# CHEM 2 ELECTRON CONFIGURATION

## Relationship to position on the Periodic Table; formation of cations and anions.

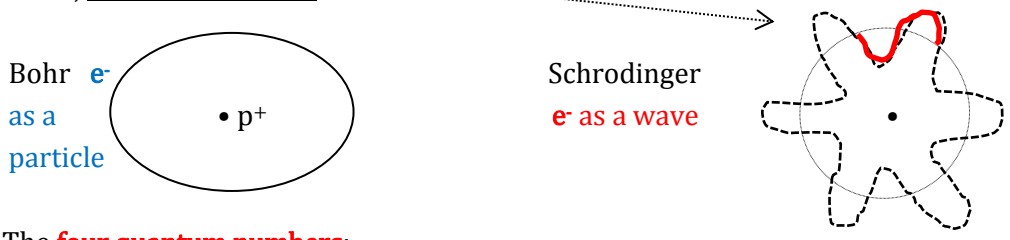
**Bohr planetary (particle) model**

Energy of electron in orbit $E_n = -R / n^2$ n = principal quantum number

Maximum number of electrons per shell = $2.n^2$, so for n=1, $2e^-$ n=2, $8e^-$ n=3, 18 $e^-$ etc.

**Schrodinger's wave mechanical model**

**Electron behaving as a wave**. (wave functions, Ψ) -such that a stable energy state is only established when an integral number of wavelengths are "quantized" into the orbital to produce a "stationary state", a confined $e^-$ wave.




The four quantum numbers:

**n = principal quantum number**, n = 1, 2,3 .....;

Gives the ENERGY of the electron shell via, $E_n = -R/n^2$

**$\ell$ = orbital quantum number, $\ell$ = 0, 1, 2... (n-1)** ;

Gives the SHAPE of the sub-shell electron cloud (orbital shape)

$\ell = 0$ = s-orbital, spherical; $\ell = 1$= p-orbital, dumbbell shape , $\ell = 2$ = d-orbital

**See next page for the shapes of s- p- and d-atomic orbitals.**

**$m_\ell$ = magnetic quantum number, $m_\ell = 0, \pm1, \pm2....\pm\ell$** ;

Gives the NUMBER OF ORBITALS in the sub-shell and their orientation in space

$m_\ell = 0$, ONE s-orbital, $m_\ell = 0, \pm1$, THREE p-orbitals $m_\ell = 0, \pm1, \pm2$, FIVE d-orbitals

Eg. If **n = 2**, then **$\ell$ = 0** or 1, and for **$\ell$ = 0**, **$m_\ell = 0$** ; and for **$\ell$** = 1, **$m_\ell$** = 0 +1 -1,

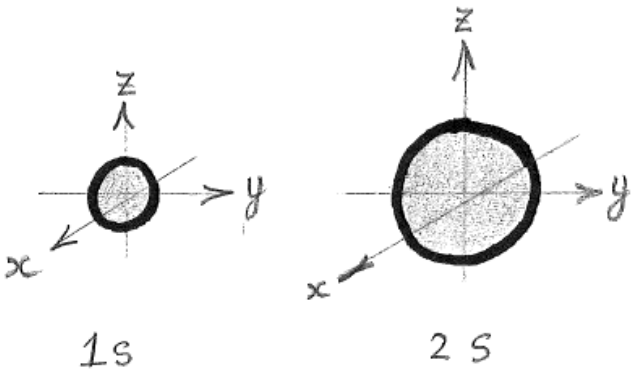
For **$\ell$** = 0, **$m_\ell$** = 0 only : this defines **one** orbital – in this case the ***2s-orbital***.

For **$\ell$** = 1, **$m_\ell$** = 0, +1 or -1 only; this defines **3 separate** orbitals – in this case the three ***2p-orbitals.***

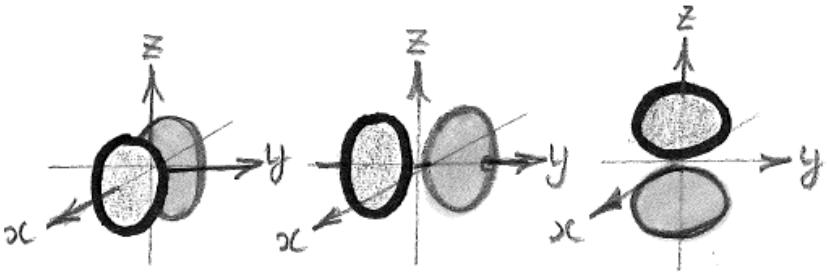
**$m_s$ = SPIN quantum number**, $m_s = +½$ or -½, often represented as ↑ or ↓, to indicate spin up or down.

