv_0^2}{2} = mv_0^2$

$E_1 = m\frac{4}{9}v_0^2 + \frac{m\frac{4}{9}v_0^2}{2} = \frac{2}{3}mv_0^2$

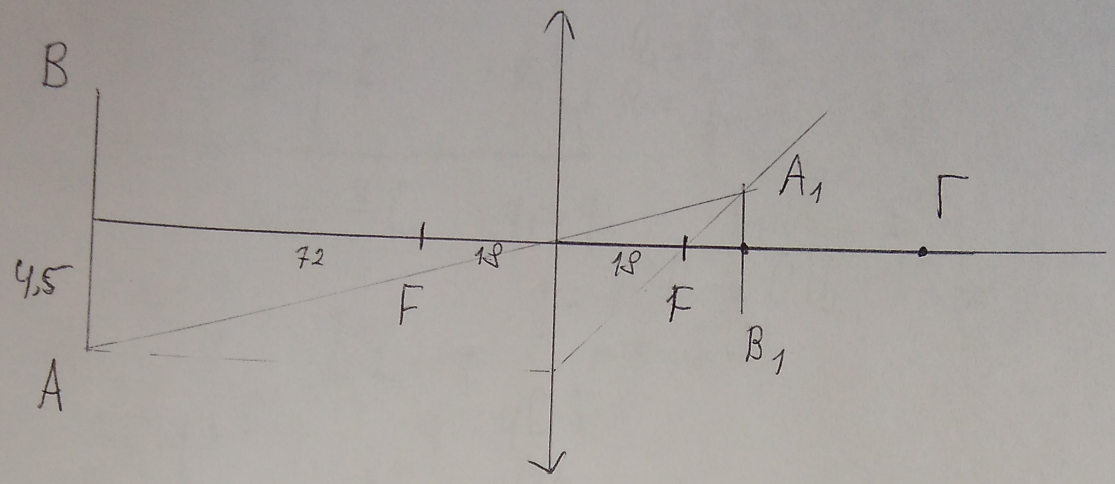
$Q = \frac{I^2}{R}\cdot\Delta t = \frac{\Delta q\cdot\Delta q}{\Delta t\cdot R}$

$a = \frac{3}{8}\cdot\frac{B^2L^2v_0}{8mR}$

$\frac{\Delta v}{\Delta t} = \frac{3B^2L^2}{8mR}\cdot\frac{\Delta S}{\Delta t}$

$\Delta v = \frac{3B^2L^2}{8mR}\cdot\Delta S$

Человек



$$\frac{1}{18} = \frac{1}{72} + \frac{1}{f_1}$$

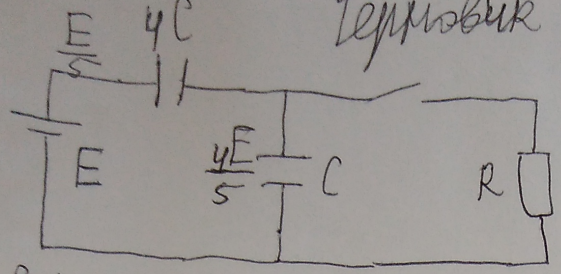
$$\frac{3}{72} = \frac{1}{f_1}$$

$f_1 = 24$ см

1) $24 + 24 = 48$

2)

3. Черновик



$I = \frac{U_2}{R} = \frac{4E}{5R}$

$Q_1 = \frac{4C \cdot E^2}{25 \cdot 2} = \frac{2CE^2}{25}$ $\quad Q_1' = \frac{4C \cdot E^2}{2} = 2CE^2$

$Q_2 = \frac{C \cdot 16E^2}{25 \cdot 2} = \frac{8CE^2}{25}$

$4U_1 = U_2$ $\quad U_2 = \frac{4E}{5}$

$q = CU$ $\quad C_{общ} = \frac{4}{5}C$ $\quad q_1 = q_2$ $\quad U_1 + U_2 = E$

$U = \frac{q}{C}$ $\quad E = C_{общ} \cdot q$ $\quad q = 4CU_1 = CU_2$ $\quad U_1 = \frac{E}{5}$

$q = \frac{5E}{4C}$ $\quad \Delta q = \Delta(CU)$

$E = 4C \cdot q + C \cdot q$ $\quad \Delta t \cdot I_0 = \Delta q$ $\quad q = 4C \cdot E$

$q = \frac{E}{5C} \cdot C$ $\quad \Delta t \cdot I_0 = \Delta(CU)$ $\quad t = \frac{S}{v} = \frac{m}{\beta}$

$U_1 = \frac{4}{5}E$ $\quad U_1' = E$ $\quad I_0 = \frac{\Delta(CU)}{\Delta t}$

$U_2 = \frac{E}{5}$ $\quad \beta S = mv_0$

$I = \frac{E}{5R}$ $\quad Q_1 = \frac{4 \cdot 16CE^2}{50} = \frac{32CE^2}{25}$ $\quad Q_1' = 2\frac{CE^2}{2}$ $\quad \beta \frac{\Delta S}{\Delta t} = m\frac{\Delta v}{\Delta t}$

