Chemistry in aqueous and non-aqueous solutions

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Chemistry in aqueous and non-aqueous solutions

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Chemistry in aqueous and non-aqueous solutions

Physical properties of liq NH_3

- Ammonia is a compound of nitrogen and hydrogen
- Anhydrous ammonia is a liquid or gaseous chemical compound

Formula: NH_3

Molar mass: 17.031 g/mol

Boiling point: -33.34 °C

Density: 0.73 kg/m³

Melting point: -77.73 °C

Chemistry in aqueous and non-aqueous solutions

Liquid ammonia (NH_3)

- It is a heavy liquid
- It has a high vapor pressure at ordinary temperatures that causes freezing when brought into contact with the skin
- It is obtained by compressing anhydrous gaseous ammonia

Applications

- Used in Cleaning
- Used in Fertilizer production
- Used in manufacturing Drug
- Used in refrigeration and as a solvent (as in the study of ammono compounds)
- Used as a source of gaseous ammonia.

Chemistry in aqueous and non-aqueous solutions

Liquid ammonia (NH_3) act as a non-aqueous solvent.

- There is no water in liquid ammonia
- When liquid ammonia is cooled then it can be liquid.
- It can be used as solvent for many reactions
- It has properties of dissolving many solute.
- When water is used as a solvent then it is called aqueous solvent.
- It is a stable binary hydride
- Ammonia is a colourless gas with a characteristic pungent smell.

Chemistry in aqueous and non-aqueous solutions

Categories of non-aqueous solvents:

Protic solvents

They contain contain hydrogen atom and connected directly to an electronegative

They are capable of hydrogen bonding atom (such as O-H or N-H bonds)

Example:

HF, H2SO4 , MeOH, HOSO2F

Aprotic Solvents

They contain no hydrogen atoms connected directly to an electronegative atom

They are not capable of hydrogen bonding.

Example:

N2O4 , BrF3

Chemistry in aqueous and non-aqueous solutions

- Acids and bases: a solvent oriented definition Self-ionizing solvent: an acid is a substance that produces the cation characteristic of the solvent,
- A base is a substance that produces the anion characteristic of the solvent.

$$2H_2O \rightleftharpoons [H_3O]^+ + [OH]^- + 2NH_3 \rightleftharpoons [NH_4]^+ + [NH_2]^-$$

Hydronium ion Hydroxide ion Ammonium ion Amide ion

Chemistry in aqueous and non-aqueous solutions

Precipitation reactions in liquid ammonia In aqueous solution:

$BaCl_2$ (aq) + $2AgNO_3$ (aq) $\longrightarrow$ $2AgCl$ (s) + $Ba(NO_3)_2$ (aq)

In NH_3:

$Ba(NO_3)_2$ (solv) + $2AgCl$ (solv) $\longrightarrow$ $BaCl_2$ (s) + $2AgNO_3$ (solv)

Solubility of AgCl is 0.29 g/100 g H_2O liquid NH_3 compared with 1.91×10^{-4} g per 100 g H_2O

In NH_3:

KNO_3 (solv) + AgCl (solv) $\longrightarrow$ KCl (s) + $AgNO_3$ (solv)

Neutralization reactions in liquid ammonia

Acid + Base $\longrightarrow$ Salt + Ammonia

NH_4Br + KNH_2 $\longrightarrow$ KBr + $2NH_3$

Chemistry in aqueous and non-aqueous solutions

Solutions of s-block metals in liquid NH3

- All Group-I alkali metals and group-2 metals Ca, Sr, and Ba dissolve in liquid NH3 Dilute solutions of the metals are bright blue in color
- Color is arised in the IR region due to a broad and intense absorption
- $M \longrightarrow M^+(solv) + e^-(solv)$
- Dissolve in liquid NH3
- Dilute solutions are paramagnetic with unpaired electron
- The magnetic response corresponds to that of one free electron per metal atom.

Chemistry in aqueous and non-aqueous solutions

Liquid ammonia (NH_3) act as a non-aqueous solvent.

- Molar conductivity initially decreases with increasing concentration and reaching a minimum near 0.05 M.
- Conductivity increases at higher concentrations
- The concentration is comparable with the solid metal in saturated solutions
- Saturated solutions are not blue and paramagnetic, but instead they are bronze and diamagnetic.
- Termed expanded metals and sometimes called an electride

$$2NH_3 + 2e^- \longrightarrow 2[NH_2]^- + H_2$$

Decompose slowly

Used as a reducing agent in a variety of reactions