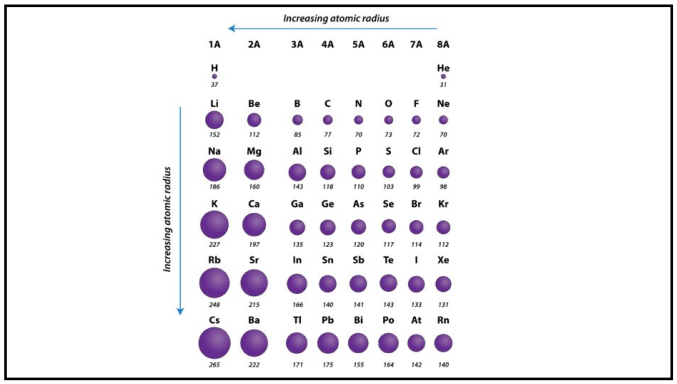
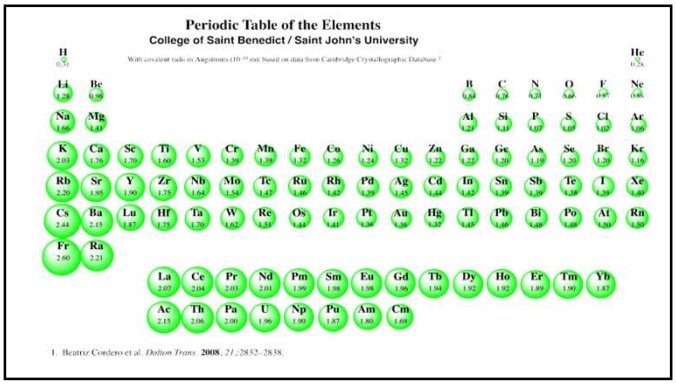
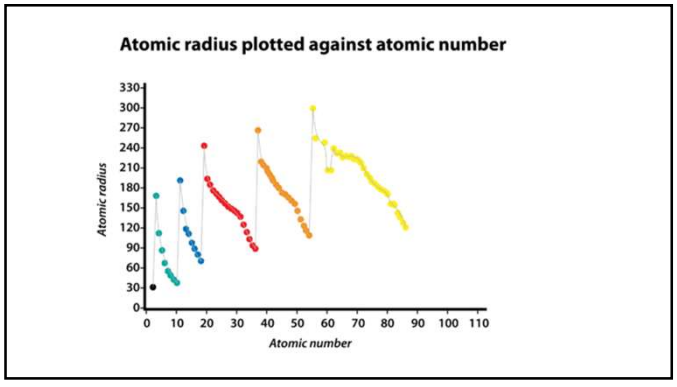
Periodic Properties At a Glance

Atomic Size (Covalent Radii)

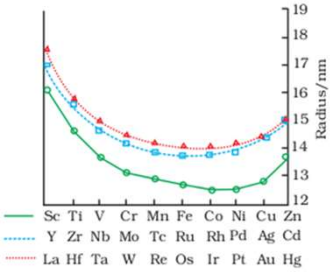
- In a period, atomic size decreases and in a group size increase among Normal elements(s- and p-blocks)
- In Transition series, the size decreases, but the variations are inconsistent.
- In Transition Groups, the size increases from 1st to 2nd element and then remains nearly same in the 3rd element (except Sc group)
- In the Ln and An series too size decreases but inconsistently.





