SIERRA COLLEGE OBSERVATIONAL ASTRONOMY LABORATORY EXERCISE	
Lab N08: The Sun	
NAME	**GROUP**

Lab N08: The Sun

OBJECTIVE:

- Learn about the basic functions of the Sun's rotation.
- Determine an image scale.
- See what the Sun looks like right now.

INTRODUCTION:

The Sun is the star at the center of our solar system. It is enormous—approximately 100 times as big as the Earth—and generates its prodigious energy output via *nuclear fusion* in its core.

The visible layer of the Sun is called its *photosphere*, which usually has dark marks on it—*sunspots*—which are cooler regions of strong magnetic activity. We can determine how quickly the Sun rotates by watching the sunspots move across the solar globe.

Exterior to the photosphere is the *chromosphere*—a brightly colored region. Beyond that is the extended atmosphere of the Sun, called the *corona*.

When interpreting photographs of objects, we can often learn about them by calculating the photograph's *image scale*. The image scale tells you how many km of real distance on an object is represented by the mm on the photograph.

> Image Scale Example: If a photograph of the Moon shows a crater 200 km across, but the crater is only 50 mm across in the photo, then the image scale is 200 km per 50 mm, or 4 km/mm. If you measure something else in the photograph that is 3 mm long, then you know that in real life the size of the object is:
>
> Size = 3 mm x 4 km/mm = 12 km.

PROCEDURE I: Solar rotation

1. You have sheets of solar images, showing the sunspots on the Sun during a few weeks of a recent spring season. Notice that each solar image is numbered, and that the south polar region of the Sun is indicated with a small black tick mark. Image number 5 has a sunspot circled—this will be our study object.

Your transparent solar overlay indicates solar longitudes (ranging from -90° to +90°) and solar latitudes (labelled only for northern latitudes). Place the transparent overlay over solar image #1. Carefully make sure the south pole of the overlay is positioned over the tick mark on the photograph. Measure the solar latitude and longitude of the sunspot, recording your data in Table 1. Repeat this for all the images.

Table A: Sunspot coordinates							
Image	**Relative date**	**Solar Latitude**	**Solar Longitude**	**Image**	**Relative date**	**Solar Latitude**	**Solar Longitude**
#1	0.0 d			#13	5.5 d		
#2	0.5 d			#14	6.0 d		
#3	1.0 d			#15	6.5 d		
#4	1.5 d			#16	7.0 d		
#5	2.0 d			#17	7.5 d		
#6	2.5 d			#18	8.0 d		
#7	3.0 d			#19	8.5 d		
#8	3.5 d			#20	9.0 d		
#9	4.0 d			#21	9.5 d		
#10	4.5 d			#22	10.0 d		
#11	5.0 d			#23	10.5 d		
#12	5.3 d			#24	10.8 d		

2. Plot the values of the sunspot's latitude on Figure 1, as a function of relative date from the date of the first image. Fit the data with a straight line using a ruler. Label the line, "latitude of sunspot."

