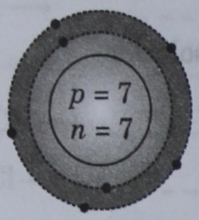
CHAPTER

9 Ammonia

IMPORTANT POINTS TO REMEMBER

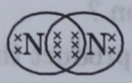
1. Nitrogen was discovered by **Daniel Rutherford**. The properties of this gas were studied by **Lavoisier** and **Chaptal** named the gas as Nitrogen.
2. Nitrogen is present in **group 15** and in **second period** in the periodic table.

Mass number	*Atomic number*	*No. of protons(p)*	*No. of neutrons(n)*	*No. of electrons (e)*
14	7	7	7	7



Electronic configuration : 2, 5

3. Nitrogen forms a **diatomic** molecule.



$N \equiv N$ N_2– Triple covalent bond

4. Nitrogen occurs in **free state** as well as in **combined** state in the form of **Nitrates**.
5. **Preparation of Nitrogen by Industrial methods :**

Industrially, Nitrogen is prepared by the **fractional distillation** of **liquified air** which involves following steps :

(*a*) **Purification of air** – Air is a mixture of dust particles, Carbon dioxide, Water vapour, Oxygen, Nitrogen and traces of Inert gases. Air is passed through filters to remove dust particles and then passed through soda lime (NaOH + CaO) which absorbs Carbon dioxide, and finally through anhydrous Calcium chloride to absorb moisture.

(*b*) **Liquifaction of purified air** – The purified air is repeatedly compressed, circulated through special pipes and finally it is allowed to escape through a small nozzle till the air is cooled sufficiently and finally liquified.

(*c*) **Fractional distillation of liquified air** – Liquid Nitrogen having lower boiling point distils out first leaving behind liquid Oxygen.

6. **Preparation of Nitrogen by Chemical methods :**

In general, Nitrogen is prepared chemically :

(*a*) **By passing Ammonia over heated Copper oxide and Lead oxide**

$$\underset{\text{Copper oxide}}{3CuO} + \underset{\text{Ammonia}}{2NH_3} \longrightarrow \underset{\text{Copper}}{3Cu} + \underset{\text{Nitrogen}}{N_2} + \underset{\text{Water vapour}}{3H_2O}$$

$$\underset{\text{Lead oxide}}{3PbO} + \underset{\text{Ammonia}}{2NH_3} \longrightarrow \underset{\text{Lead}}{3Pb} + \underset{\text{Nitrogen}}{N_2} + \underset{\text{Water vapour}}{3H_2O}$$

(*b*) **By mixing Chlorine with excess of Ammonia**

$$\underset{\text{Ammonia}}{8NH_3} + \underset{\text{Chlorine}}{3Cl_2} \longrightarrow \underset{\text{Ammonium chloride}}{6NH_4Cl} + N_2$$

(*c*) **Ammonia is burnt in atmosphere of Oxygen. It burns with green flame.**

$$\underset{\text{Ammonia}}{4NH_3} + 3O_2 \longrightarrow \underset{\text{Nitrogen}}{2N_2} + 6H_2O$$

(*d*) **By passing Ammonia over bleaching powder**

$$\underset{\text{Bleaching powder}}{3CaOCl_2} + \underset{\text{Ammonia}}{2NH_3} \longrightarrow \underset{\text{Calcium chloride}}{3CaCl_2} + 3H_2O + N_2$$

(e) By heating Ammonium dichromate

$$(NH_4)_2Cr_2O_7 \xrightarrow{\Delta} Cr_2O_3 + 4H_2O + N_2$$

(f) In **laboratory**, Nitrogen is prepared by heating the solution of **Ammonium chloride** and **Sodium nitrite**. In solid state, they are not heated because Ammonium chloride in solid state sublimes on heating.

$$NH_4Cl + NaNO_2 \xrightarrow{\Delta} NH_4NO_2 + NaCl$$

$$NH_4NO_2 \xrightarrow{\Delta} N_2 + 2H_2O$$

Nitrogen **cannot** be obtained by **heating** only **Ammonium nitrite** as it is **highly unstable** and readily **decomposes** even at **room temperature**.

7. Nitrogen obtained is **collected** over **Water** as it is practically **insoluble in Water**.
8. Nitrogen obtained **from air** is **more denser** as compared to the Nitrogen obtained **from chemicals** because Nitrogen obtained from air contains traces of **inert gases**.
9. Nitrogen is a **colourless, odourless, tasteless** gas which is practically **insoluble** in water. It is **non-poisonous** in nature however animals die in the atmosphere of Nitrogen due to want of Oxygen.
10. Chemically, Nitrogen is non-reactive at ordinary temperature because of the presence of a triple covalent bond in its molecule.
11. Nitrogen is **neutral** towards litmus.
12. Nitrogen is **neither combustible nor a supporter of combustion**.
13. Burning metals like **Calcium**, **Magnesium** and **Aluminium** continue to **burn** in the **jar of Nitrogen**.

$$\underset{\text{Magnesium (Burning)}}{3Mg} + N_2 \longrightarrow \underset{\text{Magnesium nitride}}{Mg_3N_2}$$

$$\underset{\text{Calcium (Burning)}}{3Ca} + N_2 \longrightarrow \underset{\text{Calcium nitride}}{Ca_3N_2}$$

$$\underset{\text{Aluminium (Burning)}}{2Al} + N_2 \longrightarrow \underset{\text{Aluminium nitride}}{2AlN}$$

These metallic nitrides are warmed with water to produce their respective hydroxides with the liberation of Ammonia gas.

$$\underset{\text{Magnesium nitride}}{Mg_3N_2} + 6H_2O \xrightarrow{\text{Warm}} \underset{\text{Magnesium hydroxide}}{3Mg(OH)_2} + \underset{\text{Ammonia}}{2NH_3}$$

$$\underset{\text{Calcium nitride}}{Ca_3N_2} + 6H_2O \xrightarrow{\text{Warm}} \underset{\text{Calcium hydroxide}}{3Ca(OH)_2} + \underset{\text{Ammonia}}{2NH_3}$$

$$\underset{\text{Aluminium nitride}}{AlN} + 3H_2O \xrightarrow{\text{Warm}} \underset{\text{Aluminium hydroxide}}{Al(OH)_3} + \underset{\text{Ammonia}}{NH_3}$$

14. **Ammonia** is **synthesized** from its elements, *i.e.*, Nitrogen and Hydrogen by **Haber's process**.

$$\underset{\text{Nitrogen}}{N_2} + \underset{\text{Hydrogen}}{3H_2} \rightleftharpoons \underset{\text{Ammonia}}{2NH_3} + \text{heat}$$

Catalyst	Finely divided iron
Promoter	Molybdenum
Temperature	450-500 °C
Atmospheric pressure	200-1000 atmosphere.

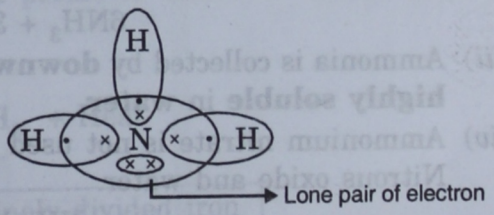
15. Nitrogen combines with **Oxygen at 3000 °C** or during **thunder** and **lightning** to form **Nitric oxide**.

$$\underset{\text{Nitrogen}}{N_2} + \underset{\text{Oxygen}}{O_2} \xrightarrow[3000^\circ C]{\text{electric arc}} \underset{\text{Nitric oxide}}{2NO}$$

16. Nitrogen reacts with **Calcium carbide** at **1000 °C** to form **Nitrolim** which is an **important fertilizer**.

$$\underset{\text{Calcium carbide}}{CaC_2} + N_2 \xrightarrow{1000\,^\circ C} \underset{\text{Calcium cyanamide (Nitrolim)}}{CaNCN} + C$$

17. The **molecular formula** of **Ammonia** is **NH_3**. The relative molecular mass is 17.
18. **Ammonia** is a **polar covalent compound**.



