Activity - Sunspot Tracking

Adapted by NSO from NASA and the European Space Agency (ESA).
https://sohowww.nascom.nasa.gov/classroom/docs/Spotexerweb.pdf / Retrieved on 01/23/18.

Objectives

In this activity, students determine the rate of the Sun's rotation by tracking and analyzing real solar data over a period of 7 days.

Materials

- ◻ Student activity sheet
- ◻ Calculator
- ◻ Pen or pencil

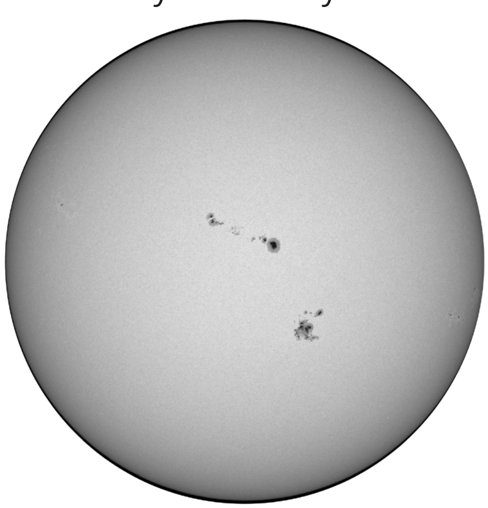
Background

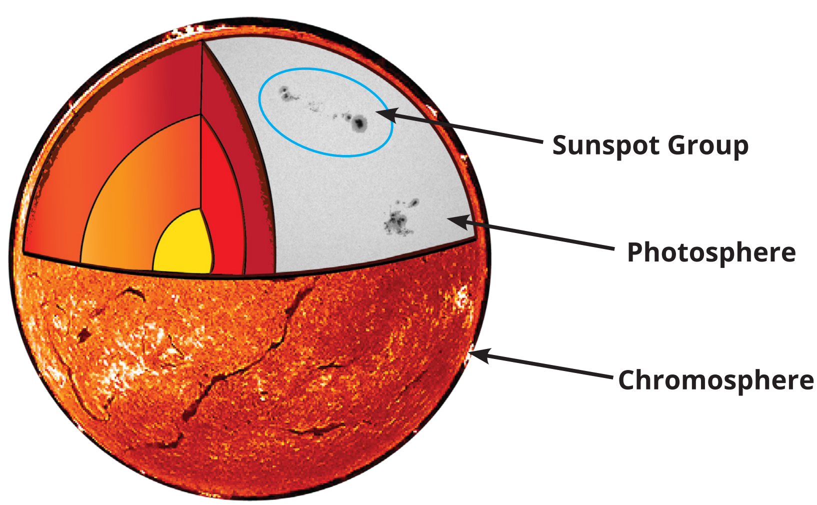
In this activity, you'll observe and track sunspots across the Sun, using real images from the National Solar Observatory's: Global Oscillation Network Group (GONG). This can also be completed with data students gather using www.helioviewer.org. See lesson 4 for instructions.

GONG uses specialized telescope cameras to observe different layers of the Sun in different wavelengths of light. Each layer has a different story to tell. For example, the chromosphere is a layer in the lower solar atmosphere. Scientists observe this layer in H-alpha light (656.28nm) to study features such as filaments and prominences, which are clearly visible in the chromosphere.

For the best view of sunspots, GONG looks to the photosphere. The photosphere is the lowest layer of the Sun's atmosphere. It's the layer that we consider to be the "surface" of the Sun. It's the visible portion of the Sun that most people are familiar with. In order to best observe sunspots, scientists use photospheric light with a wavelength of 676.8nm.

The images that you will analyze in this activity are of the solar ***photosphere.*** The data gathered in this activity will allow you to determine the rate of the Sun's rotation.





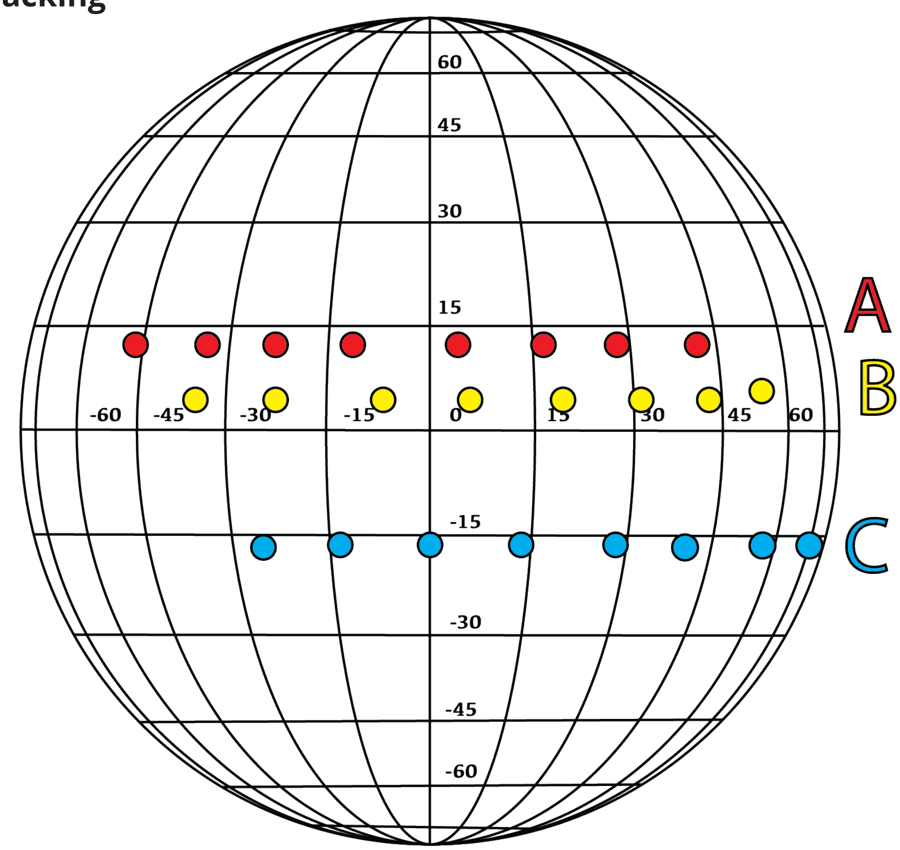
Directions

This activity can be completed individually or in groups of 3. Each student in a group will track one of the 3 visible sunspot groups (A, B, or C). If a student works individually, they will track all 3 sunspot groups.

