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TOPIC:- Group-wise systematic study of p-block elements

Group-13

Physical properties and Oxidation states

Group-13

The elements in this group are boron, aluminium, gallium, indium and thallium. The general electronic configuration is ns^2np^1. Boron is a non-metal while the others are fairly reactive metals.

Physical Properties

Some important physical constants of the Group 13 elements are shown in table 1

Table 1: Physical properties of Group 13 Elements

Property	B	Al	Ga	In	Tl
Electronic Configuration	$[He]2s^2 2p^1$	$[Ne]3s^2 3p^1$	$[Ar]3d^{10}$ $4s^2 4p^1$	$[Kr]4d^{10}$ $5s^2 5p^1$	$[Xe]4f^{14}$ $5d^{10} 6s^2 6p^1$
Atomic radius (pm)	85	143	135	167	170
Ionization Energy (I) ($KJmol^{-1}$)	801	578	579	558	589
Electronegativity	2.05	1.61	1.75	1.65	1.79

Melting Point (^{0}C)	2180	660	29.8	157	304
Boiling Point (^{0}C)	3650	2467	2403	2080	1457

The elements of Group 13 have smaller atomic radii and higher electronegativities as compared to s-block elements. However, these properties do not vary in a regular manner. The atomic radius of gallium (135 pm) is slightly less than that of aluminum (143 pm). This is because Ga follows the d-block elements and the inner core of Ga contains ten 'd' electrons that do not shield the nuclear charge efficiently. Therefore, the effective nuclear charge of Ga is more than that of Al so that the outer electrons are attracted towards the nucleus and the size is smaller than expected. The electronegativity and ionization energy consequently are higher than expected. Similarly, the inclusion of fourteen *f*' electrons on the inner core affect the size and ionization energy of Tl.

Oxidation states and Bond Type

The common oxidation states are +3 and +1. The stability of the +1 oxidation state, due to inert pair effect, increases down the group. Compounds of Ga (I), In (I) and Tl (I) are known Tl (I) compounds are more stable than Tl (III) and the latter are oxidizing in nature. Ga (I) compounds are reducing indicating that Ga (III) is more stable. The higher oxidation state is generally covalent. Boron is always covalent and does not form B^{3+} ion. Some compounds of Al and Ga like

$AlCl_3$ and $GaCl_3$ are covalent in the anhydrous state. However the M^{3+} ions are associated with high hydration energies, which compensate the high ionization energies, and hydrated cations are known.