

# XXXI Санкт-Петербургска олимпиада по астрономия

4.02.2024 г.

10 клас — Codr-04

Зад. 1  $t_{max} - 15 \text{ май } 1987$

$\Delta t_1$  ( $t_1 - 11 \text{ фев } 1988$ )

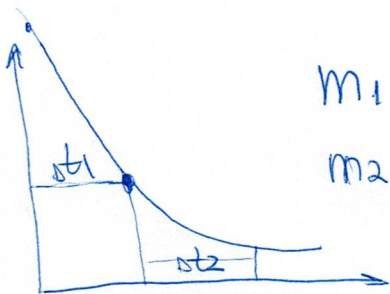
$\Delta t_2$  ( $t_2 - 21 \text{ април } 1989$ )

$$\Delta t_1 = 16 + 30 + 31 + 31 + 30 + 31 + 30 + 31 + 31 + 4 = 265 \text{ d}$$

$\downarrow$  май  $\downarrow$  фев

$$\Delta t_2 = 365 + 24 + 31 + 21 = 441 \text{ d}$$

$\downarrow$  фев  $\downarrow$  март  $\downarrow$  април



$m_1 = 6,5$  — границата зв. вел. на човека

$m_2 = m_{lim}$  на телескопа = 11,5 маг

$$m_{lim} = 5 \lg D + 7,5$$

$\downarrow$  от закона на Погсон Кирето

от закона на Погсон Кирето

$\rightarrow$  диаметър на зеницата  $\rightarrow 6 \text{ mm}$   
 $\frac{E \cdot d^2}{E \cdot D^2} = 2,512$  (mem-6)  
 $\downarrow$  диаметър на обектива

$$m_{lim} = 5 \lg 6 + 7,5$$

$$m_{lim} = 5 \cdot \lg 2 + 5 \lg 3 + 7,5$$

$$m_{lim} = 5 \cdot 0,3 + 5 \cdot 0,5 + 7,5$$

$$m_{lim} = 1,5 + 2,5 + 7,5$$

$$m_{lim} = 11,5$$

$$\lg \Delta t_1 = \lg 265 \approx \lg 264 = \lg 2 + \lg 2 + \lg 2 + \lg 3 + \lg 11 =$$

$$\begin{array}{r} 265 \overline{) 53} \\ 106 \\ \hline 159 \\ 158 \\ \hline 11 \end{array}$$

$$\begin{array}{r} 264 \overline{) 2} \\ 132 \\ \hline 66 \\ 66 \\ \hline 33 \\ 33 \\ \hline 11 \end{array}$$

$$= 0,3 \cdot 3 + 0,5 + 1,05 = 2,45$$

$$\lg(\Delta t_1 + \Delta t_2) = \lg 706 = 6 \cdot \lg 2 + \lg 11 = 6 \cdot 0,3 + 1,05 = 2,85$$

~~$$\begin{array}{r} 706 \overline{) 353} \\ 141 \\ \hline 265 \\ 265 \\ \hline 11 \end{array}$$~~

$$\begin{array}{r} 706 \overline{) 2} \\ 353 \\ \hline 353 \\ \hline 11 \end{array}$$

$$\begin{array}{r} 705 \overline{) 3} \\ 235 \\ \hline 47 \end{array}$$

$$\begin{array}{r} 704 \overline{) 2} \\ 352 \\ \hline 176 \\ 176 \\ \hline 88 \\ 88 \\ \hline 44 \\ 44 \\ \hline 22 \\ 22 \\ \hline 11 \end{array}$$

зап. 1

код - 04

$$\lg m_1 = \lg 6,5 = \lg \frac{65}{10} = \lg 5 + \lg 13 - \lg 10 = 0,7 + 1,1 - 1 = 0,8$$

$$\lg m_2 = \lg 11,5 \approx \lg 11 = 1,05$$

$$\lg m_1 = a \lg s t_1 + b$$

$$\lg m_2 = a \lg (s t_1 + t_2) + b$$

$$0,8 = a \cdot 2,45 + b$$

$$1,05 = a \cdot 2,85 + b$$

$$a = \frac{1,05 - 0,8}{2,85 - 2,45} = \frac{0,25}{0,4} = 0,625$$

$$b = 0,8 - a \cdot 2,45 =$$
$$= 0,8 - 0,625 \cdot 2,45 =$$
$$= 0,8 - 1,53 =$$
$$= -0,73$$

$$\begin{array}{r} 0,625 \cdot 2,45 \\ \underline{3125} \\ 2500 \\ \underline{1250} \\ 1,53125 \end{array}$$

В момента на  $m$  максимума ( $t_{\max} = 0$ )  $\Rightarrow$

$$\Rightarrow \lg m_{\max} = b = -0,73$$

$$\Rightarrow m_{\max} = 10^{-0,73} = \frac{1}{10^{0,73}} = \frac{1}{5} = 0,2 \text{ мдг}$$