Electron dot diagram of Ammonia

19. **Ammonia** is **found** in **free state** in **traces.**
20. In **combined** state **Ammonia** is found in the form of **Ammonium salts** like **Ammonium chloride, Ammonium sulphate** etc.
21. The smell of Ammonia in toilets is due to the bacterial decomposition of urea present in urine.

$$NH_2CONH_2 + 2H_2O \longrightarrow 2NH_3 + H_2O + CO_2$$

22. Preparation of Ammonia : Generally, **Ammonia** is **prepared** by the following methods :

(*a*) In laboratory **Ammonia** is **prepared** by **heating ammonium salts** (Except ammonium nitrate) with caustic alkalies like sodium hydroxide, potassium hydroxide or calcium hydroxide. **(Fig. 1)**

$$\underset{\text{Calcium hydroxide}}{Ca(OH)_2} + \underset{\text{Ammonium chloride}}{2NH_4Cl} \xrightarrow{\Delta} \underset{\text{Calcium chloride}}{CaCl_2} + \underset{\text{Ammonia}}{2NH_3} + \underset{\text{Water}}{2H_2O}$$

$$\underset{\text{Sodium hydroxide}}{NaOH} + \underset{\text{Ammonium chloride}}{NH_4Cl} \xrightarrow{\Delta} \underset{\text{Sodium chloride}}{NaCl} + \underset{\text{Ammonia}}{NH_3} + \underset{\text{Water}}{H_2O}$$

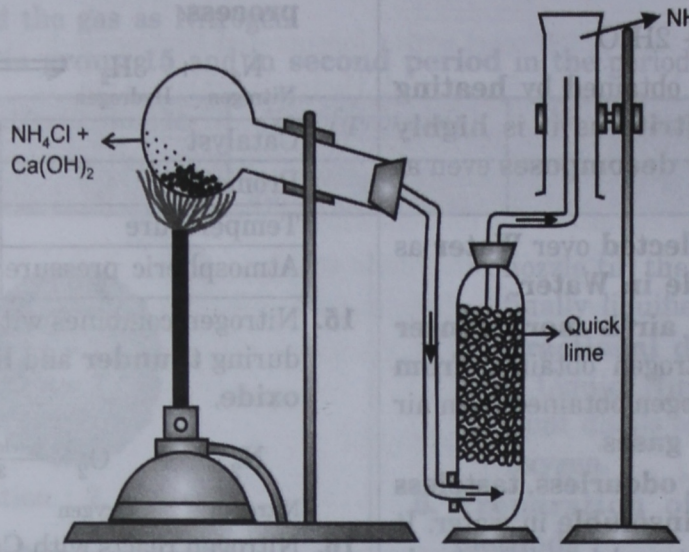


Fig.1 : Laboratory preparation of ammonia from ammonium chloride.

(*i*) The reactants are finely ground and then taken in a round bottom flask. The round bottom flask is fitted in a slanting position bending in the downward direction.

(*ii*) Ammonia is **dried** by passing over **Quick lime**, *i.e.*, **Calcium oxide**. It is **not dried** by passing through **conventional drying agents** like **conc. Sulphuric acid, anhydrous Calcium chloride, Phosphorus pentaoxide** because these drying agents undergo chemical reaction with ammonia.

$$2NH_3 + H_2SO_4 \longrightarrow (NH_4)_2SO_4$$

$$CaCl_2 + 8NH_3 \longrightarrow CaCl_2.8NH_3$$

$$6NH_3 + 3H_2O + P_2O_5 \longrightarrow 2(NH_4)_3PO_4$$

(*iii*) Ammonia is collected by **downward displacement** of air as the gas is **lighter** than **air** and **highly soluble** in **water**.

(*iv*) Ammonium nitrate is not used for the preparation of Ammonia as it is explosive and gives Nitrous oxide and water.

$$NH_4NO_3 \longrightarrow N_2O + 2H_2O$$

(*b*) Action of warm water on **metallic nitrides (Fig. 2)**

Magnesium nitride, Calcium nitride and Aluminium nitride on warming with water produces their respective metallic hydroxide with the liberation of Ammonia.

$$Mg_3N_2 + 6H_2O \xrightarrow{\text{Warm}} 3Mg(OH)_2 + 2NH_3$$

$$Ca_3N_2 + 6H_2O \xrightarrow{\text{Warm}} 3Ca(OH)_2 + 2NH_3$$

$$AlN + 3H_2O \xrightarrow{\text{Warm}} Al(OH)_3 + NH_3$$

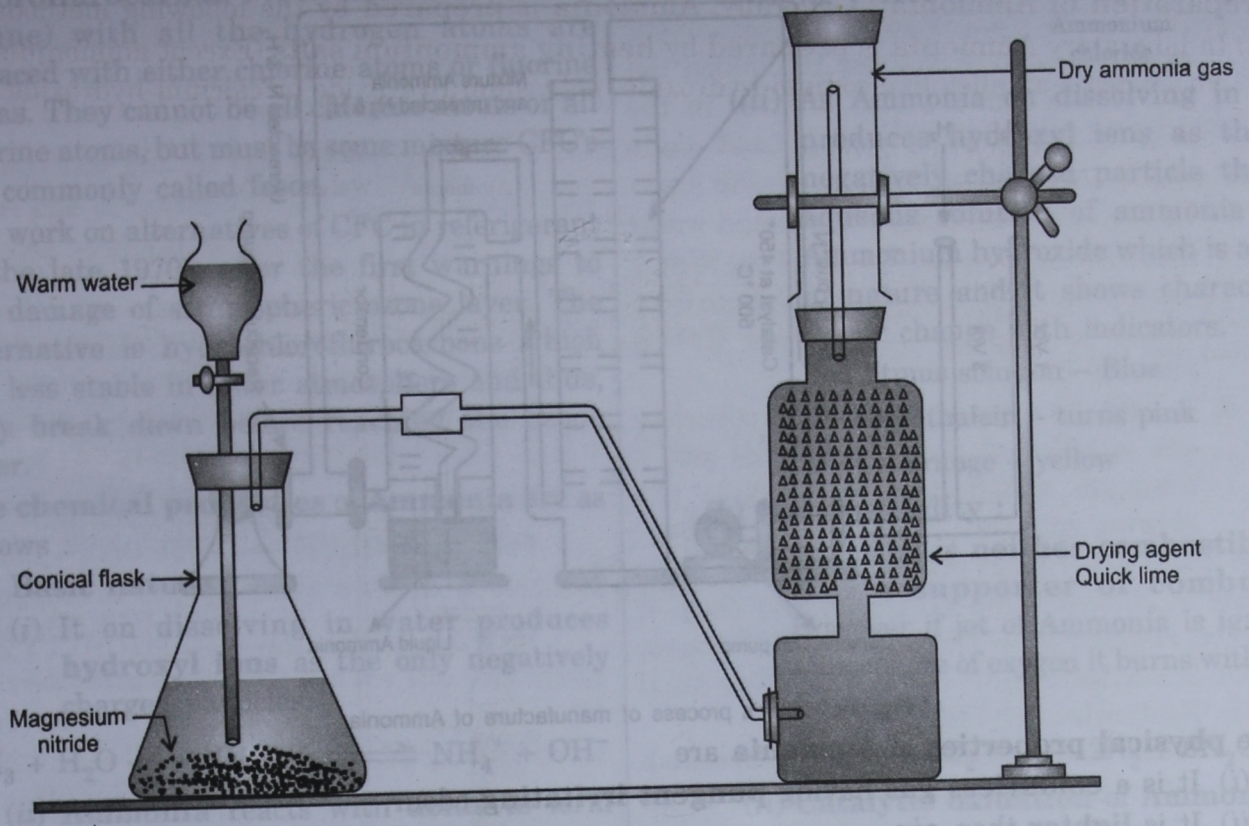


Fig.2. Laboratory preparation of Ammonia gas from Magnesium nitride

(c) Manufacture of Ammonia-Haber's-Process (Fig. 3)

(*i*) Ammonia is manufactured by Haber's process. The ratio by volume of Nitrogen and Hydrogen is 1: 3.

