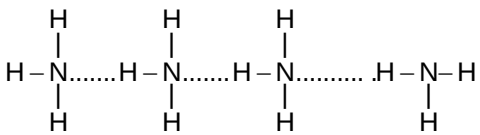
HYDRIDES :

- These elements form hydrides of the type MH_3
  NH_3(Ammonia) PH_3(Phosphine)
  AsH_3(Arsine) SbH_3(Stibine)
  BiH_3 (Bismuthine)
- NH_3 to BiH_3 the stability decreases.
- The size of the central atom increase and there by the metal – hydrogen bond becomes weaker due to decreased overlap between the large central atom and the small H – atom.
- Reducing character of these hydrides gradually increases. Stibine and bismuthine are strong reducing agents.
- All the hydrides can be prepared in similar methods. On hydrolysis of binary compounds of these metals with water or dilute acids gives these hydrides.
  $Mg_3N_2 + 6H_2O \rightarrow 3Mg(OH)_2 \downarrow + 2NH_3 \uparrow$
  $Ca_3P_2 + 6HCl \rightarrow 3CaCl_2 + 2PH_3 \uparrow$
- NH_3 and PH_3 are volatile , colourless gases.
- The thermal stability of this hydrides decreases from $NH_3$to BiH_3 due to decrease in M – H bond energy.
- These hydrides have a pyramidal shape with a lone pair of electron on the central atom.
- In NH_3 N is sp^3 hybridised in other hydrides central atom uses pure p-orbitals.
- In NH_3 the bond angle is 107°.
- In PH_3 the bond angle is 94°.
- Due to presence of lone pair of electrons on the central atom these hydrides acts as lewis bases.
- The basic nature decreases as follows
  $NH_3 > PH_3 > AsH_3 > SbH_3 > BiH_3$
  Due to decrease in the electron density of the lone pair on the central atom.
  When Hydrogens are methylated basic nature increases $PH_3 < P(CH_3)_3$.
- Because of donation of lone pair of electron by NH_3 to H^+ ion NH_4^+ ion forms.
- Phosphonium (PH_4^+) ion is less stable.
- Due to high electronegative difference between Nitrogen and Hydrogen NH_3 is capable of forming hydrogen bonding.



- M–H bond energies $NH_3 > PH_3 > AsH_3 > SbH_3 > BiH_3$

From NH_3 to BH_3 :

1) Thermal stability decreases
2) Reducing character increases
3) Basic nature decreases
4) Complex forming ability decreases
5) Ease of formation of hydrides decreases

HALIDES :

- All trihalides of these elements are possible except NBr_3 and NI_3 due to large size difference.
- Trihalides are covalent and have a tetrahedral structure.
- Trichlorides act as Lewis acids by utilizing the vacant d- orbitals.
- On hydrolysis of NCl_3 the products are NH_3 and HOCl.
- On hydrolysis of PCl_3 the main product is H_3PO_3 (Phosphorous acid).
- On hydrolysis of $ASCl_3$ the main product is H_3ASO_3 (Arsenious acid).
- On hydrolysis of $SbCl_3$ the main product is SbOCl (Antimony chloride).
- On hydrolysis of $BiCl_3$ the main product is BiOCl (Bismuthyl chloride).
  In SbOCl and BiOCl the radicals are SbO^+ and BiO^+ are present.
- With the increasing metallic character of the elements the halides become more ionic and their tendency towards hydrolysis decreases.
- PF_3 and PF_5 are not hydrolysed because P–F bonds are stronger bonds than P – O bonds.
- With the increase in the metallic character of the elements the halides become more ionic and their tendency towards hydrolysis decreases.
- All these elements except N and Bi doesn't form pentahalides. N because of non – available vacant d –orbitals and Bi due to inert pair effect.
- PCl_5 and $SbCl_5$ exists in triagonal bipyramid structures.
- But as some bond angles are 90° and some are of 120° they are not stable.
  $PCl_5 \Leftrightarrow PCl_3 + Cl_2$(chlorinating agent)
- Hydrolysis of PCl_5 gives orthophosphoric acid.
  $PCl_5 + 4H_2O \rightarrow H_3PO_4 + 5HCl$
- Solid PCl_5 is ionic compound consisting of $[PCl_4]^+$, $[PCl_6^{(-)}]$ cation is tetrahedral anion is octahedral.
- PBr_5 exists as $[PBr_2]\ Br_3^{(-)}$.