KNOCKHARDY NOTES

A LEVEL CHEMISTRY

IONISATION ENERGY

AT A GLANCE

Ionisation Energy (I.E.)

- A measure of the energy required to remove electrons from atoms
- The value depends on the ...
  distance of the electron from the nucleus and
  effective nuclear charge (ENC)

1st I.E.

The energy required to remove one mole of electrons to infinity from one mole of gaseous atoms to form one mole of gaseous positive ions.

e.g. $Na_{(g)} \longrightarrow Na^+_{(g)} + e^-$

Its value gives an idea of how strongly the nucleus pulls on the electron being removed. The stronger the pull on the electron, the more energy one needs to pull it out of the atom.

Element	*Electronic Configuration*	*Nuclear Charge*	*Effective Nuclear Charge*	*Filled inner levels*	*Ionisation Energy / kJ mol^{-1}*
H	$1s^1$	1+	1+	0	1300
He	$1s^2$	2+	2+	0	2370
Li	$1s^2\ 2s^1$	3+	1+	1	519
Be	$1s^2\ 2s^2$	4+	2+	1	900
B	$1s^2\ 2s^2\ 2p^1$	5+	3+	2	**799**
C	$1s^2\ 2s^2\ 2p^2$	6+	4+	2	1090
N	$1s^2\ 2s^2\ 2p^3$	7+	5+	2	1400
O	$1s^2\ 2s^2\ 2p^4$	8+	6+	2	**1310**
F	$1s^2\ 2s^2\ 2p^5$	9+	7+	2	1680
Ne	$1s^2\ 2s^2\ 2p^6$	10+	8+	2	2080
Na	$1s^2\ 2s^2\ 2p^6\ 3s^1$	11+	1+	3	494

Nuclear Charge (**NC**) The charge due to the protons in the nucleus

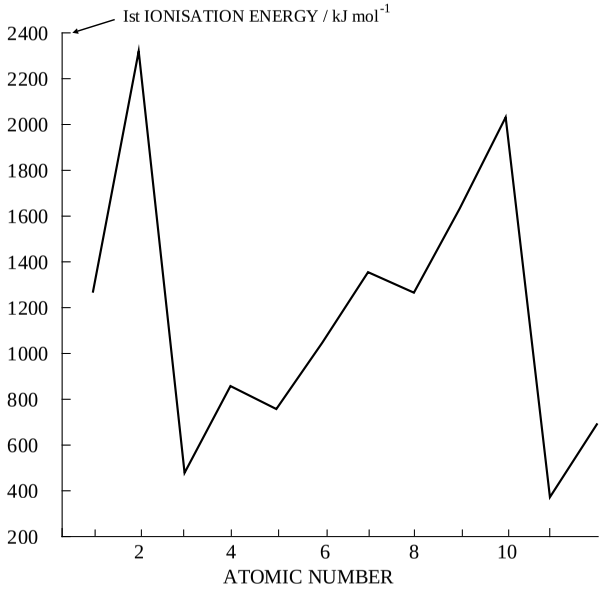
Effective nuclear Charge (**ENC**) The effectiveness of the nuclear charge after passing through any filled inner shells.

To get the **ENC :** *Knock 1+ off the* **NC** *for every electron in a filled inner orbital*

Ionisation Energy - Variation

He > H

One extra proton therefore the nuclear charge is greater and the extra electron has gone into the same energy level. Increased attraction makes the electron harder to remove.



Li < He

Despite the increased nuclear charge, the outer electron is held less strongly because it is shielded by full inner level of electrons and is further away - easier to remove

Be > Li

Increased nuclear charge plus the electrons in the same energy level

B < Be

Despite the increased nuclear charge, the outer electron is held less strongly because it is now shielded by the 2s energy sub-level and is also further away.

(EVIDENCE FOR THE EXISTENCE OF SUB LEVELS)

O < N

Despite the increased nuclear charge the electron is easier to remove. This is because, in N the three electrons in the 2p level are in separate orbitals whereas in O two of the four electrons are in the same orbital. This leads to repulsion so less energy is needed for the removal of one of them.

Na < Li

Despite the increased nuclear charge due to the larger number of protons in the nucleus, the increased shielding due to filled inner energy levels coupled with the greater distance from the nucleus means that the outer electron is held less strongly and easier to remove.

N.B. Under the old 2,8,1 system, there would be no explanation for the two 'blips' in the values of Ionisation Energy

© J. L. HOPTON 1998