(*ii*) Nitrogen is obtained by the fractional distillation of liquified air. Hydrogen is obtained by Bosch process.

(*iii*) Ammonia is separated from unreacted Nitrogen and Hydrogen by

(1) Liquifaction : Ammonia can be easily liquified in comparison to Nitrogen and Hydrogen.

(2) By absorbing Ammonia in water. As Ammonia is highly soluble in water where as Nitrogen and Hydrogen are insoluble in water.

(*iv*) The speed of the reaction can be enhanced by taking finely divided iron as the catalyst. The efficiency of a catalyst is increased by using a promoter which is either Molybdenum or Aluminium oxide.

The reaction is reversible and exothermic.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3 + \text{Heat}$$

The favourable conditions for the reaction are

Catalyst	Finely divided iron
Promoter	Molybdenum
Temperature	450-500 °C
Atmospheric pressure	200-1000 atm.

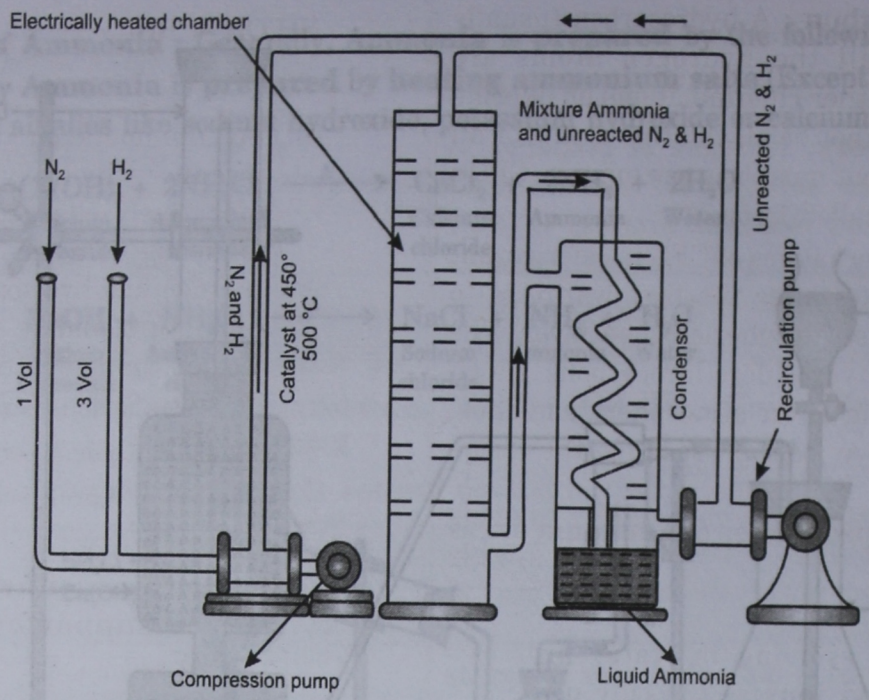


Fig. 3 : Haber's process of manufacture of Ammonia.

23. The **physical properties** of **Ammonia** are

(*i*) It is a **colourless gas** having **pungent irritating** odour.

(*ii*) It is **lighter** than **air**

(*iii*) It is **highly** or **extremely soluble** in water. The extreme solubility of Ammonia is demonstrated by **Fountain's experiment**. (Fig. 4)

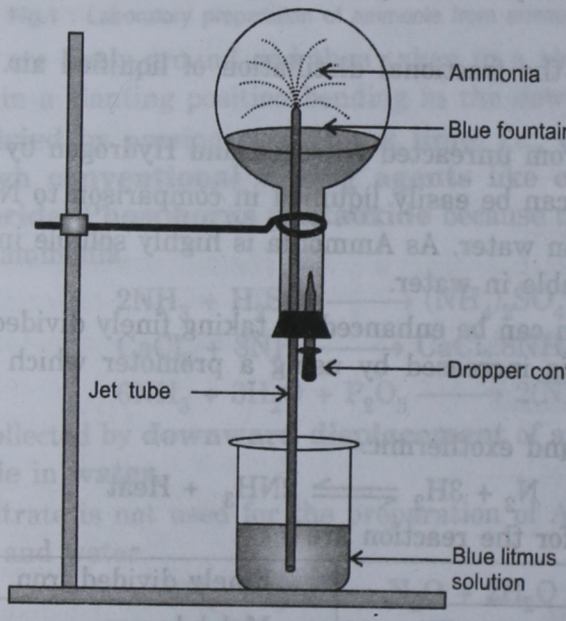


Fig. 4 : Fountain experiment to demonstrate extreme solubility of NH_3 gas

24. Ammonia is **dissolved** in **water** with the help of **funnel arrangement** so as to prevent **back suction of water** as the gas is **highly soluble** in water. Ammonia when dissolved in water produces **Ammonium hydroxide** which is **alkaline** in nature.

$$NH_3 + H_2O \longrightarrow \underset{\text{Ammonium hydroxide}}{NH_4OH}$$

$$NH_4OH \longrightarrow \underset{\text{Ammonium ion}}{NH_4^+} + \underset{\text{Hydroxide ion}}{OH^-}$$

25. Chloroflurocarbon : A hydrocarbon (usually alkane) with all the hydrogen atoms are replaced with either chlorine atoms or fluorine atoms. They cannot be all chlorine atoms or all flourine atoms, but must be some mixture CFC's are commonly called freon.

The work on alternatives of CFC in referigerant in the late 1970's after the first warnings to the damage of stratospheric ozone layer. The alternative is hydrochloroflurocarbons which are less stable in lower atmosphere and thus, they break down before reaching the ozone layer.

26. The **chemical properties** of **Ammonia** are as follows :

(*a*) Basic nature :

(*i*) It on dissolving in water produces **hydroxyl ions** as the only negatively charged particles.

$$NH_3 + H_2O \longrightarrow NH_4OH \rightleftharpoons NH_4^+ + OH^-$$

(*ii*) **Ammonia** reacts with **acids** to form salts.

$$NH_3 + HCl \longrightarrow NH_4Cl$$

Hydrochloric acid — Ammonium chloride (Dense white forms)

$$NH_3 + HNO_3 \longrightarrow NH_4NO_3$$

Nitric acid — Ammonium nitrate

$$2NH_3 + H_2SO_4 \longrightarrow (NH_4)_2SO_4$$

Sulphuric acid — Ammonium sulphate

$$2NH_4OH + H_2SO_4 \longrightarrow (NH_4)_2SO_4 + 2H_2O$$

$$NH_4OH + HNO_3 \longrightarrow NH_4NO_3 + H_2O$$

Nitric acid — Ammonium nitrate

$$NH_4OH + HCl \longrightarrow NH_4Cl + H_2O$$

Ammonium chloride

(*iii*) As Ammonia on dissolving in Water produces hydroxyl ions as the only negatively charged particle thus the aqueous solution of ammonia called Ammonium hydroxide which is alkaline in nature and it shows characteristic colour change with indicators.

