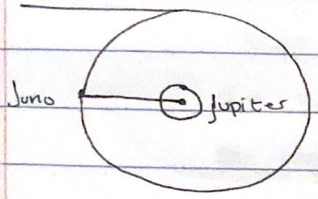
Julia Nelson Homework 2 PEP 151

"I pledge my honor that I have abided by the Stevens Honor System."

Problem 1

11+31+11=53



July 21 → Sept 12 = 53 days

Time = 53 days × 3600 × 24 = 4.5792e6 seconds

Jupiter Mass = 1.90e27 kg

ignore mass of satellite

$p = \frac{4\pi^2 a^3}{GM} \rightarrow a^3 = \frac{PGM}{4\pi^2}$

$G = 6.67 \times 10^{-11}$

53 × 3600 × 24 = 4579200 Seconds

$a^3 = \frac{PGM}{4\pi^2}$

$\Rightarrow a^3 = \frac{(4579200 * (6.67 \times 10^{-11}) * (1.90e27))}{39.478} = \frac{5.803 \times 10^{23}}{39.478}$

$a^3 =$ 1.4699884 e22

$a = 24496533.7315$ m

$a = 24496.5337315$ km

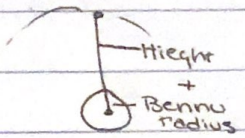
→ The semi-major axis of Juno's orbit around Jupiter is 24496.5337315 km

Problem 2

Mass Bennu = 7.8e10 kg

Radius Bennu = 250m

Height Bennu = 2.0 km = 2000m



r = Bennu Radius + Height = 250m + 2000m = 2250m

$\frac{mv^2}{r} \rightarrow \frac{GMm}{r^2} \rightarrow v = \sqrt{\frac{GM}{r}}$

$$\Rightarrow v = \sqrt{\frac{(6.67 \times 10^{-11})(7.8e10)}{(250+2000)}} = \boxed{v = 0.04808 \text{ m/s}}$$

Problem 3

Total energy (E) of Meteor = potential energy + kinetic energy

$= \frac{1}{2}mv^2 - GMm/r$

initial speed = 0 $\quad r \rightarrow \infty$ (At Infinity) ← (potential, kinetic)

Total Energy initial $\Rightarrow \frac{1}{2}(0) - GMm/\infty = 0 - 0 = 0$

At Surface of Mars

Total Energy Final $\Rightarrow E_f = \frac{1}{2}mv^2 - \frac{GMm}{R}$

Because law of energy conservation $E_i = E_f$

$\frac{1}{2}mv^2 - \frac{GMm}{R}$

$\Rightarrow v = \sqrt{2GM/R}$

Mass Mars = 6.39×10^{23} kg

Radius Mars = 3389.5 km

$$v = \sqrt{\frac{2 \times (6.67 \times 10^{-11})(6.39e23)}{3389.5 \text{ km}}}$$

$$v = \sqrt{\frac{8.52426e13}{3389.5}} = \sqrt{25149019029.4} = 158584.422404$$

$$\boxed{v = 158584.4224 \text{ m/s}}$$

Problem 4

Earth avg temp $15^{\circ}C$ $\qquad b = 2.897 \times 10^{-3}\ mK$

$15 + 273 = 288$ Kelvin

$\lambda_{max} T = \text{Constant} = b$

$\lambda_{max} \cdot 288K = 2.897 \times 10^{-3}\ mK$

$\lambda_{max} = \dfrac{2.897 \times 10^{-3}\ mK}{288\ K}$

$= \dfrac{0.002897}{288}\ m = 0.00001005902\ m$

Ans $\times 10^{9} \Rightarrow 10059.02\ nm$

$\lambda_{max} = 1.00559.02 \times 10^{4}\ nm$ $\qquad \boxed{\approx 1.006e4\ nm}$

→ In the Infrared portion of spectrum

Problem 5

$\lambda = 1\ mm = 1 \times 10^{-3}\ m$ $\qquad$ diameter $= 10\ m$

Angular resolution $\Rightarrow \quad \theta = 1.22 * \dfrac{\lambda}{d}$

$= \dfrac{1.22 * (1 * 10^{-3}\ m)}{10\ m}$

$= \dfrac{1.22 \times 10^{-3}}{10} = 1.22 \times 10^{-4} = 0.000122\ rad$

$= 0.000122\ \text{radian} \times \dfrac{180}{\pi}$

$= 0.00699\ \text{degrees}$

$\Rightarrow 0.00699\ \text{degrees} \times \dfrac{60\ \text{arc min}}{1\ \text{degree}}$

$\boxed{= 0.4194\ \text{arcmin}}$