PHYS 101- Concepts of Physics I- Fall 2006
Homework #1
Due in class Thursday September 21st

You must mostly type the text part of your work. But hand-write equations and drawings as needed; just please be neat. [Late work will not be carefully graded, but will be given a moderate amount of credit if it's generally satisfactory. If submitting late work, you must keep a back-up copy for yourself.]

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1. (a) Measure the angle of the sun above the horizon, in Charlottesville, between 12:30 pm and 1:30 pm. (This will be close to "local noon" because we are on daylight savings time until October 29th, 2006.) State the location where you took the measurement, the time, and the date. Show your method and calculation.

   (b) Does your answer in part (a) make sense? Answer this by calculating the maximum angle of the sun in Charlottesville for the date of your measurement. You will need to look up the latitude of Charlottesville—round it off to the nearest whole degree. Then, answer the following questions, which will lead you to the correct prediction:

   The first day of autumn is approximately Sept. 21st. What will be the angle of the sun at the equator on this day?

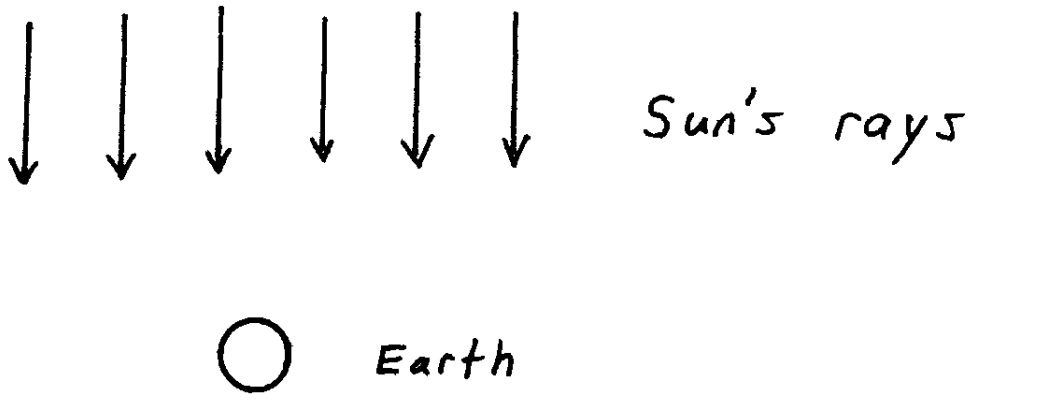
   Will the angle of the sun in Charlottesville be less or greater than this? By how much?

   Since your measurement will be a few days before Sept. 21st, you must take into account the tilt of the Earth. Will this add or subtract from the Sept. 21st number? By how much? (see chart of "tilt of the Earth" on last page)

2. Answer the following questions using your globe. (Reminder: you must have your very own globe by the date of the midterm exam, Thursday Oct. 19, 2006. You will not be admitted to the exam without it.)

   (a) What is the length of the day (number of hours and minutes between sunrise and sunset) on June 21st for a city on the equator? For Charlottesville? For Edmonton, Canada? For Fairbanks, Alaska? For Murmansk, Russia? Try to be as accurate as possible, although this is more difficult for the very long days.
   (b) What will be the length of the day for the same five locations in part (a) on December 21st? Do you need to make new measurements from your globe? Explain.
   (c) Check your answers for part (a) using www.weatherunderground.com. Briefly explain how close your answers agree, and why some of your measurements may be more difficult than others.
   (d) One standard flat map of the Earth is called the "Mercator Projection" (see last page of this assignment). According to this map, what would the shortest route from Washington, D.C., USA to Moscow, Russia look like? (briefly describe it). Now use your globe and find the actual shortest route, and describe it and explain how you found it.
   (e) Using great circles, how could you find the point on the Earth directly opposite a given location? (i.e. the line connecting them goes through the center of the Earth) Use this method to find the point opposite Charlottesville (hint: it's not in China!) Also find the point opposite Xian, China. Be as accurate as you can, but you don't have to be perfect.

3. Below is shown the Earth and some light rays from the Sun (which is very distant). Trace this drawing onto the top of a blank sheet of unlined paper. (so that we will all be consistent, the diameter of the Earth should be 8.5 millimeters on paper) Then:



   (a) Draw **<u>to scale</u>** a circle to represent the Moon when it's <u>full</u>. Be sure to correctly locate the Moon on the drawing, and make its size and distance from the Earth conform to the scale. You will need the following information: Earth radius = 6400 km, Moon radius = 1740 km, distance from center of Earth to center of Moon = 380,000 km.
   (b) Neatly draw several (about ten) light rays emanating from the Moon, and heading towards the Earth. Draw them all the way from the Moon, to just before the position of Earth. Some of them should be on a path to hit the Earth, and some to pass close by. Then answer this: Are we justified in assuming that light rays from the Moon are all approximately parallel? Why or why not? (Don't just say "yes" or "no". Instead, direct the reader to the portion of your sketch that proves your answer.)
   (c) If the Sun, Earth, and Moon were all in the same plane, you would expect the Earth to prevent light from reaching the full Moon (known as an eclipse). Why does this not usually happen?