Red litmus solution – Blue

Phenolphthalein – turns pink

Methyl orange – yellow

(*b*) Combustibility :

(*i*) Ammonia is **neither combustible nor** it is a **supporter of combustion**. However if jet of Ammonia is ignited in atmosphere of oxygen it burns with **green flame**.

$$4NH_3 + 3O_2 \longrightarrow 2N_2 + 6H_2O$$

(*ii*) **Catalytic oxidation** of **Ammonia :**

$$4NH_3 + 5O_2 \xrightarrow[800^\circ C]{Pt} 4NO + 6H_2O$$

Ammonia — Oxygen — Nitric oxide — Water vapour

Pt = Platinum – catalyst.

(*c*) Reducing nature of Ammonia :

(*i*) Ammonia reduces heated metallic oxides to corresponding metals, water vapour and nitrogen (Fig. 5).

$$3CuO + 2NH_3 \longrightarrow 3Cu + N_2 + 3H_2O$$

Heated (Black) — Pinkish red

$$3PbO + 2NH_3 \longrightarrow 3Pb + N_2 + 3H_2O$$

Heated (Yellow) — Greyish white

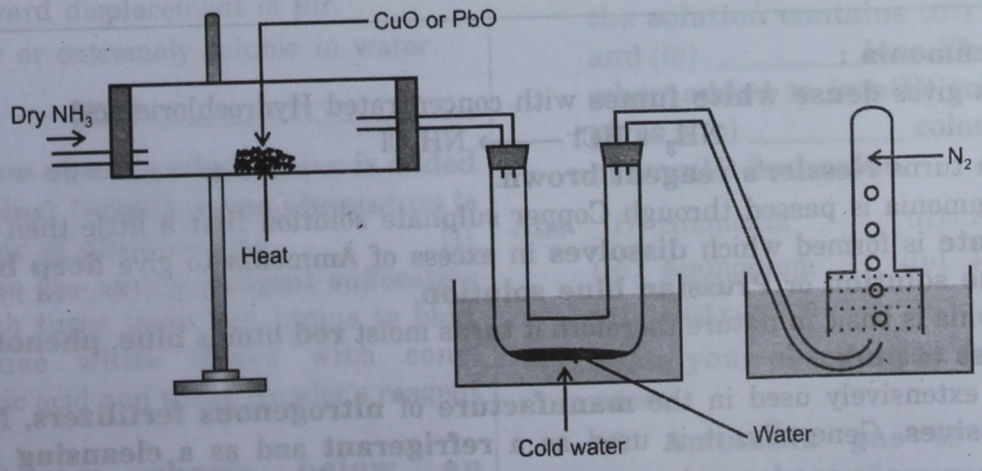


Fig. 5 : Showing reducing nature of NH_3

Observations

1. In case of Copper oxide, black Copper oxide on heating changes to pinkish red or reddish brown metal whereas in the case of Lead oxide, yellow Lead oxide changes to greyish white metallic lead.
2. In both the cases, colourless liquid water gets condensed in the U-tube. Water converts anhydrous Copper sulphate from white to blue and anhydrous Cobalt chloride from blue to pink.
3. In both the cases, colourless and odourless gas is collected over water. This gas is nitrogen which does not relight the glowing splinter.

The above experiment proves that Ammonia is made of Nitrogen and Hydrogen and thus, it can be referred to as the hydride of Nitrogen.

(*ii*) $3CaOCl_2 + 2NH_3 \longrightarrow 3CaCl_2 + N_2 + 3H_2O$

(*iii*) **Reduction of Chlorine :**

When Ammonia is in excess : Greenish yellow Chlorine disappears to give dense white fumes of Ammonium chloride.

$$\underset{\text{Excess}}{8NH_3} + 3Cl_2 \longrightarrow 6NH_4Cl + N_2$$

When Chlorine is in excess

$$NH_3 + \underset{\text{Excess}}{3Cl_2} \longrightarrow NCl_3 + 3HCl$$

These reactions show that

1. Ammonia is a reducing agent
2. Chlorine has strong affinity for Hydrogen.

(*d*) **Ammonia reacts with Carbon dioxide to form Urea which is a very important nitrogenous fertilizer containing 46.66% of Nitrogen.**

$$2NH_3 + CO_2 \xrightarrow[150\text{ atm.}]{150^\circ C} NH_2CONH_2 + H_2O$$

(*e*) **Aqueous solution of Ammonia** precipitates **metallic hydroxides** from their **soluble salts.**

$$FeCl_3 + 3NH_4OH \longrightarrow \underset{\substack{\text{Ferric hydroxide}\\ \text{(Reddish brown ppt.)}}}{Fe(OH)_3\downarrow} + 3NH_4Cl$$

$$FeSO_4 + 2NH_4OH \longrightarrow \underset{\substack{\text{Ferrous hydroxide}\\ \text{(Dirty green ppt.)}}}{Fe(OH)_2} + (NH_4)_2SO_4$$

$$Pb(NO_3)_2 + 2NH_4OH \longrightarrow \underset{\substack{\text{Lead hydroxide}\\ \text{(White ppt.)}}}{Pb(OH)_2\downarrow} + 2NH_4NO_3$$

$$Zn(NO_3)_2 + 2NH_4OH \longrightarrow \underset{\substack{\text{Zinc hydroxide}\\ \text{(White gelatinous ppt.)}}}{Zn(OH)_2\downarrow} + 2NH_4NO_3$$

$$Zn(OH)_2 + 4NH_4OH \longrightarrow \underset{\text{Tetraamminezinc hydroxide}}{[Zn(NH_3)_4](OH)_2} + 4H_2O$$

$$CuSO_4 + 2NH_4OH \longrightarrow \underset{\substack{\text{Copper hydroxide}\\ \text{(Pale blue ppt.)}}}{Cu(OH)_2\downarrow} + (NH_4)_2SO_4$$

$$Cu(OH)_2 + 4NH_4OH \longrightarrow \underset{\substack{\text{Tetraamminecopper}\\ \text{hydroxide}}}{[Cu(NH_3)_4](OH)_2} + 4H_2O$$

Metallic salt solution	*Colour of the ppt (in small quantity)*	*Nature of ppt (soluble/Insoluble) in excess*
(*i*) Iron (III) chloride	Reddish brown	Insoluble
(*ii*) Iron (II) sulphate	Dirty green	Insoluble
(*iii*) Lead nitrate	White	Insoluble
(*iv*) Zinc nitrate	White	Soluble
(*v*) Copper sulphate	Pale blue or Bluish white	Soluble

27. Tests for Ammonia :

(*a*) Ammonia gives **dense white fumes** with concentrated Hydrochloric acid.

$$NH_3 + HCl \longrightarrow NH_4Cl$$

(*b*) Ammonia turns **Nessler's reagent brown**.

(*c*) When Ammonia is passed through Copper sulphate solution first a little then a **bluish white precipitate** is formed which **dissolves** in excess of Ammonia to give **deep blue solution** or **inky blue solution** or **Prussian blue solution**.

(*d*) As Ammonia is basic in nature therefore it turns moist **red** litmus **blue, phenolphthalein** from **colourless** to **pink**.

28. Ammonia is extensively used in the **manufacture** of **nitrogenous fertilizers, Nitric acid** and **other explosives**. Generally, it is used as a **refrigerant** and as a **cleansing agent** (removes grease).

