Exoplanet Name: _____

Prelab 3: Seasons and The Sun

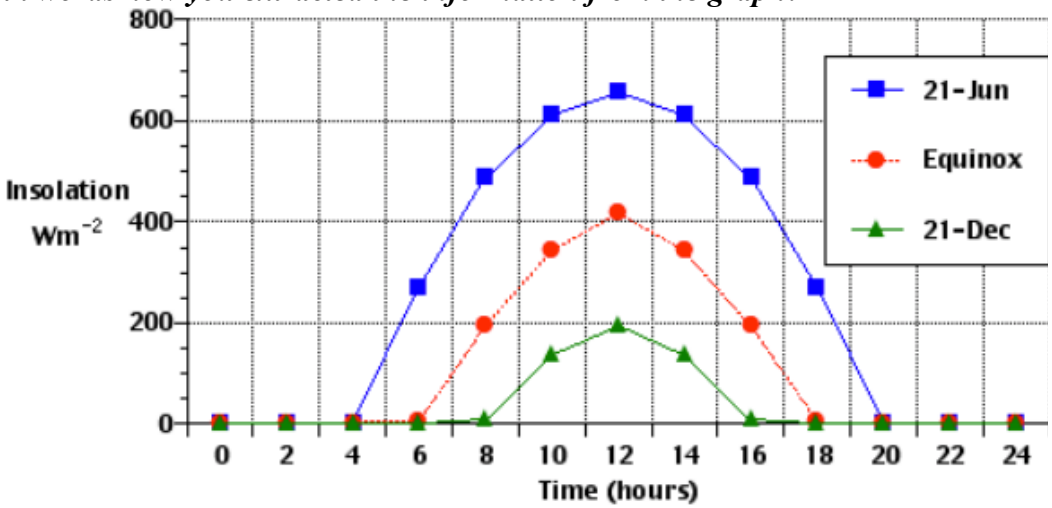
Due Friday, September 21 at the start of class

Must be handed in on paper to the assignment inbox

30 total points*

Please write legibly or type your answers. Illegibile assignments will not be graded
**Note that all assignments are scaled to count equally toward your final grade, so total point values are arbitrary*

1. The following graph compares the *insolation* (amount of sunlight received) in the city of Minneapolis over the course of a year. Use the graph to answer the following questions. ***The Answers for b-d must be quantitative and must explain in words how you extracted the information from the graph***:



   a. Why did the creators of the graph choose the three days in question to graph? What is special about them and why is the middle (red) one not labeled with a specific date? (2 points)
   b. How much does the length of the day in Minneapolis vary over the course of the year? (2 points)
   c. How many times more total energy is received in Minneapolis on June 21 than Dec 21. *Hint: This requires the "area under the curve", but no calculus is needed here. There is a handy grid drawn on the graph that will allow you to estimate the area.* (4 points)
   d. Estimate how much more insolation (the y-axis quantity) Minneapolis receives each day between December 21 and June 21 relative to the day before. *Hint: pick a time of day, and use the Y-axis value.* (4 points)

Go to: http://astro.unl.edu/naap/motion3/animations/sunmotions.html and use the simulator there to answer questions 2-4 (Note that you need to enable Adobe Flash in order to run the simulator)

2. If you click and drag on the frame of the animation, you can change your view. Drag it so that you are looking directly down on the observer. This happens when the faint white N/S and E/W lines meet right at his feet. Note that this intersection corresponds then to that observer's zenith. Run the animation forward in time by clicking "Start Animation".
    a. What do the white and yellow lines represent? *Hint: play with the check boxes at right, but explain what the lines mean in your own words.* (2 points)
    b. From our location here in Amherst (*hint: latitude = 42.4deg N*), does the sun ever pass through the zenith? If so, at what time of year? If not, how close does it get? *Hint: If you drag the date slider, you won't have to wait for the animation to run through the whole year, and you can use the "information" box to determine the sun's altitude at a given point in the simulation* (2 points)
3. Click "trace analemma". The sun's analemma is the path it traces across your local sky over the course of the year at a given time of day. The analemma will appear as a red figure 8 shape in the animation.
    a. What time do you need to set the animation to in order to make the analemma centered on the meridian? (*Reminder: the meridian is the line that connects north and south and passes through your zenith*) (1 point)
    b. Change your animation settings to "step by day" and run it with the analemma centered on the meridian. You'll note the sun moving along the analemma. On what day of the year is it at the highest and lowest points along the analemma, and why does this make sense? (2 points)
    c. With the animation still running, drag the observer's latitude south until you reach a point where the sun touches the point right below the observer's feet (*hint: stop when the top of the analemma touches it*). This latitude marks the tropic of Cancer (and the same southern latitude the Tropic of Capricorn). What is significant about it? Is it related to another angle that you know? (2 points)
    d. What does the sun do in the tropics that it does not do at more extreme latitudes? Does it do this special thing every day of the year? Does it do it on the same day at all locations in the tropics? (3 points)
4. Move your observer to the North Pole (90 degrees north latitude). Under "Animation Controls" choose "step by day". Drag the animation so that you're looking at the observer from an angle.
    a. If you were to live at the north pole, how long would your days and nights be? (2 points)
    b. What is the maximum altitude that the sun reaches in the sky for this observer (*Hint: use the "information" box directly below the animation*). Is this number familiar? What does it correspond to? (2 points)
    c. Stop the animation on the day when the sun reaches the highest point in the sky (*Hint: it should be on a solstice*). Select "continuous" under "Animation Controls" and replay it. This shows how the sun moves over the course of a day at the North Pole. Describe its motion in the sky over the course of a 24 hour period. (2 points)