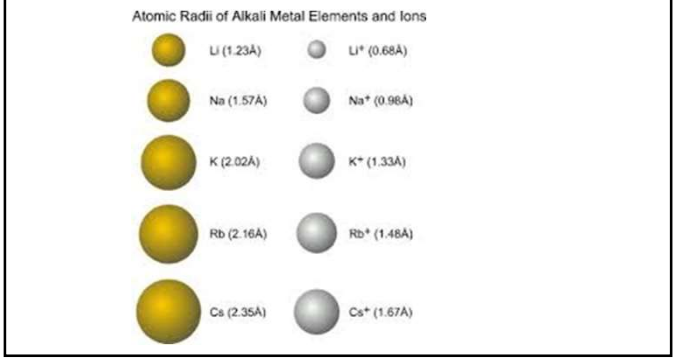


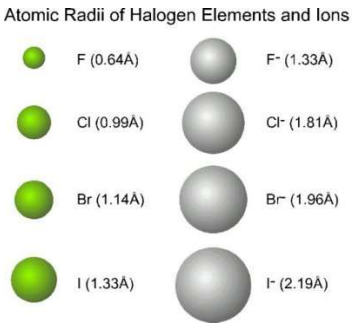
Variation of Size in d-block Elements

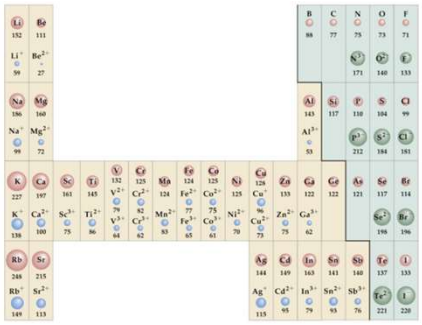


Ionic Size

- Cationic Size always less than its neutral atomic Size. ($Na^+ < Na$)
- Anionic Size is always greater than its neutral atomic Size ($Cl^- > Cl$)
- In Isoelectronic Speices(eg. S^{2-}, Cl^-, Ar, K^+, Ca^{2+}), more the nuclear charge, less is the size.
- $S^{2-} > Cl^- > Ar > K^+ > Ca^{2+}$







Do you know the size of H^-(hydride ion) ?

- H^- = 1.4 Å
- Hydride ion is bigger than Fluoride ion.

Ionization Energy(IE)

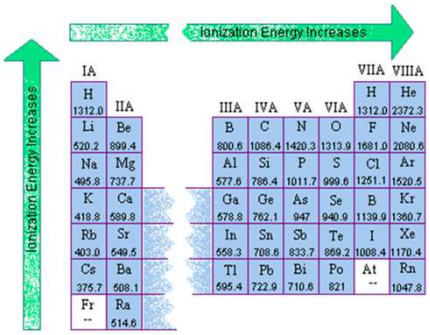
- The amount of energy required to knock out the outermost loosely bound electron from an isolated gaseous atom. For removal of 1st electron, it is called 1st Ionization Energy(IE_1) and so on.

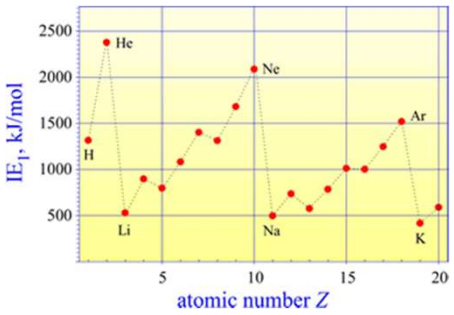
$X(g) + IE_1 \rightarrow X^+(g) + e$
$X^+(g) + IE_2 \rightarrow X^{++}(g) + e$
$X^{++}(g) + IE_3 \rightarrow X^{+++}(g) + e$ and so on

$IE_1 < IE_2 < IE_3 < .....$

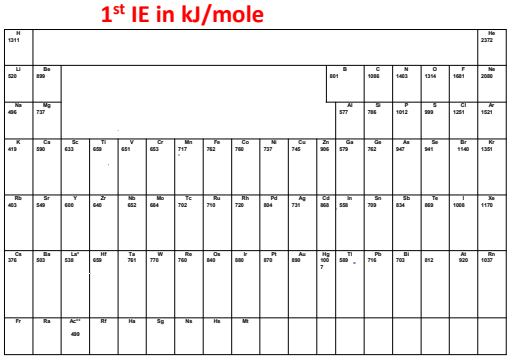
Trends in 1st Ionization Energy(IE_1)

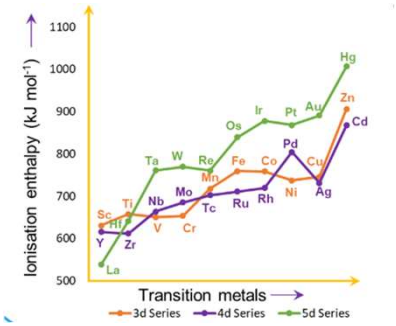
- IE_1 increases across a period and decreases along groups in normal elements(main groups of s- and p-blocks) with some anomalies at Groups 2 and 15.
- Metals have lower IE values and hence form +ve ions easily.
- In Transition series, IE_1 increases but highly inconsistently.
- In Transition Groups, IE_1 is highest in the 3rd element down each group. In some groups increases down the groups(V, Cr and Ni groups) and in all other groups, decreases first and then increases.
- In Ln series, the IE_1 also increases, but inconsistently.