PREVIOUS YEARS' QUESTIONS

2012

Q1. Name the gas in the following :
The gas produced when excess ammonia reacts with chlorine. [1]

Ans. Nitrogen

Q2. Some word/words are missing in the following statements. You are required to rewrite the statements in the correct form using the appropriate word/words : [1]

Magnesium nitride reacts with warm water to Liberate Ammonia.

Ans. Magnesium nitride reacts with warm water to liberate Ammonia.

Q3. Give balanced equations for the following reactions : [1]

Ammonia and Oxygen in the presence of a catalyst.

Ans. $4NH_3 + 5O_2 \xrightarrow[800\,°C]{Pt.} 4NO + 6H_2O.$

Q4. The following questions are based on the preparation of ammonia gas in the laboratory:

(i) Explain why ammonium nitrate is not used in the preparation of ammonia.

(ii) Name the compound normally used as a drying agent during the process.

(iii) How is ammonia gas collected ?

(iv) Explain why it is not collected over water. [4]

Ans. (i) Ammonium nitrate is explosive

(ii) Quick lime

(iii) downward displacement of air.

(iv) Highly or extremely soluble in water.

2011

Q1. What do you observe when water is added to the product formed, when aluminium is burnt in jar of nitrogen gas [1]

Ans. A colourless gas having pungent suffocating smell which turns moist red litmus to blue, gives dense white fames with conc. hydrochloric acid and turns Nessler's reagent brown.

Q2. The diagram shows below an experimental set up for the laboratory preparation of pungent smelling gas :

The gas is alkaline in nature

(i) Name the gas collected in jar.

(ii) Write balanced equation for the above preparation.

(iii) How is gas being collected ?

(iv) Name the drying agent used.

(v) How will you find that the jar is full of gas. [5]

Ans. (i) Ammonia

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

(iii) Down ward displacement of air

(iv) Quick lime or calcium oxide

(v) A glass rod dipped in conc. HCl, gives dense white forms.

2010

Q1. From the list given below, select the word(s) required to correctly complete the blanks (i) to (v) in the following passage :

Note : Words chosen from the list are to be used only once. Write only the answers. Do not copy the passage.

[reddish brown, ammonium, nitrogen dioxide, hydroxyl, dirty green, ammonia, acidic, alkaline]

Nitrogen and hydrogen combine in the presence of a catalyst to give (i)_____ gas. When the above mentioned gas is passed through water it forms a solution which will be (ii) _____ in nature and the solution contains (iii) _____ ions and (iv) _____ ions. The above solution when added to iron(II) sulphate solution, gives a (v) _____ coloured precipitate of iron(II) hydroxide. [5]

Ans. (i) Ammonia (ii) Alkaline

(iii) Ammonium (iv) Hydroxyl

(v) Dirty green

Q2. State your observation for the following case: [2]

(i) Ammonia gas is burnt in an atmosphere of oxygen in the absence of a catalyst.

(*ii*) **Glass rod dipped in ammonium hydroxide is brought near the mouth of the concentrated hydrochloric acid bottle.**

Ans. (*i*) Green flame,

(*ii*) Dense white fumes

Q3. Write the equation for the following reaction: Ammonium chloride is heated with sodium hydroxide. [1]

Ans. $NH_4Cl + NaOH \xrightarrow{\Delta} NaCl + H_2O + NH_3$

Q4. The questions below are related to the manufacture of ammonia.

(*i*) Name the process.

(*ii*) In what ratio must the reactants be taken ?

(*iii*) Name the catalyst used.

(*iv*) Give the equation for the manufacture of ammonia.

(*v*) Ammonia can act as a reducing agent–write a relevant equation for such a reaction. [5]

Ans. (*i*) Haber's process (*ii*) 1 : 3

(*iii*) Iron

(*iv*) $N_2 + 3H_2 \underset{\text{450-500 °C, 200-1000 atm}}{\overset{\text{Fe, Mo}}{\rightleftharpoons}} 2NH_3$.

(*v*) $3CuO + 2NH_3 \xrightarrow{\Delta} 3Cu + N_2 + 3H_2O$.

2009

Q1. Write a fully balanced equation for the following case : Magnesium nitride is treated with warm water. [1]

Ans. $Mg_3N_2 + 6H_2O \xrightarrow{\Delta} 3Mg(OH)_2 + 2NH_3$

Q2. Identify the substance Q based on the information given : The white crystalline solid 'Q' is soluble in water. It liberates a pungent smelling gas when heated with sodium hydroxide solution. [1]

Ans. Ammonium chloride

2008

Q1. Select the correct answer from the choices A, B, C, D which are given

Ammonia can be obtained by adding water to

A. Ammonium chloride

B. Ammonium nitrite

C. Magnesium nitride

D. Magnesium nitrate [1]

Ans. C

Q2. Identify the following substance :

An alkaline gas (A) which gives dense white fumes with hydrogen chloride. [1]

Ans. Ammonia

Q3. Write equations for the following reactions :

(*i*) Aluminium nitride and Water [1]

Ans. (*i*) $AlN + 3H_2O \longrightarrow Al(OH)_3 + NH_3$

Q4. Copy and complete the following table relating to important industrial processes. Output refers to the product of the process not the intermediate steps. [4]

Name of process	*Inputs*	*Catalyst*	*Equation for catalysed reaction*	*Output*
Haber's Process	**Hydrogen +** _ _ _	_ _ _ _ _ _ _ _ _	_ _ _ _ _ _ _ _	_ _ _ _ _ _ _ _

Ans.

Name of process	*Inputs*	*Catalyst*	*Equation for catalysed reaction*	*Output*
Haber's process	Hydrogen + **Nitrogen**	**Iron**	$N_2 + 3H_2 \longrightarrow 2NH_3$	**Ammonia**

2007

Q1. (*a*) (*i*) Of the two gases, Ammonia and Hydrogen chloride, which is more dense? Name the method of collection of this gas.

(*ii*) Give one example of a reaction between the above two gases which produces a solid compound. [3]

(*b*) Write a balanced equation for a reaction in which Ammonia is oxidized by :

(*i*) a metal oxide,

(*ii*) a gas which is not Oxygen. [2]

Ans. (*a*) (*i*) Hydrogen chloride gas. It is collected by the upward displacement of air as it is denser than air.

(*ii*) $NH_3 + HCl \longrightarrow NH_4Cl$

(b) (i) $3CuO + 2NH_3 \longrightarrow 3Cu + N_2 + 3H_2O$

(ii) $8NH_3 + 3Cl_2 \longrightarrow 6NH_4Cl + N_2$

Q2. You enter a laboratory after a class has completed the Fountain experiment. How will you be able to tell whether the gas used in the experiment was Hydrogen chloride or Ammonia ? [2]

Ans. In case of Ammonia the solution in the flask was blue; whereas in Hydrogen chloride gas the solution entering the flask was red.

2006

Q1. What do you observe when :
excess of Ammonia is passed through an aqueous solution of Lead nitrate ? [1]

Ans. White precipitate appears which is insoluble in excess of Ammonia.

Q2. (i) Name the substance used for drying Ammonia.
(ii) Write an equation to illustrate the reducing nature of Ammonia.
(iii) With reference to Haber's process for the preparation of Ammonia, write the equation and the conditions required. [4]

Ans. (i) Calcium oxide or quick lime.

