ST. LAWRENCE HIGH SCHOOL

A Jesuit Christian Minority Institution

Class: X

STUDY MATERIAL

FOR GOD AND COUNTRY

Sub: Physical Science

Topic: Inorganic Chemistry **Date: 16th May 2020**

Q.1. How does nitrogen react with oxygen ?

Ans. Reaction of nitrogen with oxygen : Nitrogen reacts with oxygen forming nitric oxide under the influence of electric arc at a temperature of 3000°C.

$$N_2 + O_2 \rightleftharpoons 2NO - \text{heat (Endothermic reaction)}$$

Q.2. Why is the solution of ammonium chloride and sodium nitrite is heated to produce nitrogen instead of heating ammonium nitrite directly ?

Ans. Nitrogen gas is not prepared by heating ammonium nitrite (NH_4NO_2) directly, for in that case rapid explosive dissociation of ammonium nitrite takes place.

Q.3. How does nitrogen react with magnesium ?

Ans. Reaction with magnesium : When turnings of magnesium metal are strongly heated in nitrogen gas, the metal directly combines with nitrogen to form magnesium nitride (Mg_3N_2).

$$3Mg + N_2 = Mg_3N_2$$

Q.4. What happens if magnesium nitride is boiled with water ?

Ans. Magnesium nitride is boiled with water to form magnesium hydroxide and ammonia.

$$Mg_3N_2 + 6H_2O = 3Mg(OH)_2 + 2NH_3$$

Q.5. What is nitrolim ? How it is formed ? Mention its important use.

Ans. Nitrolim : When small lumps of white calcium carbide (CaC_2) are heated in nitrogen gas at about 1100°C, calcium cyanamide (CaNCN) is formed, along with the separation of carbon particles (black). The blackish brown mixture of the products (CaNCN + C) is commercially known as nitrolim.

Use of nitrolim : It is largely used as a fertilizer.

Q.6. State the uses of nitrogen.

Ans. Uses of nitrogen :

(a) It is used in the industrial preparation of ammonia and nitric acid.

(b) It is used for the production of fertilizer, such as ammonium sulphate, ammonium nitrate.

(c) Liquid nitrogen (b.p. –195·8°C) is used as condenser.

(d) In many chemical reactions, nitrogen is used as inert medium.

(e) It is used in the preparation of electric bulb and gas thermometer.

Q.7. Why gaseous nitrogen is chemically quite inactive at ordinary temperatures, but it is active at higher temperatures ?

Ans. Chemical nature of gaseous nitrogen : The unreactivity of nitrogen at ordinary temperatures, is due to the structure of nitrogen molecule (N_2), in which two nitrogen atoms are bonded together by three covalent bonds ($N \equiv N$). The force of attraction of two nitrogen atoms so bonded is very high. So large

amount of energy (generally heat energy) is required to break up this bond to set free the two nitrogen atoms so that they can enter into chemical combination.

Q.8. State the physical properties of nitrogen.

Ans. Physical properties of nitrogen :

(i) It is colourless gas without smell or taste,

(ii) Density of the gas is 1·25 g/L at NTP.

(iii) It is slightly soluble in water.

Solubility of nitrogen in water is about 23·5 ml/L at NTP.

C. Broad Answer Type Questions — Marks for each 3

Q.1. Describe the laboratory method of preparation of nitrogen. State the following matters : (a) chemicals required (b) condition (c) drying (d) chemical equation (e) collection of gas.

Ans. Laboratory method of preparation of nitrogen :

(a) **Chemicals required :**

(i) Sodium nitrite ($NaNO_2$)

(ii) Ammonium chloride (NH_4Cl)

(b) **Condition :** The chemicals ammonium chloride and sodium nitrite must not be in solid state but as solution. The mixture is heated gently to evolve nitrogen gas.

(c) **drying :** The nitrogen gas is dried by passing through a U-tube containing conc., sulphuric acid.

(d) **Chemical equation :**

(i) $NH_4C1 + NaNO_2 \triangleq NH_4NO_2 + NaCl$ (1st stage)

(ii) $NH_4NO_2 \triangleq N_2\uparrow + 2H_2O$ (Final stage)

(e) **Collection of gas :** Though nitrogen gas is slightly soluble in water, it is collected by the downward displacement of water.

Q.2. State briefly the significance of the presence of nitrogen in air.

Ans. Significance of the presence of nitrogen in air : Nitrogen in air dilutes oxygen present therein. Oxygen is a very active oxidant. The mixture of nitrogen with oxygen in air moderates the intense activity of pure oxygen in the processes of respiration, combustion etc, which would have otherwise occurred very rapidly. The intake of only oxygen during respiration would have caused increased rate of respiration, causing excessive burning of body tissues. This would have caused high and unchecked rise in the temperature of body, which results death. Without nitrogen in air, the combustion of earthly materials would have been explosively vigorous.

