Solar Observing Exercise Work Booklet

Grade 9 Science

Names_____

Due Date (Day Month Year)

Date Submitted_____

Notes on Introduction

On this page, you record the main ideas from the introduction and any insights you gained.

1st Reason for Studying the Sun

2nd Reason for Studying the Sun

3rd Reason for Studying the Sun

4th Reason for Studying the Sun

A key to understanding flares and sunspots on the sun is ….

Activity 1: Pin Hole Camera Observations and Calculations[1]

A.

		Observations and Calculations
1	**Distance from pinhole to screen in mm**	
2	**Estimate the error (+ or -) of distance measurement in mm**	
3	**Diameter of image on screen in mm**	
4	**Estimate the error (+ or -) of the diameter measurement in mm**	
5	**Calculate the diameter of the sun using your answers to 1 and 3 given that the distance from the Earth to the Sun is 149,600,000 km (this varies slightly during the year)**	
6	**Using the error estimates (lines 2 and 4), calculate what could be the maximum size of the sun**	
7	**Using the error estimates (lines 2 and 4), calculate what could be the minimum size of the sun**	
8	**Restate your answer in Line 5 to show the + or – values.**	

B. What happened to the image of the sun on the screen as you increased and decreased the distance between the pinhole and the screen? Why?

- The image became dimmer and larger as the distance was increased and brighter, smaller and more defined as the distance decreased.

1) Identify the sources of error.

a) If the screen is not parallel to the pinhole board, then image will be more oval than round.
b) The distance between the screen and pinhole could be inaccurate.

[1] CC: Grade 9, Science, Academic and Applied, Inquiry and Communication, 2.4, gather and record data

i) This could be caused by measuring the distance between the screen and the board holding the pinhole and not to the aluminium foil with the pinhole.
ii) This could also be caused by the difficulty of holding steady the screen and the pinhole board.

c) The method used to measure the diameter of the image could be inaccurate.

2) If you were to design a better pinhole device for this exercise, how would you do that? Identify specific changes and characteristics of this new device[2].

A shoebox could be converted into a better pinhole device. The two narrow sides could function as the pinhole and screen, reducing the two errors identified above. A small section of the lid could be cut away to allow the observer a good view and easy access to the image for measurement.

3) Find the formula used to calculate volume of a sphere[3] and find the ratio of the volume of the sun to earth.

$Volume = \frac{4}{3}\pi r^3$ Therefore, the ratio is $\frac{r_{sun}^3}{r_{earth}^3} = \frac{(6.955x10^8\,m)^3}{(6.378x10^6\,m)^3} = 1{,}296{,}695$

[2] CC: Grade 9 Math and other grades, Thinking and Reasoning
[3] CC: Grade 9 Math, Academic and Applied, Measurement and Geometry

Internet Research Homework[4]

Research the following URLs and be prepared to discuss what you found or learned:

http://curious.astro.cornell.edu/question.php?number=319

- Discusses how the size of the sun and moon are measured using angles. It's short article and leads nicely into the next activity.

www.google.ca for images of the sun, using those or other similar terms

www.google.ca , select "images" from the top bar and run the search again.

- What difference did you find between the two google searches?

http://sohowww.nascom.nasa.gov/gallery/Movies/sunspots.html

- This site has some amazing video images of the sun through different filters.

http://sohowww.nascom.nasa.gov/gallery/Movies/animations.html

- View the animations on sunspot formation, and the CME affecting the earth's magnetosphere.

http://sohodata.nascom.nasa.gov/cgi-bin/data_query

- This is the location where the images used in the sunspot activity where retrieved.
- View some images based on whatever selections you like.
- Look at the Sun Now section. Can we see images of the sun here at any time of the day? Why?