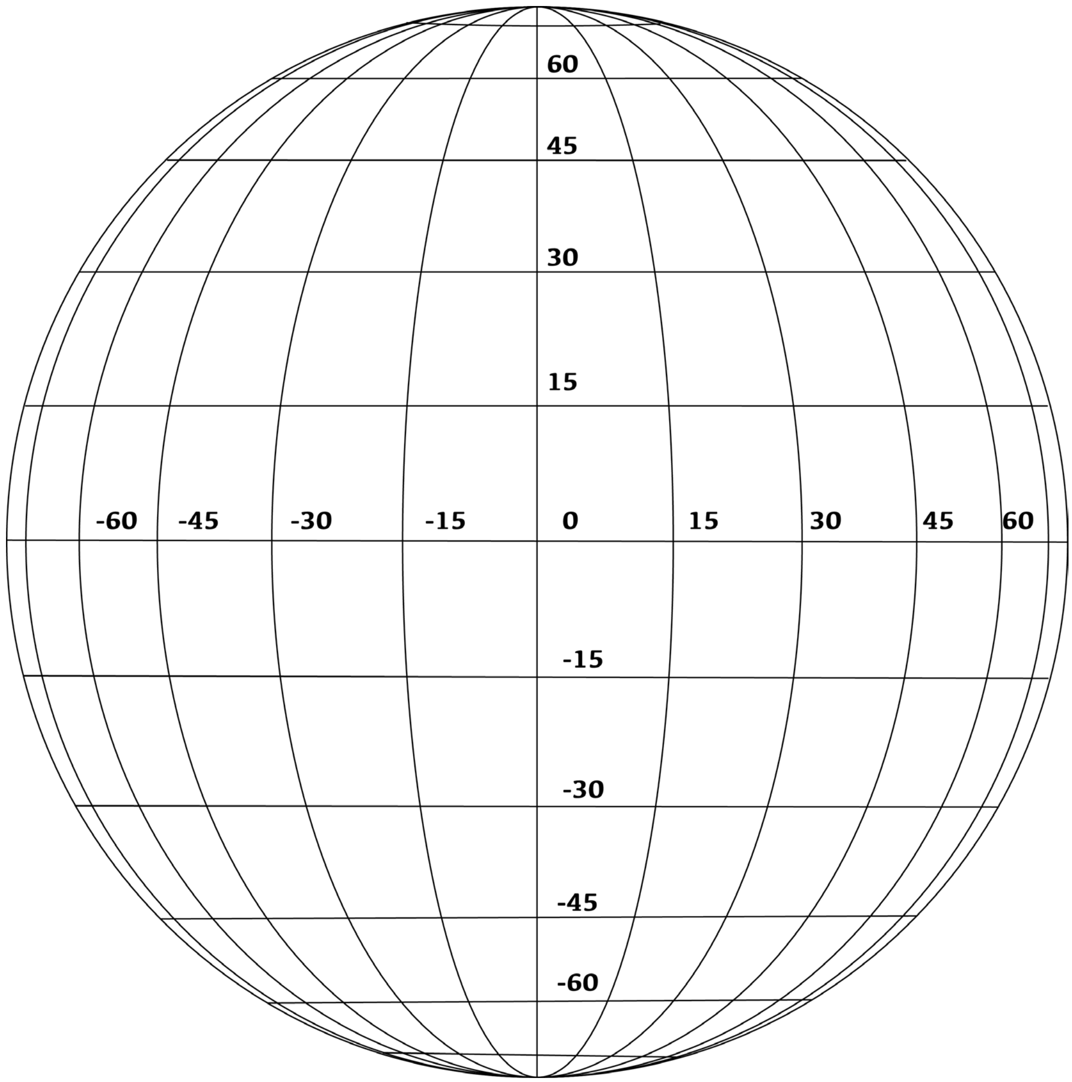
1. Print out the Sunspot Tracking Data Sheet. Each student or group of students will need one.
2. Observe the sunspot images from September 1st to September 8th.
3. For each day, mark where the sunspots appear on your mapping grid. Note the date and any changes in shape or size. Also, write down each sunspot's position in terms of longitude.

This activity is meant to simulate stepping outside at the same time each day and observing sunspots with a solar telescope. NSO images are provided to use in the event that there are no actual sunspots present on the sun at the start of this activity.