(ii) $3CuO + 2NH_3 \longrightarrow 3Cu + N_2 + 3H_2O$

$3PbO + 2NH_3 \longrightarrow 3Pb + N_2 + 3H_2O$

(iii) $N_2 + 3H_2 \longrightarrow 2NH_3 + \text{heat}$

Catalyst	Iron
Promoter	Molybdenum
Temperature	450 – 500°C
Pressure	200 – 1000 atm

2005

Q1. (a)(i) Which feature of the Ammonia molecules leads to the formation of Ammonium ion when Ammonia dissolves in Water ?
(ii) Name the other ion formed when Ammonia dissolves in Water.
(iii) Give one test that can be used to detect the presence of the ion produced in (a) (ii). [3]
(b) Write the equations for the following reactions which result in the formation of Ammonia :
(i) A mixture of Ammonium chloride and Slaked lime is heated.
(ii) Aluminium nitride and Water. [2]

Ans. (a)(i) Nitrogen in Ammonia has a lone pair of electrons which leads to the formation of Ammonium ion.

(ii) Hydroxyl ion.

(iii) It turns red litmus paper blue.

(b)(i) $Ca(OH)_2 + 2NH_4Cl \xrightarrow{\Delta} CaCl_2 + 2H_2O + 2NH_3$

(ii) $AlN + 3H_2O \longrightarrow Al(OH)_3 + NH_3$

IMPORTANT QUESTIONS

Q1. (a) Name one element, in following case, to which the following description would apply :
The burning metal which combines directly with Nitrogen.
(b) Name the gas that you can obtain in the laboratory from each of the following and write the equation for the reaction taking place in each case :
(i) Ammonium nitrite
(ii) Ammonium chloride
(c) What CFC's commonly called as ?

Ans. (a) Magnesium, Calcium and Aluminium.

(b)(i) $NH_4NO_2 \longrightarrow \underset{\text{(Nitrogen)}}{N_2} + 2H_2O$

(ii) $NH_4Cl + NaOH \xrightarrow{\Delta} NaCl + \underset{\text{(Ammonia)}}{NH_3} + H_2O$

(c) Freon

Q2. (a) Write equations for the following reactions :
(i) Burning of Ammonia in Oxygen
(ii) Catalytic oxidation of Ammonia.
(b)(i) What do you see in (a) (i) above ?
(ii) Name the catalyst used in (a) (ii).
(iii) In the reaction referred to in (a) (ii) the catalyst glows red hot, why ?
(iv) What is the name of the industrial process which starts with the reaction referred to in (a) (ii) ?
(c)(i) How soluble is Ammonia in water ?
(ii) Give two reasons to show that the solution of Ammonia in water contains Hydroxide ions.
(iii) Name a simple method you would employ to prepare Ammonium salts in your laboratory.

Ans.(*a*) (*i*) $4NH_3 + 3O_2 \longrightarrow 2N_2 + 6H_2O$

(*ii*) $4NH_3 + 5O_2 \xrightarrow[800°C]{Pt} 4NO + 6H_2O$

(*b*)(*i*) Green flame. (*ii*) Platinum.

(*iii*) As the reaction is exothermic in nature.

(*iv*) Ostwald's process.

(*c*)(*i*) Extremely soluble.

(*ii*) It turns red litmus solution blue and it reacts with acids to form salt and water.

(*iii*) Neutralization.

Q3. (*a*) Name the following :

Two compounds heated together in solution to produce Nitrogen.

(*b*) What do you observe when :

Ammonia gas is bubbled through red litmus solution.

(*c*) Explain why the following statement is not correct :

Ammonium salts, on heating, decompose to give ammonia.

(*d*) Write balanced chemical equations for the following reactions :

(*i*) Ammonium chloride solution is added to Sodium hydroxide solution.

(*ii*) Copper sulphate solution is added to Sodium hydroxide solution.

Ans.(*a*) Ammonium chloride and Sodium nitrite.

(*b*) It turns blue.

(*c*) All Ammonium salts, on heating, do not liberate Ammonia as Ammonium nitrate, on heating gives Nitrous oxide.

(*d*) (*i*) $NH_4Cl + NaOH \xrightarrow{\Delta} NaCl + H_2O + NH_3$

(*ii*) $CuSO_4 + 2NaOH \longrightarrow Cu(OH)_2 + Na_2SO_4$

Q4. Name the gas evolved when the following mixtures are heated :

(*i*) Calcium hydroxide and Ammonium chloride.

(*ii*) Sodium nitrite and Ammonium chloride.

Ans. (*i*) Ammonia

(*ii*) Nitrogen

Q5. (*a*) Copy and complete the following equations :

(*i*) $Mg_3N_2 + 6H_2O \longrightarrow$

(*ii*) $2NH_3 + 3CuO \longrightarrow$

(*iii*) $8NH_3 + 3Cl_2 \longrightarrow$

(*iv*) $4NH_3 + 5O_2 \longrightarrow$

(*b*)(*i*) How would you obtain compound Magnesium nitride ?

(*ii*) Which property of Ammonia is illustrated by reaction (*a*) (*ii*) above ?

(*iii*) What is the name of important industrial process that starts with reaction (*a*) (*iv*) above ? Name the catalyst used.

(*iv*) During laboratory preparation how is Ammonia dried and collected ?

Ans. (*a*)(*i*) $Mg_3N_2 + 6H_2O \longrightarrow 3Mg(OH)_2 + 2NH_3$

(*ii*) $2NH_3 + 3CuO \longrightarrow 3Cu + N_2 + 3H_2O$

(*iii*) $8NH_3 + 3Cl_2 \longrightarrow 6NH_4Cl + N_2$

(*iv*) $4NH_3 + 5O_2 \xrightarrow[800°C]{Pt} 4NO + 6H_2O$

(*b*)(*i*) By introducing burning Magnesium in the jar of Nitrogen.

(*ii*) Reducing property.

(*iii*) Ostwald's process for the manufacture of Nitric acid. The catalyst used is Platinum.

(*iv*) Ammonia is dried by passing through Quick lime, *i.e.*, Calcium oxide and collected by the downward displacement of air.

Q6. Explain why Ammonia gas is evolved when Water is added to the product formed when Magnesium is burnt in the air.

Ans. When Magnesium is burnt in air, it forms Magnesium nitride which, on warming with water produces Ammonia.

$$3Mg + N_2 \xrightarrow[Burning]{} Mg_3N_2$$

$$Mg_3N_2 + 6H_2O \xrightarrow{Warm} 3Mg(OH)_2 + 2NH_3$$

Q7. Write equations for the laboratory preparation of :

Ammonia from Ammonium chloride.

Ans. $NH_4Cl + NaOH \xrightarrow{\Delta} NaCl + NH_3 + H_2O$

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

Q8. Using Sodium hydroxide solution, how would you distinguish Ammonium sulphate from Sodium sulphate ?

Ans. Ammonium sulphate, on reaction with Sodium hydroxide, produces a colourless gas which turns Nessler's reagent brown and gives dense white fumes with concentrated Hydrochloric acid whereas with Sodium sulphate, there is no reaction.

Q9. Complete and balance the following equations :

(a) $CuO + NH_3 \xrightarrow[\text{(heated)}]{}$

(b) $Pb(NO_3)_2 \xrightarrow{\text{heat}(\Delta)}$

Ans. (a) $3CuO + 2NH_3 \xrightarrow[\text{(heated)}]{} 3Cu + N_2 + 3H_2O$

(b) $2Pb(NO_3)_2 \xrightarrow{\Delta} 2PbO + 4NO_2 + O_2$

Q10. (a) Give reasons for the following :

(i) Though Ammonium nitrite readily gives Nitrogen on heating, a mixture of Ammonium chloride and Sodium nitrite in water is heated to prepare Nitrogen in the laboratory.

