



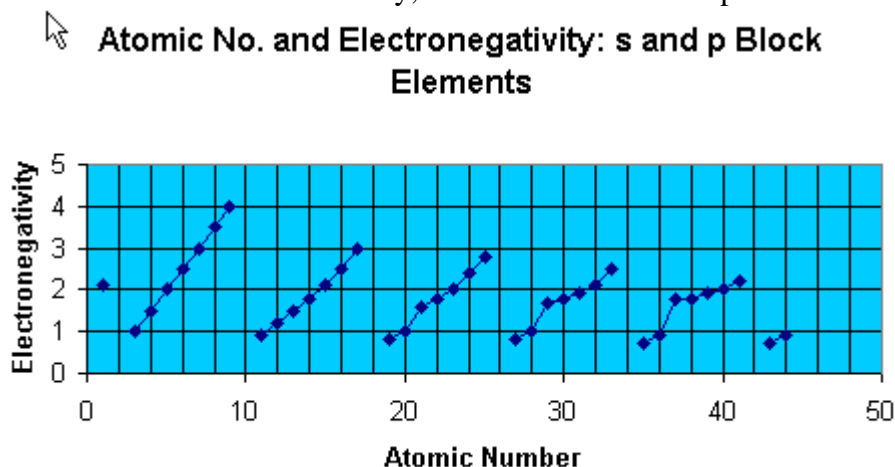
## Electronegativity Trends

### Activity Overview

#### Grades 10-12

Looking for a new way to teach periodic table trends? Chemistry teachers often ask students to prepare handdrawn and time consuming graphs of properties such as electronegativity and atomic number. In this activity, students use an Excel spreadsheet containing atomic number and electronegativity

and electronegativity data to study the relationship between the periodic table position of an element and its electronegativity



The Chem Data set included with this lesson is a spreadsheet containing the following information for all elements in the periodic table:

- Atomic symbols
- Group location
  - A-group elements: groups 1, 2, 13-18
  - B-group elements: the transition elements in groups 3-12
  - F-block elements: the lanthanide and actinide series elements
- Group number
- Element name
- Atomic number
- Atomic mass
- Melting point and boiling point
- Electronegativity value
- First ionization energy
- Covalent atomic radius

Graphs of atomic number and electronegativity for s- and p-block elements (a-group elements) on the periodic table will be prepared quickly using the Excel spreadsheet graphing program. Periodic trends for electronegativity may be deduced from examination of the graphs.

### *Advantages of Technology*

Although there may be some advantage in terms of comprehension in students' building graphs by hand, this task quickly reaches a point of diminishing returns when students are making multiple graphs of similar data. Spreadsheets allow students to create quickly multiple graphical representations of data and focus their classroom time and energies on the analysis of the graphical trends depicted, rather than on the tedious task of graphing by hand.

### *Materials*

#### **Technology:**

- Computers with spreadsheet software. (The screenshots and instructions in this activity are from Microsoft Excel 2000, but other spreadsheets should work similarly.)
- Chem Data files (choose from one of three available formats):

Excel file: [ChemData.xls](#)

Text file: [ChemData.txt](#)

HTML: [ChemData.htm](#) (for better print version)

#### **Other Supplies:**

- Access to a periodic table.

## Procedure

### NOTE TO TEACHERS:

These procedures are written to show you how you might use these technologies to teach science concepts. Suggested questions, approaches, and expected answers are all provided. Therefore, these activity descriptions should be used as a guide for your instructional planning, rather than as step-by-step directions for students.

### Getting Started

Electronegativity is defined as a measure of the ability of an atom in a chemical bond to attract electrons to itself.

*Based on your knowledge of the physical and chemical properties of the elements, how would you expect electronegativity to vary with increasing atomic number?*

Open the Excel [ChemData file](#) and select **Save As** from the **File** menu to save the file using your last name as the filename.

[If you are using a different spreadsheet, you may need to use the [text](#) file version of of the ChemData.]