Sample Tracking Grid

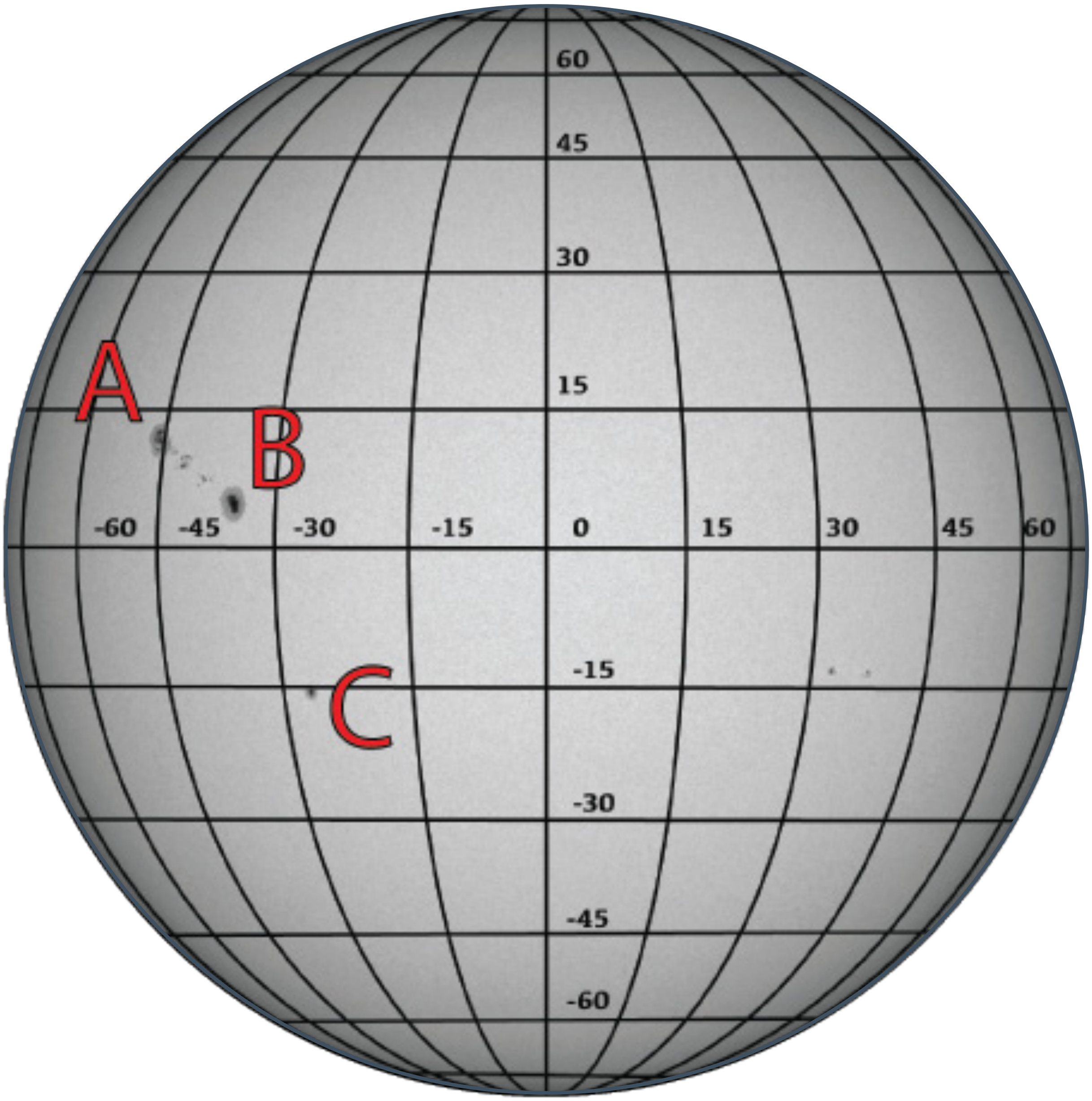


Sunspot Tracking - Student Data Sheet

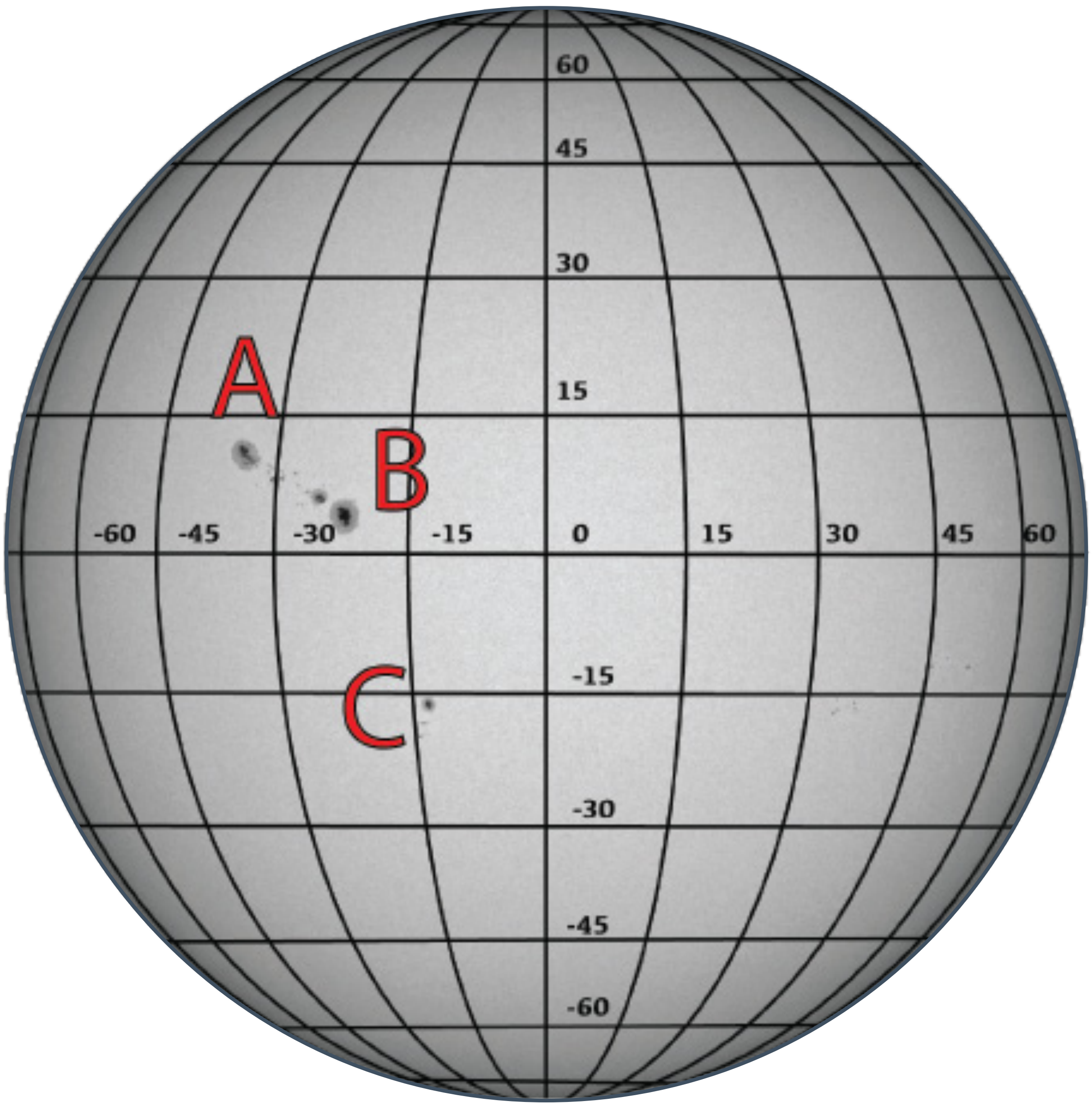


DAY	Sunspot Longitude (degrees)			Number of degrees sunspots moved from previous day		
	A	B	C	A	B	C
1						
2						
3						
4						
5						
6						
7						
8						

