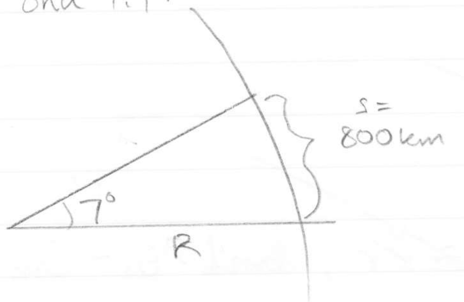
AST 121 HW #1

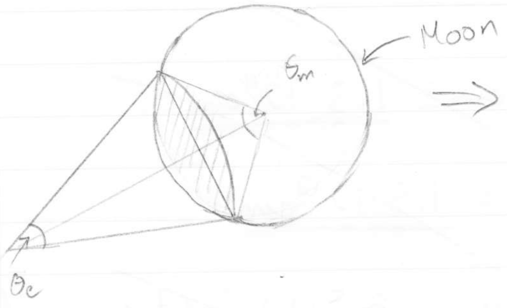
1. Shu 1.1:



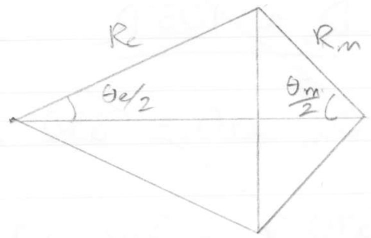
Arc length is 800 km
From Appdx. B, $s = \theta R$,
θ in rad $\Rightarrow$ $\theta \approx 2\pi/50 = 1.26 \cdot 10^{-1}$
$s/\theta = R$
$R = 800\text{ km}/1.26 \cdot 10^{-1} = 6.35 \cdot 10^{3}\text{ km}$

So about $6.4 \cdot 10^{8}$ cm (vs. $6.37 \cdot 10^{8}$ cm from Appdx. A).

To infer size of Moon:

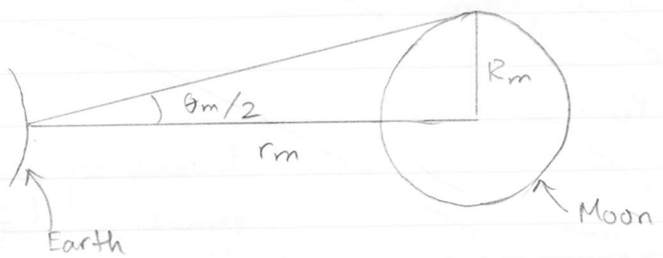


$\Rightarrow$



$$R_m \sin(\theta_m/2) = R_e \sin(\theta_e/2)$$
$$R_m = R_e \frac{\sin(\theta_e/2)}{\sin(\theta_m/2)}$$

$\frac{D_m}{D_e} = 0.27$, so $D_m \approx 0.27 \cdot 1.28 \cdot 10^{9}$ cm $3.4 \cdot 10^{8}$ cm



$\tan\left(\frac{\theta_m}{2}\right) = R_m/r_m$
(Remember θ_m is angular diameter)

For small θ_m, $\tan\left(\frac{\theta_m}{2}\right) = \frac{\sin(\theta_m/2)}{\cos(\theta_m/2)} \approx \theta_m/2$

(This is because $\cos(\theta_m/2) \approx 1$, $\sin(\theta_m/2) \approx \theta_m/2$ when $\theta_m \ll 1$)

So $\theta_m = 2R_m/r_m = D_m/r_m$;
$r_m = D_m/\theta_m$ $\qquad \theta_m = 0.5° = 8.7266\ldots \cdot 10^{-3}$ rad
$= 3.4 \cdot 10^{8}\text{ cm}/8.7266\ldots \cdot 10^{-3} = 3.9 \cdot 10^{10}$ cm

~~$\frac{1}{2}(r_{e-v}(max) + r_{e-v}(min)) = r_e \rightarrow$ dist from Sun to Earth~~

~~$\frac{1}{2}(r_{e-v}(max) - r_{e-v}(min)) = r_v \rightarrow$ dist from Sun to Venus.~~

