Name: _____

Date: _____

Section: _____

Astron 104 Laboratory #7
Sunspots and the Solar Cycle
Section 9.4

In this exercise, you will observe how the physical appearance of the Sun changes from day to day over the period of one month. You will look at images obtained (mostly) from the Big Bear Solar Observatory in California over the month of Dec 2011 and the beginning of Jan 2012. Find a set of images at:

`http://www.gravity.phys.uwm.edu/~kaplan/astron104/sun_month.html`

Click on each image for a larger view. You can also navigate directly from the individual pages.

In these "white-light" images, features such as **sunspots** and **limb-darkening** are clearly visible. At the time these data were taken, we were approaching a maximum in the 11 year sunspot cycle, so there are a fair number of sunspots visible on most of the days. You will be both counting and sketching the appearance of these sunspots.

Sunspots

Procedure:

- On the computer, look at the image for each date in the period. Count the number of sunspots visible on the Sun for that day, and record your results on the answer sheet. You can also use the comment column to make notes on the clarity of the image and/or how easy it was to see the sunspots on that day. **[30 pts]**
- Look again at each of the 6 images for Dec 30 to Jan 4. On the sheet provided, sketch the approxiate size and location of the sunspots you see for each day. The resulting set of drawings will show the changes from one day to the next. They will also show the rotation of the Sun. (Note: be sure to label each drawing with the correct date). **[5 pts each]**
- The Sun rotates once in about a month. The exact rate varies depending on the latitude: at the equator, the period is about 25 days, while at the poles it is close to 35 days. Compare the images from the beginning of the period with those from the end. Since larger sunspot groups can last for two months, see if you can find the same sunspot group in images taken a month apart.

Questions:

1. Is it always clear just what is a single sunspot? Do you think it better to split complicated regions into multiple spots, or lump them all in together? [**5 pts**]

2. Sunspots are related to strong magnetic fields on the Sun. These magnetic fields work like particle accelerators, producing photons with very high energies compared to most of the Sun. Given that, what type of radiation do you expect to detect from the regions of the sunspots? Why? [**5 pts**]

3. How could sunspot activity affect the weather on Earth? There are two effects to consider: the total amount of radiation emitted by the Sun, and the energetic particles coming in the Solar wind. [**5 pts**]

4. The photosphere (the visible surface of the Sun) is at a temperature of 5800 K and sunspots on average are around 4200 K. What is the percent difference in temperature between the photosphere and sunspots? At what wavelength does the radiation emitted by each region peak? (Hint: use Wien's law, which says that the peak wavelength $\lambda_{\text{peak}} = 3 \times 10^6\,\text{nm}/T$, where T is in Kelvin) **[10 pts]**

5. Now figure out the percentage change in the *flux* from the normal photosphere (5800 K) compared to the sunspots (4200 K). Use the Stefan-Boltzmann law: $F = \sigma T^4$, where T is in Kelvin and $\sigma = 5.7 \times 10^{-8}\,\text{W/m}^2/\text{K}^4$. Does this help explain why the sunspots look so much darker? **[10 pts]**

Solar Cycle

Now you will look at data taken once per month for 6 years (which is approximately half of a Solar Cycle):

`http://www.gravity.phys.uwm.edu/~kaplan/astron104/sun_cycle.html`

1. Look at the images for each date. Can you notice any trends between the beginning of the period (at the bottom of the page) and the end of the period (at the top)? Which do you think is closer to the *maximum* of the Solar Cycle, when sun-spot activity is highest? [**10 pts**]

2. Look at the images for each date. Can you notice any trends in the overall size of the Sun in each image? What might cause this? [**5 pts**]

Date	Number of Sunspots	Comments
Nov 30		
Dec 01		
Dec 02		
Dec 03		
Dec 04		
Dec 05		
Dec 06		
Dec 07		
Dec 08		
Dec 09		
Dec 10		
Dec 11		
Dec 12		
Dec 13		
Dec 14		
Dec 15		
Dec 16		
Dec 17		
Dec 18		
Dec 19		
Dec 20		

