
Electron affinity, Electronegativity, Ionization energy

1. Electron affinity

Definition: The energy released when an electron is added to a gaseous atom which is in its ground state to form a gaseous negative ion is defined as the first electron affinity. The symbol is E_{A_1} and the unit is kJ/mol.

Values and tendencies in the periodic table: The first electron affinities of elements are negative in general except the group VIII and group IIA elements. Because the electron falls into the electrostatic field which is yielded by the atomic nucleus of a neutral atom, and lead to the potential reduction, the energy of this system is reduced. The second electron affinities of all elements are positive. This is because the negative ion is a negative electric field. And if now the other electrons enter the negative field, energy has to be applied to the system to overcome the repulsion that the negative electric field interacts with the electrons. According to the elements of one period, E_A generally decreases from the left to the right across the periodic table. According to the elements of one main group, E_A generally increases from the top to the bottom of the periodic table.

2. Ionization energy

Definition: The ionization energy, E_i , of an atom/ion is the minimum energy which is required to remove an electron of an atom. The unit of ionization energy is kJ/mol.

Values and tendencies in the periodic table: The first ionization energy is the energy which is required when a gaseous atom/ion loses an electron to form a gaseous +1 valence ion. The energy which is required for a gaseous +1 valence ion to lose an electron to form a gaseous +2 valence ion, is called the second ionization energy of an element.

In general, the second ionization energy is higher than the first ionization energy of an element. The first ionization energies of the elements of one period increase from the left to the right across the periodic table. According to the elements of main group, the first ionization energies generally decrease from top to bottom across the periodic table.

3. Electronegativity

Definition: The electronegativity, χ , describes the ability of an atom to attract electrons towards itself.

Values and tendencies in the periodic table: In general, the electronegativity of a non-metal is larger than that of metal. For the elements of one period the electronegativities increase from left to right across the periodic table. For the elements of one main group the electronegativities decrease from top to bottom across the periodic table. To the subgroup elements, there's no regular rule.

4. Importance

Electron affinity can reflect the ability of an atom to gain electrons. The smaller the first electron affinity, the easier an atom gains electrons. The greater the electron affinity, the weaker is the ability of an atom to gain electrons. The ionization energy shows the ability of an atom to lose its electrons. This ability can explain the metal activity of an element.

According to the electronegativities, the intensity of metallicity or non-metallicity of elements can be measured.

In terms of the *Born-Haber cycle*, we can see the relationship among the lattice energy, electron affinity and ionization energy. The lattice energy can't be measured directly, so we can sign a

Born-Haber cycle to calculate lattice energy by electron affinity and ionization energy.

Reference:

D.F. Shriver, P. W. Atkins, *Shriver & Atkins' Inorganic Chemistry*, 3th edition, 1999, Oxford University Press, Oxford.

Questions:

1. For the elements of one period the ionization energies generally increase from left to right across the periodic table. Please try to explain why the second ionization energy of gallium is higher, not lower, than that of germanium.
2. Use the following electronegativity values and Lewis structures to answer which molecule is the most polar and explain it:

(CH₃)C=O , acetone; C₂H₆, ethane; CO₂, carbon dioxide; CH₃Cl, Methyl chloride

The electronegativity values of the elements above: C 2.5; Cl 3.2; H 2.2; N 3.0; O 3.4