заг. 2

Содб-04

$$\Delta\theta = \frac{V}{c} = \frac{\sqrt{\frac{GM}{R}}}{c} \rightarrow \text{аберауцията}$$

$$\pi = \frac{R}{d} \rightarrow \text{наранакс}$$

~~d~~ d = 2,2 pc - разстоянието до звездата

$$\Rightarrow \frac{\pi}{5} = \Delta\theta$$

$$\frac{R}{5d} = \frac{\sqrt{\frac{GM}{R}}}{c}$$

$$\frac{R^2 \cdot c^2}{25d^2} = \frac{GM}{R}$$

$$R^3 = \frac{GM \cdot 25d^2}{c^2}$$

$$G = 6,67 \cdot 10^{-11} \text{ m}^3 \cdot \text{s}^{-2} \cdot \text{kg}^{-1}$$

$$M = 2 \cdot 2 \cdot 10^{30} \text{ kg (2 } M_{\odot})$$

$$d = 2,2 \text{ pc} = 2,2 \cdot 206265 \text{ au} = 2,2 \cdot 206265 \cdot 150 \cdot 10^9 \text{ m}$$

$$c = 300\,000\,000 \text{ m/s}$$

$$R^3 = \frac{6,67 \cdot 10^{-11} \cdot 4 \cdot 10^{30} \cdot 25 \cdot (2,2 \cdot 206265 \cdot 150 \cdot 10^9)^2}{(3 \cdot 10^8)^2}$$

$$2,2 \cdot 2,2 = 4,84$$

$$R^3 = \frac{6,67 \cdot 10^{-11} \cdot 4 \cdot 10^{30} \cdot 25 \cdot 4,84 \cdot (2 \cdot 10^5)^2 \cdot 150^2 \cdot 10^{18}}{9 \cdot 10^{16}}$$

$$R^3 = \frac{6,67 \cdot 4 \cdot 10^3 \cdot 25 \cdot 4,84 \cdot 4 \cdot 10^{10} \cdot 150^2 \cdot 10^{18}}{9}$$

$$R^3 = \frac{6,67 \cdot 10^3 \cdot 100 \cdot 4,84 \cdot 4 \cdot 10^{28} \cdot 22500}{9}$$

$$R^3 = \frac{6,67 \cdot 4,84 \cdot 4 \cdot 22500 \cdot 10^{33}}{9} =$$

$$R^3 = \frac{6,67 \cdot 4 \cdot 10^5 \cdot 10^{33}}{9} = \frac{6,66}{216} \cdot 10^{38}$$

$$R^3 = \frac{27 \cdot 10^{38}}{9} = 3 \cdot 10^{38}$$

$$R = \sqrt[3]{3 \cdot 10^{38}} = \sqrt[3]{10^{36} \cdot 300} = 10^{12} \cdot \sqrt[3]{300} \approx 10^{12} \cdot 6,5 \text{ m} = 6,5 \cdot 10^9 \text{ km} = 4,3 \cdot 10 \text{ au} = 43 \text{ au}$$

$$150^2 = \frac{150 \cdot 150}{750} = \frac{150}{22500}$$

$$\frac{4,84 \cdot 22500}{2420} = \frac{968}{268} = 10880000$$

$$\frac{6,67 \cdot 4}{26,68} \approx 27$$

# Содр - 04

заг. 3



$$a^3 = a_1^3 \quad \text{кѐрето} \quad a_1 = a + \Delta a$$

$$\frac{a^3}{T^2} = \frac{a_1^3}{T_1^2} \quad T_1 = T - \Delta t$$

$$\frac{a^3}{T^2} = \frac{(a - \Delta a)^3}{(T - \Delta t)^2} = \frac{a^3 (1 - \frac{\Delta a}{a})^3}{T^2 (1 - \frac{\Delta t}{T})^2}$$

$$\left(1 - \frac{\Delta a}{a}\right)^3 = \left(1 - \frac{\Delta t}{T}\right)^2$$

$$1 - 3\frac{\Delta a}{a} \approx 1 - 2\frac{\Delta t}{T}$$

$$3\frac{\Delta a}{a} = 2\frac{\Delta t}{T}$$

$$\Rightarrow \frac{\Delta a}{a} = \frac{2\Delta t}{3T}$$

$(1+x)^n \approx 1+nx$  ако  $x \ll 1$

От ЗЗЕ за тантата:

$$\frac{mV_{\text{мкс}}^2}{2} - \frac{GM\oplus m}{a} = -\frac{GM\oplus m}{2a}$$

$$\frac{mV_1^2}{2} - \frac{GM\oplus m}{a} = -\frac{GM\oplus m}{2(a - \Delta a)}$$

$$\frac{mV_{\text{мкс}}^2}{2} - \frac{mV_1^2}{2} - \frac{GM\oplus m}{a} + \frac{GM\oplus m}{a} = -\frac{GM\oplus m}{2a} + \frac{GM\oplus m}{2(a - \Delta a)}$$