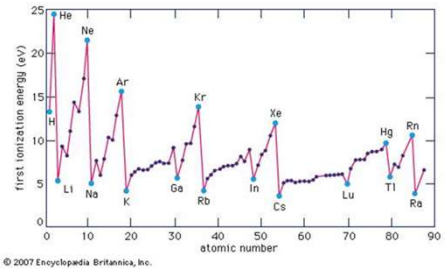


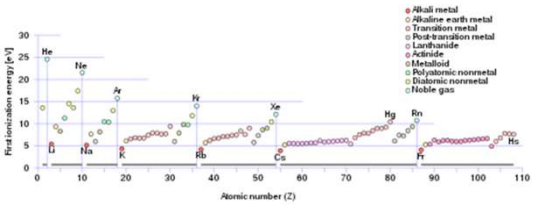


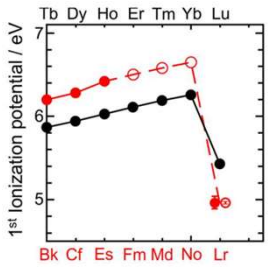
1st IE in kJ/mole







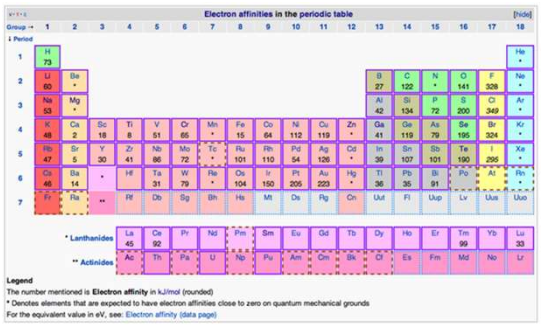


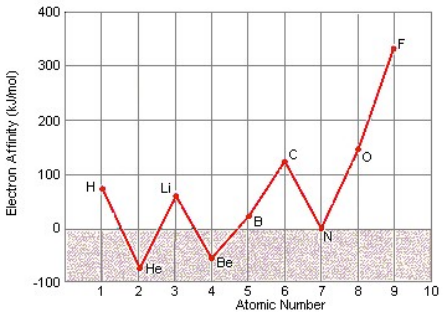


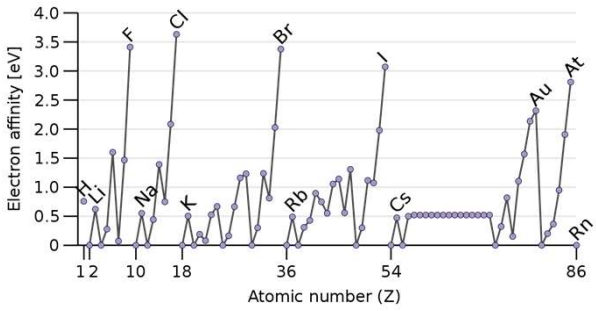
Electron Affinity/Affinity Energy(EA/AE)

- It is amount of energy liberated by a neutral isolated gaseous atom to accept an electron to form uni-negative ion.
- Those which do not liberate energy, we assume their EA values as Zero. In fact, they have negative EA values.
- Non-metals have greater EA values hence form negative ions easily.
- $X(g) + e \rightarrow X^-(g) + EA$

H 73																	He -50
Li 60	Be -50											B 27	C 122	N -0.07	O 141	F 328	Ne -120
Na 53	Mg -40											Al 43	Si 134	P 72	S 200	Cl 349	Ar -96
K 48	Ca 2	Sc 18	Ti 8	V 51	Cr 64	Mn -50	Fe 16	Co 64	Ni 111	Cu 118	Zn -60	Ga 30	Ge 120	As 78	Se 195	Br 325	Kr -60
Rb 47	Sr 5	Y 30	Zr 41	Nb 82	Mo 72	Tc 53	Ru 101	Rh 110	Pd 54	Ag 126	Cd -70	In 30	Sn 120	Sb 103	Te 190	I 295	Xe -80
Cs 45	Ba 14	La* 50	Hf 17	Ta 31	W 79	Re 14	Os 110	Ir 151	Pt 205	Au 223	Hg -50	Tl 20	Pb 35	Bi 91	Po 180	At 222	Rn -70
Fr 47	Ra 10	Ac** 34	Rf	Ha	Sg	Ns	Hs	Mt									

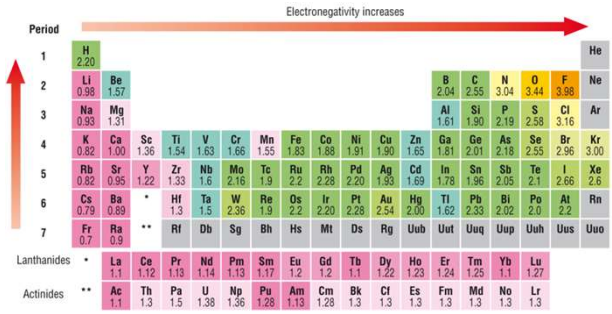






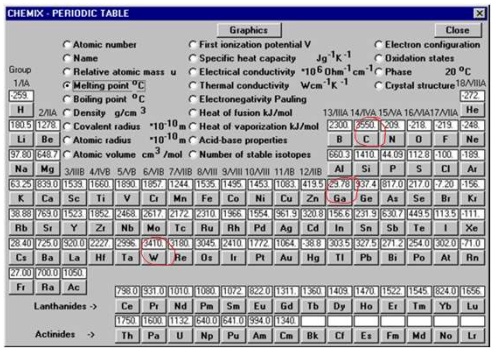
Electronegativity(EN)

