Ionization Energy Reading Assignment
Chemistry

Name: _____

Date: _____ Hour: _____

Ionization Energy (from *Chemistry: Matter and Change*, pp. 191-193, Glencoe, 2008)

To form a positive ion, an electron must be removed from a neutral atom. This requires energy. The energy is needed to overcome the attraction between the positive charge of the nucleus and the negative charge of the electron. Ionization energy is defined as the energy required to remove an electron from a gaseous atom. For example, 8.64×10^{-19} J is required to remove an electron from a gaseous lithium atom. The energy required to remove the first electron from an atom is called the first ionization energy. Therefore, the first ionization energy of lithium equals 8.64×10^{-19} J. The loss of the electron results in the formation of a Li^+ ion. The first ionization energies of the elements in periods 1 through 5 are plotted on the graph in Figure 6.16.

Why is energy required to form a cation? _____

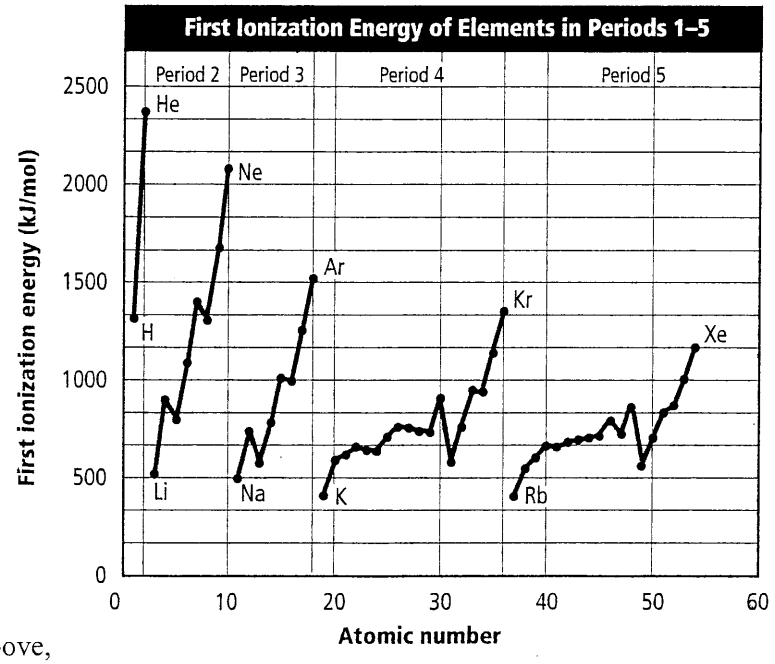
_____

Does it take a lot of energy to remove an electron from a lithium atom? Explain how you know. _____

_____

_____

Figure 6.16:



Looking at the figure above,

(a) What is plotted on the graph's x-axis? _____

(b) What is plotted on the graph's y-axis? _____

(c) Which element in period 4 has the lowest first ionization energy? _____

(d) Which element in each period has the highest first ionization energy? _____

Think of ionization energy as an indication of how strongly an atom's nucleus holds onto its valence electrons. A high ionization energy value indicates the atom has a strong hold on its electrons. Atoms with large ionization energy values are less likely to form positive ions. Likewise, a low ionization energy value indicates an atom loses its outer electron easily. Such atoms are likely to form positive ions. Lithium's low ionization energy, for example, is important for its use in lithium-ion computer backup batteries where the ability to lose electrons easily makes a battery that can quickly

provide a large amount of electrical power.

What type of ion is an atom likely to form if it has a high ionization energy? _____

Table 6.5: Successive Ionization Energies for the Period 2 Elements

Element	Valence Electrons	Ionization Energy (kJ/mol)								
		1st	2nd	3rd	4th	5th	6th	7th	8th	9th
Li	1	520	7 300							
Be	2	900	1 760	14 850						
B	3	800	2 430	3 660	25 020					
C	4	1 090	2 350	4 620	6 220	37 380				
N	5	1 400	2 860	4 580	7 480	9 440	53 270			
O	6	1 310	3 390	5 300	7 470	10 980	13 330	71 330		
F	7	1 680	3 370	6 050	8 410	11 020	15 160	17 870	92 040	
Ne	8	2 080	3 950	6 120	9 370	12 180	15 240	20 000	23 070	115 380

Looking at the table above,

(a) Which element has the highest third ionization energy? _____

(b) Which element has four valence electrons? _____

(c) Why is the eighth ionization energy higher than the seventh for fluorine ? _____

_____

(d) Why is nitrogen's first ionization energy higher than oxygen's (hint: think stability)? _____

_____

After removing the first electron from an atom, it is possible to remove additional electrons. The amount of energy required to remove a second electron from a 1+ ion is called the second ionization energy, the amount of energy required to remove a third electron from a 2+ ion is called the third ionization energy, and so on. Table 6.5 lists the first-through-ninth ionization energies for elements in period 2.

How is a 2+ ion formed? _____

Reading across Table 6.5 from left to right, you will see that the energy required for each successive ionization always increases. However, the increase in energy does not occur smoothly. Note that for each element there is an ionization for which the required energy increases dramatically. For example, the second ionization energy of lithium (7300 kJ/mol) is much greater than its first ionization energy (520 kJ/mol). This means that a lithium atom is likely to lose its first valence electron but extremely unlikely to lose its second.

How many valence electrons does lithium have? _____

Why is it difficult to remove two electrons from lithium? _____

_____