2

1. naloga

Prvi sladkor, ki so ga astronomi odkrili v medzvezdnih oblakih, je glikolaldehid CH_2OHCHO. V nekem medzvezdnem oblaku s polmerom 2 parseka je koncentracija molekul (število molekul v stolpcu oblaka z osnovno ploskvijo 1 kvadratni centimeter) v smeri proti središču oblaka $2{,}8 \times 10^{14}$ molekul/cm^2. Oceni celotno maso molekul glikolaldehida v tem oblaku.

Koncentracija $K = 2{,}8 \cdot 10^{14}$ m/cm^2

Polmer $r = 2pc$

$m = ?$

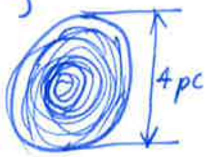
$1pc^3 = (3{,}17 \cdot 10^{18} cm)^3 = \underline{1{,}024 \cdot 10^{55} cm^3}$

Najprej izračunamo molsko maso molekule: (m_m)

$m_m = 2 \cdot (C) + 4 \cdot (H) + 2 \cdot (O) = (2 \cdot 12 + 4 \cdot 1 + 2 \cdot 16) = (24 + 4 + 32) = \underline{60 \frac{mol}{kg}}$

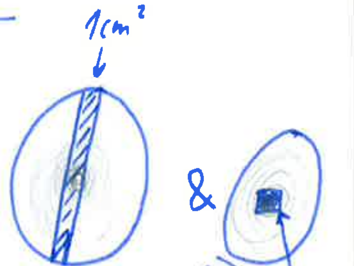
Sedaj je na vrsti prostornina V_0:

$V_0 = \frac{4}{3}\pi r^3 = \frac{4}{3}\pi \cdot 8pc = \underline{33pc^3} =$



$= \underline{3{,}366 \cdot 10^{56} cm^3}$

Malo so čudna navodila, ampak mislim da je K =



K = stolpec "zraka" čez središče

$V_e = 1cm^2 \cdot 1pc =$

$V_K = 1cm^2 \cdot 1pc = 1cm^2 \cdot 3{,}17 \cdot 10^{18} cm = \underline{3{,}17 \cdot 10^{18} cm^3}$

Kolikokrat se ta stolpec pojavi v oblaku?

$n = \frac{V_0}{V_K} = \frac{1\ \cancel{3{,}366} \cdot 10^{56} \cancel{cm^3}}{1\ \cancel{3{,}17} \cdot 10^{18} \cancel{cm^3}} = \underline{10^{38}}$

Koliko je torej molekul?

$n_m = 10^{38} \cdot K = 10^{38} \cdot 2{,}8 \frac{molekul}{cm^2} = \underline{2{,}8 \cdot 10^{52} molekul}$

$\frac{2{,}8 \cdot 10^{52} molekul}{6 \cdot 10^{24}} = \underline{4{,}5 \cdot 10^{27} mol}$

Koliko torej tehtajo?

$\frac{n_m}{m_m} = \frac{4{,}5 \cdot 10^{26} mol \cdot kg}{60\ mol} = \underline{\underline{7{,}5 \cdot 10^{25} kg}}$

Rešitev = $\boxed{7{,}5 \cdot 10^{25} kg} = \underline{7{,}5 \cdot 10^{25} kg}$

Concentration: $K = 2{,}8 \cdot 10^{14} \frac{m}{cm^2}$ see google translate sl-ru ↓ molska masa (МОЛСКА МАСА)

Radius $r = 2pc$

3

$m = ?$

First we calculate molic (?) mass [1] (m_m):

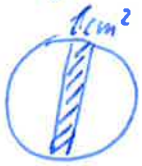
$m_m = 2 \cdot v(C) + 4 \cdot v(H) + 2 \cdot v(O) = (2 \cdot 12 + 4 \cdot 1 + 2 \cdot 16) \frac{mol}{kg} = \underline{60 \frac{mol}{kg}}$ 1.