- It gives the relative tendency of an atom to attract a shared pair of electrons towards itself in a covalent bond e.g X-Y.
- Partial or fractional charges develop in diatomic molecule with different electronegativities giving polar covalent bond.
- Max: F≈4, 2nd: O ≈ 3.5, 3rd : N, Cl ≈ 3.0 4th : Br ≈ 2.9, Na = 0.9
- Metals have lower EN while non-metals have higher(>2) EN.
- Down the group EN decreases and across a period EN increases.
- More the EN, more is the non-metallic character and vice versa.
- If difference in EN is greater than 1.7, the bond is predominantly ionic if it is less than 1.7 it is predominantly covalent.

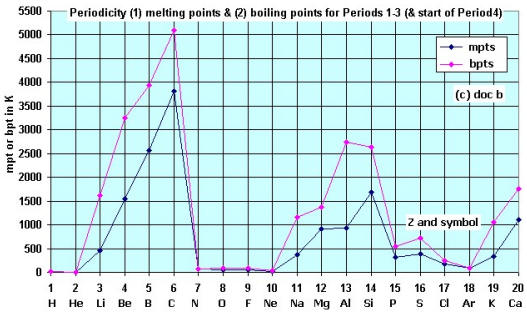


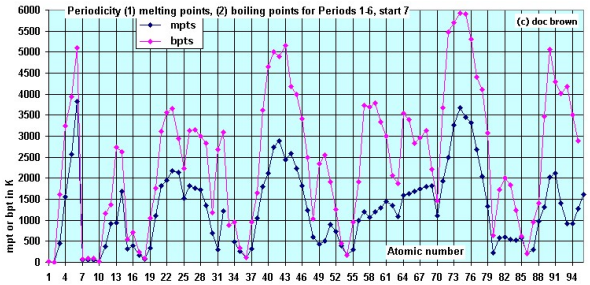
Melting and Boiling Points

- The temperature at which a substance in solid state is changed to liquid state or the liquid is changed to its solid state(Freezing Point) at 1 atm pressure is called MELTING POINT(MP).
- The temperature at which a liquid changes to vapour(gaseous state) or a vapour is converted to its liquid state at 1 atm. Pressure is called BOILING POINT(BP).
- MP < BP
- For gases we have to decrease the temperature to first meet its BP and further cool to meet its Freezing Point(MP).

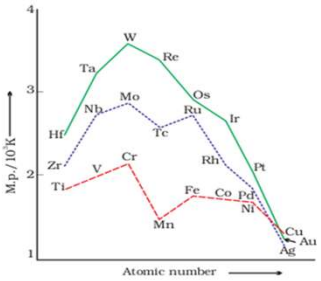


- In a period MP increases upto certain element and then decreases and down the group it shows inconsistent patterns.
- In alkali metals, MP decreases down the group. Group 2 metals have higher MP than Group 1, but the variation is irregular.
- In p-block, Diamond(C) has the highest MP among elements and Ga is the lowest melting metal(around 30^{0}C)
- In d-block, MP increases upto certain element and then decreases and down the transition group, MP increases, except in Cu and Zn group (Cu > Au >Au); (Zn>Cd>Hg)



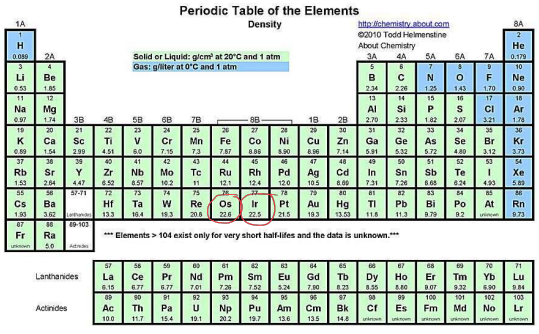


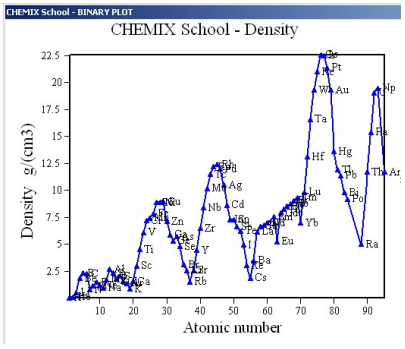
Variation of MP in d-block elements



Densities (at Standard State)

