Chemistry Lecture #30: Electron Configuration & the Periodic Chart

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^6\ 5s^2\ 4d^{10}\ 5p^6\ 6s^2\ 4f^{14}\ 5d^{10}\ 6p^6\ 7s^2$

The periodic chart can be used to predict the valence electron configuration of the elements. The configurations repeat in an orderly pattern.

Here are the configurations of H, Li, and Na. Can you see a pattern?

Element	Electron Configuration	End Config.	Valence Electrons
H	$1s^1$	$1s^1$	1
Li	$1s^2\ 2s^1$	$2s^1$	1
Na	$1s^2\ 2s^2\ 2p^6\ 3s^1$	$3s^1$	1

H, Li, and Na are all in group 1 (or 1A) on the periodic chart. Notice that they all have one valence electron.

All elements in group 1A have one valence electron.

Here are the configurations of Be, Mg, and Ca

Element	Electron Configuration	End Config.	Valence Electrons
Be	$1s^2\ 2s^2$	$2s^2$	2
Mg	$1s^2\ 2s^2\ 2p^6\ 3s^2$	$3s^2$	2
Ca	[Ar] $4s^2$	$4s^2$	2

Be, Mg, and Ca are all in group 2 (or 2A). Notice that they all have two valence electrons.

All elements in group 2A have two valence electrons.

Notice also that for both groups 1A and 2A, the valence electrons are in the s orbitals. Groups 1A and 2A are sometimes called the s-block elements.

Here are the end configurations for various elements in groups 3A through 8A. Next to the element I've put the period and group it is in.

Element	Period	Group	End Config.	Valence Electrons
B	2	3A	$2s^2\ 2p^1$	3
Si	3	4A	$3s^2\ 3p^2$	4
As	4	5A	$4s^2\ 3d^{10}\ 4p^3$	5
Te	5	6A	$5s^2\ 4d^{10}\ 5p^4$	6
At	6	7A	$6s^2\ 4f^{14}\ 5d^{10}\ 6p^5$	7
Rn	6	8A	$6s^2\ 4f^{14}\ 5d^{10}\ 6p^6$	8

Like groups 1A and 2A, the group number of the element corresponds with the number of valence electrons. B in group 3A has 3 valence electrons, Si in group 4A has 4 valence electrons, and so on.

For representative elements 1A-8A, the group number corresponds with the number of valence electrons.

You can also see that the outer most sublevel with electrons is the p sublevel. The end configurations all end in p. Thus, groups 3A-8A are sometimes called the p-block elements.

Notice also that the period of the element corresponds to its end configuration. Te is in period 5. The end configuration of Te, $5s^2\ 4d^{10}\ 5p^4$, shows the highest energy level of the valence electrons is the 5th energy level. This relationships also holds for groups 1A and 2A.

Thus, for groups 1A through 8A, the energy level of the valence electrons corresponds with the period number.

Which element has the end configuration of $5s^2$?

$5s^2$ means it is in the 5th period and is in group 2A. The element is Sr, and it has two valence electrons.

Which element has the end configuration of $3s^2\ 3p^1$?

$3s^2\ 3p^1$ means it is in the 3rd period and is in group 3A (2 + 1 = 3). The element is Al, and it has 3 valence electrons.

Which element has the end configuration of $4s^2\ 3d^{10}\ 4p^5$?

$4s^2\ 3d^{10}\ 4p^5$ means it is in the 4th period, and is in group 7 (2 + 5 = 7). The element is Br, and it has 7 valence electrons. Sometimes you see the end configuration written as $4s^2\ 4p^5$, but the answer is the same.

Helium is the only element that doesn't quite fit our scheme. It has 2 valence electrons, but we place it in group 8A since it shares identical properties with group 8A elements.

Transition elements are groups 3 through 12 (or 3B - 8B, 1B & 2B). Here are the end configurations of some transition elements.

Element	Period	End Configuration
Sc	4	$4s^2\ 3d^1$
Zr	5	$5s^2\ 4d^2$
Ta	6	$6s^2\ 4f^{14}\ 5d^3$

The period of the elements match the first term in the end configuration. For example, Sc is in period 4, and it starts with $4s^2$. The energy level of the last term is one level below the first term (4 - 1 = 3). So, since Sc is in period 4, the last term starts with 3, and the last term is $3d^1$.

Notice that the configurations end with the d sublevel. Thus, the transition elements are sometimes called the d-block elements.

A transition element can sometimes be identified from its end configuration. For example, let's identify an element with the end configuration of $4s^2\ 3d^6$. It is in the 4^{th} period, and it ends with a d sublevel, so it is a transition element. Go to the 4^{th} period, move from left to right and count off the first 6 elements in the transition region. The elements are Sc, Ti, V, Cr, Mn, and Fe. Fe is the 6^{th} element in the transition region of period 4, so that is the identity of our element.

Can you identify an element with the end configuration of $6s^2\ 4f^{14}\ 5d^7$? Answer: Ir

Here are the end configurations of some elements in the lanthanide and actinide groups. Lanthanides are in period 6, and actinides are in period 7.

Element	Period	End configuration
Pr	6	$6s^2\ 4f^3$
Eu	6	$6s^2\ 4f^7$
Pu	7	$7s^2\ 5f^6$
Bk	7	$7s^2\ 5f^9$

Lanthanides and actinides end with the f sublevel, so these are called the f-block elements.

Notice also that energy of the f sublevel is two less than its period. For example, Pr is in period 6, 6 - 2 = 4, and it ends in $4f^3$.

Below is a summary of the end configuration of the elements.