$(1pc^3 = (3{,}17 \cdot 10^{18} cm)^3 = 1{,}024 \cdot 10^{55} cm$

Now, volume V_0:

$V_0 = \frac{4}{3}\pi r^3 = \frac{4}{3}\pi \cdot 8pc = 33pc^3 = \underline{3{,}366 \cdot 10^{56} cm^3}$

Little bit ununderstandable instructions, but I understood that

$K =$  & 

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$V_K = 1cm^2 \cdot 1pc$

$V_K = 1cm^2 \cdot 1pc = 1cm^2 \cdot 3{,}17 \cdot 10^{18} cm = \underline{3{,}17 \cdot 10^{18} cm^3}$

How many times does this figure repeats in the whole sphere?

$n = \frac{V_0}{V_k} = \frac{3{,}366 \cdot 10^{\cancel{56}\,40} cm^3}{3{,}17 \cdot 10^{15} cm^3} = \underline{10^{38}}$

How many are there molecules, then?

$n_m = 10^{38} \cdot K = 10^{38} \cdot \underset{\uparrow \cdot 10^{14}}{2{,}8} \frac{molecules}{cm^2} = 2{,}8 \cdot 10^{52}$ molecules

~~Kg~~

How many is then their mass? $\frac{2{,}8 \cdot 10^{52} \text{ molecules}}{6 \cdot 10^{24}} = \underline{4{,}5 \cdot 10^{28} mol}$

$m = \frac{n_m}{m_m} = \frac{4{,}5 \cdot 10^{28} mol \cdot kg}{60 \cdot mol} = \underline{7{,}5 \cdot 10^{25} kg}$

The Result = $\boxed{7{,}5 \cdot 10^{25} kg}$

4

2. naloga

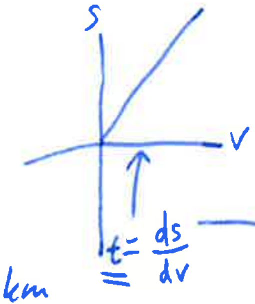
Vesoljska ladja ima neverjeten pogon, ki troši zanemarljivo malo goriva in lahko mnogo let ladjo pospešuje s pospeškom 1 *g*. Ta vesoljska ladja vozi med nizko orbito okoli Zemlje do nizke orbite okoli Marsa. Oceni, najmanj koliko časa in največ koliko časa lahko traja dolžina leta te vesoljske ladje. Predpostavi, da mora imeti ladja v bližini Zemlje in Marsa hitrost nič glede na Sonce.

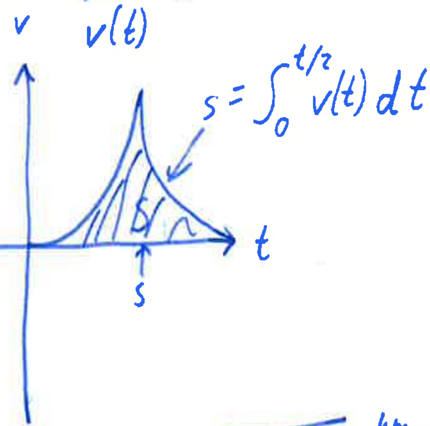
Ladja mora pospeševati (a), a na določeni točki mora tudi začeti pojenjati (-a). ← na sredini

Če vedno izkoristimo vse od ladje ($a = 1g$), potem mora do polovice poti pospeševati, nato pa že upočasnjevati.

$a_{\oplus} = 1AU = 1{,}5 \cdot 10^8 km$

$a_{♂} = 1{,}5 AU = 2{,}25 \cdot 10^8 km$





$s = a_{♂} - a_{\oplus} = 0{,}75 \cdot 10^8 km$

Pot pospeševanja: $\frac{s}{2} = 3{,}7 \cdot 10^7 km$

Začetna hitrost: $v_1 = 0 \frac{km}{s}$

Sredinska hitrost: $v_2 = \sqrt{as} = \sqrt{0{,}0098 \frac{km}{s^2} \cdot 3{,}7 \cdot 10^7 km} = \sqrt{362600} \frac{km}{s} = 600 \frac{km}{s}$

$\frac{čas}{2} = \frac{t}{2} = \frac{\Delta \vec{v}}{\vec{a}} = \frac{600 km\, s^2}{0{,}0098 s\, km} = 60000 s = 17h$

$t_M = 17h \cdot 2 = \underline{34h}$

To je najmanjši čas, če bi ladja iz orbite zbrzela v trenutku.

