PERIODIC PROPERTY: ELECTRON GAIN ENTHALPY OR ELECTRON AFFINITY

You must have heard about energy. Either something is being done or happening spontaneously, energy is involved in every process. Whenever you talk about a process you talk about the energy changes. Just like when you are talking about a business, you talk about profit and loss, the energy change in every process is also in the terms of profit and loss. Similar to the financial profit and loss, energy is also influenced by various factors and we have to keep these factors constant to get the accurate amount of energy. Pressure and volume are two variables for this process so if you keep them constant, you can get the accurate value of energy for this process. This energy is termed as the enthalpy of the process or in the other words, if a process is carried out at constant pressure and volume, the energy change is called the enthalpy of the process.

Electron Gain Enthalpy is opposite to the Ionization enthalpy. As you know that Ionization Enthalpy is the energy required to remove an electron from a neutral atom. On the contrary, when an electron is added to a neutral atom, a certain amount of energy is required or released. This energy is termed as Electron Gain Enthalpy.

When an electron is added to an atom it gets support from the nucleus in the form of nuclear attraction but it also has to face repulsion from other electrons. That is why Electron Gain Enthalpy depends on the element's nature as well as its requirements. If an element is going to complete its octet on adding an electron, it will accept the incoming electron easily. When it is beneficial for an element to add an electron, it requires lesser energy to do so or even sometimes energy is released. When addition of

electron requires energy, EGE gets a positive sign and when it releases energy, EGE gets a negative sign.

Whenever you talk about any property/quality of an element you have to consider all the specifications of its atom such as size of the atom, nuclear charge, amount of shielding, electronic arrangement and the type of electron which is involved in the process. Let's see how these factors affect the electron gain enthalpy.

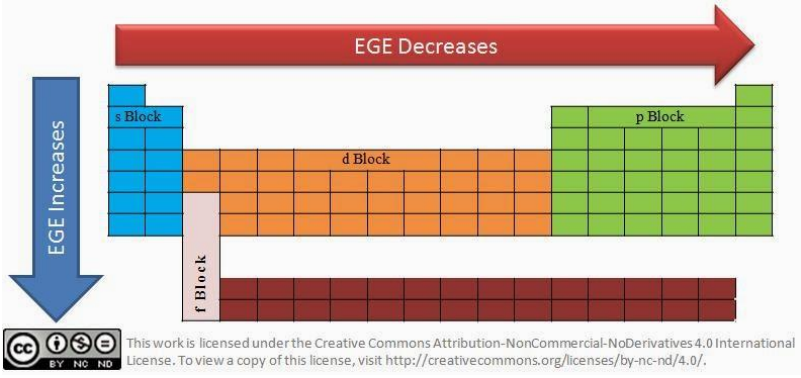
- **Size of the atom:** In a smaller atom electrons are placed closely to the nucleus, so the nucleus can attract the incoming electron and requires lesser energy to accommodate an extra electron.
- **Nuclear charge:** Larger nuclear charge supports the process by attracting the incoming electron more efficiently.
- **Shielding effect of inner sub-shells:** When the electron is added to the outer sub-shell, it will be favorable if the inner sub-shells have weak shielding effect so that the incoming electron can seek out support from the nucleus and experience better nuclear attraction. (order of shielding effect $s > p > d > f$).
- **The type of sub-shell where the incoming electron is being added (*s, p, d* or *f*):** Electrons are packed most tightly in *s* sub-shell as it is the smallest one. Sub-shell *p* has more space for electrons than *s*, so it will be easier to insert an extra electron in *p*sub-shell than in *s* sub-shell. In a larger sub-shell incoming electron has to face lesser repulsion from other electrons. The order of the electron gain enthalpy for the sub-shells is $s > p > d > f$.
- **Electronic configuration:** As we discussed earlier that half-filled and full-filled electronic configurations have extra stability. So the atoms that need an electron to achieve half-filled or full-filled state of its outer most sub-shell easily accommodate incoming electron and require lesser energy.

As we go downward in a column the size of atom increases, so it would be difficult for nucleus to attract incoming electron at a distance. So the addition is to be done forcefully, which means certain amount of energy is required. That's why elements towards the bottom of column have low negative values of Electron Gain Enthalpy (release lesser amount of energy) as compared to the elements towards the top.

Elements of 1st and 2nd group (column) have least negative electron gain enthalpy. They can achieve octet on losing electron so they prefer to lose electron rather than gaining it. Lower negative values show that they accept the incoming electron quite unhappily.

Noble elements of 18th group have quite large positive values of electron gain enthalpy. It means that the electron is being introduced forcefully and they have to accommodate it unwillingly, as a result of which a large amount of energy is required.

As we go towards right side in a period (row), the size of the atom decreases and the strength of the nucleus (nuclear charge) increases. Since the addition of electron is supported by the strength of nucleus, the process is accomplished easily with lesser energy.



General Trend of Electron Gain Enthalpy

Elements of 17^{th} group have larger negative values of electron gain enthalpy. If you write their electronic configuration you will find that they are just one electron short to achieve octet, that's why their behaviour is very much welcoming for the incoming electron. They release large amount of energy on introducing an extra electron to them, which means the process is quite feasible.

The trend of electron gain enthalpy is not as symmetrical as ionization energy (enthalpy) because the factors deciding it are closely intedependent and and their effects on the process vary considerably.

Source : http://chemistrynotmystery.blogspot.in/2014/07/periodic-property-electron-gain.html