$$V_{\text{мкс}}^2 - V_1^2 = -\frac{GM\oplus}{a} + \frac{GM\oplus}{a - \Delta a}$$

$$V_1 = V_{\text{мкс}} - V_{\text{мин}}$$

$$V_{\text{мкс}}^2 - (V_{\text{мкс}} - V_{\text{мин}})^2 = -\frac{GM\oplus}{a} + \frac{GM\oplus}{a - \Delta a}$$

$$V_{\text{мкс}}^2 - V_{\text{мкс}}^2 + 2V_{\text{мкс}}V_{\text{мин}} - V_{\text{мин}}^2 = -\frac{GM\oplus}{a} + \frac{GM\oplus}{a(1 - \frac{\Delta a}{a})}$$

30.9.3

$$2 V_{krc} V_{min} - V_{min}^2 = \frac{-GM\oplus}{a} \left( 1 - \frac{1}{1 - \frac{\Delta a}{a}} \right)$$

$$V_{min} \ll V_{krc}$$

$$\Rightarrow V_{min}^2 \ll V_{krc}^2$$

$$2 V_{krc} V_{min} = \frac{-GM\oplus}{a} \left( 1 - \frac{1}{1 - \frac{2\Delta T}{3T}} \right)$$

$$2 V_{krc} V_{min} = \frac{-GM\oplus}{a} \left( \frac{1 - \frac{2\Delta T}{3T}}{1 - \frac{2\Delta T}{3T}} - 1 \right)$$

$$2 V_{krc} V_{min} = \frac{+GM\oplus}{a} \cdot \frac{\frac{2\Delta T}{3T}}{1 - \frac{2\Delta T}{3T}}$$

$$V_{min} = \frac{GM\oplus}{2aV_{krc}} \cdot \frac{\frac{2\Delta T}{3T}}{1 - \frac{2\Delta T}{3T}}$$

$$G = 6.67 \cdot 10^{-11} \text{ m}^3 \text{ s}^{-2} \text{ kg}^{-1}$$

$$M\oplus = 6 \cdot 10^{24} \text{ kg}$$

$$a = R\oplus + h_{krc} = 6400 \text{ km} + 400 \text{ km} = 6800 \text{ km}$$

$$V_{krc} = \sqrt{\frac{GM\oplus}{a}} = \sqrt{\frac{6.67 \cdot 10^{-11} \cdot 6 \cdot 10^{24}}{6800000}} = \sqrt{\frac{6.67 \cdot 6 \cdot 10^{13}}{6.8 \cdot 10^6}} = \sqrt{6 \cdot 10^7} = \sqrt{60 \cdot 10^6} = 1000 \cdot \sqrt{60} = 1000 \cdot 2.45 = 2450 \text{ m/s}$$

$$T = \sqrt{\frac{a^3 \cdot 4\pi^2}{GM\oplus}} = 2\pi \sqrt{\frac{a^3}{GM\oplus}} = 2\pi \sqrt{\frac{(6.8 \cdot 10^6)^3}{6.67 \cdot 10^{-11} \cdot 6 \cdot 10^{24}}} = 2\pi \cdot 6.8 \cdot 10^6 \cdot \sqrt{\frac{6.8 \cdot 10^6}{6.67 \cdot 10^{13} \cdot 6}} = 7.75 \cdot 10^3 \text{ s} = 7.75 \text{ h}$$

$$T = 2\pi \cdot 6.8 \cdot 10^6 \cdot \sqrt{\frac{1}{6 \cdot 10^7}} = \frac{2\pi \cdot 6.8 \cdot 10^6}{1000 \cdot 3.16 \cdot 2.45} = \frac{2 \cdot 6.8 \cdot 10^3}{2.45} = 5.5 \cdot 10^3 \text{ s} = 5.5 \text{ h}$$

$$V_{min} = \frac{6.67 \cdot 10^{-11} \cdot 6 \cdot 10^{24}}{2 \cdot 6.8 \cdot 10^6 \cdot 7.75} \cdot \frac{\frac{2}{3} \cdot \frac{3 \cdot 60}{55 \cdot 10^3}}{1 - \frac{2 \cdot 3 \cdot 60}{3 \cdot 55 \cdot 10^3}} = \frac{6 \cdot 10^{14}}{2 \cdot 7.75 \cdot 10^6} \cdot \frac{2 \cdot 60}{55 \cdot 10^3} = \frac{6 \cdot 10^4 \cdot 60}{7.75 \cdot 55} = \frac{6 \cdot 10^4 \cdot 60}{7.75 \cdot 55}$$

$$V_{min} = \frac{6 \cdot 10^4 \cdot 60}{4260} = \frac{6 \cdot 10^4}{71} = \frac{6 \cdot 10^4}{70} = \frac{6000}{7} = 857 \text{ m/s}$$