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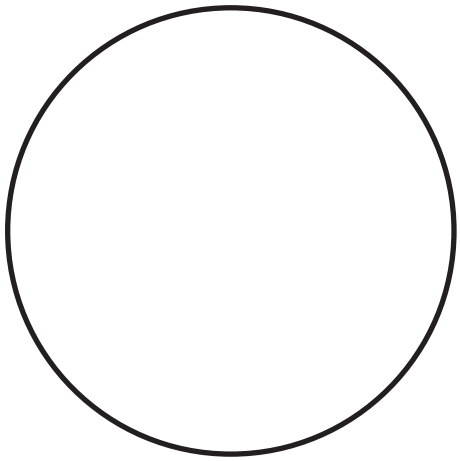
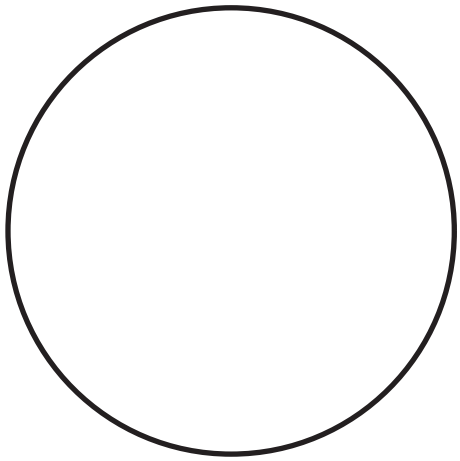
Date	Number of Sunspots	Comments
Dec 21		
Dec 22		
Dec 23		
Dec 24		
Dec 25		
Dec 26		
Dec 27		
Dec 28		
Dec 29		
Dec 30		
Dec 31		
Jan 01		
Jan 02		
Jan 03		
Jan 04		



Date: _____



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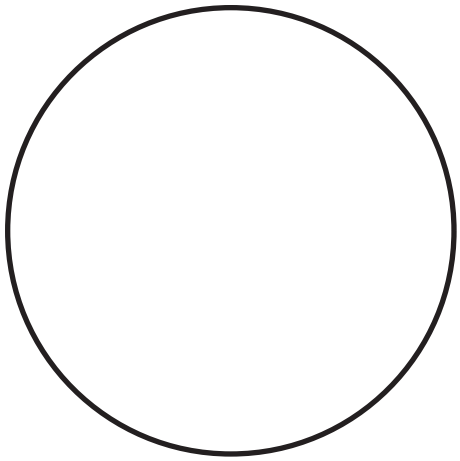

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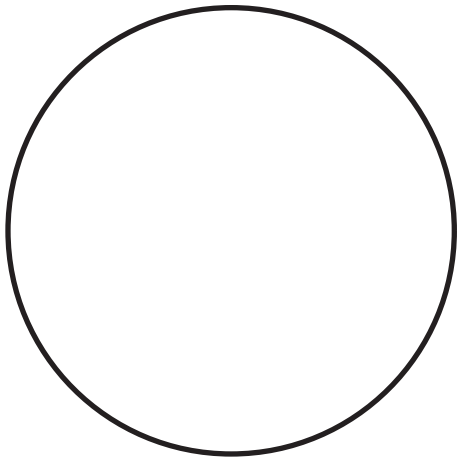

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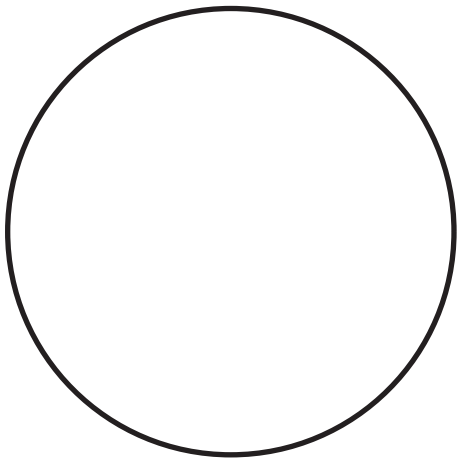

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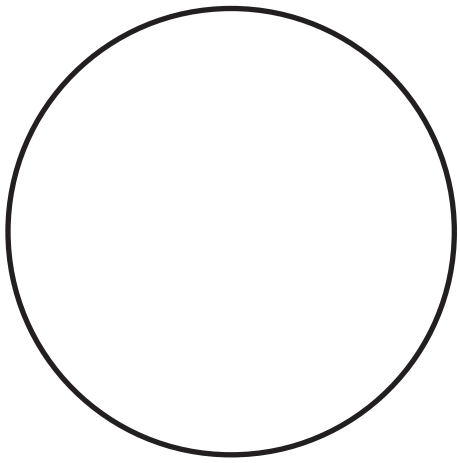

Date: _____