Worksheet 1: Astronomy

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Q1) $R = 6.36 \times 10^6$ m

(a) $2\pi R = 39.9408 \times 10^3$ Km = circumference

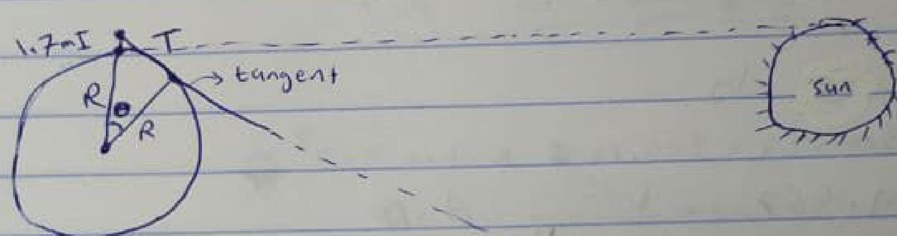
(b) $4\pi R^2 = 508.046976 \times 10^6$ km = surface Area

(c) $(4/3)\pi R^3 = 1077.060 \times 10^9$ km = Volume

Q2) 1 century $\rightarrow$ 1.0 ms

20 centuries $\rightarrow$ 20 ms

Q3)



According to observer at $t = 0$

According to observer when standing at $t = 1.1$ s

$(R + 1.7)^2 = R^2 + T^2$

$\cancel{R^2} + 3.4R + 2.38 = \cancel{R^2} + T^2$

$R = \dfrac{T^2 - 2.38}{3.4}$

To find T:

$360^\circ \rightarrow 24\cancel{h} * 3600 \frac{s}{\cancel{h}}$

$\theta \rightarrow 1.1$ s

$\Rightarrow \theta = \dfrac{1.1 \times 360}{24 \times 3600} = 0.004583^\circ = 4.583^\circ \times 10^{-3}$

$\tan\theta = \dfrac{T}{R} \Rightarrow T = 8 \times 10^{-5} R$

$\Rightarrow R = \dfrac{(8 \times 10^{-5})^2 R^2 - 2.38}{3.4}$

$64 \times 10^{-10} R^2 - 3.4R - 2.38 = 0$

$R = \dfrac{3.4 \pm \sqrt{(3.4)^2 + 4(2.38)(64 \times 10^{-10})}}{2(64 \times 10^{-10})} =$

Q4) $M = 5.98 \times 10^{24}$ Kg , $m = 40u = 40 \times 1.66 \times 10^{-27}$ Kg

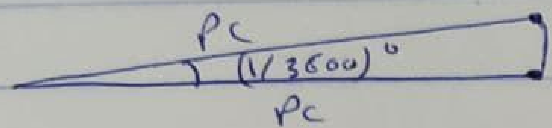
number of atoms $= n = \dfrac{M}{m} = 9.0 \times 10^{49}$ atoms

Q5) $1\,AU = 1.50 \times 10^{8}\ Km$

$c = 3.0 \times 10^{8}\ m/s = \frac{3.0 \times 10^{8}}{1.50 \times 10^{11}}\ \frac{Au}{s} = 2 \times 10^{-3}\ \frac{Au}{1/60\ min}$

$\boxed{= 0.120\ \frac{Au}{min}}$

Q6) (a) $Au = 1.50 \times 10^{8}\ Km \Rightarrow x\ pc$



$\rightarrow AU = \left(\frac{1}{3600}\right)^{\circ} * \frac{\pi}{180}\ \frac{rad}{\circ}\ Pc$

$\Rightarrow 1\ Pc = 206265\ AU$

$\Rightarrow \boxed{1\,Au = 4.8481368 \times 10^{-6}\ pc}$

(b) $Au \Rightarrow x\ ly$

$ly = 3600 \times 24 \times 365.25 \times 3.0 \times 10^{8}\ m$

$= 9.46728 * \frac{10^{15}}{1.5 \times 10^{11}}\ Au$

$\boxed{1\ ly = 63115.2\ AU}$

* $\Delta\phi = \phi - \phi'$ has a max $11.5'$ at latitude 45°

↳ proof: $\tan\phi' = \frac{b^2}{a^2}\tan\phi = \frac{b^2}{a^2}\tan(\Delta\phi + \phi')$

$$\frac{a^2}{b^2}\tan\phi' = \tan(\Delta\phi + \phi')$$

$$\Delta\phi = \tan^{-1}\left(\frac{a^2}{b^2}\tan\phi'\right) - \phi'$$

$$\frac{d\Delta\phi}{d\phi'} = \frac{\frac{a^2}{b^2}\sec^2\phi'}{1 + \frac{a^2}{b^2}\tan\phi'} - 1 = 0$$

$$\frac{a^2}{b^2}\sec^2\phi' = 1 + \frac{a^2}{b^2}\tan\phi'$$

$$\frac{a^2}{b^2}(1 + \tan^2\phi') = 1 + \frac{a^2}{b^2}\tan\phi'$$

$$\frac{a^2}{b^2}\tan^2\phi' - \frac{a^2}{b^2}\tan\phi' + \frac{a^2}{b^2} - 1 = 0$$

let $c = a^2/b^2$

$c = 1.006739$

$$\tan\phi' = \frac{c \pm \sqrt{c^2 - 4c^2 + 4c}}{2c} = \frac{1}{2} \pm \frac{1}{2}\sqrt{4c - 3c^2}$$

$\tan\phi' = 0.996584469$ or $0.0034155306 07$

$\phi' = 44.90198495^\circ$ or 0.195694727°

$\Delta\phi = 0.19242712^\circ$ or $1.318893641^\circ \times 10^{-3}$

$\Delta\phi = 11'\ 32.74''$ or $4.75''$

max min