заг. 4  $\text{Cодо} - 04$

$$\frac{M_1}{m_1} = 8_{\text{mag}}$$

$$a = 13'$$

$$b = 12'$$

$$h_1 = 20$$

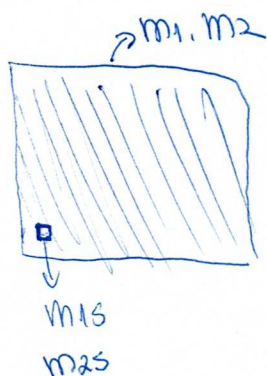
$$\frac{NGC 7000}{m_2} = 4_{\text{mag}}$$

$$a = 120'$$

$$b = 100'$$

$$h_2 = ?$$

$m_1$  и  $m_2$  - интегрални звездни величини (избират E от ъглата попу)



$$\frac{E_{1.13'.13'}}{156} = 2.512^{(m-m_{15})}$$

$$E_{1.12'.13'}$$

$$\frac{10'}{156} = 10^{0.4(m-m_{15})}$$

$$m - m_{15} = 2.5 \lg \frac{1}{156} =$$

$$= 2.5 \lg 1 - 2.5 \lg 156 =$$

$$= 0 - 2.5 \lg (12 \cdot 13) =$$

$$= -2.5 \lg 12 - 2.5 \lg 13 =$$

$$= -2.5 \lg 3 - 5 \lg 2 - 2.5 \lg 13 =$$

$$= -2.5 \cdot 0.5 - 5 \cdot 0.3 - 2.5 \cdot 1.1 =$$

$$= -1.25 - 1.5 - 2.65$$

$$m - m_{15} = -5.4$$

$$8 - m_{15} = -5.4$$

$$m_{15} = 13.4$$

повърхностната зв. величина

$$\frac{E_{2.120'.100'}}{12000} = 2.512^{(m-m_{25})}$$

$$E_{2.120'.100'}$$

$$\frac{10'}{12000} = 10^{0.4(m-m_{25})}$$

$$m - m_{25} = 2.5 \lg \frac{1}{12000} =$$

$$= 2.5 \lg 1 - 2.5 \lg 12000 =$$

$$= 0 - 2.5 \lg (12 \cdot 1000) =$$

$$= -2.5 \lg 12 - 2.5 \lg 1000 =$$

$$= -2.5 \lg 3 - 5 \lg 2 - 2.5 \cdot 3 =$$

$$= -2.5 \cdot 0.5 - 5 \cdot 0.3 - 7.5 =$$

$$= -1.25 - 1.5 - 7.5 =$$

$$= -10.25$$

$$m - m_{25} = -10.25$$

$$4 - m_{25} = -10.25$$

$$m_{25} = 14.25$$

заг.4 Кодб-04

$$m_1 = 13,4$$

$$m_2 = 14,25$$

$$\frac{E_1}{E_2} = 2,512^{(m_2 - m_1)}$$

$$\frac{E_1}{E_2}$$

$$\frac{E_1}{E_2} = 10^{0,4(14,25 - 13,4)}$$

$$\frac{E_1}{E_2}$$

$$\frac{0,4 \cdot 0,85}{0,340} =$$

$$\frac{E_1}{E_2} = 10^{0,4 \cdot 0,85}$$

$$\frac{E_1}{E_2}$$

$$\frac{E_1}{E_2} = 10^{0,34}$$

$$\frac{E_1}{E_2}$$

$$\text{НО } \lg 2 = 0,3 \quad \Rightarrow \quad \frac{E_1}{E_2} \approx 2$$

$$\lg 3 = 0,48$$

$$\frac{E_1}{E_2}$$

$$E_1 \cdot n_1 = E_2 \cdot n_2$$

$$n_2 = \frac{E_1}{E_2} \cdot n_1 = 2 \cdot 20 = 40 \text{ картра}$$

зап. 5

Содб - 04

$p = 22 \text{ min}$

$\Rightarrow \omega = \frac{2\pi}{p} = \frac{2\pi}{22 \cdot 60} = \frac{1}{22 \cdot 10} = 0,0045 \text{ rad/s}$



тясно насотени сигнали  $\Rightarrow$   
обектът е или неутронна звезда  
или блазар

