**Graphing Sunspots:**

**Name: Date: Period:**

Objective:

 By the end of the lab period, students will be able to graph the sunspot cycles and determine patterns.

Materials:

* Large sheet of newsprint paper
* Ruler or meter stick
* Data sheet

Background Information:

Sunspots are dark, [planet-sized](http://www.windows2universe.org/sun/atmosphere/sunspot_size.html) regions that appear on the "surface" of the Sun. Sunspots are "dark" because they are colder than the areas around them. A large sunspot might have a temperature of about 4,000 K (about 3,700° C or 6,700° F). This is much lower than the 5,800 K (about 5,500° C or 10,000° F) temperature of the bright photosphere that surrounds the sunspots.

Sunspots are only dark in contrast to the bright face of the Sun. If you could cut an average sunspot out of the Sun and place it in the night sky, it would be about as bright as a full moon. Sunspots have a lighter outer section called the penumbra, and a darker middle region named the umbra.

Sunspots are caused by the Sun's magnetic field welling up to the photosphere, the Sun's visible "surface". The powerful magnetic fields around sunspots produce active regions on the Sun, which often lead to solar flares and Coronal Mass Ejections (CMEs). The solar activity of flares and CMEs are called "solar storms".

Sunspots form over periods lasting from days to weeks, and can last for weeks or even months. The average number of spots that can be seen on the face of the Sun is not always the same, but goes up and down in a cycle. Historical records of sunspot counts show that this sunspot cycle has an average period of about eleven years.

Sunspots have been known and recorded for hundreds of years. The reporting techniques have not always been consistent. Currently we can determine the average number of sunspots appearing each day. The yearly number is the annual average daily sunspot number. It is highly instructive to determine the nature of the cyclic characteristics of sunspot numbers. A large number of natural phenomena have been related to sunspots (or the periods of great numbers or few, etc.). A new area of scientific research called [spaceweather](http://www.windows.ucar.edu/spaceweather) has been formed to try and explain these Sun-Earth connections.

Procedure:

1. Obtain a piece of newsprint from your teacher. Fold it in half length wise, unfold it, and cut it into two hot dog halves. Tape pieces together to form one long, skinny piece of paper.
2. Look at the data set, and using a ruler/meter stick create an axis the length of your combined sheet of paper such that it encompasses all the years listed on the x-axis.
3. The y-axis should be used for the number of sunspots.
4. Graph the data. A good method might be having one partner start on one end and the other start on the other end and meet up in the middle.
5. Label your graph appropriately

Data Sheet:

