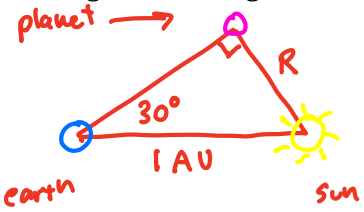
Astronomy Problems II

1. What would be the distance to the sun, in astronomical units, of an inferior planet that had a greatest elongation of 30°? Assume circular orbits for the planet and the earth.



$\sin 30 = \frac{R}{1}$

$R = \frac{1}{2}$ AU

2. The earth's distance to the sun varies from 147.4 million to 152.1 million km. What is the eccentricity of its orbit?

$R + C = 152.1$

$R - C = 147.4$

$\therefore \quad 2C = 4.7$

$C = 2.35$

So $R + 2.35 = 152.1$

$R = 149.75$

$\therefore \quad e = \frac{C}{R}$

$e = \frac{2.35}{149.75}$

$e = 0.016$

3. If a comet were discovered that had a sidereal period of 150 years, how far away from the sun would it be?

$\frac{T_1^2}{R_1^3} = \frac{T_2^2}{R_2^3}$ (T_1, R_1: earth; T_2, R_2: comet)

So $\frac{1^2}{1^3} = \frac{(150)^2}{R^3}$

$R = 150^{2/3}$

$R = 28.2$ AU

4. If an asteroid were discovered that had a sidereal period of 850 days, how far away from the sun would it be?

$\frac{T_1^2}{R_1^3} = \frac{T_2^2}{R_2^3}$ (T_1, R_1: earth; T_2, R_2: asteroid)

$\frac{(365.25)^2}{1^3} = \frac{(850)^2}{R^3}$

$R^3 = 5.416$

$R = 1.76$ AU

5. What would be the sidereal period of a planet whose orbit had a semimajor axis of 4 AU?

$\frac{T_1^2}{R_1^3} = \frac{T_2^2}{R_2^3}$ (T_1, R_1: earth; T_2, R_2: planet)

$\frac{1^2}{1^3} = \frac{T^2}{4^3}$

$T^2 = 64$

$T = 8$ yrs.

6. Kepler's Laws also apply to the motion of the moon around Jupiter. Suppose that moon A has a period 5.196 times as long as moon B. What would be the ratio of the semimajor axes of their orbits?

$T_A = 5.196\, T_B$

$\frac{T_A^2}{R_A^3} = \frac{T_B^2}{R_B^3}$

$\frac{(5.196\, T_B)^2}{R_A^3} = \frac{T_B^2}{R_B^3}$

$\left(\frac{R_A}{R_B}\right)^3 = 26.998$

$\frac{R_A}{R_B} = 3$

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7. Mercury has a perihelion of 0.31 AU and an aphelion of 0.47 AU. How many days does it take to go around the sun?

$R = \frac{a+p}{2} = \frac{(.31)+(.47)}{2}$

$A = 0.39$ AU

$\frac{T_1^2}{R_1^3} = \frac{T_2^2}{R_2^3}$ (T_1: earth, R_1: earth, T_2: planet, R_2: planet)

$1 = \frac{T^2}{(.39)^3}$

$T^2 = .059$

$T = 0.24$ yrs

$T = 89$ days

8. Halley's Comet has a period of 76 years, and an orbital eccentricity of 0.97. What is the semimajor axis of the orbit of this famous comet around the sun, in astronomical units? What is its perihelion? Aphelion?

$\frac{T_1^2}{R_1^3} = \frac{T_2^2}{R_2^3}$ (T_1: earth, R_1: earth, T_2: Comet, R_2: Comet) $\rightarrow 1 = \frac{76^2}{R^3} \rightarrow R = 76^{2/3}$

$R = 17.94$ AU

$e = \frac{c}{R}$ so $c = eR$

$p = R - c = R - eR = (1-e)R = (1-.97)(17.94)$

$p = 0.538$ AU

$a = R + c = (1+e)R = (1+.97)(17.94)$

$a = 35.35$ AU

(Hey! $T = \frac{S}{S-1}$ $76 = \frac{S}{S-1}$ $76S - 76 = S$ $75S = 76$ $S = \frac{76}{75}$

Synodic Period would be $\frac{76}{75} = 1.01$ years)

Answers:

1) D=0.5 AU 2) e=0.0157 3) 28.2 AU 4) 1.76 AU 5) 8 years 6) $R_A/R_B = 3$

7) 89 days 8) R=17.9 AU; p=0.5 AU; a=35.3 AU