$\Delta t = 5 \text{ min}$

$\Delta \theta = \frac{5}{22} \cdot 360^\circ \approx 81.8^\circ$

- областта, в която излъчва  
сигналите

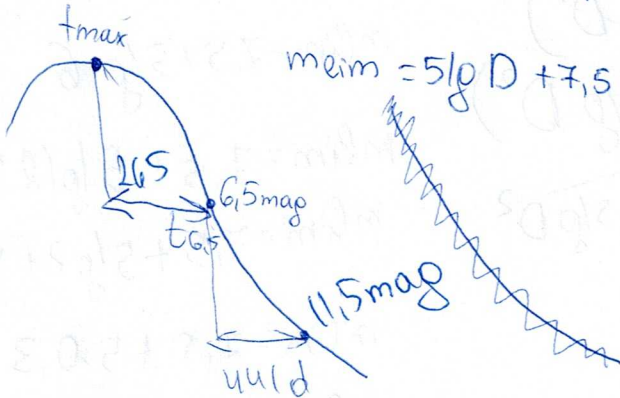


# Содб-04

заг 1

$t_{max} = 15 \text{ мая } 1987$   $\rightarrow 16 + 30 + 31 + 31 + 30 + 31 + 30 + 31 + 31 + 4$   
 $t_{0.5} = 4 \text{ декаб } 1988 = 265 \text{ d}$

~~Содб~~  $D = 6 \text{ см} - 2 \text{ ланп. } 1988 \text{ Pr.}$   $\rightarrow 365 + 24 + 31 + 21 = 441 \text{ d}$   
 $= 365 + 76 = 441 \text{ d}$



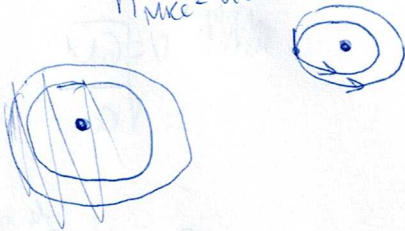
заг 2  $d = 2.2 \text{ pc}$   $M = 2 M_{\odot}$   ~~$\pi = \frac{a}{d}$~~   $\frac{\pi}{5} = \frac{a}{d} =$

$G = \frac{m \cdot 3.5^{-2} \text{ kg}^{-1} \text{ s}^{-2}}$

заг 3 ~~2023~~

$\Delta t = 3$

$r_{mxc} = 400 \text{ km} = 6100 \Rightarrow a_{mxc} = 6700 \text{ km}$



$\frac{a^3}{T^2} = \frac{a'^3}{T'^2}$   $\left| \begin{array}{l} \frac{m V_{mxc}^2}{2} - \frac{GM_{\oplus} m}{a_{mxc}} = -\frac{GM_{\oplus} m}{2a_{mxc}} \\ \frac{m V_1^2}{2} - \frac{GM_{\oplus} m}{a} = -\frac{GM_{\oplus} m}{2(a+\Delta a)} \end{array} \right.$

$v = \sqrt{\frac{GM}{r}}$   
 $v^2 r = GM$   
 $(\text{m/s})^2 \cdot \text{m} = 6.67 \times 10^{-11} \text{ m}^3 \text{ kg}^{-1} \text{ s}^{-2} \cdot \text{kg}$

~~$2V_{mxc}V_{min} - V_{min}^2 = \frac{GM_{\oplus}}{a(1+\frac{\Delta a}{a})} - \frac{GM_{\oplus}}{a}$~~   $\frac{a^3}{T^2} = \frac{a^3(1+\frac{\Delta a}{a})^3}{(T+\Delta T)^2}$   $\frac{m V_{mxc}^2}{2} - \frac{m V_1^2}{2} = \frac{GM_{\oplus} m}{2(a+\Delta a)} - \frac{GM_{\oplus} m}{2a}$

$2V_{mxc}V_{min} = \frac{GM_{\oplus}}{a} \left( \frac{1}{1+\frac{\Delta a}{a}} - 1 \right)$   $\frac{3\Delta a}{a} = \frac{2\Delta T}{T}$   $V_1 = V_{mxc} - V_{min}$

$2V_{mxc}V_{min} = \frac{GM_{\oplus}}{a}$   $\frac{3\Delta a}{a} = \frac{2\Delta T}{T}$   $V_{mxc}^2 - V_{mxc}^2 + 2V_{mxc}V_{min} - V_{min}^2 = \frac{GM_{\oplus}}{a(1+\frac{\Delta a}{a})} - \frac{GM_{\oplus}}{a}$

