During Class Invention

Name(s) with Lab section in Group

Ionization Energy

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Element	Nuclear Charge	Complete Electron configuration	Total # of electrons	# of inner core electrons	# of valence Electrons	Effective Nuclear Charge
hydrogen	**+1**	$1s^1$	**1**	**0**	**1**	**+1**
lithium	**+3**	$1s^2 2s^1$	**3**	**2**	**1**	**+1**
Beryllium	**+4**	$1s^2 2s^2$	**4**	**2**	**2**	**+2**
Boron	**+5**	$1s^2 2s^2 2p^1$	**5**	**2**	**3**	**+3**
Carbon	**+6**	$1s^2 2s^2 2p^2$	**6**	**2**	**4**	**+4**
Nitrogen	**+7**	$1s^2 2s^2 2p^3$	**7**	**2**	**5**	**+5**
Oxygen	**+8**	$1s^2 2s^2 2p^4$	**8**	**2**	**6**	**+6**
Fluorine	**+9**	$1s^2 2s^2 2p^5$	**9**	**2**	**7**	**+7**
Sulfur	**+16**	$1s^2 2s^2 2p^6 3s^2 3p^4$	**16**	**10**	**6**	**+6**
Potassium	**+19**	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$	**19**	**18**	**1**	**+1**
Bromine	**+35**	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^5$	**35**	**28**	**7**	**+7**

2. What does the term ‘shield’ mean when describing the attraction experienced by an electron in an outer shell?

   Shielding is what the inner core electrons do to part of the nuclear charge experienced by the valence electrons. Consider carbon in the Table in DCI25.1. There are 2 inner core electrons (electrons in the n = 1 level), 4 valence electrons and 6 protons in the nucleus. The 2 inner core electrons are shielding the 4 valence electrons from the nucleus. The result is that each of the valence electrons experience an effective nuclear charge of +4.

3. Why is the first ionization energy for nitrogen greater than the first ionization energy for lithium?

The electron configurations are:

Lithium	$1s^2 2s^1$
Nitrogen	$1s^2 2s^2 2p^3$

Both elements have valence electrons in the same outer shell, and the same number of electrons shielding those valence electrons. The ENC on the valence electron in lithium is +1, and the ENC on the valence electrons in nitrogen is +5. Therefore the valence electrons in nitrogen experience a greater attraction to the nucleus compared to the valence electron in lithium and the first ionization energy will be greater for nitrogen compared to lithium.

4. Calculate the effective nuclear charge experienced by an electron in the 2nd shell in a bromine atom?

The electron configuration for bromine is,

$$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^5$$

For the ENC for an electron in the n = 2 shell we use the equation,

$$\text{ENC (n = 2 shell)} = Z - \text{IC electrons}$$

For bromine Z = 35 and for an electron in the n = 2 level only the electrons in the n =1 level are inner core electrons. So,

$$\text{ENC} = 35 - 2 = +33$$

5. Why is the third ionization energy for magnesium so much greater than the second ionization energy?

The electron configuration for magnesium is:

Mg $1s^2 2s^2 2p^6 3s^2$

The first two electron removed from magnesium (the first and second ionization energy) come from the 3s orbital. The ENC on both of these electrons is a +2. The third electron removed from magnesium must come from the second shell. The ENC on an electron in the second shell is +10 (since only the two 1*s* electrons are shielding the electrons in the second shell from the nuclear charge on magnesium). An ENC of +10 means that it takes a very large amount of energy to remove the third electron from magnesium. The second electron removed from magnesium only experiences an ENC of +2 and is much easier to remove.

6. Explain the basis for the rule "the atomic radius decreases going across a period".

Going across a period all of the electrons are in the same shell, the number of inner core electrons (the ones shielding the valence electrons from a portion of the nuclear charge) remain constant. Since the nuclear charge increases going across the period the valence electrons experience an increasing ENC that causes the valence electrons to experience a greater attraction to the nucleus. This means the valence electrons are pulled closer to the nucleus and the atomic radius will decrease going across the period. (see the table is DCI 25.1)