

## Main Energy Levels

- 1) Electrons follow paths called orbits, shells, or levels.
- 2) Each shell can hold a specific maximum number of electrons.
- 3) Each electron possesses a definite amount of energy.
- 4) The radius of the orbit depends on the amount of energy that electron has and on the attractive force the nucleus has for that electron.

Bohr model of the atom (with main energy levels identified by number: 1 --> 7)

shell #1	closest to nucleus	can hold a maximum of 2 e
shell #2		next shell outward can hold a maximum of 8 e
shell #3	next shell outward	for elements $Z = 1 \rightarrow 20$ , this shell can hold a maximum of 8 e <sup>-</sup> , for all others a maximum of 18 e
shell #4		next shell outward can hold a maximum of 32 e
and so forth		

When scientist started measuring energy given off or taken in by atoms more closely they found:

- 1) when e<sup>-</sup> absorb energy they move to higher energy levels (become 'excited e') this was found by spectrum analysis and the scattering effects of Rutherford's alpha particles
- 2) when e<sup>-</sup> fall back to lower energy levels they must lose this energy by emitting radiation, usually as photons of light
- 3) if e<sup>-</sup> absorb too much energy they can be ionized (which means completely removed from the electron cloud)
- 4) \*\*\* e<sup>-</sup> in the highest energy level (greatest distance from nucleus) require the least energy to escape from the atom and are usually the e<sup>-</sup> involved in chemical reactions
- 5) Bohr's model of fixed electron paths has now been changed to an 'electron cloud' model which describes areas of space around the nucleus where electrons of various energy levels are to be found

See example of electrons shells on board

Match example:

- 1) the match itself contains potential energy (stored as chemical energy in bonds)
- 2) to release this fuel (by way of oxidation) and given off light and heat the match must absorb energy which comes from the heat of kinetic energy of motion (friction) as match is scratched across strike plate
- 3) as energy is absorbed electrons become excited (absorb energy and move to higher energy levels) and perhaps ionized (have absorbed enough energy to break free from the electron cloud entirely)
- 4) as kindling temperature is reached and oxidation takes place electrons begin to fall back down the stair step energy levels and the electrons that were ionized begin to recombine with ions left behind in such a way that they must radiate away this excess energy as photons of light that we see or as heat energy we can feel
- 5) continued combustion takes place as wood, oxygen in the air, and other chemicals in the match oxidize rapidly

## Subshells

The electrons that are closest to the nucleus are held most strongly. In the energy levels (shells) at the greatest distance from the nucleus, the **number of electrons .that each level** can hold increases, and their attraction for the nucleus decreases.

a) 4 subshells (found by spectral lines) have these names and symbols: sharp (s), principal (p), diffuse (d), fundamental (f)

b) these subshells differ in size, shape, and orientation in space

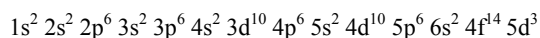
c) first main shell = s subshell only = max. of 2 electrons in s subshell

second main shell = s and p subshell = max. of 6 electrons in p subshell

third main shell = s and p and d = max. of 10 electrons in d subshell

fourth main shell = s and p and d and f = max. of 14 electrons in f subshell

d) filling order (example of tantalum with 73 electrons)



or in the core configuration [Xe]  $6s^2 4f^{14} 5d^3$

$2p^3$  2 is specific main energy level, p is subshell shape, and 3 is the number of electrons in that subshell

e) Rules:

1) main energy levels are numbered 1, 2, 3, 4, 5, 6, 7

2) the larger the number of main shell, the greater the volume of orbital (2s orbital is larger than 1s)

3) the order in which subshells are filled usually follows energy ranking starting with subshell lowest in energy and then working up the filling order (with exceptions)

4) within a given sublevel, each orbital is usually occupied by a single electron before any orbital has 2 electrons (its maximum)

f) Added hints:

1) the number of sublevels within a main level is numerically equal to the number of that main level

2) the square of the main level number gives the number of orbitals in that level

3) the number of orbitals multiplied by 2 gives the maximum number of electrons in that main energy level.

4)  $\uparrow$  symbol used for electron spin up

5)  $\downarrow$  symbol used for electron spin down

6) electrons can stay close together (in orbital) if spins are opposite

7) \*\*\* NO more than 2 electrons (spin opposed) will occupy any one region of space, orbital, or bond. \*\*\*