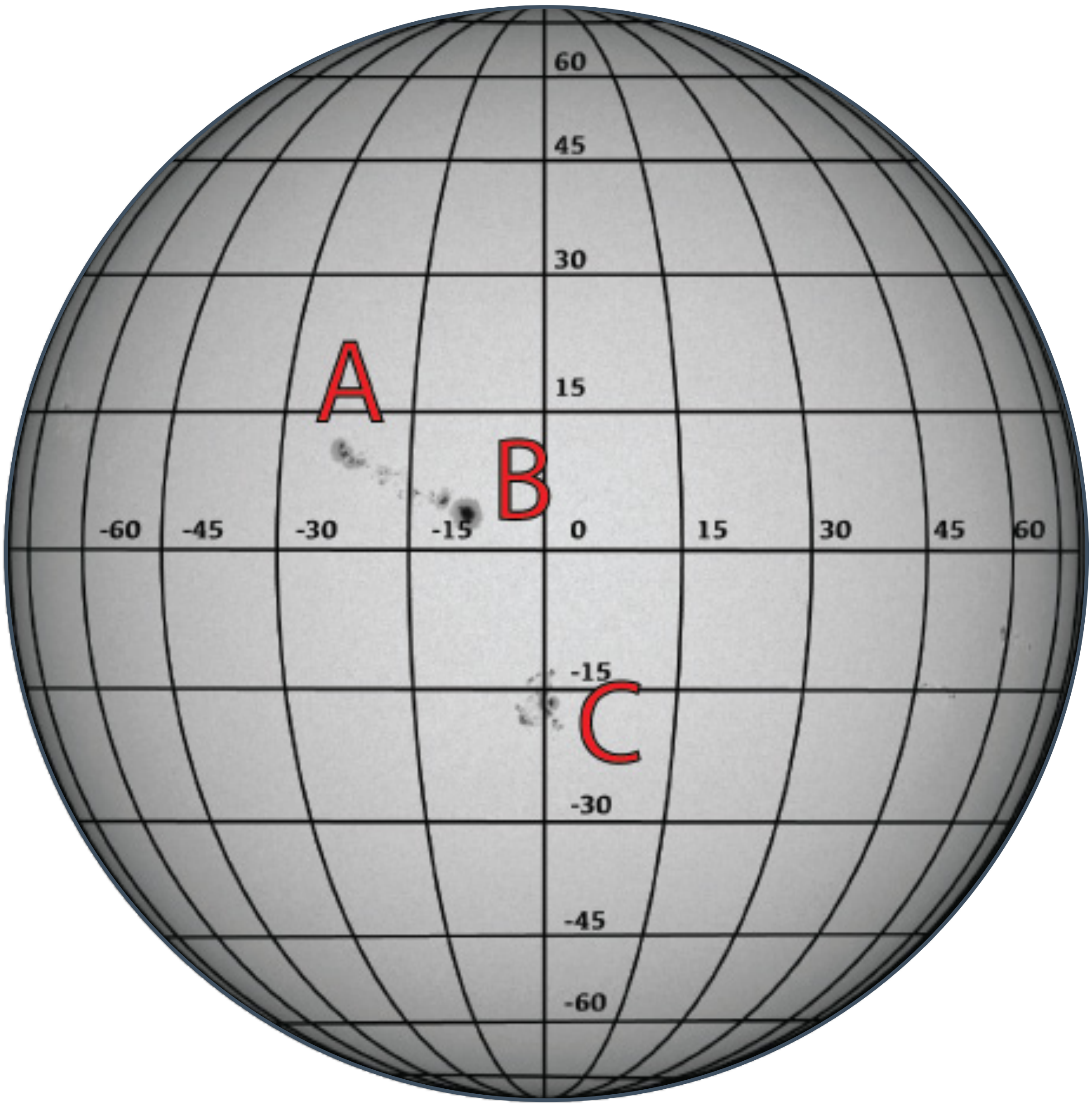
September 1st



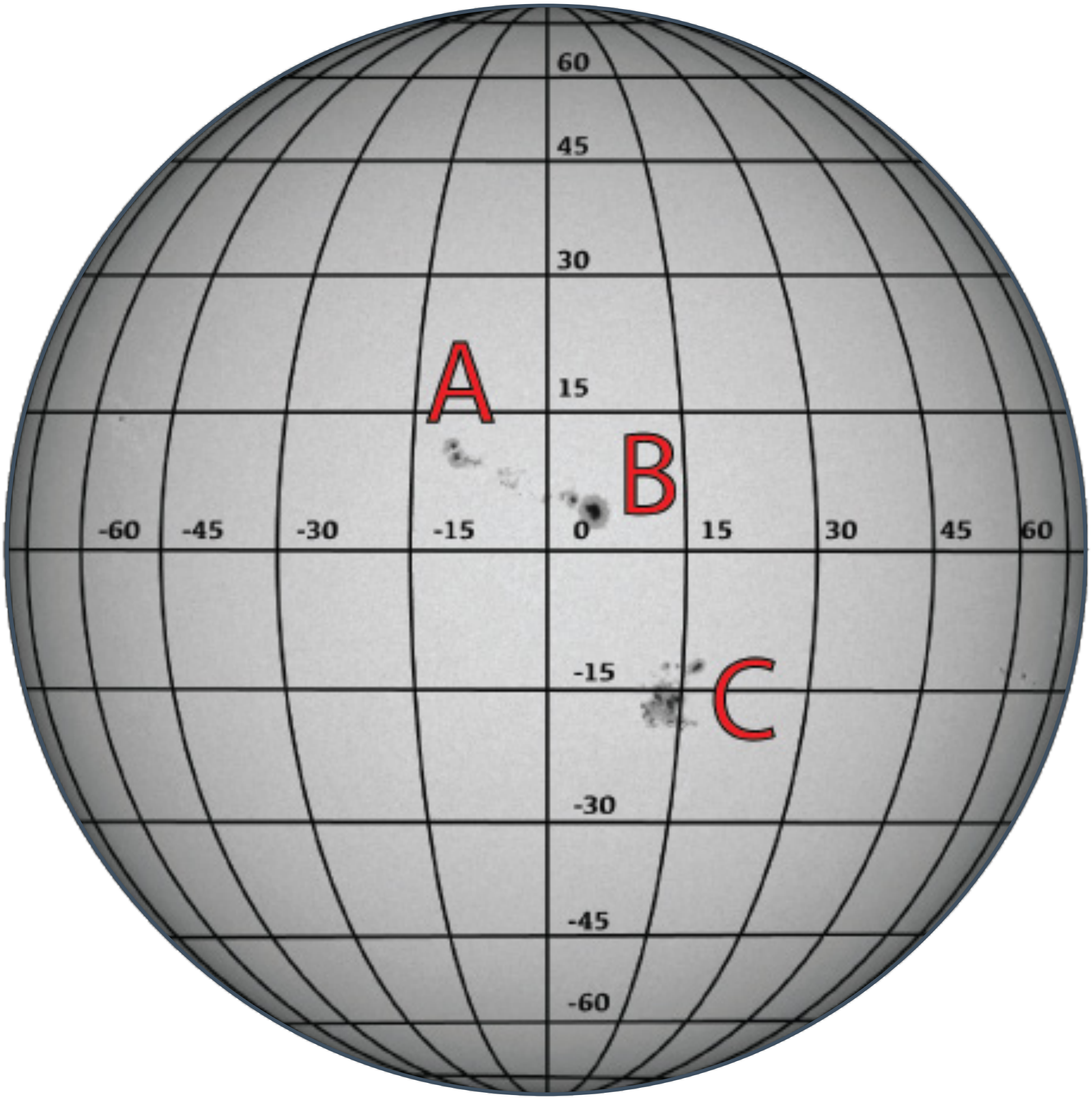
September 2nd



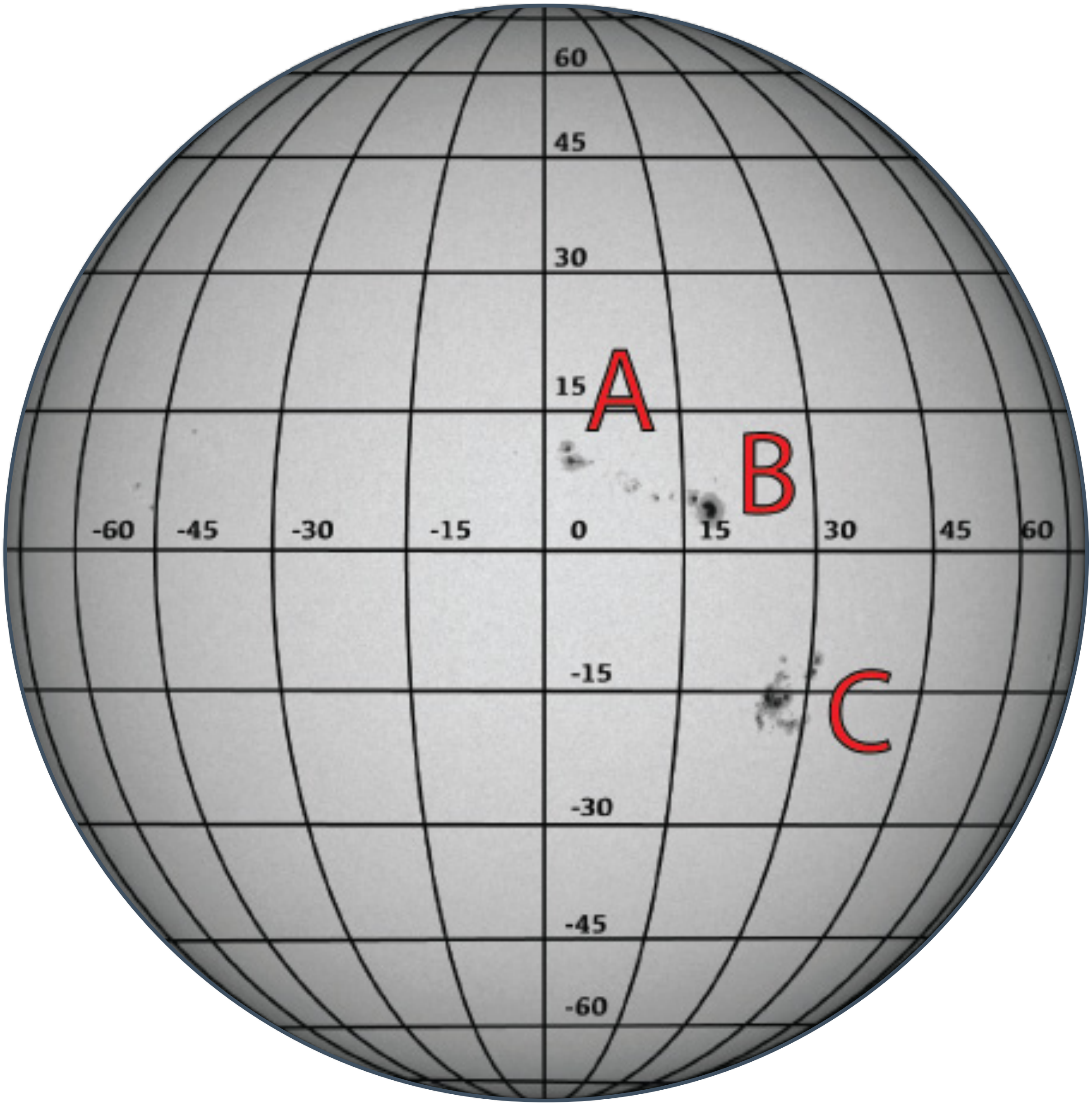
September 3rd



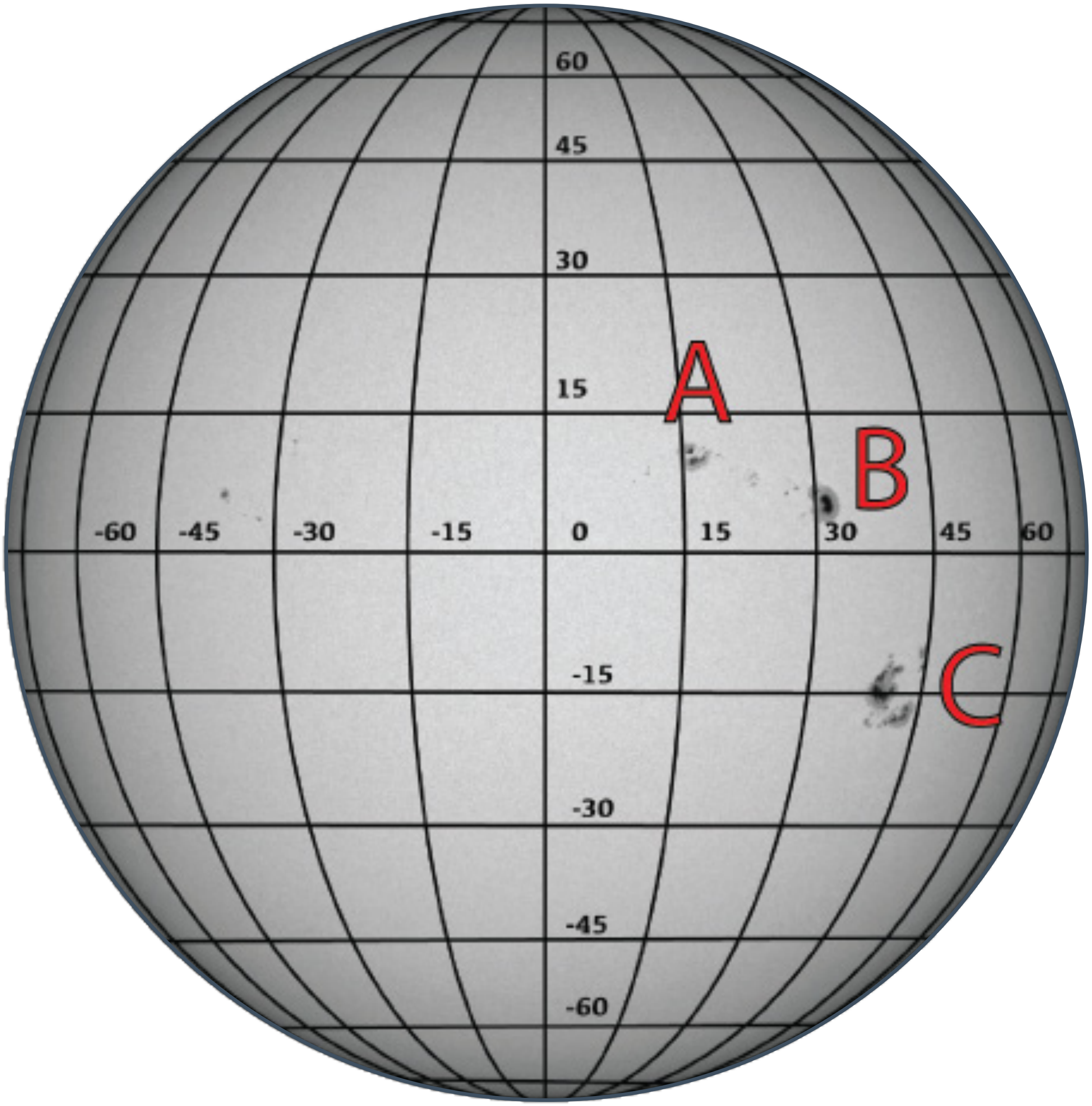
September 4th



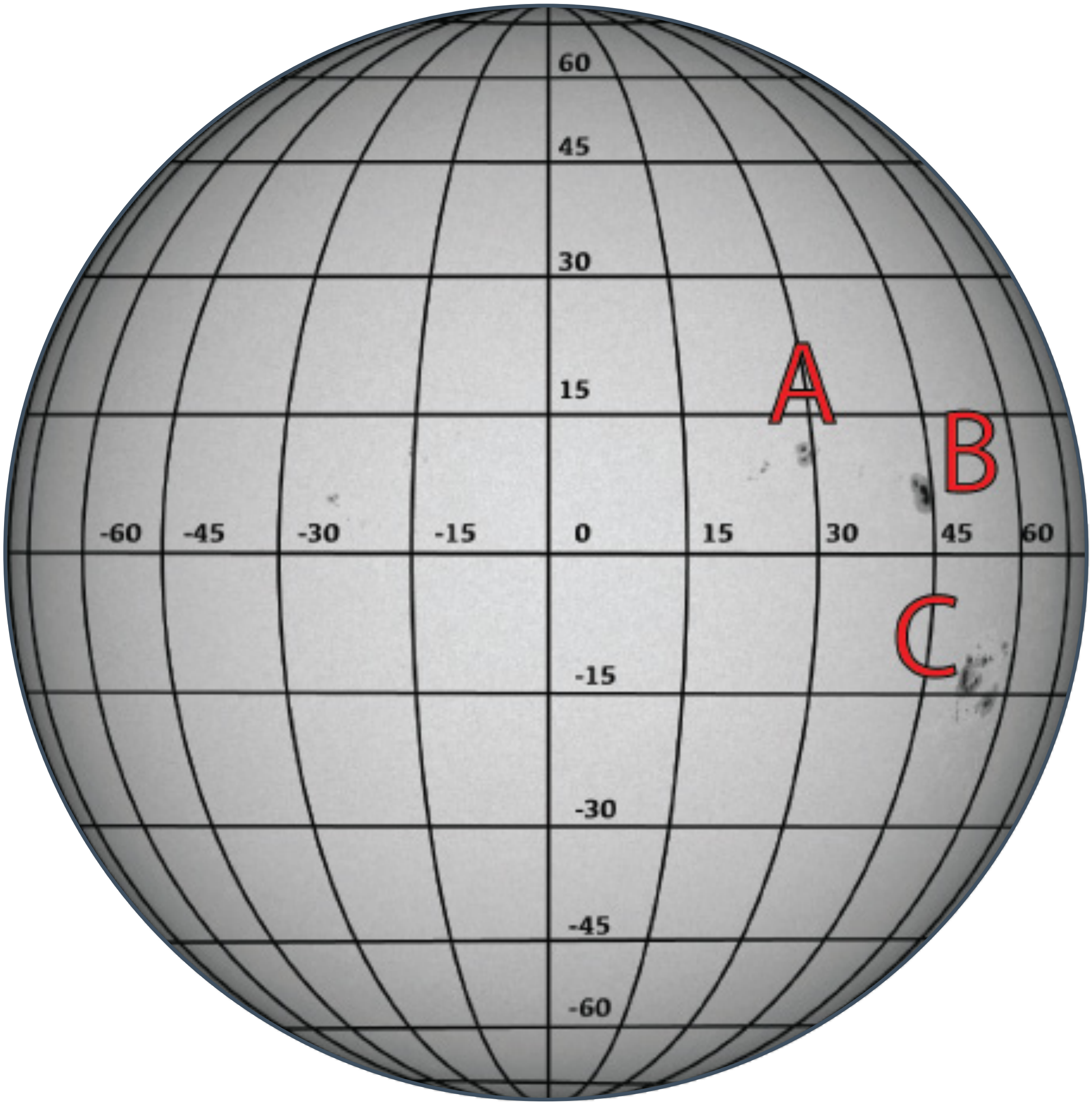
September 5th



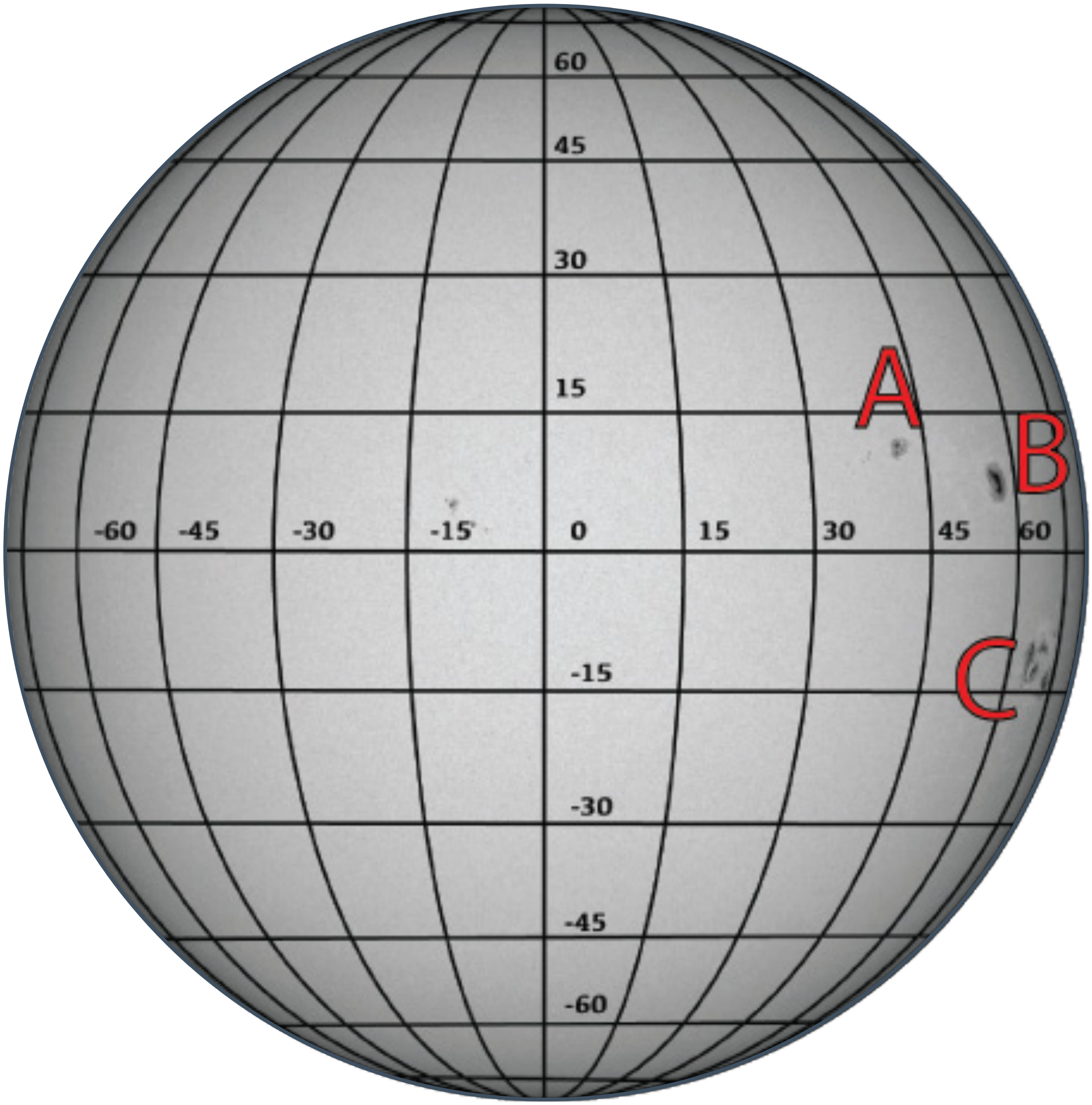
September 6th



September 7th



September 8th



Analysis

What is the average daily rate of sunspot movement?