$$\frac{E \cdot d^2}{E \cdot D^2} = 2,512 \quad (m_{lim} - 6,5)$$

$$m_{lim} - 6,5 = 2,5 \lg \frac{d^2}{D^2}$$

~~$$m_{lim} - 6,5 = 2,5 (\lg d^2 - \lg D^2)$$~~

~~$$m_{lim} - 6,5 = 2,5 (\lg 36 - \lg D^2)$$~~

~~$$m_{lim} - 6,5 = 2,5 \lg 36 - 2,5 \lg D^2$$~~

$$m_{lim} - 6,5 = 5 \lg \frac{d}{D}$$

$$m_{lim} - 6,5 = 5 \lg d - 5 \lg D$$

~~$$m_{lim} - 6,5 = 5 \lg 6 - 5 \lg D$$~~

~~$$m_{lim} - 6,5 = 5 \lg (2,3) - 5 \lg D$$~~

~~$$m_{lim} - 6,5 = 5 \lg 6 - 5 \lg D$$~~

~~$$m_{lim} - 6,5 = 5 \cdot 0,3 + 5 \cdot 0,5 - 5 \lg D$$~~

~~$$m_{lim} - 6,5 = 1,5 + 2,5 - 5 \lg D$$~~

~~$$m_{lim} - 6,5 = 4 - 5 \lg D$$~~

~~$$m_{lim} - 6,5 = -1 - 5 \lg D$$~~

~~$$\text{[scribble]}$$~~

$$m_{lim} = 7,5 + 5 \lg D_{[cm]}$$

$$m_{lim} = 7,5 + 5 \lg 6$$

$$m_{lim} = 7,5 + 5 \lg (2,3)$$

$$m_{lim} = 7,5 + 5 \lg 2 + 5 \lg 3$$

$$m_{lim} = 7,5 + 5 \cdot 0,3 + 5 \cdot 0,5$$

$$m_{lim} = 7,5 + 1,5 + 2,5$$

$$m_{lim} = 11,5 \text{ mag}$$

$$\sin \theta' = \frac{v}{c} \sin \theta \quad \theta \approx 30^\circ$$

$$\sin \theta' = 206265 \frac{v}{c}$$

~~$$v = \frac{\sqrt{GM}}{\sqrt{a}}$$~~

$$a^3 = 6,67 \cdot 10^{-11} \cdot 2,2 \cdot 10^{30} \cdot 25 \cdot 2,2 \cdot 10^8$$

$$\frac{\pi}{5} = \frac{a}{sd} = \frac{v}{c}$$

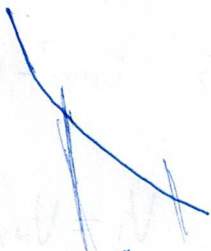
$$a^3 = 6,67 \cdot 10^{-11} \cdot 4 \cdot 10^{30} \cdot 25 \cdot 484 \cdot 206265^2$$

$$\frac{a}{sd} = 206265 \frac{\sqrt{GM}}{\sqrt{a}}$$

$$a^3 = 6,67 \cdot 10^{-11} \cdot 4 \cdot 10^{30} \cdot 25 \cdot 22500 \cdot 206265^2$$

~~$$\frac{a \cdot c}{5 \cdot 206265 d_{[cm]}} = \frac{\sqrt{GM}}{\sqrt{a}}$$~~

~~$$\frac{a \cdot c^2}{5 \cdot 206265^2 d_{[cm]}^2} = \frac{GM}{a}$$~~



~~$$a^3 = 6M \cdot (206265)^2$$~~

$$a^3 = \frac{6M \cdot 25 \cdot d^2}{c^2}$$

~~$$m^2 \cdot \frac{m^2}{m^2} \cdot \frac{m^2}{m^2}$$~~

$$210^5 \cdot 2 \cdot 10^5$$

$$4 \cdot 10^{10}$$

$$14886 \cdot 150 \cdot 151$$

$$750$$

$$450$$

Coop-04

$$6,67 \cdot 10^{23} \cdot 4,84 \cdot 4 \cdot 10^{10} \cdot 22500 \cdot \frac{22}{6,67 \cdot 4} \cdot 100000$$