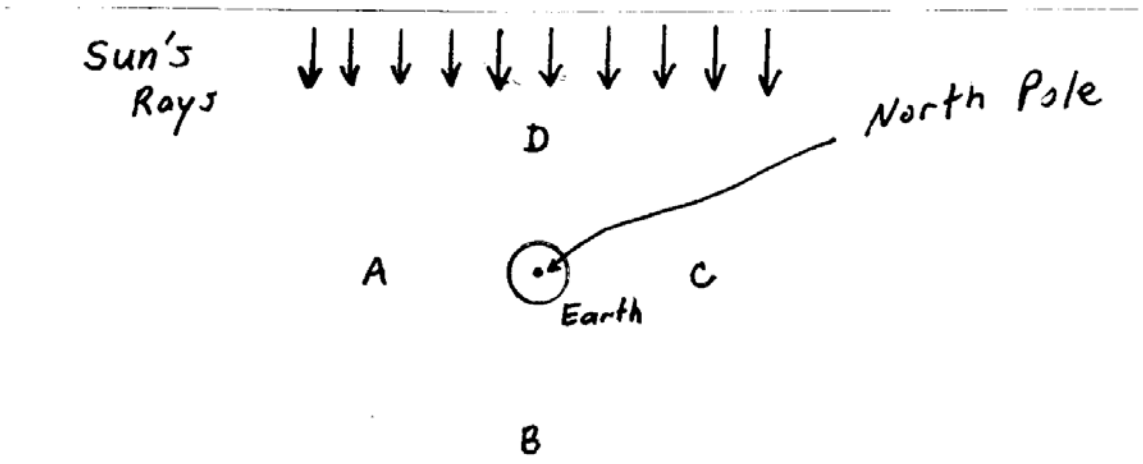
4. Do a little research and then, in a paragraph or so, explain when and how Galileo (full name Galileo Galilei) was able to see moons orbiting Jupiter, and what impact this observation had on the prevailing theory of our solar system. Things you might mention: Sidereus Nuncius, Ptolemaic planetary system, Copernican planetary system.

5. Hobson, 4th edition, exercise 8 on page 28. Be sure to explain your answer.

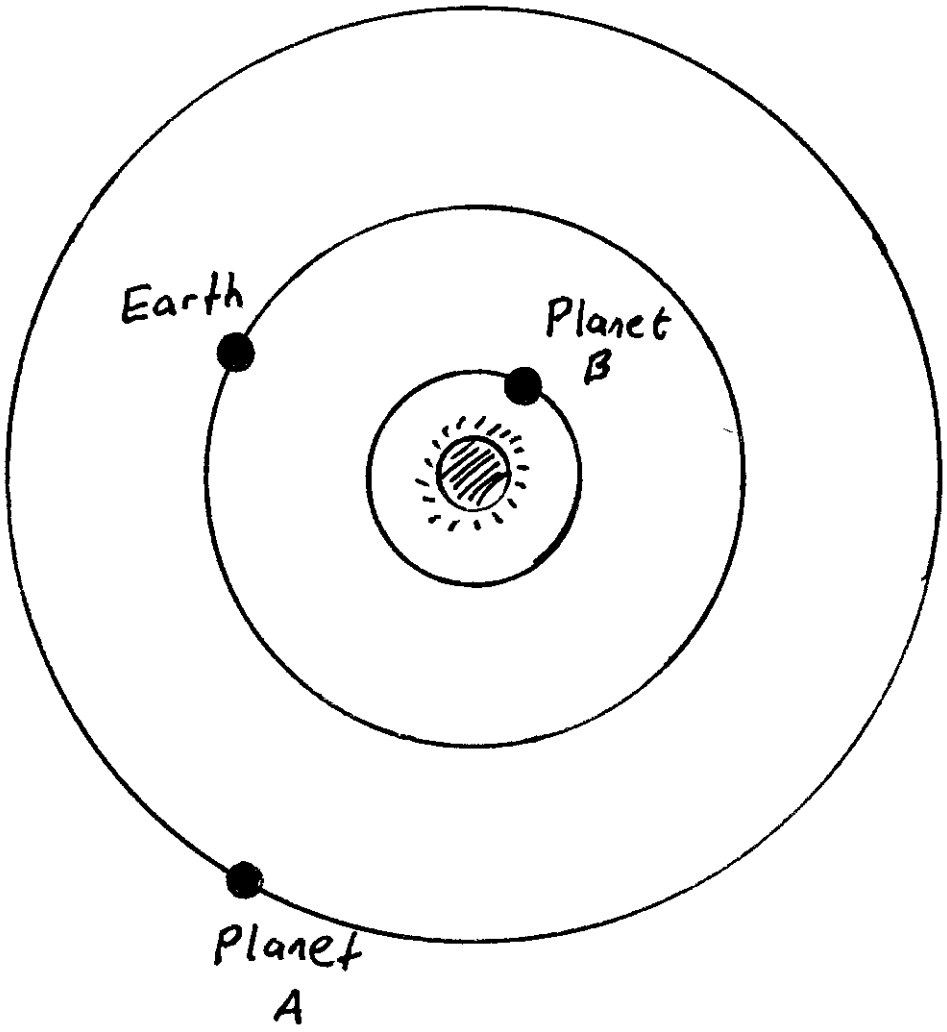
6. Using the simple model from class in which the north pole points straight up (that is, ignoring the tilt of the Earth's axis), answer the following questions. (Your answers will therefore be approximate. The actual observed times could be a couple of hours or so different.)