Še najdaljši čas:

$s = a_{♂} + a_{\oplus} = 2{,}5 AU = \underline{3{,}8 \cdot 10^8 km}$

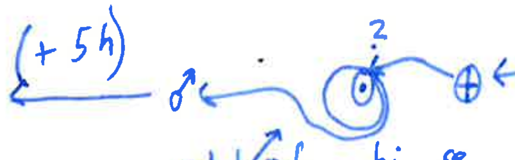
$\frac{s}{2} = 1{,}9 \cdot 10^8 km$

$v_1 = 0 \frac{km}{s}$ $\quad v_2 = \sqrt{as} = \sqrt{0{,}0098 km \cdot s^{-2} \cdot 1{,}9 \cdot 10^8 km} = 1400 \frac{km}{s}$

$\frac{čas}{2} = \frac{t}{2} = \frac{\Delta \vec{v}}{\vec{a}} = \frac{1400 km\, s^2}{0{,}0098 s\, km} = 140000 s$

$t_N = 140000 s \cdot 2 = 4700 min = \boxed{80h}$

Rešitev:
Najmanj 34h
Največ 85h.



naleteli na Sonce.

Seveda pa bi pri tej vožnji podaljšalo bi se za 5h.

(2.)

The ship needs to accelerate (a), but on the middle it has to de-accelerate (-a). If the ship goes on full power, then this is the point of stopping.

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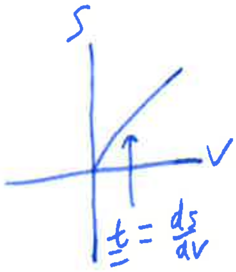
$a_{\oplus} = 1AU = 1{,}5 \cdot 10^8 km$

$a_{♂} = 1{,}5 AU = 2{,}25 \cdot 10^8 km$

$s = a_{♂} - a_{\oplus} = 0{,}75 \cdot 10^8 km$



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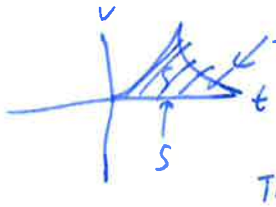

$s = \int_0^{t/2} v(t)dt$

This doesn't help

Distance we accelerate: $\frac{s}{2} = 3{,}7 \cdot 10^7 km$

Initial velocity: $v_1 = 0 \frac{km}{s}$

Full velocity: $v_2 = \sqrt{as} = \sqrt{0{,}0098 \frac{km}{s^2} \cdot 3{,}7 \cdot 10^7 km} = \sqrt{362600} \frac{km}{s} = \underline{600 \frac{km}{s}}$

$\frac{time}{2} = \frac{t}{2} = \frac{\Delta \vec{v}}{\vec{a}} = \frac{600 \, km \, s^2}{0{,}00985 \, km} = 60000 s = 17h$

$t_{MIN} = 17h \cdot 2 = \underline{34h}$

This is the lowest time we need if the ship immediately starts to accelerating in the orbit.

