

Lab: Graphing Trends in the Periodic Table



Objective: To understand trends of the periodic table and practice methods of graphing

The periodic table is arranged according to the Periodic Law. The Periodic Law states that when elements are arranged in order of increasing atomic number, their physical and chemical properties show a periodic pattern. In this lab, you will be exploring the following properties:

- atomic radius
- ionization energy
- electronegativity

Prediction: On a separate piece of paper predict an answer to the following question based on what you already know.

What do you think will happen to the size of an atom as you move from left to right across a period on the periodic table? Will the size of the atom increase? Decrease? Remain the same? Suggest a reason.

Procedure:

Use the data table provided to complete steps 1 and 2.

Step 1. Graph the following information according to the steps described.

Graph 1: Atomic radius vs atomic number: Elements 3-20

For elements 3-20, make a graph of atomic radius as a function of atomic number. Plot atomic number on the X axis and atomic radius on the Y axis. After creating the graph, use a colored pen or pencil to draw a vertical line that represents the beginning of each period on the periodic table. Connect the dots to highlight the trend.

Graph 2: Ionization energy vs atomic number: Elements 3-20

For elements 3-20, make a graph of the energy needed to remove the easiest (first ionization energy) as a function of atomic number. Plot atomic number on the X axis and energy required on the Y axis. After creating the graph, use a colored pen or pencil to draw a vertical line that represents the beginning of each period on the periodic table. Connect the dots to highlight the trend.

Step 2. Electronegativity vs atomic number: Group 1 and Period 3 elements

For Group 1 and Period 3 elements, write the electronegativity of each element under its element symbol in Figure 1.

Table 1. Atomic radii, first ionization energy and electronegativity values for selected periodic table elements.

Symbol	Atomic number	Atomic radius (picometres)	First ionization energy (kJ/mol)	Electronegativity (4 point scale)
H	1	31	1312	2.1
Li	3	128	520	1.0
Be	4	112	900	1.5
B	5	87	801	2.0
C	6	67	1086	2.5
N	7	56	1402	3.0
O	8	48	1314	3.5
F	9	42	1681	4.0
Ne	10	38	2081	---
Na	11	166	496	0.9
Mg	12	141	738	1.2
Al	13	121	578	1.5
Si	14	111	787	1.8
P	15	107	1012	2.1
S	16	105	1000	2.5
Cl	17	100	1251	3.0
Ar	18	71	1521	---
K	19	220	410	0.8
Ca	20	180	590	1.0
Rb	37	220	403	0.8
Cs	55	244	376	0.7

Analysis:

Answer the following on a separate piece of paper. Be sure to write complete sentences. You should have a minimum of three paragraphs.

Paragraph 1

- What happened to the size of the atoms as you moved left to right across a period?
- What is electrostatic force? Use your understanding of electrostatic force and how the numbers of protons and electrons differ in atoms to explain the observed change in atomic size.
- What happened to the size of the atoms as you move down a group? Use your understanding of the wave mechanical model to explain the observed change in atomic size.
- Consider ions:
 - Assume extra electrons are added to a neutral atom to make a negative ion (e.g. O becomes O^{2-})
 - What happens to the amount of electrostatic repulsion existing between the electrons?
 - What happens to the volume occupied by the electrons due to the change in the amount of electron-electron repulsion?
 - Would you say that negative ions are larger or smaller in atomic size than the corresponding neutral atom?
 - Assume electrons are removed from a neutral atom to make a positive ion (e.g. Na becomes Na^+)
 - What happens to the amount of electrostatic repulsion existing between the electrons?
 - What happens to the volume occupied by the electrons due to the change in repulsion?
 - Would you say that positive ions are larger or smaller in atomic size than the corresponding neutral atom?

Paragraph 2

- What is ionization energy?
- What happened to the first ionization energy as you moved left to right across a period?
- What happened to the first ionization energy as you moved down a group?
- Why are the ionization energies for He, Ne and Ar so high? What family of elements do they belong to?
- Use your understanding of the wave mechanical model to explain the trends in ionization energy for periods and groups.

Paragraph 3



- What is electronegativity?
- What happened to electronegativity as you moved from left to right across a period?
- What happened to electronegativity as you moved down a group?
- Use your understanding of the wave mechanical model to explain the trends in electronegativity for periods and groups.

Conclusion:



Was your prediction correct? Support your statement by summarizing the trends in atomic radius, ionization energy and electronegativity. Sketch an outline of a periodic table and use arrows to indicate direction of **increase** for each characteristic.

Group 1

H								
Li								
Na	Mg	Al	Si	P	S	Cl	Ar	Period 3
K								
Rb								
Cs								

Figure 1. Electronegativity for Group 1 and Period 3 elements.