	A	B	C	D	E	F	G	H	I	J	K	L
1	CHEM DATA											
2												
3												
4												
5	Symbol	New Group #	Old Group #	Period	Name	atomic #	atomic mass	Notes	Melting Point, °C	Boiling Point, °C	density g/mL	Electro-negativity
6	H	1	1a	1	hydrogen	1	1.008		-259.1	-252.9	6.99E-05	2
7	He	18	VIIa	1	helium	2	4.003		-272.2	-268.5	1.79E-04	
8	Li	1	1a	2	lithium	3	6.941		180.5	1342	5.43E-01	
9	Be	2	IIa	2	beryllium	4	9.012		1278	2970	1.85E+00	1
10	B	13	IIIa	2	boron	5	10.81	sublimes	2075	2550	2.34E+00	
11	C	14	IVa	2	carbon	6	12.01	graphite	3367	4827	2.25E+00	2
12	N	15	Va	2	nitrogen	7	14.01		-209.5	-195.8	1.25E-03	
13	O	16	VIa	2	oxygen	8	15.99		-218.4	-183	1.43E-03	3
14	F	17	VIIa	2	fluorine	9	18.99		-219.8	-188.1	1.70E-03	
15	Ne	18	VIIIa	2	neon	10	20.18		-248	-248.7	9.00E-04	
16	Na	1	1a	3	sodium	11	22.99		97.8	883	9.71E-01	0
17	Mg	2	IIa	3	magnesium	12	24.31		645	1090	1.74E+00	1
18	Al	13	IIIa	3	aluminum	13	26.98		660	2467	2.70E+00	1
19	Si	14	IVa	3	silicon	14	28.09		1410	2355	2.33E+00	1

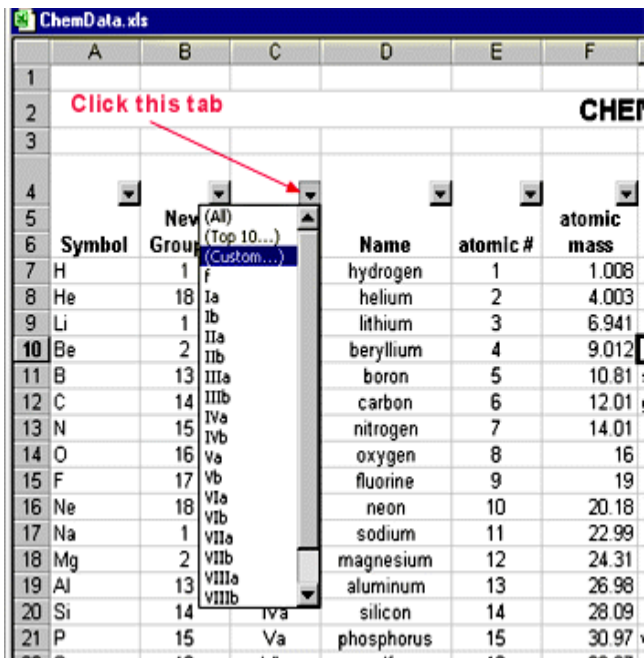
### Graph Your Data

Now that you have the data in your spreadsheet, you are ready to create a graph of the relationship between atomic number and electronegativity. The first task involves selecting only the elements in the s and p blocks of the periodic table to simplify the trends (hiding the data for the transition elements and the lanthanide and actinide series).

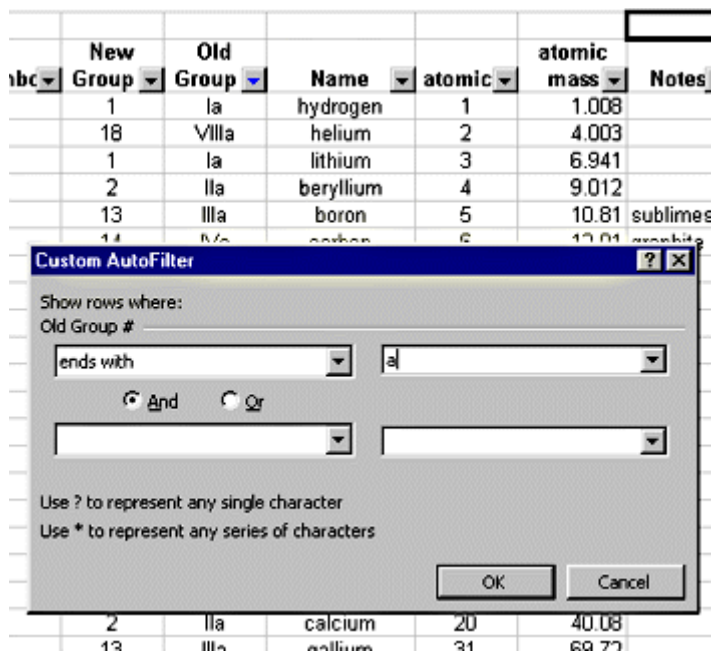
In order to select data for only the s and p block elements (groups 1, 2, 13-18) from the complete data set, pull down the menu under the tool bar heading **Data**, select **Filter** then