~~Add~~ The longest time is then:

$s = a_{♂} + a_{\oplus} = 2{,}5 AU = \underline{3{,}8 \cdot 10^8 km}$

$\frac{s}{2} = 1{,}9 \cdot 10^8 km$

$v_1 = 0 \frac{km}{s}$; $v_2 = \sqrt{as} = \sqrt{0{,}0098 \frac{km}{s^2} \cdot 1{,}9 \cdot 10^8 km} \approx 1400 \frac{km}{s}$

$\frac{time}{2} = \frac{t}{2} = \frac{\Delta \vec{v}}{\vec{a}} = \frac{1400 \cdot s^2 \cdot km}{0{,}00985 \cdot km} \approx 140000 s$

$t_{MAX} = 140000 s \cdot 2 = \approx 4700 min \approx \boxed{80h}$

But we will here jump into the Sun, so we must avoid it: $\oplus \rightarrow ⊙ \rightarrow ♂$

(+5h)

So, the results are:

At least: $\underline{34h}$

Maximum: $\underline{85h}$

EN

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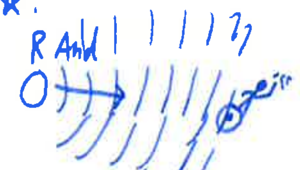
3. naloga

Zvezda R Andromede zaradi močnega zvezdnega vetra izgublja 10^{-6} mase Sonca letno. Oceni gostoto delcev zvezdnega vetra iz te zvezde v bližini Osončja. Predpostavi, da delci z zvezde letijo enakomerno in premočrtno v vse smeri s hitrostjo $3x10^2$ km/s. Letna paralaksa R Andromede je 0,004".

Oddaljenost zvezde je:/The distance of the ★:



$$d \doteq \frac{1}{\pi''} = \frac{1}{0{,}004''} \doteq \frac{1000}{4} = \underline{250\,pc}$$

So the surface of this sphere is about:

$$S \doteq \underline{60000\,pc^2}$$

It goes $10^{-6}\frac{M_\odot}{yr}$ through this.

Through $1pc^2$ it goes $\frac{\cancel{10^{-6}}^{\,-10}\,\frac{M_\odot}{yr}}{\cancel{60000}\,pc^2} = \frac{1}{6}\cdot 10^{-10}\frac{M_\odot}{yr\cdot pc^2}$

$$1\,M_\odot = 2\cdot 10^{30}\,kg$$

$$\frac{1}{6}\cdot 10^{-10}\frac{kg}{yr\,pc^2}\cdot 2\cdot 10^{30} = \frac{1}{3}\cdot 10^{20}\frac{kg}{yr\,pc^2} = 10^{10}\frac{kg}{s\,pc^2}$$

Now we just divide it with the velocity $\left(v = 300\frac{km}{s} = \frac{1}{10^{11}}\right)$

$$10^{10}\frac{kg}{s\cdot pc^2} : \frac{1}{10^{11}}\frac{pc}{s} = \boxed{10^{21}\frac{kg}{pc^3}}$$

This is also the result.

$$10^{21}\frac{kg}{pc^3}$$

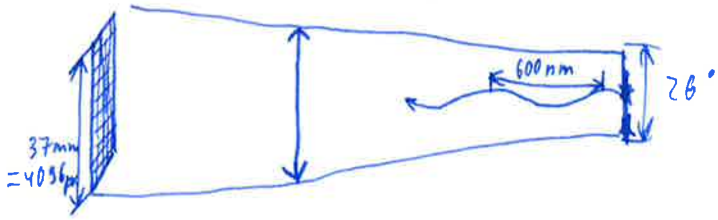
EN

7

4. naloga

Vsak od teleskopov sistema KELT je opremljen z objektivom premera 42 mm in CCD kamero velikosti 37x37 mm in z 4096x4096 slikovnimi elementi (piksli). Teleskop pokriva 26°x26° veliko polje neba. Kamera je najbolj občutljiva pri valovni dolžini svetlobe 600 nm. Izračunaj teoretično kotno ločljivost sistema teleskop-CCD kamera.

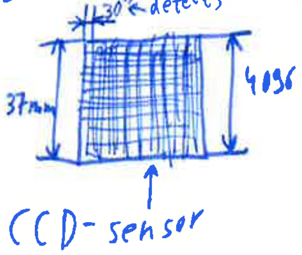
Skica:



We define the size of 1 pixel:

$$1p = \frac{37mm}{4096} = \underline{9,25\ nm}$$

So this size correspondents to $\frac{26}{4096}°$ of the sky.