To answer this, determine the total degrees of change from one day to the next. For example, if you noted the sunspot at -60° on Monday, than at -45° at the same time on Tuesday, then you can conclude that the sunspot moved 15° in one day. Repeat this calculation for each 24-hour period. Then, add the daily movement values together and divide by the total number of days (24-hour periods) over which the changes took place.

Example:

DAY	Sunspot Longitude (degree)	Number of degrees sunspot moved from previous day
Day 1	-60	
Day 2	-50	(60-50) = 10
Day 3	-40	(50-40) = 10
Day 4	-30	(40-30) = 10

Total number of degrees moved = (10+10+10) = 30

Total number of observation days = (4-1) = 3 days

Average rate of sunspot movement = 30 degrees / 3 days = 10 degrees per day.

**Remember, this is just an example, Sunspots do NOT actually move at a rate of 10 degrees per day. You will calculate the actual rate using the data that YOU gather.*

Fill in with your ACTUAL data:

Total Number of Degrees Moved from Day 1 to Day 8 =

A:____ B:____ C:____

Total Number of Days (24-hr. periods between day 1 and day 8) = 7

Rate of Sunspot movement =

A: ______ degrees per day

B: ______ degrees per day

C: ______ degrees per day

Average Rate of Sunspot Movement between groups A, B, and C:

__________________ degrees per day

How long does it take the Sun to make one full rotation of 360º?