2. 1 grain of sand: 0.1 mm across → assume $0.1 \times 0.1 \times 0.1$

$$= 10^{-3}\ mm^3$$
$$= 10^{-12}\ m^3$$

Average beach is ~100m wide and 1m deep.
Assume 50% of world coastline consists of beaches.
Assume 5x circumference of Earth is coastline. Circumference of Earth $= 4 \cdot 10^7$ m. So volume of beach in world is
$50\% \cdot 5 \cdot 4 \cdot 10^7 m \cdot 100 m \cdot 1 m = 10^{10}\ m^3$

So # grains of sand:

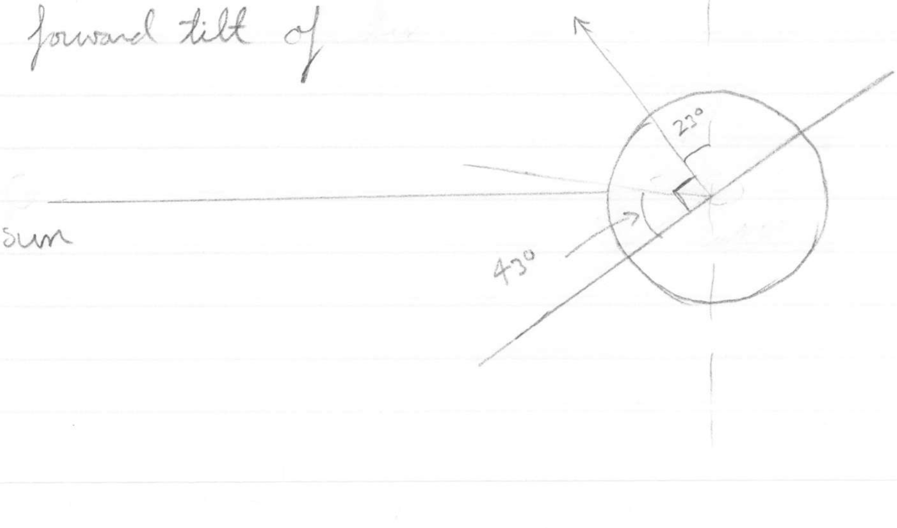
$$\frac{10^{10}\ m^3}{10^{-12}\ m^3} = 10^{22} \text{ grains}$$

So ~10^{22} grains, which is same as # of stars!

See http://astronomy.swin.edu.au/~gmackie/billions.html for another estimate → $5 \cdot 10^{22}$ stars, vs $2 \cdot 10^{21}$ grains

2b at end of document!

3. Max. forward tilt of



So angle b/twn Toronto $\overset{\text{zenith}}{\checkmark}$ at noon and ecliptic is
$43^\circ - 23^\circ = \underline{\underline{20^\circ}}$

4. a) Kepler's 3rd

R^3/T^2 = constant (R = semi-major axis, T = period).

For earth, R = 1 AU, T = 1 year, so in these units:

$$\frac{R^3}{T^2} = 1$$

$$T_{eris} = \sqrt{R^3} = 955 \text{ years}$$

b). $\theta \approx d/r$

$1\,AU = 1.49 \cdot 10^8\, km \rightarrow 97\,AU = 1.45 \cdot 10^8\, km$

$$\theta \approx \frac{2400\, km}{1.45 \cdot 10^8\, km} = 1.655\ldots \cdot 10^{-5}\, rad$$
$$= 9.48\ldots 10^{-4}\, \text{degrees}$$
$$= \underline{\underline{3.4''}}$$

2 b). 1 cell is ~10 micron in length

$V = \sim 10^{-15}\, m^3$

Human body is ~ cylinder 1.6 m in height, 15 cm rad.

$$V = \pi \cdot 0.15^2 \cdot 1.6 = 1.13 \cdot 10^{-1}\, m^3$$

So # cells:

$$\frac{\sim 1.13 \cdot 10^{-1}\, m^3}{\sim 10^{-15}\, m^3} \approx \underline{10^{14} \text{ cells}}$$