Periodic Trends

Can the properties of an element be predicted using a periodic table?

Why?

The periodic table is often considered to be the "best friend" of chemists and chemistry students alike. It includes information about atomic masses and element symbols, but it can also be used to make predictions about atomic size, electronegativity, ionization energies, bonding, solubility, and reactivity. In this activity you will look at a few periodic trends that can help you make those predictions. Like most trends, they are not perfect, but useful just the same.

1. Consider the data in Model 1 on the following page.

   a. Each element has three numbers listed under it. Which value represents the atomic radius?

   The top value is atomic radius

   b. What are the units for the atomic radius?

   pm (picometers)

   c. Write a complete sentence to convey your understanding of atomic radius. *Note:* You many not use the word "radius" in your definition.

The atomic radius is the distance from the nucleus to the valence electrons

2. In general, what is the trend in atomic radius as you go down a group in Model 1? Support your answer, using examples from three groups.

Atomic radius increases.

Evidence

Group 1 H (37) increases to K (227)
Group 2 Be (112) increases to Ca (197)
Group 3 B (83) increases to Ga (122)

3. Using your knowledge of Coulombic attraction and the structure of the atom, explain the trend in atomic radius that you identified in Question 2. *Hint:* You should discuss either a change in distance between the nucleus and outer shell of electrons or a change in the number of protons in the nucleus.

As new shells are added, the distance between the nucleus and valence electrons increases, resulting in a weaker nuclear force

4. In general, what is the trend in atomic radius as you go across a period (left to right) in Model 1? Support your answer, using examples from two periods.

Atomic radius decreases.

Evidence

Period 1 H (37) to He (31)
Period 2 Li (152) to Ne (70)

5. Using your knowledge of Coulombic attraction and the structure of the atom, explain the trend in atomic radius that you identified in Question 4.

As more protons are added, the nuclear force increases and the valence electrons are pulled inwards

6. Locate the numbers in Model 1 that represent the ionization energy. The **ionization energy** is the amount of energy needed to remove an electron from an atom.

   a. Using your knowledge of Coulombic attraction, explain why ionization—removing an electron from an atom—takes energy.

Protons and electrons have opposite charges and therefore attract. It will take energy to separate them.

   b. Which takes more energy, removing an electron from an atom where the nucleus has a tight hold on its electrons, or a weak hold on its electrons? Explain.

It will take more energy to take electrons from an atom with a tight hold, since you need to overcome a stronger force

7. In general, what is the trend in ionization energy as you go down a group? Support your answer using examples from three groups.

Ionization energy decreases:

Evidence
Group 1 H (1312) to K (404)
Group 2 Be (900) to Ca (550)
Group 3 B (801) to Ga (558)

8. Using your knowledge of Coulombic attraction and the structure of the atom, explain the trend in ionization energy that you identified in Question 7.

As atoms get larger, the nuclear force is weaker. This means it will take less energy to remove an electron.

9. In general, what is the trend in ionization energy as you go across a period? Support your answer using examples from two periods.

Ionization energy increases

Evidence
Period 1 H (1312) to He (2372)
Period 2 Li (520) to Ne (2081)

10. Using your knowledge of Coulombic attraction and the structure of the atom, explain the trend in ionization energy that you identified in Question 9.

As atoms get smaller, the nuclear force is stronger. This means it will take more energy to remove an electron

11. Atoms with loosely held electrons are usually classified as metals. They will exhibit high conductivity, ductility, and malleability because of their atomic structure. Would you expect metals to have high ionization energies or low ionization energies? Explain your answer in one to two complete sentences.

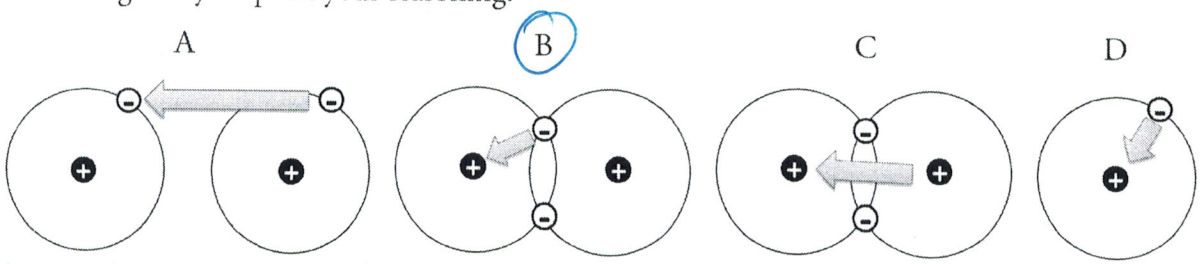
Metals will have low ionization energies since they have a "loose" grip on their electrons

Honors Groups

Read This!

Electronegativity is a measure of the ability of an atom's nucleus to attract electrons from a different atom within a covalent bond. A higher electronegativity value correlates to a stronger pull on the electrons in a bond. This value is only theoretical. It cannot be directly measured in the lab.

12. Using the definition stated in the *Read This!* box above, select the best visual representation for electronegativity. Explain your reasoning.



Model B shows the attraction between a nucleus and an electron from another atom.

13. Locate the electronegativity values in Model 1.

    a. What is the trend in electronegativity going down a group in Model 1?

    Electronegativity decreases

    b. Explain the existence of the trend described in part *a* in terms of atomic structure and Coulombic attraction.

    As atoms get larger, the nuclear force is weaker.

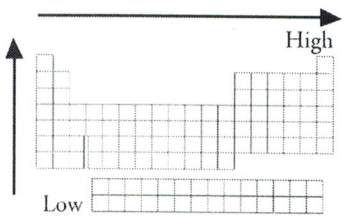
    c. What is the trend in electronegativity going across a period in Model 1?

    Electronegativity increases.

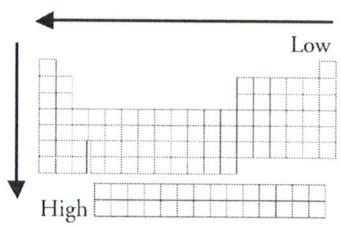
    d. Explain the existence of the trend described in part *c* in terms of atomic structure and Coulombic attraction.

    As atoms get smaller, nuclear force increases.

14. The two diagrams below can summarize each of the three trends discussed in this activity. Write "atomic radius," "ionization energy," and "electronegativity" under the appropriate diagram.



ionization energy
electronegativity



atomic radius