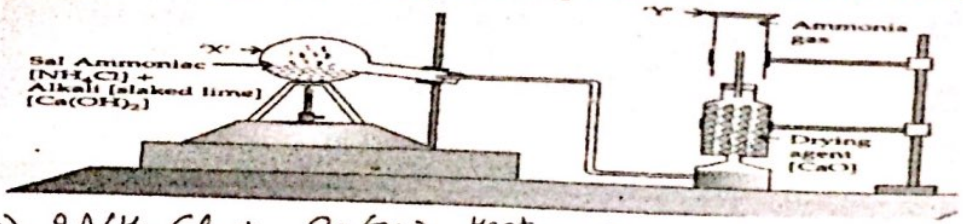
AMMONIA

SOFTWAYS ACADEMY

① NH_3 is found in free state in atmosphere, natural water, decay of nitrogenous matter.

② Lab method of Preparation :- From Ammonium Salt



a) $2NH_4Cl + Ca(OH)_2 \xrightarrow{Heat} CaCl_2 + 2H_2O + 2NH_3$

2 : 3 {slaked lime} (by weight)

b) Note: NH_4NO_3 also gives same reaction, but is not used as :
(i) NH_4NO_3 is explosive (ii) It decomposes to give Nitrous Oxide and water vapour

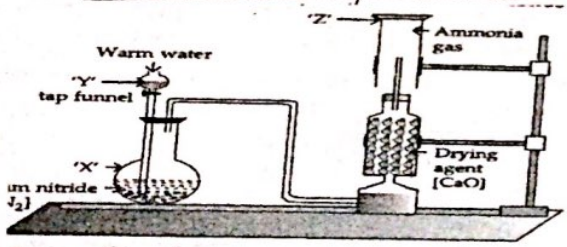
c) CaO is used for drying, being basic it does not react with ammonia. Other drying agents like conc H_2SO_4, P_2O_5, fused $CaCl_2$ cannot be used for drying as they react with NH_3. CaO is cheap too.

d) The flask is kept tilted so as any water vapour formed does not trickle back and crack the glass

e) The gas is collected by downward displacement of air :
i) NH_3 is lighter than air ii) NH_3 is highly soluble in water

f) A higher ratio of alkalie ensures forward reaction, even when some NH_4Cl vaporises (sublimes).

③ Lab Method of Preparation :- [Lesser Preferred] ---- From Metal Nitrides



a) $Mg_3N_2 + 6H_2O \xrightarrow[(warm)]{} 3Mg(OH)_2 + 2NH_3(g)$

b) $Ca_3N_2 + 6H_2O \xrightarrow[(warm)]{} 3Ca(OH)_2 + 2NH_3(g)$

c) $AlN + 3H_2O \longrightarrow Al(OH)_3 + NH_3(g)$
Hydrolysis of metal nitride

d) Nitrides are expensive, method is seldom used.

④ Manufacture :- HABER'S PROCESS ||||| INDUSTRIAL METHOD

a) equation $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3 + \Delta$ (22,400 Calorie)
1 vol 3 vol 2 vol

b) Temp = 400-450°C (moderate) (optimum)

c) Pressure = 200-900 atm (High) (optimum)

d) Catalyst = Finely divided Iron

e) Promoter = Molybdenum [Mo]

f) Collection of NH_3 — i) liquification (H_2 & N_2 do not liquify)
ii) Dissolving in water (H_2 & N_2 do not dissolve)

g) Impurities of CO, CO_2 and H_2S may poison the catalyst so N_2 & H_2 must be free from impurities

h) Promotor : enhances the activity of catalyst

NOTES :

→ To check if Ammonia is collected?
Test for Ammonia
Ans Bring a glass rod dipped in HCl and we will notice dense white fumes of NH_4Cl.

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(5) Physical Properties: a) Colourless, Strong Pungent Smell, Slightly alkaline taste
c) Highly Soluble in water [Fountain experiment]
b) Non-poisnous But Fatal in excess

* In HCl, the colour of fountain entering the flask is Red
In NH_3, the " " " " " " " " BLUE.

(6) Fountain experiment → Done in HCl ↑ [Difference]

(7) Combustibility: a) Catalytic Oxidation :- (Pt, 800C)

i) $4NH_3 + 5O_2 \xrightarrow[800C]{Pt} 4NO + 6H_2O + \Delta$
nitric oxide, steam

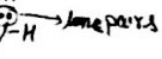
Observations: i) $2NO + O_2 \longrightarrow 2NO_2$
Colourless → Reddish Brown vapours seen

ii) Pt continues to glow even after heating is stopped, as the reaction is exothermic

b) Burning in Oxygen/Air:

$4NH_3 + 3O_2 \longrightarrow 2N_2 + 6H_2O$ (Greenish Yellow Flame)

