PHY 241 Planetary Systems - Coursework #1

Due: Tuesday, October 5, 2010 12pm

References:

- Ch. 1 Physical Processes in the Solar System, Landstreet
- Ch. 1 Introductory Astronomy & Astrophysics, by Zeilik, Gregory and Smith (several copies in the Library)
- Ch. 2 Moons & Planets, Hartmann.

Please write up your solutions neatly and turn in your coursework by the due date listed above. Where numerical evaluations are needed, work the problem symbolically, using numerical values only at the end. Where a written answer is requested, please write a few complete sentences. Please state any assumptions you may be making (e.g. circular orbit) and list the source of the physical dimensions of solar system bodies you have used.

You will need to look up the appropriate solar system properties (e.g. in the text or on the web). Please site the source of information.

1. What is the radius of the Sun measured in Astronomical Units? [1 mark]
2. What is the semi-major axis of Mercury measured in solar radii (i.e. $a/R_\odot$) [1 mark]
3. Vulcanoids are a hypothetical group of asteroids that may orbit in a dynamically stable zone between 0.08 and 0.21 AU from the Sun, well within the orbit of Mercury. Here are embedded hyperlinks (which you should be able to 'click' on with Acroread) to two pages that describe the search for these objects.
   http://en.wikipedia.org/wiki/Vulcanoid
   http://www.planetary.org/news/2004/0202_Small_Faint_and_Elusive_The_Search.html
   a) What is the maximum elongation, as seen from the Earth, of Vulcanoids on circular orbits at the inner and outer edges of this region? [1 mark]
   b) Describe some of the difficulties associated with observing these putative asteroids? [2 marks]
4. Imagine you are standing on the equator of Mars and are able to see both Martian moons in the sky. [5 marks]
   a) When Phobos is directly overhead, what is it's angular size in the sky (recall that you are on the surface, not at the center of Mars)?
   b) Similarly, what is the angular size of the Sun in the Martian sky?
   c) Describe what would you see when Phobos passes in front of the Sun? By what factor would the apparent brightness of the Sun change?
5. (From Landstreet Problem 1.4) As seen from the Earth, the maximum angular distance on the sky between the Sun and Mercury during one period of the planet's visibility either in the evening or morning sky (the greatest elongation of the planet) during its orbit can vary from as little as 17° 52' to as much as 27° 49'.

a) Assume that the largest and smallest values of greatest elongation occur when the line of sight from Earth is perpendicular to the major axis of Mercury's orbit, contacting it at aphelion and perihelion respectively. Sketch the line-of-sight triangles that describe the largest and smallest values of greatest elongation. [2 marks]

b) Assuming that the Earth's orbit is circular and coplanar with that of Mercury, calculate the semi-major axis (in astronomical units, AU) and eccentricity of Mercury's orbit from these observed extreme values of greatest elongation. [3 marks]

Just for Interest

Comets are also interlopers in the inner solar system. The SOHO spacecraft has been monitoring the Sun for an extended period and has witnessed numerous comets collide with the Sun. That's right they hit the Sun. Here's footage from the spacecraft showing this. Why does this happen? Why does this happen frequently? (It could make a good project to understand and model this spectacular phenomena.)

Check this link for movies of Sungrazing Comets
http://sohowww.nascom.nasa.gov/bestofsoho/Movies/movies2.html#comets