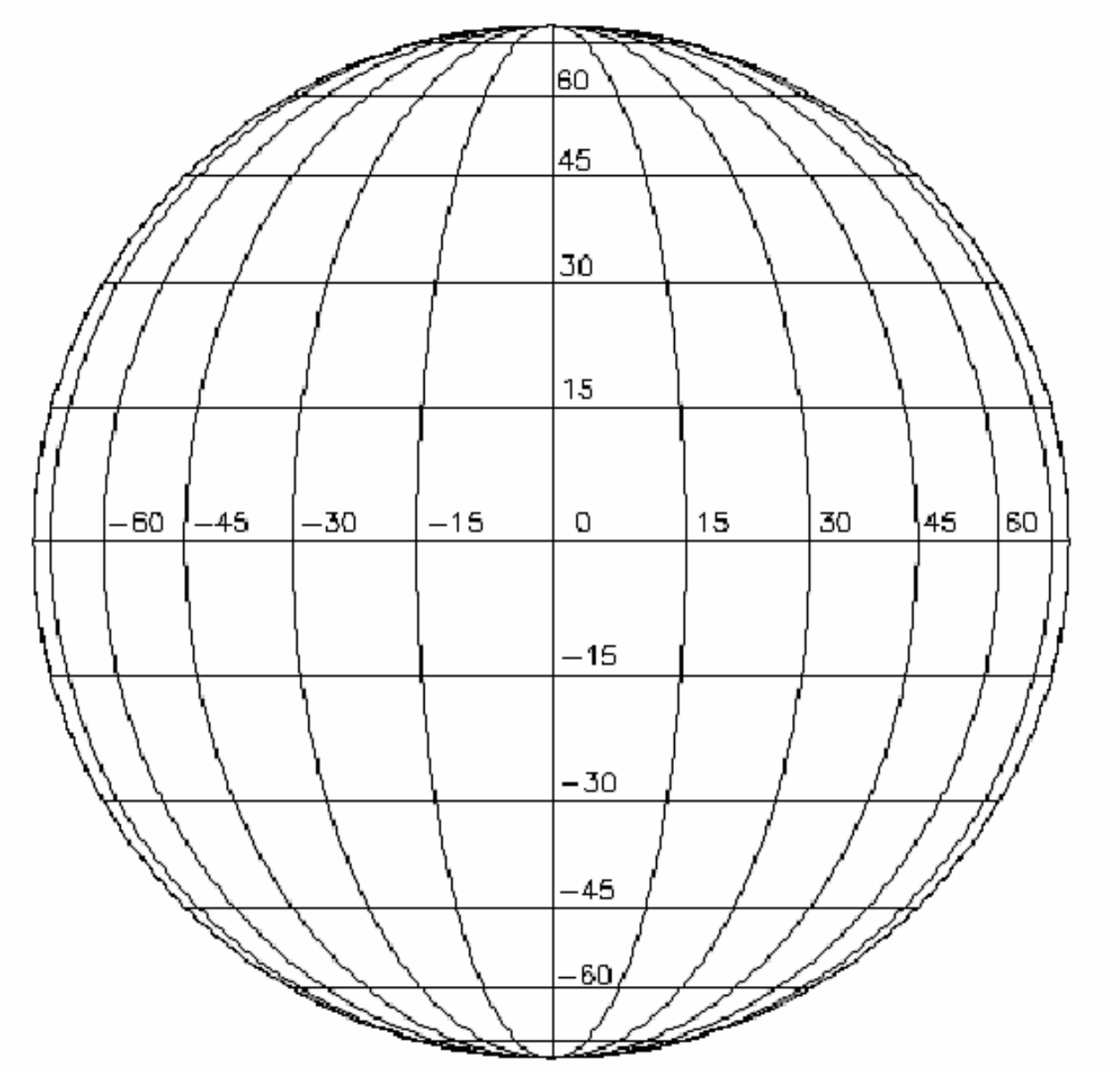
http://www.astrosociety.org/education/publications/tnl/05/05.html

- Determine which stars are closest to the earth and how our sun compares to some of these stars.

[4] CC: Grade 9, Science, Academic and Applied, Inquiry and Communication, 2.4, gather and record data

Activity 2: Sunspot Movement[5]

Record the movement of sunspots on the diagram below, and the details of the large sunspot in the middle and any other one on the left side of the image in the tables.



[5] CC: Grade 9, Science, Academic and Applied, Inquiry and Communication, 2.4, gather and record data

How to Measure Angles on the Disc of the Sun

The diagram below is a summary of the method that can be used to measure the change in longitude of sun spots.