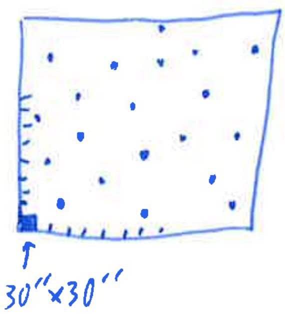


$$= \frac{1}{180}° = \boxed{30''}$$

Every pixel detects so much of the sky, so this is pretty close to the final result.

We said that light behaves like particle ≐ completelly straight line

The result is ≐ 30'', which means that every pixel "lies" on 30'' of the sky:



EN

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5. naloga

Rentgenski izvor Cyg X-3 v Labodu je spremenljiv. Astronomi so opazili, da iz območja neba, ki je od izvora Cyg X-3 na nebu oddaljen 16", ravno tako prihaja rentgenska svetloba z enako periodo spremembe sija, le da s časovnim zamikom 2,7 let glede na Cyg X-3. Izračunaj, kako daleč je Cyg X-3 od Sonca. Kako daleč pa je od središča naše Galaksije?

⊙

P = period

$d(x)$ = distance of x

2,7 and a multiplicator of this

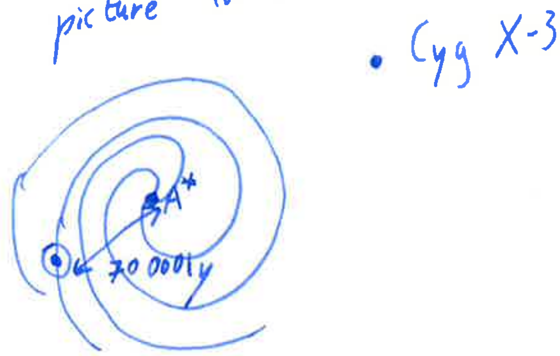
$d(X) - d(\text{Cyg X-3}) = \cancel{(2,7 n P)\,ly} = (2,7 \cdot n)\,ly$

The distance which we will get minus ~~...~~ 70 000ly is the distance from the center of our galaxy.

Why?

Saggitarius A* lies on the summer sky, Cygnus too.

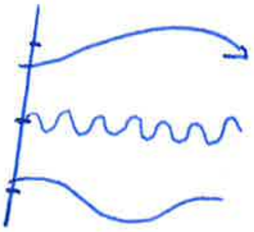
So the picture looks like this:



$37mm \sim 4096px \sim 26°$

"Appendix"

$E = hf$



9

$0{,}75 : 2 = 0{,}37$

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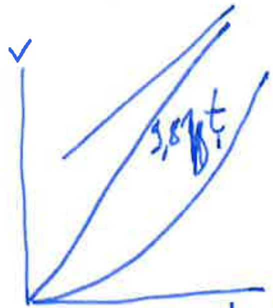


$v = \frac{s}{t}$

$\frac{9{,}6 \cdot 10^{12} \cdot 3{,}3}{9{,}6 \cdot 10^{15}}$

$a = \frac{\Delta v}{t}$

$3{,}13 \cdot 10^{13}$

$a = \frac{v_1 - v_2}{t}$

1pc

a, s, v_1, v_2

$v = \frac{s}{t}$

$a = \frac{\frac{s}{t}}{t}$

$3{,}17 \cdot 10$

$a = \frac{s}{t^2}$

$at + v_1 = v_2$

s(v)