- At standard states(25^{0}C and 1 atm pressure), gases have much lower densities than solids and liquids.
- In a period, increases upto certain element and then decreases and in a group increases with some irregularities.
- In Transition series, density increases upto certain element and then decreases and in transition groups density increases down. Heaviest Elements: Os, Ir
- Os > Ir (1 atm), Ir > Os (higher pressure)

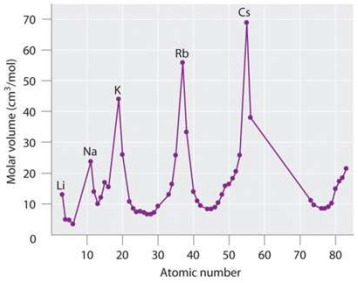


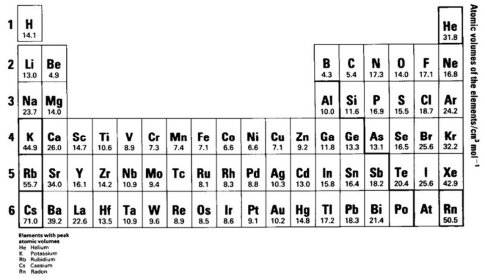


Here densities in the Condensed states are taken. Gaseous elements are liquefied to measure density.

Atomic Volume(Molar Volume)V_M

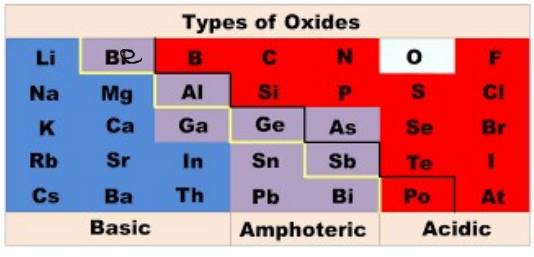
- Volume of 1 mole of element in the condensed state(Mostly solid state)
- $Atomic\ Volume = \frac{Atomic\ Mass}{density\ in\ the\ condensed\ state}$
- Density of Fe =7.86 g/cc, what is its atomic volume ?
- Atomic Volume(Fe) = $\frac{56}{7.86}$= 7.12 cc/mol





Nature of Oxides

- s-block metallic oxides are basic and base strength increases down the groups. (Except: BeO is amphoteric)
- In p-block, non-metallic oxides are acidic and metallic oxides are basic.
- Oxides of some metals and metalloids are amphoteric.
- Transition metal oxides are mostly basic in their lower OS, while can be acidic in higher OS. But in the intermediate OS, it can be amphoteric. (CrO – basic, Cr_2O_3- amphoteric, CrO_3- acidic)

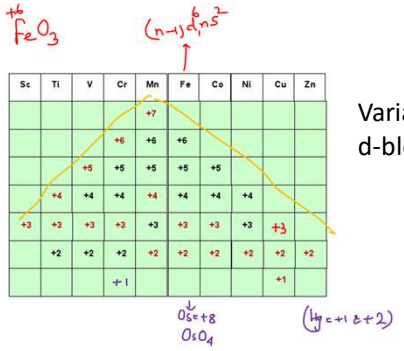


Oxidation States(Valency)

- Group 1 : +1
- Group 2: +2
- Group13 : +3 (+1)
- Group 14: +4, -4 (+2)
- Group 15: +5, -3 (+3)
- Group 16: +6, -2, (+4, +2)
- Group 17: +7, -1 (+5, +3, +1)

Table 1. Common oxidation states of p-block elements

Group	13	14	15	16	17	18
General electronic configuration	ns^2np^1	ns^2np^2	ns^2np^3	ns^2np^4	ns^2np^5	ns^2np^6
Group oxidation state	+ 3	+ 4	+ 5	+ 6	+ 7	+ 8
Various oxidation states	B +3 Al +3 Ga, In, Tl +3, +1	C +4, -4 Si +4 Ge, Sn, Pb +4, +2	N +5 to -3 P, As +3, +5, -3 Sb, Bi +3, +5	O -1, -2 S, Se, Te -2, +2, +4, +6	F -1 Cl, Br, I -1, +1, +3 +5, +7	 Kr +2, +4 Xe +2, +4, +6, +8



Variation of OS in d-block elements