   (a) At what times do sunrise and sunset occur? Why aren't these different for different longitudes (east-west positions on Earth)?
   (b) Look up the actual sunrise and sunset times for either Charlottesville or Washington, DC on a particular day this week (mid-September). Be sure to state the city and your source. Then, translate those times to standard time (because we are on Daylight Savings Time until Oct. 29, 2006). Then compare to your approximation in part (a). What time(s) of the year would you expect the approximation in part (a) to be the best? The worst? Explain.
   (c) At what times do moonrise and moonset occur for each of the four moon positions A,B,C and D, shown?

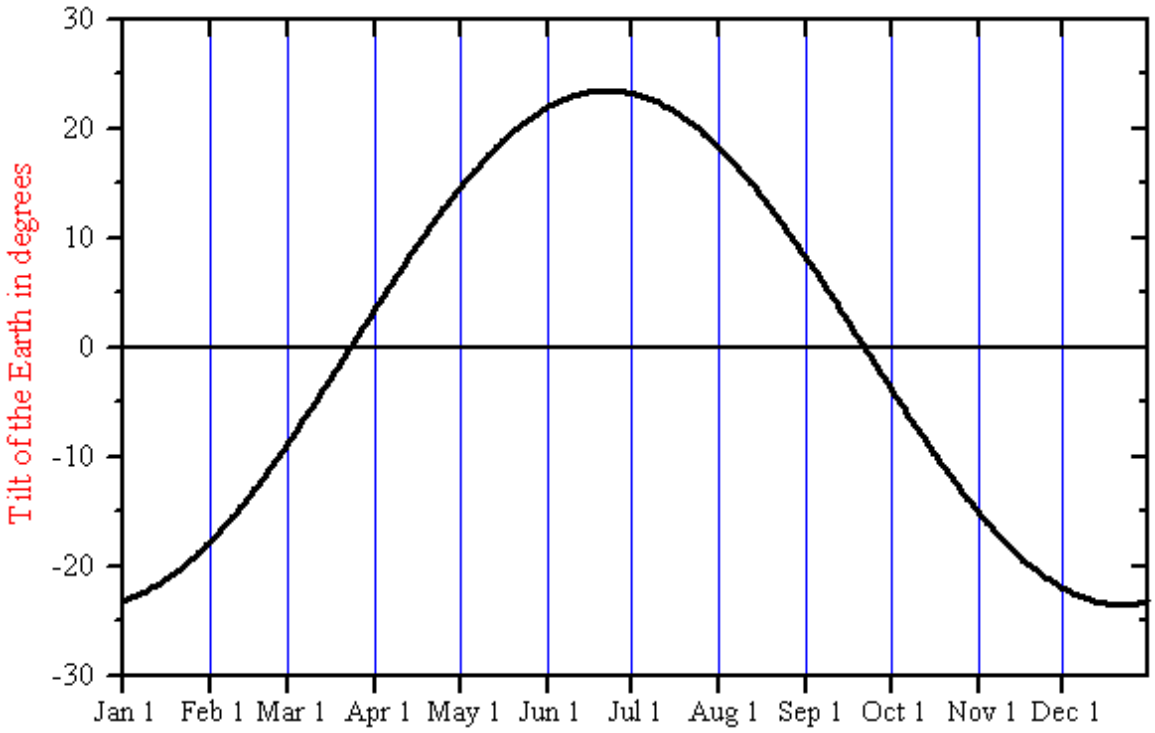
   (d) From Charlottesville, what does the moon look like when in each of these four positions? Make a nice sketch of each one. When making your sketches, be sure your point of view is from Charlottesville, and not from outer space. (For consistency, use white to denote illuminated portions of the moon.)
   (e) Where in the sky would you see the moon at 9 am when it is half-illuminated on the left side as viewed from Charlottesville? (directly overhead?…northern part of the sky near the horizon?…just rising in the east?…etc.)



7. The view of the solar system below is from far above the North Pole, and includes two fictitious planets.



(a) In which direction does the Earth rotate on its axis?
(b) Ignoring the tilt of the Earth, and assuming the Earth and the planets move a negligible amount during an Earth day, at what time will planet A rise and set? planet B? Make a sketch to justify your answers.



Mercator Projection of Earth