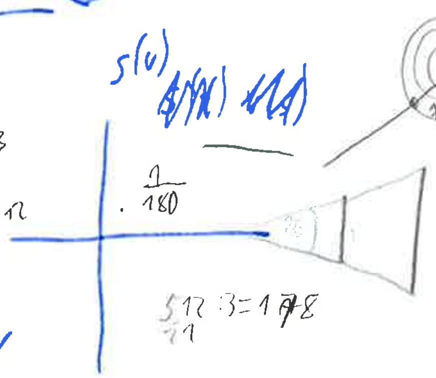
$\frac{76}{4096}$ 6

3

2048 · 512

1024

$\frac{1}{180}$



$\frac{300}{3{,}17 \cdot 10^{13}}$

$\frac{s}{t^2} = \frac{v_2 - v_1}{t}$

$512 : 3 = 178$

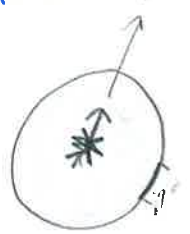
$t = \frac{s}{v}$

$\frac{1}{3{,}17 \cdot 10^{17}}$

$\frac{76}{4096}$

$\frac{1}{60} = 1'$

$\frac{s}{v}$



$\frac{s}{t} =$

$v = \frac{s}{t}$

1pc = 30''

$37 : 4096 = 0{,}00$

370

3700

37000

$(250pc)^2 =$

$v = \frac{s}{t}$

$f = \frac{3 \cdot 10^8 \, m/s}{600 \cdot 10^{-9}}$

$v = \frac{s}{t}$

$\frac{4096 \cdot 8}{32000}$

$f = \frac{\lambda}{c}$

10^{-9}

10^{-6}

675008

600 00

300 000

10^{-6}

660nm

60000 px²

$1800 \cdot 10^{17}$

$1{,}8 \cdot 10^{20}$ Hz

$\frac{s}{c} = \frac{1}{t}$

πr^2

10^8 m/s

$H_z = \frac{m}{s}$

$\frac{M_\odot}{pc^2}$

$f = \frac{c}{\lambda}$

$f = \frac{s}{c}$

$600 \cdot 10$

$\frac{600 \cdot 10^{-9} \, m/s}{3 \cdot 10^8 \, m/s}$

$P = 60000 \, pc$

$10^{-6} \, M_\odot$

3

$\frac{37}{4096}$

$37 \cdot 4000$

9,25

$0{,}037 : 4 = 0{,}00925$

$10^{-6} \, \frac{M_\odot}{yr}$

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10

$1 \text{ mol} = 6 \cdot 10^{24}$ molekul

$1\,kg$

$1 \frac{mol}{kg}$ $14 \frac{mol}{kg} = \frac{14\,mol}{1\,kg}$

$\rho = \frac{kg}{pc^2}$

$v = \frac{s}{t}$ $a = \frac{\Delta v}{t}$

$\frac{14\,mol \cdot kg}{14\,mol} = 1\,kg$

$a = \frac{v}{t}$ $t = \frac{v}{a}$ $t = \frac{s}{v}$

$\rho = \frac{m}{V}$ $m = \rho \cdot V$

$\frac{v}{a} = \frac{s}{v} = t$

$\frac{3{,}14 \cdot 4}{}$ $\frac{3{,}1 \cdot 4}{12{,}4}$ $\frac{pc}{yr}$

$\frac{12{,}6 \cdot 8}{100{,}8} : 3 = 33$

$3{,}6 \cdot 10^{12}\,km$

$9{,}6 \cdot 10^{12}\,cm$

$\frac{98000 \cdot 19}{98000}$ 882000 1862000

31,7 cm

$\frac{3{,}2 \cdot 3{,}2}{96}$ $\frac{64}{10{,}24}$

$\frac{9{,}6 \cdot 3{,}3}{288}$ 288 31,68

$1\,pc = 3{,}17 \cdot 10^{18}\,cm$

$1{,}024 \cdot 33$

$\frac{9800 \cdot 37}{29400}$ 68600 362600

0,0098

$\frac{1{,}02 \cdot 33}{306}$ 306 33,66

$28 : 6 =$

600000

4,5

$1\,pc = 31{,}68 \cdot 10^{12}\,km = 3{,}168 \cdot 10^{13}\,km$

$9{,}6 \cdot 10^{12}$

$45 : 6 = 7{,}5$

$a = 1 \frac{m}{s^2}$ $t = 5\,s$

$3 \cdot 10^{13}$ $\cdot 10$

2,7

$v = 5 \frac{m}{s}$ $s = v\,t = 25\,m$