(8) Aqueous solution of NH_3 is basic :-

a) Dry NH_3 is very weak base :- no effect on litmus
b) Liquified NH_3 is very weak base :- no effect on litmus
c) Basic nature due to lone pair of e⁻  lone pairs
d) Liquor Ammonia :- NH_3 dissolved in water using funnel arrangement [like HCl]
e) Basic Nature: Aqueous solution of ammonia acts as weak Base

$NH_4OH \underset{95\%}{\overset{5\%}{\rightleftharpoons}} NH_4^+ + OH^-$ ← Hydroxyl ion

(9) Reaction with Acids / Formation of Salts :-

i.e. $NH_3(g) + HCl \longrightarrow NH_4Cl$ [dense white fumes]
$NH_3(g) + HNO_3 \longrightarrow NH_4NO_3$
$NH_3(g) + H_2SO_4 \longrightarrow (NH_4)_2SO_4$
NH_4OH (aq) $+ HCl \longrightarrow NH_4Cl + H_2O$
$NH_4OH + HNO_3 \longrightarrow NH_4NO_3 + H_2O$

Note: $NH_4Cl \xrightarrow[\text{dissociation}]{\text{Thermal}} NH_3 + HCl$

(10) In Analytical Chemistry → Already Done in chapter 4.

Metallic salt solution	Ammonium hydroxide	Ammonium salt	Metallic hydroxide (ppt.)	Colour of precipitate	Solubility in excess of NH_4OH
$FeSO_4$ +	$2NH_4OH \longrightarrow$	$(NH_4)_2SO_4$ +	$Fe(OH)_2\downarrow$	Dirty green	Insoluble
$FeCl_3$ +	$3NH_4OH \longrightarrow$	$3NH_4Cl$ +	$Fe(OH)_3\downarrow$	Reddish brown	Insoluble
$Pb(NO_3)_2$ +	$2NH_4OH \longrightarrow$	$2NH_4NO_3$ +	$Pb(OH)_2\downarrow$	White	Insoluble
$Zn(NO_3)_2$ +	$2NH_4OH \longrightarrow$	$2NH_4NO_3$ +	$Zn(OH)_2\downarrow$	White gelatinous	Soluble
$CuSO_4$ +	$2NH_4OH \longrightarrow$	$(NH_4)_2SO_4$ +	$Cu(OH)_2\downarrow$	Pale blue	Soluble

(11) Reducing Nature: a) $2NH_3 + CuO \longrightarrow 3Cu + 3H_2O + N_2(g)$
Reduces CuO to Cu — CuO: Heated (Black) → (Brown); H_2O: (Reddish Brown)

b) $NH_3 + 3Cl_2 \longrightarrow 3HCl + NCl_3$
[Excess] — Reduction of Chlorine — Nitrogen trichloride (explosive)

c) $8NH_3 + 3Cl_2 \longrightarrow 6NH_4Cl + N_2$
[Excess] — white fumes

Ammonia is oxidised in all three reactions (a, b, c)

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NOTES :

(Test for this ion is that it turns red litmus blue)

Compare density of NH_3 & HCl

Ans $V.D. = \frac{\text{Mol Mass}}{2} \Rightarrow$ NH_3: $V.D = \frac{17}{2} = 8.5$; HCl: $V.D = \frac{36.5}{2} = 18.25$

HCl is more dense

$NH_3 + HCl \longrightarrow NH_4Cl$ (dense White Fumes)
gas gas (solid)

NH_3 dissolves in water to give OH^- ions
This shows Basic Nature of Ammonia

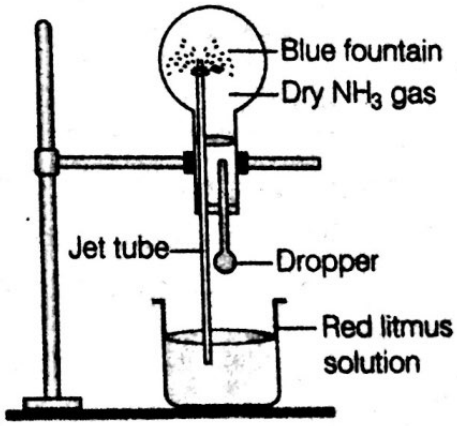
Fountain Experiment

Demonstrate the high solubility of NH_3 gas in water.

Experiment The high solubility of ammonia gas in water can be demonstrated by the fountain experiment.

Apparatus Dry round bottom flask filled with ammonia gas. Mouth of the flask has a rubber stopper with two holes for a (jet tube, b) dropper containing water. Red litmus solution.

Procedure The dropper containing water is squeezed and the water enters into the flask.



Fountain experiment

Observation Ammonia gas present in the flask dissolves in water due to its high solubility, thereby creating a partial vacuum in the flask. The outside pressure being higher pushes the red litmus solution up the jet tube which emerges out at the end of the tube as a blue fountain.