Comparison of B and Al:

Similarities: B & Al have similarities due to similar valence shell configuration.

- Both exhibit a valency of 3
- Both form similar oxides B_2O_3.Al_2O_3
- Both form similar halides BCl_3, $AlCl_3$.
- Trihalides of both act as Lewis acids.

Differences: B & Al differ due to the difference in the penultimate shell configuration.

Boron	Aluminium
$B \rightarrow (n-1)s^2$	$Al \rightarrow (n-1)s^2p^6$
B is non – metal	Al is metal
It is rare in occurance	It is very much abundant
Bad conductor	Good conductor
Exhibits allotropy (same element in different physical forms)	Does not exhibit allotropy
Maximum valency is 4	Maximum valency is 6
Forms covalent compounds	Forms both ionic and covalent compounds.
Exhibits oxidation state 3 also	Exhibits +3 oxidation state only
It does not form cation	Forms cation
It reacts with alkalies to liberate H_2 gas	It reacts with both acids & bases to liberate H_2 gas
B_2O_3 is acidic	Al_2O_3 is amphoteric
It forms stable hydrides	Its hydrides are unstable
Forms stable borates	Aluminates are unstable

Oxides :

- B_2O_3 is a white solid & soluble in water while Al_2O_3 is also white solid but insoluble in water.

  $B_2O_3 + H_2O \rightarrow B(OH)_3$ or H_3BO_3 (boric acid)
- Boric acid is a weak monobasic acid
- B_2O_3 is formed when borax reacts with strong acid

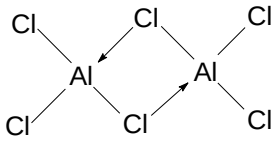
  $Na_2B_4O_7 + 2HCl + H_2O \rightarrow H_3BO_3 + 2NaCl$
- Hydroxides : Hydroxide of B is acid i.e. $B(OH)_3$
- Hydroxide of Al is amphoteric i.e., $Al(OH)_3$
- $B(OH)_3$ is soluble & $Al(OH)_3$ is insoluble in water & it is white gelatinous precipitate.
- $B(OH)_3$ is prepared from B_2O_3 and H_2O

  $B_2O_3 + 3H_2O \rightarrow 2H_3BO_3$
- $Al(OH)_3$ is prepared from Al salt & NH_3 solution.

  $AlCl_3 + 3NH_4OH \rightarrow Al(OH)_3 + 3NH_4Cl$

Trihalides : Both form trihalides. Trihalides are electron deficient. Therefore they act as Lewis acids. In these trihalides, central atom is sp^2 hybridised and trigonal planar.

- All Boron trihalides are covalent.
- AlF_3 is ionic, an $AlCl_3$ is covalent and hydrated $AlCl_3$ is ionic.
- Boron trihalides will be hydrolysed to give boric acid.
- $BCl_3 + 3H_2O \rightarrow B(OH)_3 + 3\ HCl$
- Lewis acidic strength order : $BF_3 < BCl_3 > BBr_3 > Bl_3$
- The substance which accepts electron pair is called Lewis acid.
- All electron deficient molecules are lewis acids.
- Trihalides of B & Al such as BF_3, $AlCl_3$, etc are electron deficient & act as Lewis acids.
- Because of their ability to behave like Lewis acids, they are used as Friedel crafts catalysts.
- Anhydrous $AlCl_3$ will exists as dimer $[Al_2Cl_6]$ to compensate electron deficiency.



Upto 400^0C , $AlCl_3$ will exist as dimer beyond 800^0C , it will exist as monomer.

Back – bonding : In BF_3, each fluorine has 3 lone pairs & B has vacant 2p orbital.

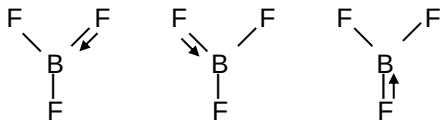
- Fluorine donates one of its three lone pairs to the vacant orbital of B & forms a dative bond in between them.
- This backbond is possible because of donation of electron pair from 2p orbital of F to 2p orbital of B. As a result of this back bonding, the electron deficiency of B is nullified to large extent.

∴ BF_3 behaves as weak lewis acid eventhough more electron-negative flourines are bonded to Boron.

Such type of back bonding is not possible in other boron trihalides because lone pair has to be donated from higher p – orbital i.e, 3p , 4p, 5p etc. to the 2p orbital of Boron.

$BF_3 < BCl_3 > BBr_3 > Bl_3$

Due to back bonding BF_3 has the following three



- Because of the above resonance structures of BF_3.
- Bond order of B – F is 4/3 i.e., 1.33
- Bond length of B – F is slightly decreased than the expected value.