To answer this, first we need to recognize that the Earth moves around the Sun in the same direction at about 1º per day:

Earth revolves 360º around the Sun in about 365 days.

Thus:

360/365 = 0.99º per day (approximately 1 degree per day)

Therefore, because our telescopes are located on Earth, it seems like the Sun is rotating slower than it really is. We have to correct for this; we must add 1º per day to our initial calculation.

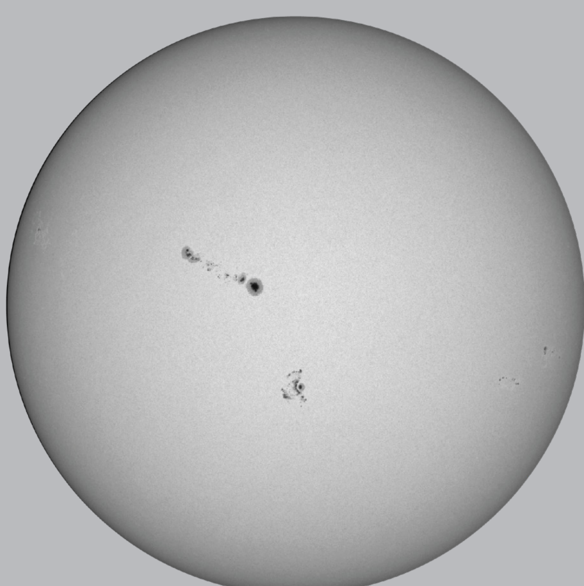
For example: If your initial calculation gave you a sunspot rate of 12° per day, the corrected rate would be 13° per day.

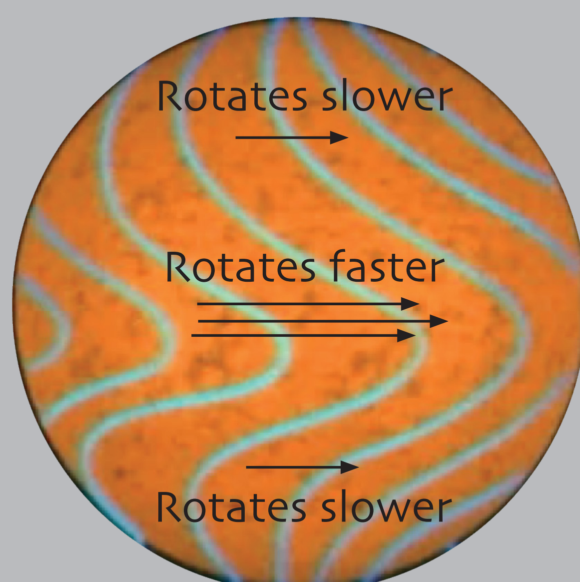
Lastly, use this information to draw your conclusion.

How long does it take the Sun to rotate 360°?

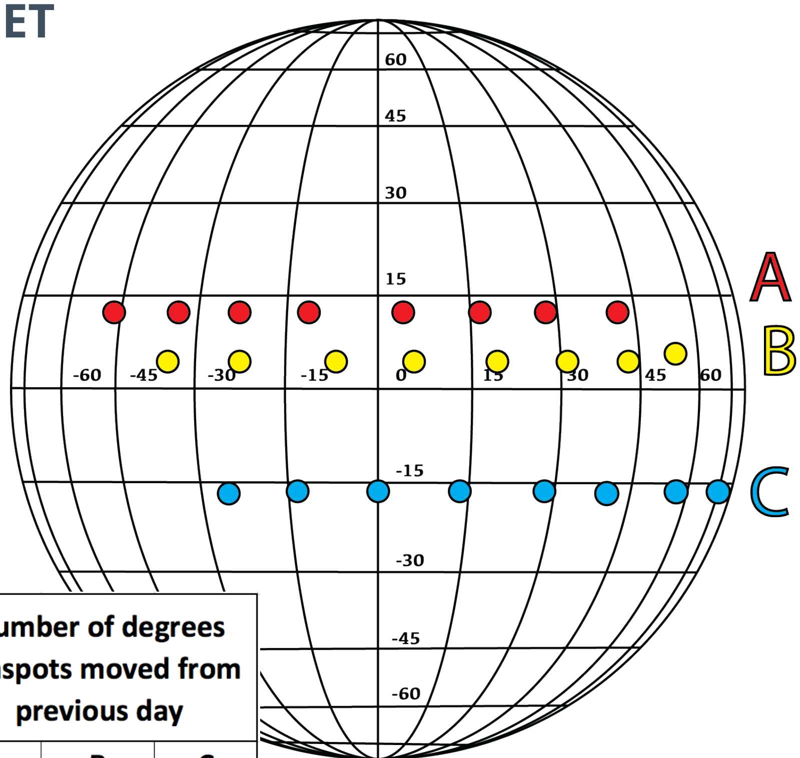
The Sun rotates once every ____ days

Note the Sun isn't a solid object, therefore it does not rotate at the same rate everywhere on its surface. The Sun rotates slightly faster at the equator than it does near the poles.





Sample Answer Sheet



DAY	Sunspot Longitude (degrees)			Number of degrees sunspots moved from previous day		
	A	B	C	A	B	C
1	-46	-35	-24			
2	-34	-23	-13	12	12	11
3	-24	-7	0	10	16	13
4	-12	5	14	12	12	14
5	3	17	29	15	12	15
6	16	31	40	13	14	11
7	28	38	59	12	7	19
8	41	49	75	13	11	16

Total Number of Degrees Moved from Day 1 to Day 8 =
A: 87 B: 84 C: 99

Total Number of Days (8-1) = 7

Rate of Sunspot movement =
A: (87/7) = 12.43 degrees per day
B: (84/7) = 12 degrees per day
C: (99/7) = 14.14 degrees per day

<u>How long does it take the Sun to rotate 360 degrees?</u>
Average degrees per day = (12.43 + 12 + 14.14) / 3 = 12.86
Account for the Earth's revolution (12.86 + 1 = 13.86)
360 degrees / 13.86 degrees per day = 26 days

*Remember, this is not a precise measurement. The Sun rotates at different speeds between the poles and equator.