$$6,67 \cdot 10^{23} \cdot 4 \cdot 10^{10} \cdot 100000 =$$

$$= 6,67 \cdot 4 \cdot 10^{38}$$

$$\sqrt[2]{27 \cdot 10^{38}}$$

$$\sqrt[3]{10^{38}}$$

$$\sqrt[3]{10^{36} \cdot 100}$$

$$3 \cdot 10^{12} \cdot 4,5$$

$$13,5 \cdot 10^{12} \text{ m}$$

$$13,5 \cdot 10^9 \text{ km}$$


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$$1,5 \cdot 10^8$$

$$150 \cdot 10^6 = 1,5 \cdot 10^8$$

$$13,5 : 1,5 = 135 : 15 = 9$$

$$9 \cdot 10 \Rightarrow 80 \text{ au}$$

$$\frac{65 \cdot 10^9}{1,5 \cdot 10^8} = 4,33$$

интегралната  
поверхнината

заг. ч

$m=8$	$m=4$
$a=13'$	$a=120'$
$b=12'$	$b=100'$

20 карта

$$n=?$$

$$\frac{12 \cdot 13}{36} = 156$$

карта



$$A_1 = a \cdot b' = 156 \text{ d}$$

$$A_2 = 12000 \text{ d}$$

$$\frac{E \cdot 10 \text{ d}}{E \cdot 156 \text{ d}} = 2512 \text{ (m-ms1)}$$

$$\frac{10'}{12000 \text{ d}} = 2512 \text{ (m-ms2)}$$

$$m - m_{s1} = 2512 \cdot \frac{1}{156}$$

$$m - m_{s2} = 2512 \cdot \frac{1}{12000}$$

$$S_{-ms1} = 2,5 \lg \frac{1}{156} =$$

1,125  
Codp-04

$$= 2,5 \lg 1 - 2,5 \lg 156 =$$

$$= 0 - 2,5 \lg 156 =$$

$$= -2,5 \lg 102 - 2,5 \lg 13 =$$

$$= -2,5 \lg 3 - 2,5 \lg 2 - 2,5 \lg 13 =$$

$$= -2,5 \cdot 0,5 - 5 \cdot 0,3 - 2,5 \cdot 1,1 =$$

$$= -1,25 - 1,5 - 2,65 =$$

$$= -4,6$$

$$S_{-ms1} = -4,6$$

$$ms1 = 12,6$$

$$U_{-ms2} = 2,5 \lg \frac{1}{12000} = 0 - 2,5 \lg 12000$$

$$U_{-ms2} = -2,5 \lg 1000 - 2,5 \lg 12$$

$$U_{-ms2} = -2,5 \cdot 3 - 2,5 \lg 3 - 5 \lg 2$$

$$U_{-ms2} = -7,5 - 2,5 \cdot 0,5 - 1,5 =$$

$$U_{-ms2} = -9 - 1,25$$

$$U_{-ms2} = -10,25$$

$$ms2 = 14,25$$

$$\frac{E_1}{E_2} = 2,5 \cdot 12^{(14,25 - 12,6)}$$

$$\frac{E_1}{E_2} = 10^{0,4 \cdot 1,65}$$

$$\frac{E_1}{E_2} = 10^{0,66}$$

$$20 \cdot E_1 = n \cdot E_2$$

$$n = 20 \cdot \frac{E_1}{E_2}$$

$$n = 20 \cdot 4,5 = 90 \text{ кагера}$$

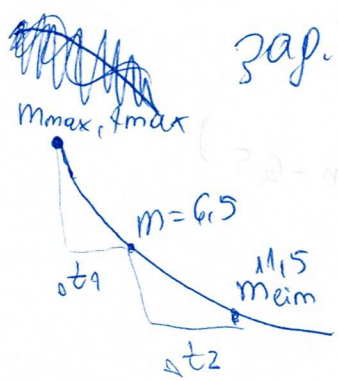
$$\lg 4 = \lg 2 + \lg 2 = 0,3 + 0,3 = 0,6$$