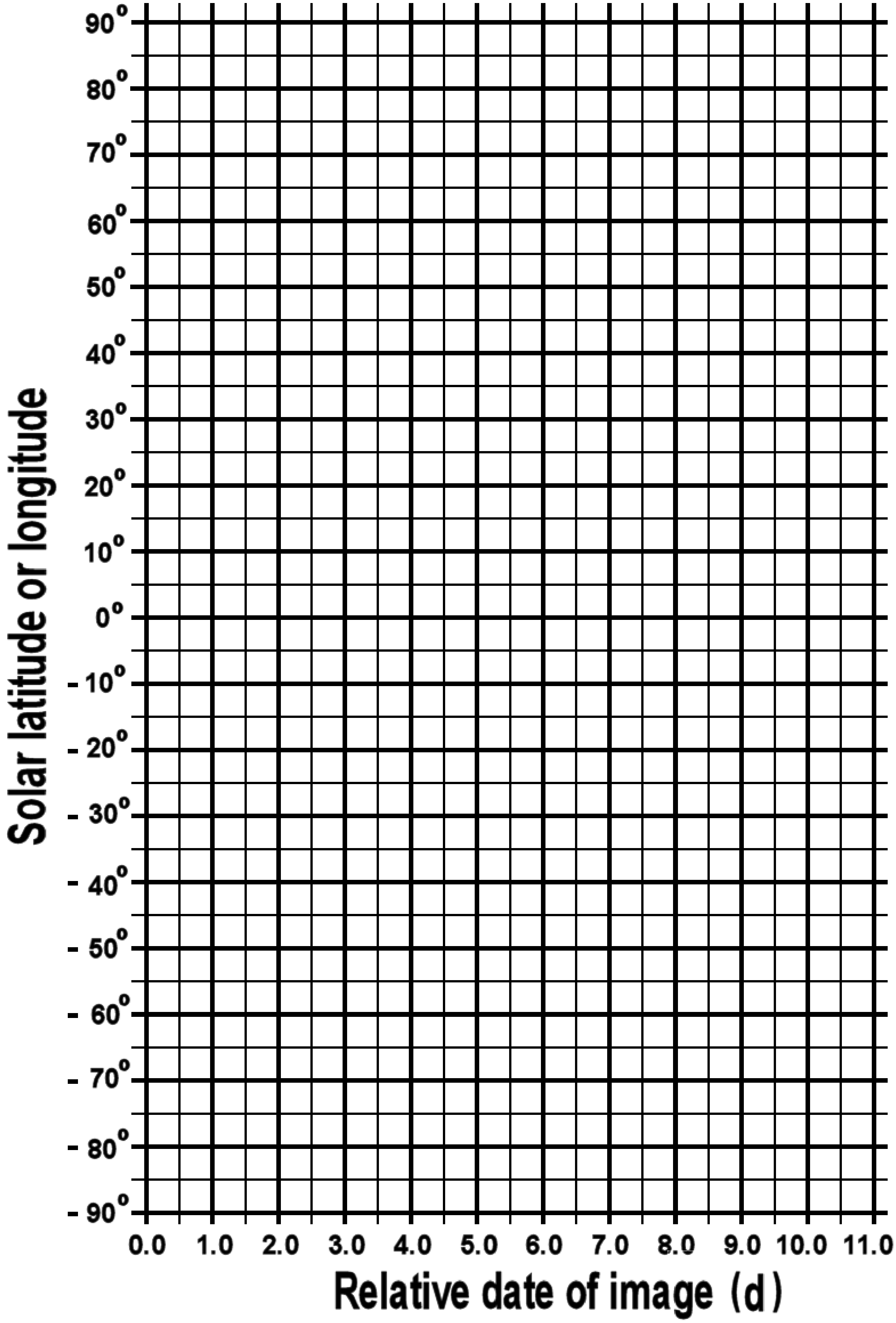
3. Using a different pen color (but not red), plot the values of the sunspot's longitude on Figure 1, as a function of relative date from the date of the first image. Fit the data with a straight line using a ruler. Make sure your line extends from the "0.0d" line on the left border of the graph, to the "11.0 d" on the right graph border. Label the line, "longitude of sunspot."

4. Referring to the longitude line for your data on Figure 1, read off the data from your line, to complete the following (x,y) coordinates for your line.

   (Starting longitude, Date #1) = (__________, 0.0 d)

   (Ending longitude, Date #2) = (__________, 11.0 d)

Figure 1: Latitude and longitude of a sunspot



5. From your values in procedure step #4, calculate the rate at which the sunspot is drifting across the sky, in °/day. Refer to the sample calculation #1, below, for help.

Sunspot drift rate = ________________________

Sample calculation #1

Suppose you obtained the following data from your longitude line:

(Starting longitude, Date #1) = (-58°, 0.0 d)
(Ending longitude, Date #2) = (66°, 11.0 d)

The total change in longitude is:
Ending longitude - starting longitude = 66° - (-58°) = 124°

The total change in time is:
Date #2 – Date #1 = 11 day – 0 d day = 11 day

The rate of sunspot drift is 124° / 11 day = 11.3 °/day.

6. From your value for sunspot drift rate from procedure step #5, calculate the time it would take for the sunspot to drift 360° around the sun. Refer to the sample calculation #2, below, for help.

Sunspot drift time = ________________________

Sample calculation #1

Suppose you calculate the drift rate to be 11.3 °/day.

The Rate Equation (R = Q/T) can be solved for time:

