# Periodicity: Periodic Trends of Elements

## Task

Introduction of the Problem: In this activity, high school chemistry students are provided with a table of values which they use to plot and draw graphs of the periodic trends in electronegativity, atomic radius and ionization energy of some elements in the periodic table. They then use the graphs to explain the periodic trends across the periods, down the groups and to predict the periodic trends of other elements in subsequent periods.

## Selected GPS:

### Co-Requisite: Characteristics of Science

Habits of Mind

- **SCSh3**: Students will identify and investigate problems scientifically
  c. Collect, organize and record appropriate data.
  d. Graphically compare and analyze data points and/or summary statistics.
  e. Develop reasonable conclusions based on data collected.
  f. Evaluate whether conclusions are reasonable by reviewing the process and checking against other available information.

- **SCSh4**: Students will use tools and instruments for observing, measuring, and manipulating scientific equipment and materials
  a. Develop and use systematic procedures for recording and organizing information.

Nature of Science

**SCSh7**: Students will analyze how scientific knowledge is developed. Students recognize that:
e. Testing, revising, and occasionally rejecting new and old theories never ends.

Content

- **SC4. Students will use the organization of the Periodic Table to predict properties of elements.**
  a. Use the Periodic Table to predict periodic trends including atomic radii, ionic radii, ionization energy, and electronegativity of various elements.
  b. Compare and contrast trends in the chemical and physical properties of elements and their placement on the Periodic Table.

**Classroom Materials: Lesson Outline**

Periodicity: Periodic Trends

Grade Level/Subject: High School Chemistry

Overview: In this lesson, high school chemistry students are provided with a table of values which they use to plot and draw graphs of the periodic trends in electronegativity, atomic radius and ionization energy of some elements in the periodic table. They then use the graphs to explain the periodic trends across the periods, down the groups and to predict the periodic trends of other elements in subsequent periods.

Key Objectives:

- To investigate a problem scientifically (GPS: SCSh3 c, d, e, f).
- To suggest reasonable conclusions /explanations based of data collected (GPS: SCSh3 e).
- To keep detailed and accurate records of data collected (GPS: SCSh4 a).
- To understand and analyze how scientific knowledge is developed and changes over time (GPS: SCSh7 e).

Learning Outcomes:
By the end of the activity, students will be able to:

- Explain the general periodic properties of elements across the periods and down the groups in terms of the periodic trends in:
    1. Ionization energy
    2. Atomic radius
    3. Electronegativity
- Establish the relationship between the atomic radius and the ionization energy.
- Compare and contrast the electronegativities of Group I elements (Alkali metals) and Group VII elements (Halogens).
- Distinguish between electron affinity and electronegativity of elements in the periodic table.
- Make a general statement (predict in terms of similarity) the periodic trend patterns for other periods in the periodic table. e.g. from Rubidium to Radium.
- Extend explanations to predict the trends in periodic properties of transition elements.
- Appreciate the importance of electron configuration in predicting and explaining the periodic properties of elements.

Possible Materials:

- The periodic table (chart)
- Graph papers
- Data (electronegativity, atomic radius and ionization energy values)
- Colored pencils/crayons
- Rulers
- Erasers

Task:

Students are provided with numerical values of the electronegativities, atomic radii and ionization energies of some elements in the periodic table. (***Hydrogen to Krypton***). They are required to plot and draw the graphs of each category of the properties on separate graph papers; with the elements and/or atomic numbers on the *x*–axis and the electronegativity, atomic radius and ionization energy on the *y*–axis respectively. Figure 1 below shows the electronegativities of select elements in the periodic table.

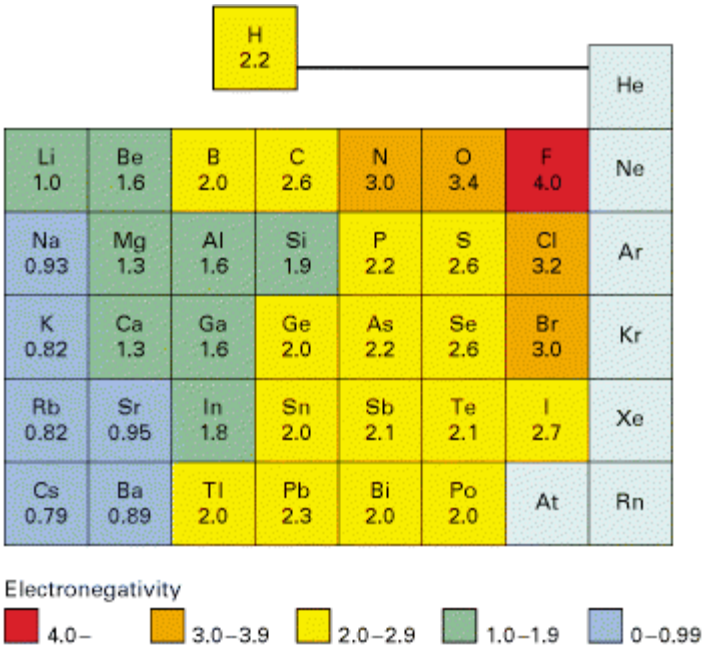


**Figure 1.** ***Electronegativity values of some elements***

Sample Questions:

- How does the electron configuration of an element determine its physical and chemical properties?
- What does it mean when we say that an element more electronegative?
- Do noble gases have electronegativities? Why? / Why not?
- Why does electronegativity increase with increase in atomic radius across the period?
- Why does the first ionization energy decrease with increase in atomic radius down the groups?

Analysis

1. Based on your graphs what is the general trend in atomic radius, electronegativity and ionization energy across the period from Lithium (Li) to Fluorine (F)?

2. Look carefully at your graphs. Are there any repeating patterns in the trends? How can these be explained in terms of the electron configuration of the atoms in each period?

3. Explain why there is very little variability in the trends for transition elements of the periodic table in general.

4. Explain the relationship between the atomic radius and the first ionization energy of the elements in the periodic table.

Assessment Ideas:

- Teacher reflections: are the objectives being met? Is there evidence for this?
- Write a detailed summary that discusses what was done in this activity and the conclusions you can draw from the data.
- Student journals or science notebooks: is there evidence of student learning?
- Teacher-constructed quizzes and tests, based on the observations made and discussed in class.

Extension Ideas:

- Allow students to predict the periodic trends for other periods not included in the original context of the discussion.

- Get the students to think in terms of how the electron configuration of elements in the periodic table determines the chemical reactivity. Let students brainstorm the idea that reactivity of elements (characterized by gain or loss of electrons) is aimed at attaining stability (octet/ noble gas configuration).

Sample Question for Further Discussion

1. Account for the difference in atomic radius between the following elements:
   a) Lithium (2.05 Å) and Fluorine (0.57 Å)

   b) Lithium (2.05 Å) and Cesium (3.34 Å)

   c) Fluorine (0.57 Å) and Iodine (1.32 Å)

2. Account for the increase in the electronegativity of elements across the period in terms of their affinity for electrons.

3. Explain the following observations about some properties of elements in the periodic table.

   a) Moving from Left ==> Right (*Across the periods*)

      - Atomic Radius Decreases

      - Ionization Energy Increases

      - Electronegativity Increases

   b) Moving from Top ==> Bottom (*Down the groups*)

      - Atomic Radius Increases

      - Ionization Energy Decreases

      - Electronegativity Decreases

4. Why do alkali metals have relatively lower electronegativities as compared to Halogens? How does the electron configuration of each family of elements determine their affinity for electrons?