**AutoFilter.** Note the small tabs that appear at the tops of every column with the **AutoFilter** feature enabled.

Pull down the tab on the top of the **Old Group #** column and select "**Custom...**"



In the Custom AutoFilter box, select "**ends with**" from the menu and then type in the letter "**a**," so only a-group elements will be displayed in the spreadsheet.



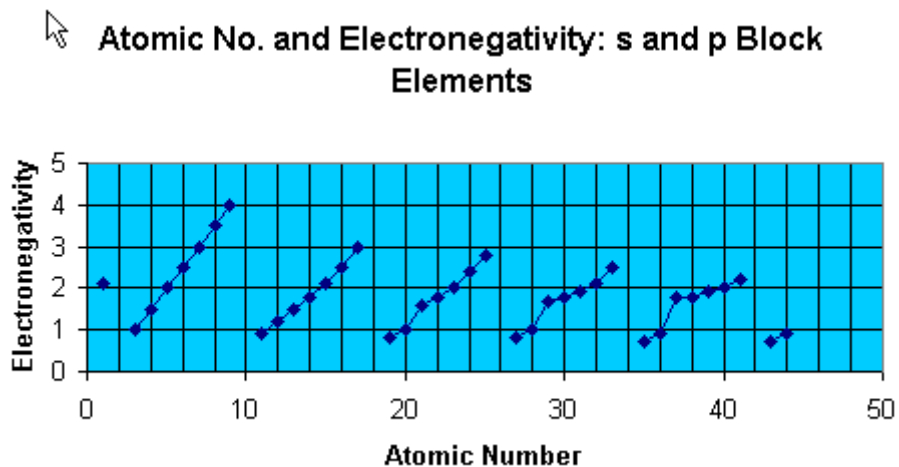
To select the atomic number and electronegativity data from the resulting chart, highlight the data for the a-group elements in the atomic number column. Click the control button (to select another non-adjacent column) and then select the data in the electronegativity column. Both columns will be highlighted.

Name	atomic	atomic mass	Notes	Melting Point, °C	Boiling Point, °C	density g/mL	Electro-negativity	First Ion. Energ
hydrogen	1	1.008		-259.1	-252.9	6.99E-05	2.1	1312
helium	2	4.003		-272.2	-268.9	1.79E-04		2377
lithium	3	6.941		180.5	1342	5.43E-01	1	520
beryllium	4	9.012		1278	2970	1.85E+00	1.5	899
boron	5	10.81	sublimes	2079	2550	2.34E+00	2	801
carbon	6	12.01	graphite	3367	4827	2.25E+00	2.5	1086
nitrogen	7	14.01		-209.9	-195.8	1.25E-03	3	1420
oxygen	8	15.99		-218.4	-183	1.43E-03	3.5	1314
fluorine	9	18.99		-219.8	-188.1	1.70E-03	4	1681
neon	10	20.18		-248	-248.7	9.00E-04		2088
sodium	11	22.99		97.8	883	9.71E-01	0.9	495
magnesium	12	24.31		649	1090	1.74E+00	1.2	735
aluminum	13	26.98		660	2467	2.70E+00	1.5	580
silicon	14	28.09		1410	2355	2.33E+00	1.8	780
phosphorus	15	30.97	white	44.1	280	1.82E+00	2.1	1060
sulfur	16	32.07	yellow	112.8	444.7	2.07E+00	2.5	1005
chlorine	17	35.45		-101	-34.6	3.21E-03	3	1255
argon	18	39.95		-189.2	-185.7	1.78E-03		1527

Now, select the chart wizard from the toolbar. Select an XY scatterplot with data points connected with smooth lines and complete the graphical display following the instructions in the Excel program.

