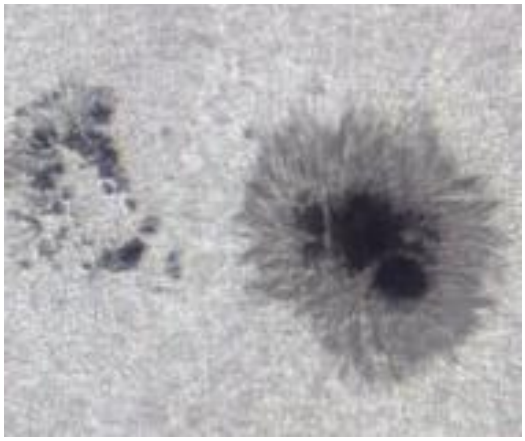
Name _____ 5

Sunspots are some of the most interesting, and longest studied, phenomena on the sun's surface. The table below shows the area of a sunspot. In comparison, the surface area of Earth is '169' units on the sunspot scale. The table also shows the brightest flare seen from the vicinity of the sunspot s beginning November 6, 2004. Flares are ranked by their brightness 'C', 'M' and 'X' with M-class flares being 10x more luminous that C-class flares, and X-class flares being 10x brighter than M-class flares.

Date	Spot #	Area	Flare
Nov 6	#696	820	M
Nov 7	#696	910	M
Nov 8	#696	650	X
Nov 10	#696	730	M
Nov 11	#696	470	X
Dec 2	#708	130	M
Dec 3	#708	150	M
Dec 9	#709	20	C
Dec 29	#713	150	M
Dec 30	#715	260	M
Dec 31	#715	350	M
Jan 1	#715	220	M
Jan 2	#715	180	X
Jan 4	#715	130	C
Jan 10	#719	100	M
Jan 14	#718	160	C
Jan 15	#720	1540	M
Jan 16	#720	1620	X
Jan 17	#720	1630	M
Jan 18	#720	1460	X
Jan 19	#720	1400	M



During the 75 day time period covered by this table, there were a total of (720-696=) 24 catalogued sunspots. The table shows only those catalogued sunspots that were active in producing flares during this time. Sunspot areas are in terms of millionths of the solar hemisphere area, so '1630' means 0.163% of the Sun's face. Earth's area = 169 millionths by comparison!

Sunspot and solar flare data from NOAA SWN data archive at http://www.sec.noaa.gov/Data/index.html

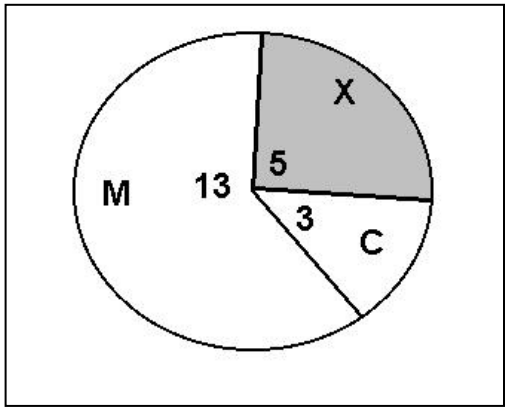
Question 1: Construct a pie chart for the X, M and C-class flare data. During this 75-day period, what percentage of flares are X-class?

Question 2: What percentage of sunspots produce X-class flares?

Question 3: What percentage of sunspots did not produce any flares during this time?

Question 4: What seems to be the minimum size for a sunspot that produces an X-class flare? An M-class flare? A C-class flare?

Question 5: If the area of Earth is '169' in the sunspot units used in the above tables, what are the maximum and minimum size of the sunspots compared to the area of Earth?



Note, there are 21 flares in the table.
X = 5 flares
M = 13 flares
C = 3 flares.
The pie chart angles are
21 = 360 degrees
X = (5/21)x360 = 86 degrees
M = (13/21)x360 = 223 degrees
C = (3/21)x360 = 51 degrees.
And to check: 223+86+51 = 360.

Question 1: With a pie chart, what percentage of flares were X-type?
Answer: 5 out of 21 or (5/21)x100% = 24%

Question 2: During this 75-day period, what percentage of flares are X-class flares?
Answer: There are 24 sunspots in the sample because the catalog numbers run from 720 to 698 as stated in the table caption (A 'reading to be informed' activity). There were three sunspots listed in the table that produced X-class flares: #696, #715, #720. The percentage is (3/24)x100% = 12.5% which may be rounded to 13%.

Question 3: What percentage of sunspots did not produce flares during this time?
Answer: There were only 8 sunspots in the table that produced flares, so there were 16 out of 24 that did not produce any flares. This is (16/24)x100% = 67%. An important thing for students to note is that MOST sunspots do not produce any significant flares.

Question 4: What seems to be the minimum size for a sunspot that produces an X-class flare? An M-class flare? A C-class flare?
Answer: Students may reasonably answer by saying that there doesn't seem to be any definite correlation for the X and M-class flares! For X-class flares, you can have them if the area is between 180 and 1620. For M-class flares, spots with areas from 130 to 1630 can have them. The two possibilities overlap. For C-class flares, they seem to be most common in the smaller spots from 20 – 130 in area, but the sample in the table is so small we cant really tell if this is a genuine correlation or not. Also, we have only shown in the table the largest flares on a given day, and smaller flares may also have occurred for many of these spots.

Question 5: If the area of Earth is '169' in the sunspot units used in the above tables, what are the maximum and minimum size of the sunspots compared to the area of Earth?
Answer: The smallest spot size occurred for #709 with an equivalent size of (20/169)x100% = 11% of Earth's area. The largest spot was #720 with a size equal to (1630/169) = 9.6 times Earth's area.