 Sunspot Sunspot Sunspot Sunspot Sunspot Sunspot

Year Number Year Number Year Number Year Number Year Number Year Number

1700 5

1701 11 1761 85.9 1821 6.6 1881 54.3 1941 47.5 2001 110.9

1702 16 1762 61.2 1822 4.0 1882 59.7 1942 30.6 2002 104.0

1703 23 1763 45.1 1823 1.8 1883 63.7 1943 16.3 2003 63.7

1704 36 1764 36.4 1824 8.5 1884 63.5 1944 9.6 2004 40.4

1705 58 1765 20.9 1825 16.6 1885 52.2 1945 33.2 2005 29.8

1706 29 1766 11.4 1826 36.3 1886 25.4 1946 92.6 2006 15.2

1707 20 1767 37.8 1827 49.6 1887 13.1 1947 151.6 2007 7.5

1708 10 1768 69.8 1828 64.2 1888 6.8 1948 136.3 2008 2.9

1709 8 1769 106.1 1829 67.0 1889 6.3 1949 134.7 2009 3.1

1710 3 1770 100.8 1830 70.9 1890 7.1 1950 83.9

1711 0 1771 81.6 1831 47.8 1891 35.6 1951 69.4

1712 0 1772 66.5 1832 27.5 1892 73.0 1952 31.5

1713 2 1773 34.8 1833 8.5 1893 85.1 1953 13.9

1714 11 1774 30.6 1834 13.2 1894 78.0 1954 4.4

1715 27 1775 7.0 1835 56.9 1895 64.0 1955 38.0

1716 47 1776 19.8 1836 121.5 1896 41.8 1956 141.7

1717 63 1777 92.5 1837 138.3 1897 26.2 1957 190.2

1718 60 1778 154.4 1838 103.2 1898 26.7 1958 184.8

1719 39 1779 125.9 1839 85.7 1899 12.1 1959 159.0

1720 28 1780 84.8 1840 64.6 1900 9.5 1960 112.3

1721 26 1781 68.1 1841 36.7 1901 2.7 1961 53.9

1722 22 1782 38.5 1842 24.2 1902 5.0 1962 37.6

1723 11 1783 22.8 1843 10.7 1903 24.4 1963 27.9

1724 21 1784 10.2 1844 15.0 1904 42.0 1964 10.2

1725 40 1785 24.1 1845 40.1 1905 63.5 1965 15.1

1726 78 1786 82.9 1846 61.5 1906 53.8 1966 47.0

1727 122 1787 132.0 1847 98.5 1907 62.0 1967 93.8

1728 103 1788 130.9 1848 124.7 1908 48.5 1968 105.9

1729 73 1789 118.1 1849 96.3 1909 43.9 1969 105.5

1730 47 1790 89.9 1850 66.6 1910 18.6 1970 104.5

1731 35 1791 66.6 1851 64.5 1911 5.7 1971 66.6

1732 11 1792 60.0 1852 54.1 1912 3.6 1972 68.9

1733 5 1793 46.9 1853 39.0 1913 1.4 1973 38.0

1734 16 1794 41.0 1854 20.6 1914 9.6 1974 34.5

1735 34 1795 21.3 1855 6.7 1915 47.4 1975 15.5

1736 70 1796 16.0 1856 4.3 1916 57.1 1976 12.6

1737 81 1797 6.4 1857 22.7 1917 103.9 1977 27.5

1738 111 1798 4.1 1858 54.8 1918 80.6 1978 92.5

1739 101 1799 6.8 1859 93.8 1919 63.6 1979 155.4

1740 73 1800 14.5 1860 95.8 1920 37.6 1980 154.6

1741 40 1801 34.0 1861 77.2 1921 26.1 1981 140.4

1742 20 1802 45.0 1862 59.1 1922 14.2 1982 115.9

1743 16 1803 43.1 1863 44.0 1923 5.8 1983 66.6

1744 5 1804 47.5 1864 47.0 1924 16.7 1984 45.9

1745 11 1805 42.2 1865 30.5 1925 44.3 1985 17.9

1746 22 1806 28.1 1866 16.3 1926 63.9 1986 13.4

1747 40 1807 10.1 1867 7.3 1927 69.0 1987 29.4

1748 60 1808 8.1 1868 37.6 1928 77.8 1988 100.2

1749 80.9 1809 2.5 1869 74.0 1929 64.9 1989 157.6

1750 83.4 1810 0.0 1870 139.0 1930 35.7 1990 142.2

1751 47.7 1811 1.4 1871 111.2 1931 21.2 1991 145.8

1752 47.8 1812 5.0 1872 101.6 1932 11.1 1992 94.5

1753 30.7 1813 12.2 1873 66.2 1933 5.7 1993 54.7

1754 12.2 1814 13.9 1874 44.7 1934 8.7 1994 29.9

1755 9.6 1815 35.4 1875 17.0 1935 36.1 1995 17.9

1756 10.2 1816 45.8 1876 11.3 1936 79.7 1996 8.6

1757 32.4 1817 41.1 1877 12.4 1937 114.4 1997 21.5

1758 47.6 1818 30.1 1878 3.4 1938 109.6 1998 64.3

1759 54.0 1819 23.9 1879 6.0 1939 88.8 1999 93.3

1760 62.9 1820 15.6 1880 32.3 1940 67.8 2000 119.0

Wrap-Up Questions and Tasks:

1. Connect the points you've plotted with a smooth curve. You'll notice that there are very clear peaks (maximums) and valleys (minimums).
2. Which years are the maximums and which years are minimums? Label these years on your graph with a capital M and lower case m, respectively.
3. Is there is a regular pattern? To answer this question, take note of what scientists call the solar cycle, i.e., how many years are there between a solar maximum, a solar minimum and the next solar maximum? For example, in 1705 there is a maximum, in 1711-1712 there is a minimum, in 1717 a maximum. So the first solar cycle you plotted lasted 12 years (subtract 1705 from 1717). Take note of the other solar cycles by making a table of maximums, minimums and the years between 2 maximums for a 100 year time period.

a) If you had to guess at the average solar cycle length, what would it be from 1700-present?

b) Now find the average solar cycle length with a calculator. Show your work:

1. If you had to make a prediction for the years 2011 and 2017, would the years be maximums or minimums? Explain.
2. How many sunspots were there during the year you were born? Predict whether it will be closer to a maximum or a minimum when you graduate from high school and for when you turn 21 years old. Explain.