Periodic Trends – Ionization Energy

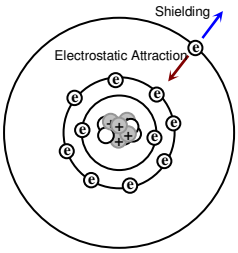
Chem Worksheet 6-2

Name _____

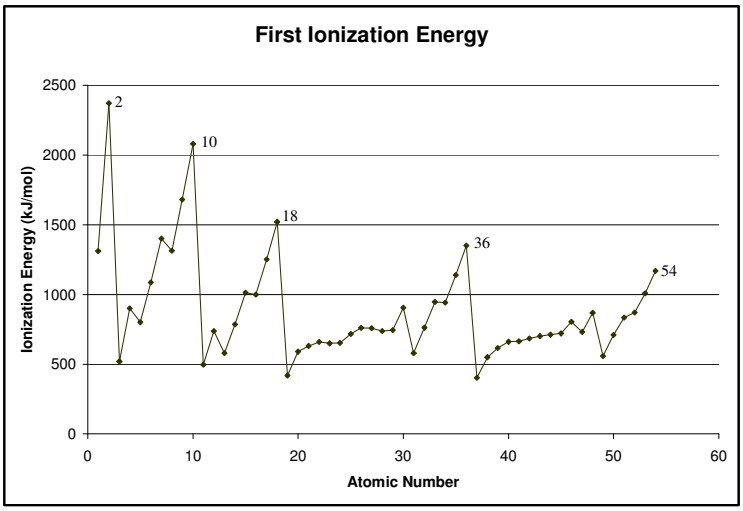
Ionization describes the process in which an electron is removed from an atom in the gaseous state. The amount of energy required to remove the outer electron is called the **first ionization energy**. Successive electrons can be removed as well. The following equations show the first and second ionization for the nitrogen atom.

First Ionization $N(g) \rightarrow N^+(g) + e^-$

Second Ionization $N^+(g) \rightarrow N^{2+}(g) + e^-$



Bohr's model of sodium. The outer electron is *attracted* to the nucleus by opposite charge. It is also *shielded* by the core electrons.



The ionization energy varies depending on how strongly each electron is held to the nucleus. This attractive force is related to three factors. First, the distance between the electron and the nucleus affects the electrostatic attraction: the closer the electron the stronger the force. Second, the number of protons in the nucleus can affect the attraction of the electrons. The more electrons there are the greater the attraction. Finally, the electrons between the nucleus and the outermost electron are responsible for a repulsion called **shielding**.

Use the chart above to answer the following questions.

1. Use the graph to list the ionization energies for the noble gases (He, Ne, Ar, Kr, and Xe).
2. Make a statement of the trend observed in ionization energy as you go down the periodic table. (from He → Ne → Ar → Kr → Xe)
3. Make a list of the ionization energies for the elements in the second period (elements 3 – 10).

lithium		boron		nitrogen		fluorine	
beryllium		carbon		oxygen		neon	

4. What is the general trend in ionization energy as you move across the second period?
5. Draw a diagram of neon ($z = 10$) and sodium ($z = 11$) atoms using the Bohr model (see above).
6. Use your model to explain why the first ionization energy for sodium is so much lower than neon.
7. There is a slight spike in the ionization energy for nitrogen ($z = 7$), phosphorus ($z = 15$) and arsenic ($z = 33$). What do these elements all have in common?
8. Draw an orbital diagram for nitrogen ($z = 7$) and oxygen ($z = 8$).

N ☐ ☐ ☐☐☐ **O** ☐ ☐ ☐☐☐

1*s* 2*s* 2*p* 1*s* 2*s* 2*p*

9. Use your orbital diagrams to explain why it is easier to remove the outer electron of oxygen than the outer electron of nitrogen.
10. Explain the large drops in ionization energy for Li ($z = 3$), Na ($z = 11$), and K ($z = 19$) from their preceding elements.