(ii) Ammonia cannot be collected over water.

(b) Write balanced equations of the reactions in the preparation of :

Ammonia from Ammonium chloride.

Ans. (a)(i) Ammonium nitrite cannot be stored even at room temperature, therefore Nitrogen is obtained by heating Ammonium chloride and Sodium nitrite.

(ii) Ammonia is highly or extremely soluble in water, and therefore, it is not collected over water.

(b) $NH_4Cl + NaOH \xrightarrow{\Delta} NaCl + NH_3 + H_2O$

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

Q11. Name the following :

(a) The fertilizer formed when Carbon dioxide is reacted with Ammonia.

(b) The process by which Ammonia is manufactured.

(c) Two metallic oxides which are reduced by Ammonia.

(d) Orange compound which on heating erupts with green mass in the form of volcano.

(e) Two gases which give dense white fumes with Ammonia.

(f) The solution which turns brown when it comes in contact with Ammonia.

(g) Drying agent for Ammonia.

(h) Experiment which demonstrates the extreme solubility of Ammonia.

(i) Gas obtained when Magnesium nitride is warmed with water.

(j) Metal which directly combines with Nitrogen on heating.

(k) Catalyst used during Haber's process.

Ans. (a) Urea.

(b) Haber's process.

(c) Copper oxide and Lead oxide.

(d) Ammonium dichromate.

(e) Chlorine and Hydrogen chloride gas.

(f) Nessler's reagent.

(g) Calcium oxide or Quick lime.

(h) Fountain experiment.

(i) Ammonia.

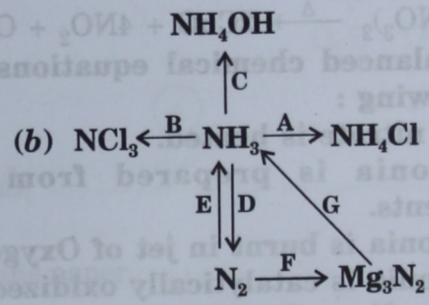
(j) Magnesium , Calcium, Aluminium.

(k) Finely divided iron.

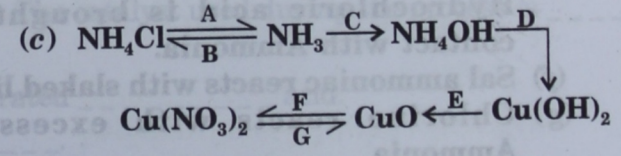
Q12. How are the following conversions carried out ? Give equations only.

(a) $NH_3 \xrightarrow{A} NO \xrightarrow{B} NO_2 \xrightarrow{C} HNO_3 \xrightarrow{D} Cu(NO_3)_2$

(b)



(c)



Ans. (a) A : $4NH_3 + 5O_2 \xrightarrow[800^\circ C]{Pt} 4NO + 6H_2O$

B : $2NO + O_2 \longrightarrow 2NO_2$

C : $4NO_2 + 2H_2O + O_2 \longrightarrow 4HNO_3$

D : $CuO + 2HNO_3(dil.) \longrightarrow Cu(NO_3)_2 + H_2O$

(b) A : $8NH_3 + 3Cl_2 \longrightarrow 6NH_4Cl + \underset{\text{excess}}{N_2}$

Or

$NH_3 + HCl \longrightarrow NH_4Cl$

B : $\underset{\text{excess}}{NH_3} + 3Cl_2 \rightarrow NCl_3 + 3HCl$

C : $NH_3 + H_2O \longrightarrow NH_4OH$

D : $4NH_3 + 3O_2 \longrightarrow 2N_2 + 6H_2O$

E : $N_2 + 3H_2 \rightleftharpoons 2NH_3$ + heat

Catalyst – Iron

Promoter – Molybdenum

Temperature – 450–500°C

Atmospheric pressure – 200–1000 atm

F : $3Mg + N_2 \xrightarrow[\text{Burning}]{} Mg_3N_2$

G : $Mg_3N_2 + 6H_2O \xrightarrow{\text{Warm}} 3Mg(OH)_2 + 2NH_3$

(c)A : $NH_4Cl + NaOH \xrightarrow{\Delta} NaCl + H_2O + NH_3$

Or

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

B : $8NH_3 + 3Cl_2 \longrightarrow 6NH_4Cl + N_2$

Or

$NH_3 + HCl \longrightarrow NH_4Cl$

C : $NH_3 + H_2O \longrightarrow NH_4OH$

D : $CuSO_4 + 2NH_4OH \rightarrow Cu(OH)_2 + (NH_4)_2SO_4$

E : $Cu(OH)_2 \xrightarrow{\Delta} CuO + H_2O$

F : $CuO + 2HNO_3$ (dil.) $\longrightarrow Cu(NO_3)_2 + H_2O$

G : $2Cu(NO_3)_2 \xrightarrow{\Delta} 2CuO + 4NO_2 + O_2$

Q13. Write balanced chemical equations for the following :

(a) Lead nitrate is heated.

(b) Ammonia is prepared from its elements.

(c) Ammonia is burnt in jet of Oxygen.

(d) Ammonia is catalytically oxidized.

(e) Rod dipped in concentrated Hydrochloric acid is brought in contact with Ammonia.

(f) Sal ammoniac reacts with slaked lime.

(g) Chlorine reacts with excess of Ammonia.

(h) Excess of Chlorine reacts with Ammonia.

(i) Burning Magnesium strip is introduced in the jar of Nitrogen.

(j) Magnesium nitride is warmed with Water.

(k) Nitrogen combines with Oxygen in the presence of electric spark at 3000°C.

(l) Ammonia is passed over the paste of Bleaching powder.

(m) Ammonia is passed over heated Copper oxide.

(n) Ammonia is passed through conc. Sulphuric acid.

(o) Ammonium dichromate is heated.

Ans. (a) $2Pb(NO_3)_2 \xrightarrow{\Delta} 2PbO + 4NO_2 + O_2$

(b) $N_2 + 3H_2 \underset{\text{450–500°C, 200–1000 atm}}{\overset{\text{Fe–Mo}}{\rightleftharpoons}} 2NH_3$ + heat

(c) $4NH_3 + 3O_2 \longrightarrow 2N_2 + 6H_2O$

(d) $4NH_3 + 5O_2 \xrightarrow[800°C]{\text{Pt}} 4NO + 6H_2O$

(e) $NH_3 + HCl$(conc.) $\longrightarrow NH_4Cl$

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

(g) $8NH_3 + 3Cl_2 \longrightarrow 6NH_4Cl + N_2$ (excess)

(h) $NH_3 + 3Cl_2 \longrightarrow NCl_3 + 3HCl$ (excess)

(i) $3Mg + N_2 \xrightarrow[\text{Burning}]{} Mg_3N_2$

(j) $Mg_3N_2 + 6H_2O \xrightarrow{\text{Warm}} 3Mg(OH)_2 + 2NH_3$

(k) $N_2 + O_2 \xrightarrow[3000°C]{\text{electric spark}} 2NO$

(l) $3CaOCl_2 + 2NH_3 \longrightarrow 3CaCl_2 + N_2 + 3H_2O$

(m) $3CuO + 2NH_3 \longrightarrow 3Cu + N_2 + 3H_2O$

(n) $2NH_3 + H_2SO_4 \longrightarrow (NH_4)_2SO_4$

(o) $(NH_4)_2Cr_2O_7 \xrightarrow{\Delta} N_2 + Cr_2O_3 + 4H_2O$

Q14. What do you observe when :

(a) Ammonia comes in contact with concentrated Hydrochloric acid.