$$\lg 5 = 0,7$$

$$\approx 11,5$$

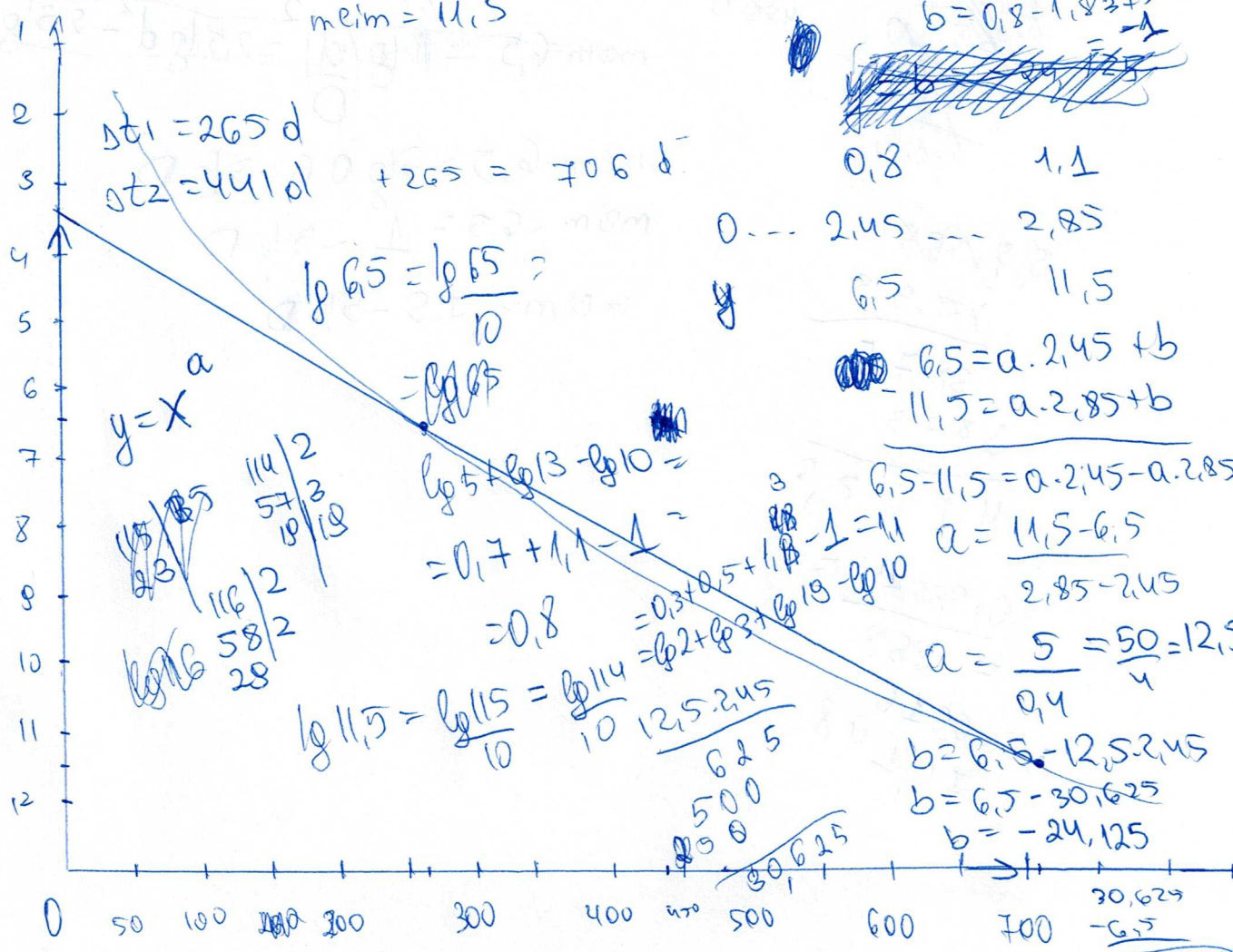
$$\frac{1,65 \cdot 0,4}{0,660}$$

zap. 1



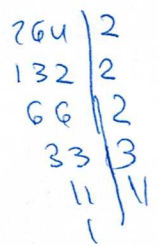
$m_{lim} = 7.5 + 5 \lg D$   
 $m_{lim} = 7.5 + 5 \lg 2 + 5 \lg 3$   
 $m_{lim} = 7.5 + 5 \cdot 0.3 + 5 \cdot 0.5$   
 $m_{lim} = 7.5 + 1.5 + 2.5$   
 $m_{lim} = 11.5$

$a = \frac{1.1 - 0.8}{2.85 - 2.45}$   
 $a = \frac{0.3}{0.4} = 0.75$   
 $b = 0.8 - 0.75 \cdot 2.45$   
 $b = 0.8 - 1.8375 = -1.0375$



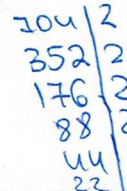
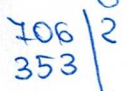
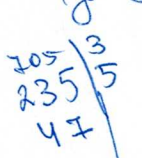
$6.5 = a \cdot 2.45 + b$   
 $11.5 = a \cdot 2.85 + b$   
 $6.5 - 11.5 = a \cdot 2.45 - a \cdot 2.85$   
 $a = \frac{11.5 - 6.5}{2.85 - 2.45} = \frac{5}{0.4} = 12.5$   
 $b = 6.5 - 12.5 \cdot 2.45 = 6.5 - 30.625 = -24.125$

$\lg st_1 = \lg 265 = \lg 2 + \lg 2 + \lg 2 + \lg 3 + \lg 11 = 0.3 + 0.3 + 0.3 + 0.5 + 1.05 = 2.45$

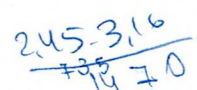


$a = \frac{5}{0.4} = 12.5$   
 $b = 6.5 - a \cdot 2.45 = -24.125$

$\lg st_2 = \lg 706 \approx \lg 704 = 6 \cdot \lg 2 + \lg 11 = 6 \cdot 0.3 + 1.05 = 2.85$



$2 \cdot 6.8 = 13.6$   
 $13.6 : 2.5 = 5.5$



$\sqrt{10} = 3.16$   
 $\sqrt{6} = 2.5$   
 $2.5 \cdot 2.5 = 6.25$

# PC Code - 04

$$12 : 550 = 0,0218$$

$$\begin{array}{r} 1200 \\ - 1100 \\ \hline 1000 \\ - 850 \\ \hline 1500 \\ - 3500 \\ \hline 2000 \\ - 3300 \\ \hline 2000 \\ - 2000 \\ \hline 0 \end{array}$$

$$\begin{array}{r} 1000 \\ - 550 \\ \hline 4500 \end{array}$$

$$\frac{E \cdot d^2}{E \cdot D^2} = 2,5^{12} \quad (\text{mem} - 6,5)$$

$$\text{mem} - 6,5 = \log \left( \frac{d}{D} \right)^2 = 2,5 \log d^2 - 2,5 \log D^2$$

$$\text{mem} - 6,5 = 5 \log 0,6 - 5 \log D$$

$$\text{mem} - 6,5 = 1 - 5 \log D$$

$$\text{mem} = 7,5 - 5 \log D$$

$$\begin{array}{r} 877,5 \\ \hline 3875 \\ 3875 \\ \hline 4162,5 \\ \hline 0,98871 \\ \hline 888 \\ 6916 \\ 70148 \end{array}$$