Electrons are often designated as arrows in orbital "boxes", eg ↑ or ↑↓

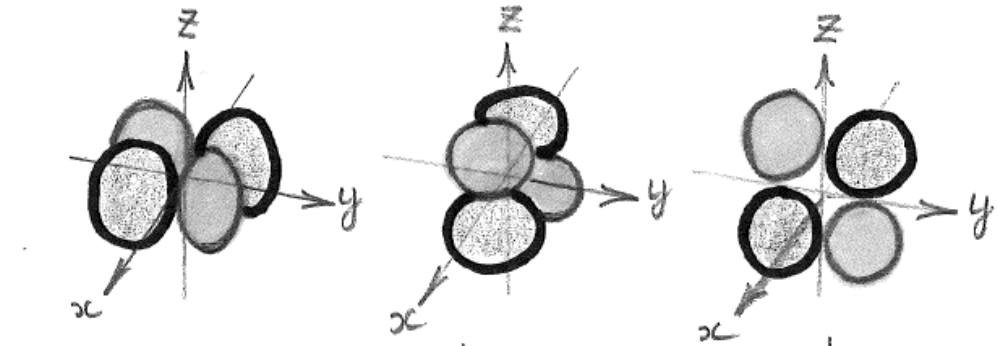
# SHAPES OF ATOMIC ORBITALS



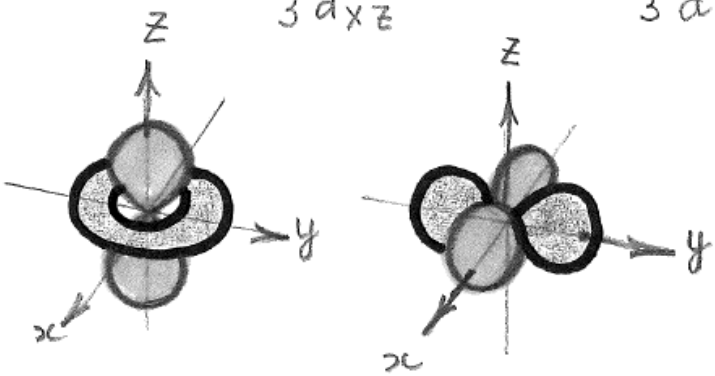

1s 2s




$2p_x$ $2p_y$ $2p_z$

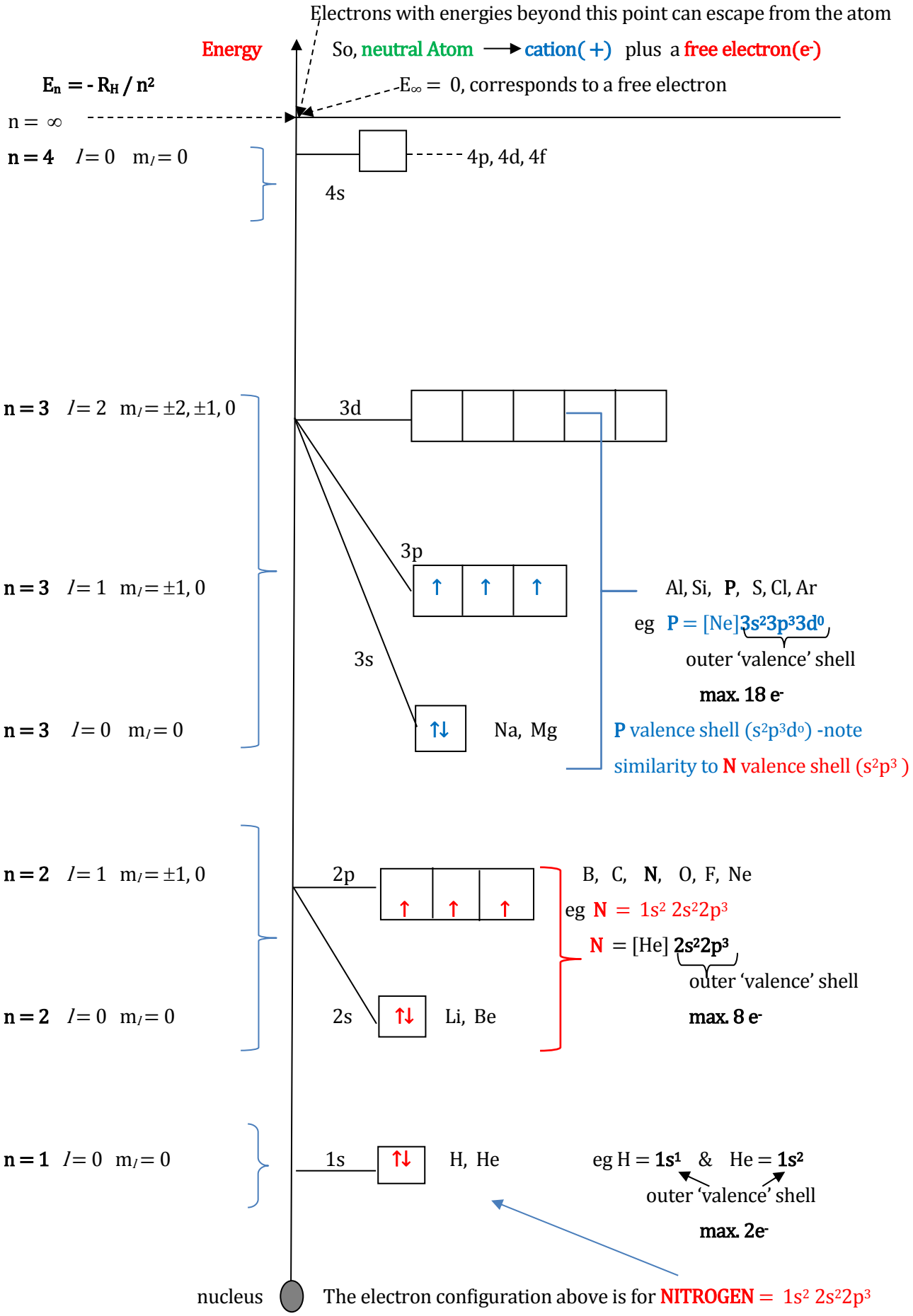



$3d_{xy}$ $3d_{xz}$ $3d_{yz}$




$3d_{z^2}$ $3d_{x^2-y^2}$

**FOR A MULTI-ELECTRON ATOM**, we can plot this as shown below :




**Note how the filling of the orbitals gives rise to the layout of the Periodic Table shown on the next page.**

# The Modern Periodic Table of the Elements

# Group Number = Number of outer shell electrons

Element name → Mercury
Atomic # → 80
Symbol → Hg
Avg. Mass → 200.59
Electronegativity → 1.9

The power to attract electrons

| # I (1) | # II (2) | | # III (13) | # IV (14) | # V (15) | # VI (16) | # VII (17) | # VIII (18) |
|---|---|---|---|---|---|---|---|---|
| Hydrogen 1 H 1.01 2.1 | | | | | | | | Helium 2 He 4.00 --- |
| Lithium 3 Li 6.94 1.0 | Beryllium 4 Be 9.01 1.5 | | Boron 5 B 10.81 2.0 | Carbon 6 C 12.01 2.5 | Nitrogen 7 N 14.01 3.0 | Oxygen 8 O 16.00 3.5 | Fluorine 9 F 19.00 4.0 | Neon 10 Ne 20.18 --- |