$Q_2 = \frac{CU_2^2}{2} = \frac{CE^2}{50}$ $\quad F_{тр} = \beta v = ma$

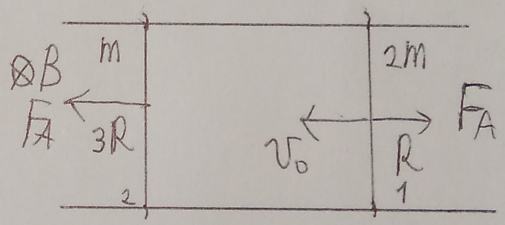
$Q =$

$P = UI$ $\quad I = \frac{\Delta q}{\Delta t}$

$Q = \frac{I^2}{R\Delta t}$ $\quad U_R = I_0 R = \frac{1}{2}C \cdot \frac{E^2}{25C^2} = \frac{E^2}{50C}$

$Q = \Delta q U = \frac{C\Delta q q}{C}$

4. $\varepsilon = -\frac{BL \cdot v_0 \cdot \Delta t}{\Delta t} = BLv_0$



$I = \frac{\varepsilon}{3R+R} = \frac{BLv_0}{4R}$

$F_A = BIL = \frac{B^2L^2v_0}{4R}$

$a_1 = \frac{F_A}{2m} = \frac{B^2L^2v_0}{8mR}$

$\Phi_0 = BS_0L$

$\varepsilon = BLv$

$I = \frac{BLv}{4R}$

$a_2 = \frac{F_A}{m} = \frac{B^2L^2v_0}{4mR}$

$v_1 = v_0 -$

$v_1 = v_0 - a_1 \cdot t$

$v_2 = a_2 \cdot t$

$\Delta v_2 = \frac{B^2L^2v_{отн}}{4mR} \cdot \Delta t$

$\Delta v_2 = \frac{B^2L^2(v_1 - v_2)}{4mR} \cdot \Delta t$

$\Delta v_1 = v_0 - \frac{B^2L^2(v_1 - v_2)}{8mR} \cdot \Delta t$

$F_1 = qvB$

$E_0 = \frac{2mv_0^2}{2} = mv_0^2$

$\frac{mv^2}{2} + mv^2 = mv_0^2$

$\frac{3}{2}v^2 = v_0^2$ $\quad v = v_0\sqrt{\frac{2}{3}}$

Чистовик

3. 1) $\begin{cases} q_1 = q_2 = 4CU_1 = CU_2 \\ U_1 + U_2 = E \end{cases}$

$U_1 = \frac{E}{5}$

$U_2 = \frac{4E}{5}$

$I = \frac{U_2}{R} = \frac{4E}{5R}$

2) $Q = \frac{CU_2^2}{2} = \frac{8CE^2}{25}$

3) $U_n = 2I_0 R$

Ответ: 1) $I = \frac{4E}{5R}$; 2) $Q = \frac{8CE^2}{25}$; 3) $U_n = 2I_0 R$

(1)

Чистовик

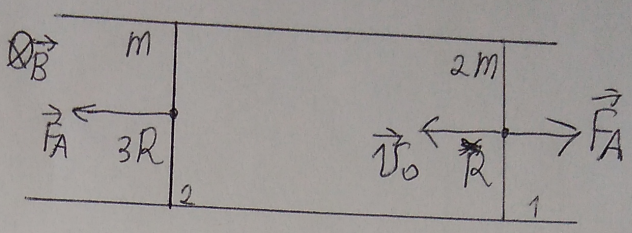
4. 1) $\mathcal{E} = BLv_0$

$I = \frac{\mathcal{E}}{4R} = \frac{BLv_0}{4R}$

$F_A = BIL = \frac{B^2L^2v_0}{4R}$

$a_1 = \frac{F_A}{2m} = \frac{B^2L^2v_0}{8mR}$

$a_2 = \frac{F_A}{m} = \frac{B^2L^2v_0}{4\cdot 8mR}$



2) т.к. $a_1 = a_2$, то $2\Delta v_1 = \Delta v_2$

$v_0 - \Delta v_1 = \Delta v_2$

$v_0 - \Delta v_1 = \frac{v_0}{3}$

$v_1 = v_2 = \frac{2}{3}v_0$

Ответ: 1) $a_1 = \frac{B^2L^2v_0}{8mR}$; 2) $v_1 = v_2 = \frac{2}{3}v_0$

(2)

Чистовик

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

$\frac{1}{18} = \frac{1}{72} + \frac{1}{f}$

$f = 24$ см

$x = 24 + f = 48$ см

Ответ: $x = 48$ см

(3)