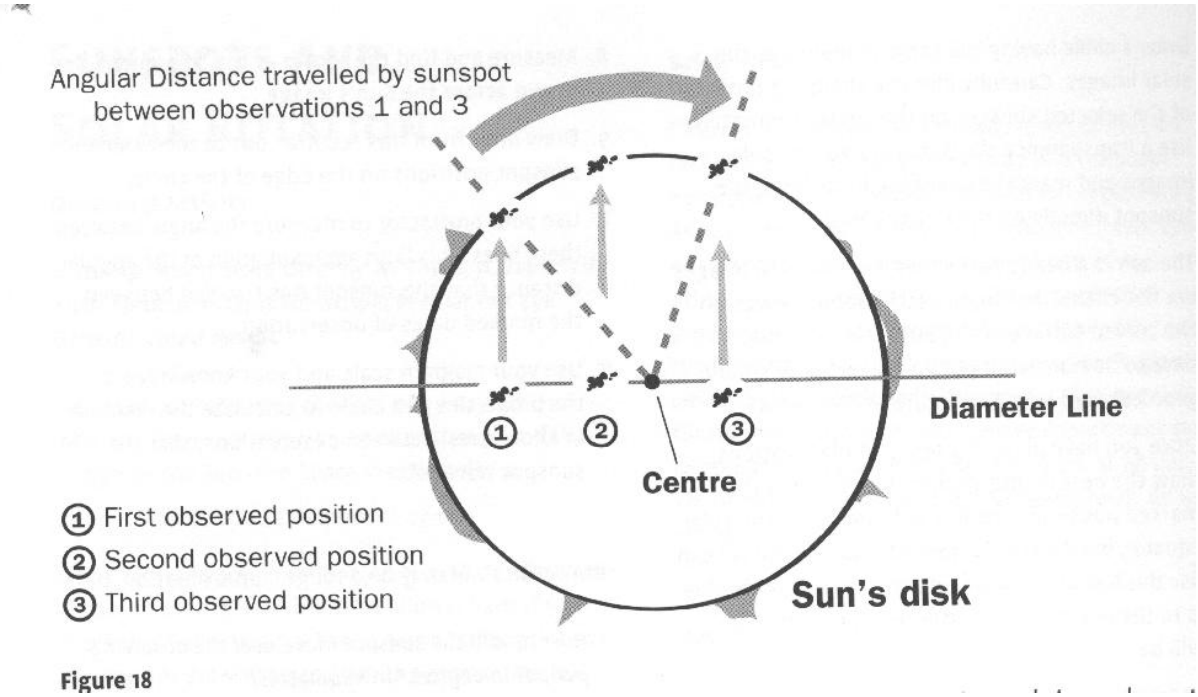


Figure 18

Activity 2: Sunspot Movement Cont'd

Spot Group Id_____

Date/Time	Latitude	Longitude	Change in Angle	Angular speed (Δ angle/ time)	Comments (size, shape, etc)

Longitude is measured **left or right** (west or east) in degrees of the line in the middle running up and down from top to bottom. Use whole degrees only.

Latitude is measured **up or down** (north or south) in degrees from the horizontal line located in the middle. Use whole degrees only.

Δ angle means change in angle**.**

Spot Group Id_____

Date/Time	Latitude	Longitude	Change in Angle	Angular speed (Δ angle/ time)	Comments (size, shape, etc)

Activity 2: Sunspot Movement Cont'd[6]

1. In general terms, describe what you observed in the images.

The sunspots travelled from left to right (west to east) at about the same latitude they started on. They appeared to travel more slowly at the edges compared to the middle. The spots changed in size and shape, and some appeared and disappeared.

2. Write a scientific question relating sunspot movement to the rotation of the sun.

Do the sunspots travel at the same speed at different latitudes?

3. Write a hypothesis regarding sunspot movement and the rotation of the sun.

Sunspots at higher latitudes will travel more slowly than sunspots at the equator.

4. Describe the angular speed for the two sunspots you studied. How do they compare? What is the + or – error of your answer. Do your results make sense and why?

At the equator, the sun takes 25 days to make one revolution. Therefore, the angular speed at the equator is 14.4 degrees / day. The students' answers should be within a degree of this for the large sunspot close to the equator near the centre in the first image.

At the poles, the sun takes 36 days to make one revolution. Therefore, the angular speed is 10 degrees / day. The speed of the other sunspot should be between 14.4 and 10 degrees/ day, depending on which one was selected.

These values make sense since the sun is fluid and not a solid like the earth. Fluids and gas do not rotate like solids do.

5. Calculate the period of rotation of the sun.

The students should provide two answers and not an average since that would not make sense.

6. Did you notice any changes in sunspots? Why is this possible?

[6] CC: Grade 9 Science, Academic and Applied, Basic Concepts, 3.3, describe major components of solar system

The sunspots changed in size and shape. This is possible given the fluid nature of the surface of the sun and the complicated magnetic forces that can changes in the spots.

7. Do the spots appear to move more slowly or quickly near the edges? Why?

The sunspots appear to move more slowly near the edges, because at the edges the spots are moving towards the viewer as well as horizontally. This movement towards the viewer makes the sunspot appear as if they're moving more slowly when in reality they are moving at constant angular speed.

Activity 3 Predicting Sunspot Activity[7]

On a separate piece of graph paper, graph the table of values shown below and predict on the graph--by drawing a dotted line--what will happen in the next 11 years or so. Explain why you drew your line the way you did. How certain are you of this dotted line?

Year	Sunspots		Year	Sunspots
1950	84		1979	55
1951	69		1980	55
1952	32		1981	41
1953	14		1982	16
1954	4		1983	67
1955	38		1984	46
1956	42		1985	18
1957	90		1986	13
1958	85		1987	29
1959	59		1988	0
1960	12		1989	58
1961	54		1990	43
1962	38		1991	46
1963	28		1992	94
1964	10		1993	55
1965	15		1994	30
1966	47		1995	18
1967	94		1996	9
1968	6		1997	22
1969	6		1998	64
1970	5		1999	93
1971	67		2000	20
1972	69		2001	11
1973	38		2002	4
1974	35		2003	64
1975	16		2004	40
1976	13		2005	30
1977	28		2006	15
1978	93		2007	8

Additional information on sunspot numbers can be found at http://www.ngdc.noaa.gov/stp/SOLAR/ftpsunspotnumber.html - international and at

http://sidc.oma.be/sunspot-index-graphics/sidc_graphics.php

What is important in this exercise is that the students develop some reason with some justification for their prediction. It could be a very simple reason. The reality is that the next solar cycle (cycle 24) is already starting later than expected.

[7] CC: Grade 9 Math and other years, Reasoning and Representing Skills & Grade 9 Science, skills: analyze quantitative data; predict quantitative characteristics