| Sodium 11 Na 22.99 0.9 | Magnesium 12 Mg 24.31 1.2 | | Aluminum 13 Al 26.98 1.5 | Silicon 14 Si 28.09 1.8 | Phosphorus 15 P 30.97 2.1 | Sulfur 16 S 32.07 2.5 | Chlorine 17 Cl 35.45 3.0 | Argon 18 Ar 39.95 --- |
| Potassium 19 K 39.10 0.8 | Calcium 20 Ca 40.08 1.0 | | Gallium 31 Ga 69.72 1.6 | Germanium 32 Ge 72.61 1.8 | Arsenic 33 As 74.92 2.0 | Selenium 34 Se 78.96 2.4 | Bromine 35 Br 79.90 2.8 | Krypton 36 Kr 83.80 3.0 |
| Rubidium 37 Rb 85.47 0.8 | Strontium 38 Sr 87.62 1.0 | | Indium 49 In 114.82 1.7 | Tin 50 Sn 118.71 1.8 | Antimony 51 Sb 121.76 1.9 | Tellurium 52 Te 127.60 2.1 | Iodine 53 I 126.90 2.5 | Xenon 54 Xe 131.29 2.6 |
| Cesium 55 Cs 132.91 0.7 | Barium 56 Ba 137.33 0.9 | 57-70 * | Thallium 81 Tl 204.38 1.8 | Lead 82 Pb 207.20 1.8 | Bismuth 83 Bi 208.98 1.9 | Polonium 84 Po (209) 2.0 | Astatine 85 At (210) 2.2 | Radon 86 Rn (222) 2.4 |
| Francium 87 Fr (223) 0.7 | Radium 88 Ra (226) 0.9 | 89-102 ** | | | | | | |