T = Q/R

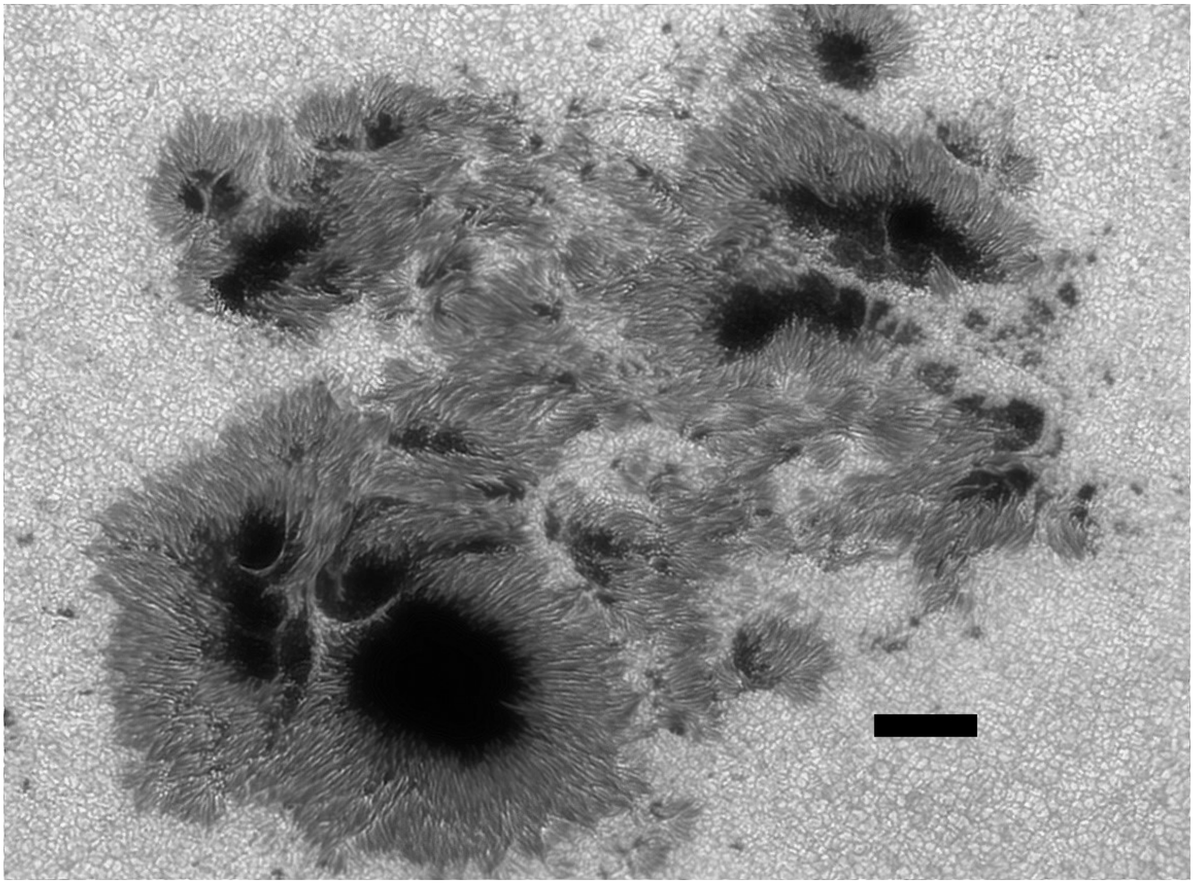
In this case, Q = 360°, so
T = Q/R = 360° / (11.3 °/day) = 31.9 day

PROCEDURE II: Size scales on the Sun

7. Figure #2 shows a giant group of sunspots, called AR 2192. The black horizontal scalebar at the lower right is equivalent to 9000 km long. Measure the length of the line, and calculate the scale of the photograph in km/mm.

Solar image scale = ________________________

Figure 2: AR 2192



8. Measure the size of the sunspot group, and using the scale from step #7, calculate the size of the sunspot group in km.

   Sunspot group size = ________________________km

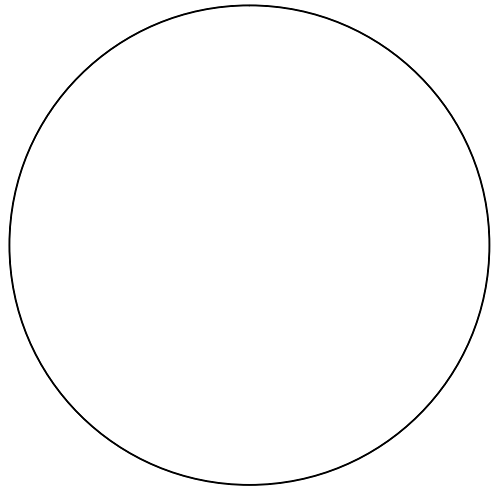
9. Look up the diameter of the Earth in km. Using that, calculate how many Earth-diameters across the giant sunspot group is:

Earth = __________________km   Sunspot group = _______________Earths

PROCEDURE III: The Sun today

Time permitting, your instructor will show you a web site where you can see the appearance of the Sun within the last 24 hours. Look for sunspots or coronal activity. Sketch these features on the Sun template on the next page.

Sun Template



VOCABULARY:

Nuclear fusion
Photosphere
Sunspots
Chromosphere
Corona
Image scale

QUESTIONS/ANALYSIS:

1) Do sunspots tend to drift N-S, or E-W on the Sun?

2) In Procedure step #6, you calculated how long it takes for a sunspot to drift around the Sun. But that was measured from the perspective of the Earth, which is also orbiting around the Sun. (Imagine if the Sun took 365 days to spin, sunspots wouldn't appear to move at all, from the Earth's perspective.)

However, we can easily correct for this. Your result from Procedure step #6 is actually called the sunspot's "synodic period" (P_s). We can calculate the true period (P_T), usually called the "sidereal period," using the following equation:

$$P_s = \frac{P_T \times E}{P_T + E}$$

Where E = 365 days. With this correction, what is your estimate for the rotational period of the Sun? Show your work.

P_T = ______________________