

## Group 15 (5):

- N gas,  $N_2$ ,  $N \equiv N$ .
- P non-metal, solid has several allotropic forms (white, red and black), acidic oxides.
- As metalloid, amphoteric oxide.
- Sb blue-white lustrous metalloid, amphoteric oxide.
- Bi pink-white metal, basic oxide.

**Nitrogen** – preparation by fractional distillation of air ( $O_2$  Bp  $-183^\circ C$ ,  $N_2$  Bp  $-196^\circ C$ )

### Uses

- Haber Bosch process  $NH_3$ .
- explosives
- Plastics
- Fertilisers. e.g.  $NH_4NO_3$  .

Some plants have a natural process for fixing nitrogen – leguminous.

## Phosphorous

- Elemental form has 19 allotropes.

Main allotropes:

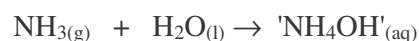
- **White:** formed from condensed  $P_{4(g)}$  molecules, it is a soft molecular solid, soluble in non-polar solvents, it is very reactive in air (ignites ) and is stored under  $H_2O$ . It glows with a greenish colour in air (phosphorescence).
- **Red:** formed on surface of ageing white  $P_4$  or from molten  $P_4$ . Thought to consist of linked  $P_4$  tetrahedron chains, less reactive, friction causes ignition in air .
- **Black** –Amorphous, formed at high temperature and pressure may have a structure like graphite – conducts electricity.

## Oxidation Numbers

- There are two main oxidation states of phosphorous 3 and 5.
- N has the widest range of oxidation numbers of any element (+5 to -3).

### Negative oxidation numbers:

**NH<sub>3</sub>** (-3) nitride, pungent, colourless gas, very soluble in water.



- NH<sub>3</sub> is a Bronsted base – accepting a H<sup>+</sup> ion
- Lewis base, donates a lone pair of e<sup>-</sup>

e.g.  $[\text{Cu}(\text{H}_2\text{O})_4]^{2+}_{(\text{aq})} + 4\text{NH}_{3(\text{aq})} \rightarrow [\text{Cu}(\text{NH}_3)_4]^{2+}_{(\text{aq})}$  (deep blue ammine).

**N<sup>3-</sup>** (-3) nitride: e.g.  $3\text{Mg}(\text{s}) + \text{N}_{2(\text{g})} \rightarrow \text{Mg}_3\text{N}_{2(\text{s})} + \text{H}_2\text{O}$ .

**N<sub>3</sub><sup>-</sup>** (-1/3) azide: e.g. NaN<sub>3</sub> used in “air bags” and detonate to give N<sub>2</sub>

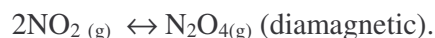
### Positive oxidation numbers :

**N<sub>2</sub>O(+1)**: di-nitrogen oxide (nitrous oxide) anaesthetic/foaming agent in cream .

**NO(+ 2)** Nitrogen oxide (nitric oxide) colourless gas that reacts with air :



**NO<sub>2</sub>(+4)** actually exists in equilibrium with its dimer in the gaseous phase



**NO<sub>2</sub>** is a poisonous brown gas .It initiates a series of photochemical reactions in the atmosphere.



All **NO<sub>x</sub>** contribute to acid rain :  $\text{NO}_{x(\text{g})} + \text{H}_2\text{O}_{(\text{l})} \rightarrow \text{HNO}_{3(\text{aq})}$  nitric acid