| 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|
| Scandium 21 Sc 44.96 1.3 | Titanium 22 Ti 47.88 1.5 | Vanadium 23 V 50.94 1.6 | Chromium 24 Cr 52.00 1.6 | Manganese 25 Mn 54.94 1.5 | Iron 26 Fe 55.85 1.8 | Cobalt 27 Co 58.93 1.8 | Nickel 28 Ni 58.69 1.8 | Copper 29 Cu 63.55 1.9 | Zinc 30 Zn 65.39 1.6 |
| Yttrium 39 Y 88.91 1.2 | Zirconium 40 Zr 91.22 1.4 | Niobium 41 Nb 92.91 1.6 | Molybdenum 42 Mo 95.94 1.8 | Technetium 43 Tc (98) 1.9 | Ruthenium 44 Ru 101.07 2.2 | Rhodium 45 Rh 102.91 2.2 | Palladium 46 Pd 106.42 2.2 | Silver 47 Ag 107.87 1.9 | Cadmium 48 Cd 112.41 1.7 |
| Lutetium 71 Lu 174.97 1.1 | Hafnium 72 Hf 178.49 1.3 | Tantalum 73 Ta 180.95 1.5 | Tungsten 74 W 183.84 1.7 | Rhenium 75 Re 186.21 1.9 | Osmium 76 Os 190.23 2.2 | Iridium 77 Ir 192.22 2.2 | Platinum 78 Pt 195.08 2.2 | Gold 79 Au 196.97 2.4 | Mercury 80 Hg 200.59 1.9 |
| Lawrencium 103 Lr (262) --- | Rutherfordium 104 Rf (261) --- | Dubnium 105 Db (262) --- | Seaborgium 106 Sg (263) --- | Bohrium 107 Bh (262) --- | Hassium 108 Hs (265) --- | Meitnerium 109 Mt (266) --- | Darmstadtium 110 Ds (271) --- | Roentgenium 111 Rg (272) --- | Ununbium 112 Uub (285) --- |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *lanthanides | Lanthanum 57 La 138.91 1.1 | Cerium 58 Ce 140.12 1.1 | Praseodymium 59 Pr 140.91 1.1 | Neodymium 60 Nd 144.24 1.1 | Promethium 61 Pm (145) 1.1 | Samarium 62 Sm 150.36 1.2 | Europium 63 Eu 151.97 1.1 | Gadolinium 64 Gd 157.25 1.2 | Terbium 65 Tb 158.93 1.1 | Dysprosium 66 Dy 162.50 1.2 | Holmium 67 Ho 164.93 1.2 | Erbium 68 Er 167.26 1.2 | Thulium 69 Tm 168.93 1.3 | Ytterbium 70 Yb 173.04 1.1 |
| **actinides | Actinium 89 Ac (227) 1.1 | Thorium 90 Th 232.04 1.3 | Protactinium 91 Pa 231.04 1.5 | Uranium 92 U 238.03 1.4 | Neptunium 93 Np (237) 1.4 | Plutonium 94 Pu (244) 1.3 | Americium 95 Am (243) 1.3 | Curium 96 Cm (247) 1.3 | Berkelium 97 Bk (247) 1.3 | Californium 98 Cf (251) 1.3 | Einsteinium 99 Es (252) 1.3 | Fermium 100 Fm (257) 1.3 | Mendelevium 101 Md (258) 1.3 | Nobelium 102 No (259) 1.3 |

INERT GASES
Very Stable electron configuration in outer shell (8e⁻) (2e⁻ for He)