The image shows an Excel spreadsheet with a table of periodic table data. The columns are: Name, atomic, atomic mass, Notes, Melting Point, °C, Boiling Point, °C, density g/mL, Electro-negativity, and First Ion. Energ. The data is highlighted in blue. Overlaid on the spreadsheet is the 'Chart Wizard - Step 1 of 4 - Chart Type' dialog box. The 'Standard Types' tab is selected, and 'XY (Scatter)' is chosen in the 'Chart type' list. In the 'Chart sub-type' section, the first option, 'Scatter with data points connected by smoothed lines', is highlighted with a red arrow and the text 'Select this chart type'. The dialog box also includes a 'Press and Hold to View Sample' button and 'Cancel', '< Back', 'Next >', and 'Finish' buttons at the bottom.

**Note:** If you wish to plot the element symbols on the x-axis instead of the atomic numbers, choose a Line Graph instead of an XY scatterplot.



### Analyze Your Graph

*What trend exists between electronegativity values and atomic numbers within a group of elements on the periodic table?*

As the atomic number increases, the electronegativity decreases within a group. As the atomic number increases, the electronegativity increases within a period.

*How does the trend in the halogen elements (group 17) compare to the alkali metals in group 1?*

The electronegativity values of the halogen elements are much higher than the alkali metals, but both groups show that as the atomic number increases, the electronegativity decreases within a group.

*Why are the noble gases not included in your data set?*

Noble gases have not been assigned electronegativity values because they do not easily form chemical bonds.

Find on your graph the elements in the second period of the periodic table (lithium, atomic number 3 to fluorine, atomic number 9) and compare the trend for the elements in the second period to those in the third period (sodium, atomic number 11 to chlorine, atomic number 17).

*How is electronegativity used by chemists to predict bonding styles for elements on the periodic table?*

The greater the difference in electronegativity between two elements, the more polar the chemical bond formed between them. Differences in electronegativity can be used to predict ionic, polar covalent, and nonpolar covalent bonding styles.

*What other properties of elements have recognizable periodic trends?*

Try graphing some of the other data provided in the Chem Data set to see if you can identify other periodic trends.

### *Assessment Strategies*

- Arrange a group of elements in order of increasing electronegativity using the periodic table only. [If the concept of polarity has already been introduced, students could use predicted electronegativity values to rank the polarity of chemical bonds.]
- Arrange the following elements in order of increasing electronegativity using the periodic table: phosphorus, sodium, chlorine, aluminum. Explain your reasoning.
- Using a periodic table, decide which of the following chemical bonds you would expect to be the most polar? The least polar? C-N, C-O, or C-F? Explain why.
- Identify pairs of elements that have the greatest differences in electronegativity or the least differences. For example, which of the following pairs of elements have the greatest differences in electronegativity values?

a) Na and Cl   b) Na and F   c) Na and I

### *Resources*

If you want students to make their own tables, you can locate electronegativity data for the elements on many web sites (including the ones below), in a Chemical Rubber Company Handbook, or in some printed periodic tables.

#### **Mendeleev's Periodic Table, 1869**

Check out Mendeleev's original periodic table at this site:

<http://chemlab.pc.maricopa.edu/periodic/foldedtable.html>

**EnvironmentalChemistry.com:** Periodic Table of the Elements. Comprehensive data on elements including scores of properties, element names in many languages and most known nuclides is provided by this periodic table. In addition environmental and

chemistry articles round out this site.

<http://klbproductions.com/yogi/periodic/>

**WebElements:** Visit WebElements, a site that claims to be the first periodic table on the WWW. This web site features a printable version of the periodic table.

<http://www.webelements.com/webelements/scholar/>

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