(b) Ammonia burns in Oxygen.

(c) Ammonia is passed over heated Copper oxide.

(d) Ammonium dichromate is heated.

Ans. (a) Dense white fumes are observed.

(b) Green flame is seen.

(c) Black coloured Copper oxide changes to Pinkish red metal, a colourless liquid is obtained which turns anhydrous Copper sulphate blue and a colourless, odourless gas is evolved which is neither combustible nor it is a supporter of combustion and does not turn lime water milky.

(d) On heating Ammonium dichromate, exothermic reaction takes place and the green mass erupts in the form of volcano.

Let's Recall

Fill Your Answer in the Space Given for Each Question.

Q1. Copy, complete and balance the following equations:

(*i*) $Mg_3N_2 + H_2O \xrightarrow{\Delta}$ _____ + _____

(*ii*) $Ca + N_2 \longrightarrow$ _____

(*iii*) $AlN + H_2O \xrightarrow{\Delta}$ _____ + _____

(*iv*) $CuO + NH_3 \longrightarrow$ _____ + _____ + _____

(*v*) $NH_3 + Cl_2 \longrightarrow$ _____ + _____
Excess

(*vi*) $NH_3 + H_2SO_4 \longrightarrow$ _____

(*vii*) $NaOH + NH_4Cl \xrightarrow{\Delta}$ _____ + _____ + _____

(*viii*) $NH_3 + HCl \longrightarrow$ _____

(*ix*) $NH_4OH + HNO_3 \longrightarrow$ _____ + _____

(*x*) $NH_3 + O_2 \xrightarrow[800°C]{Pt}$ _____ + _____

(*xi*) $NH_3 + O_2 \longrightarrow$ _____ + H_2O

(*xii*) $PbO + NH_3 \longrightarrow$ _____ + _____ + H_2O

(*xiii*) $NH_3 + Cl_2 \longrightarrow$ _____ + _____
excess

(*xiv*) $N_2 + H_2 \longrightarrow$ _____

Q2. Fill in the blanks.

(*i*) Ammonia is _____ dense than air.

(*ii*) Ammonia is _____ collected over water.

(*iii*) Ammonia is _____ soluble in water.

(*iv*) Dry ammonia has _____ effect on red litmus paper.

(*v*) Ammonia turns neutral litmus solution to _____.

(*vi*) Ammonia is synthesized by _____ process. The catalyst used during the process is _____ divided iron.

(*vii*) Ammonia is not dried by passing through concentrated _____ acid.

(*viii*) Ammonia turns _____ reagent _____.

(*ix*) When ammonia is passed over heated copper oxide the products are _____, _____ and _____.

(*x*) Ammonia gives dense white fumes with _____ and _____.

Q3. State whether the following statements are True or False.

(*i*) Ammonia is insoluble in Water. ☐

(*ii*) Ammonia dissolves in Water to give an alkali. ☐

(*iii*) Ammonium hydroxide on adding to Ferrous sulphate produces dirty green precipitate. ☐

(*iv*) Ammonia burns in Oxygen with blue flame. ☐

(*v*) Ammonia acts as a reducing agent. ☐

Q4. Choose the correct option.

(*i*) Liquid ammonia is

(*a*) basic (*b*) acidic

(*c*) neutral (*d*) none of these

Ans. (*a*) (*b*) (*c*) (*d*)

(*ii*) Ammonia dissolves in Water to give

(*a*) Ammonium hydroxide (*b*) Ammonium oxide

(*c*) Ammonium chloride (*d*) none of these

Ans. (*a*) (*b*) (*c*) (*d*)

(*iii*) Ammonia on dissolving in Water produces

(*a*) hydroxyl ion as the positive ion (*b*) hydrogen ion as the positive ion

(*c*) hydroxyl ion as the negative ion (*d*) none of these

Ans. (*a*) (*b*) (*c*) (*d*)

(*iv*) Drying agent for Ammonia is

(*a*) CaO (*b*) P_2O_5

(*c*) conc. H_2SO_4 (*d*) HCl

Ans. (*a*) (*b*) (*c*) (*d*)

(*v*) Ammonia gets catalytically oxidized to give

(*a*) $N_2 + H_2O$ (*b*) $NO_2 + H_2O$

(*c*) $NO + H_2O$ (*d*) Cu

Ans. (*a*) (*b*) (*c*) (*d*)

ANSWERS

1. (*i*) $Mg_3N_2 + 6H_2O \xrightarrow{\Delta} 3Mg(OH)_2 + 2NH_3$ (*ii*) $3Ca + N_2 \longrightarrow Ca_3N_2$

(*iii*) $AlN + 3H_2O \xrightarrow{\Delta} Al(OH)_3 + NH_3$ (*iv*) $3CuO + 2NH_3 \longrightarrow 3Cu + N_2 + 3H_2O$

(*v*) $8NH_3 + 3Cl_2 \longrightarrow 6NH_4Cl + N_2$ (Excess)

(*vi*) $2NH_3 + H_2SO_4 \longrightarrow (NH_4)_2SO_4$ (*vii*) $NaOH + NH_4Cl \xrightarrow{\Delta} NaCl + H_2O + NH_3$

(*viii*) $NH_3 + HCl \longrightarrow NH_4Cl$ (*ix*) $NH_4OH + HNO_3 \longrightarrow NH_4NO_3 + H_2O$

(*x*) $4NH_3 + 5O_2 \xrightarrow[800°C]{Pt} 4NO + 6H_2O$ (*xi*) $4NH_3 + 3O_2 \longrightarrow 2N_2 + 6H_2O$

(*xii*) $3PbO + 2NH_3 \longrightarrow 3Pb + N_2 + 3H_2O$ (*xiii*) $NH_3 + 3Cl_2 \longrightarrow NCl_3 + 3HCl$ (excess)

(*xiv*) $N_2 + 3H_2 \longrightarrow 2NH_3$

2. (*i*) less (*ii*) not (*iii*) highly (*iv*) no (*v*) blue

(*vi*) Haber's, finely (*vii*) sulphuric (*viii*) Nessler's, brown (*ix*) copper, water, nitrogen

(*x*) chlorine, hydrogen chloride gas.

3. (*i*) False (*ii*) True (*iii*) True (*iv*) False (*v*) True

4. (*i*) *c* (*ii*) *a* (*iii*) *c* (*iv*) *a* (*v*) *c*

SELF EVALUATION Test

Time : 30 Minutes *Marks : 25*

Q1. The following questions are related with the preparation, properties of ammonia. **6**

(*i*) Write balanced chemical equation for the preparation of Ammonia from Ammonium chloride.

(*ii*) How is ammonia, collected, tested and dried?

(*iii*) Name the experiment which demonstrates the extreme solubility of Ammonia gas.

Q2. Write balanced chemical equations for the following reactions. **9**

(*i*) Ammonia is oxidized catalytically

(*ii*) Ammonia is passed over heated Copper oxide

(*iii*) Excess of Ammonia reacts with Chlorine

(*iv*) Magnesium nitride is warmed with Water

(*v*) Ammonium nitrite is heated

(*vi*) Synthesis of Ammonia

(*vii*) Ammonium dichromate is heated

(*viii*) Moist ammonia is passed over P_2O_5

(*ix*) Ammonia is passed over heated Lead oxide

Q3. What do you observe and write balanced chemical equation. **5+5**

(*i*) Ammonia burns in pure oxygen

(*ii*) Ammonia mixes with Hydrogen chloride gas

(*iii*) Ammonia is passed through Copper sulphate solution in excess

(*iv*) Ammonium hydroxide is added to Ferric chloride solution