1.3: Fundamental Properties - Electron Affinity

The electron affinity (EA) of an element is defined as the energy given of when a neutral atom in the gas phase gains an extra electron to form a negatively charged ion.

$$X^{n-}_{(g)} + e^{-} \rightarrow X^{(n+1)-}_{(g)} \tag{1.3.1}$$

Electron anities are more difficult to measure than ionization energies and are usually less accurately known. Electron affinities are large and negative for elements such as fluorine and oxygen, and small and positive for metals.

Electron affinities generally become smaller as you go down a Group of the periodic table (Table 1.3.1.3). This is because the electron being added to the atom is placed in a larger orbital, where it spends less time near the nucleus of the atom, and also the number of electrons on an atom increases as we go down a column, so the force of repulsion between the electron being added and the electrons already present on a neutral atom becomes larger. Electron anities are further complicated since the repulsion between the electron being added to the atom and the electrons already present on the atom depends on the volume of the atom. Thus, for the nonmetals in Groups 6 (VIA) and 7 (VIIA), this force of repulsion is largest for the very smallest atoms in these columns: oxygen and uorine. As a result, these elements have a smaller electron anity than the elements below them in these columns as shown in Table 1.3.1.3.

Table 1.3.1.3: The electron anity for the non-metallic halogens.

Element	**Electron affinity (kJ/mol)**
F	-322
Cl	-349
Br	-325
I	-295

Although there is a general trend that for Group 1 (IA) to Group 17 (VIIA) elements the electron affinity increases across the Periodic table from left to right, the details of the trend are more complex. As may be seen from Figure 1.3.1.5, there is a cyclic trend. The explanation of this is a consequence of the unusually stable electron configurations exhibited by atoms with filled or half filled shells, i.e., helium, beryllium, nitrogen and neon (see Table 1.3.1.4). These configurations are so stable that it actually takes energy to force one of these elements to pick up an extra electron to form a negative ion.

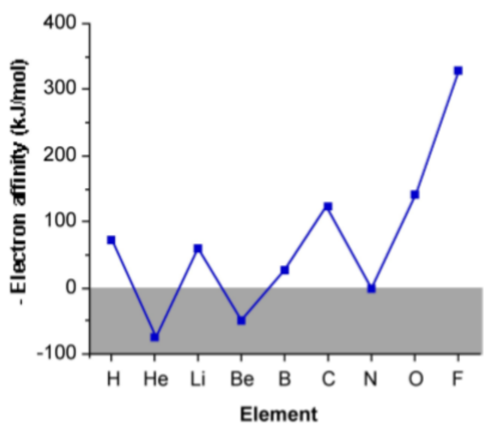

Figure 1.3.5: Plot of the electron affinity for the elements hydrogen to fluorine. N.B. Values for helium, beryllium, nitrogen, and neon are not known with any accuracy but are all positive.

Table 1.3.1.4: Electron affinities of the elements hydrogen to neon. N.B. Values for helium, beryllium, nitrogen, and neon are not known with any accuracy but are all positive.

Element	**Electron affinity (kJ/mol)**	**Electron configuration**
H	-72.8	$1s^1$

He	+ve	$1s^2$
Li	-59.8	[He] $2s^1$
Be	+ve	[He] $2s^2$
B	-27	[He] $2s^22p^1$
C	-122.3	[He] $2s^22p^2$
N	+ve	[He] $2s^22p^3$
O	-141.1	[He] $2s^22p^4$
F	-328.0	[He] $2s^22p^5$
Ne	+ve	[He] $2s^22p^6$