The huge amount (about 78% by volume) of nitrogen in air can be absorbed by certain symbiotic bacteria, such as Rhizobium leguminouserum, R. japonicum etc. Nitrogen is converted to nitrogenous salts in nature by many chemical and biochemical process. Proteins, the complex nitrogenous compounds, which are absolutely essential for living beings are also indirectly formed from the nitrogen of air.

Q.3. State the two possible ways of reaction of nitrogen with hydrogen, also write down the connected equations of reaction.

Ans. First type : Nitrogen combines with hydrogen under the influence of electric spark producing ammonia gas.

$$N_2 + 3H_2 \underset{\text{Electric spark}}{\rightleftharpoons} 2NH_3,$$

Second type : Nitrogen also combines with hydrogen at 550°C under 200 atmospheric pressure in presence of iron catalyst to form nitrogen gas.

$$N_2 + 3H_2 \underset{\text{Fe-catalyst}}{\overset{550°C\ ;\ 200\ atm}{\rightleftharpoons}} 2NH_3 + \text{heat}$$

Q.4. *State two important ways of fixation of nitrogen.*

Ans. Two ways of fixation of nitrogen :

(i) **By electric discharge** : During electric discharge in the atmosphere nitrogen and oxygen present in air combine to produce nitric oxide. The produced nitric oxide is then oxidised by atmospheric oxygen to form nitrogen dioxide. Later this oxide upon mising with water vapour or rain water produces nitric acid which falls upon our earth.

$$N_2 + O_2 \xrightarrow[\text{discharge}]{\text{electric}} \underset{\text{(nitric oxide)}}{2NO}$$

$$2NO + O_2 = 2NO_2$$

$$3NO_2 + H_2O = 2HNO_3 + NO$$

Nitric acid is then reacted with the bases present in the soil forming nitrate salts.

(ii) **Fixation of nitrogen due to bacteria** : Some micro organism and blue green algae convert nitrogen present in air to ammonia and nitrate salt by bio-chemical process. When the animal and plant bodies undergo decay most of the nitrogen (proteins) is liberated as ammonia which is oxidised in the soil by the combined action of nitrosifying and nitrifying becteria into nitrate to be again assimilated by plants. A portion of the fixed nitrogen is set free by the action of denitrifying bacteria of the soil.

Q.21. *Why nitric acid is prepared at lower temperature (200°C) in laboratory?*

Ans. Nitric acid is prepared at lower temperature (200°C) in laboratory because :

(a) At high temperature nitric acid decomposes.

$$4HNO_3 = 4NO_2 + O_2 + 2H_2O$$

(b) Nitric acid vapour attacks glass surface of the retort.

(c) Sodium sulphate (Na_2SO_4) formed at the higher temperature sticks to glass and is difficult to remove from the glass retort.

Q.22. *Why is conc. sulphuric acid used instead of conc. hydrochloric acid in the preparation of nitric acid in laboratory ?*

Ans. Choice of acid : In the preparation of an acid, the reacting acid must be less volatile than the acid to be prepared.

Hence, conc. H_2SO_4 (b.p. 338°C) is chosen because it is less volatile than nitric acid (b.p. 86°C). Hydrochloric acid is more volatile than nitric acid, so hydrochloric acid is not used. Beside this hydrochloric acid reacts with produced nitric acid to form nitrosyl chloride, chlorine and water.

$$3HCl + HNO_3 = NOCl + Cl_2 + 2H_2O$$

Q.23. What is fuming nitric acid ?

Ans. Fuming nitric acid : It is brown coloured liquid. It is actually conc. HNO_3 containing dissolved nitrogen dioxide (NO_2) gas. The dissolved nitrogen dioxide spontaneously comes out of the liquid as brown fumes. That is why, it is called fuming nitric acid.

Preparation of fuming nitric acid : It is prepared by distilling conc. nitric acid with starch or arsenious oxide (As_2O_3).

Property and use of fuming nitric acid : Fuming nitric acid is a stronger oxidising agent than ordinary conc. nitric acid. It is used for many oxidation purposes where ordinary nitric acid does not give satisfactory results.

Q.24. State the preparation of nitric acid by Ostwald process.

Ans. Preparation of nitric acid by Ostwald process (1914) :

(a) In this process ammonia is oxidised in presence of heated (750°C – 900°C) platinum gauze catalyst by oxygen in air to produce nitric oxide.

$$4NH_3 + 5O_2 = 4NO\uparrow + 6H_2O + 218{,}660 \text{ cal}$$

(b) The gases containing nitric oxide (NO) and steam (H_2O) are cooled and then mixed with air to oxidise nitric oxide to nitrogen dioxide.

$$2NO + O_2 = 2NO_2$$

(c) Nitrogen dioxide, is then absorbed in water to yield a 50% solution of nitric acid and nitric oxide.

$$3NO_2 + H_2O = 2HNO_3 + NO\uparrow$$

Q.30. What is aqua regia ? What is its use ?

Ans. **Aqua regia** : A mixture of conc. HNO_3 (1 vol.) and conc. hydrochloric acid (3 vols.) is known as aqua regia.

$$Au + 4HCl + HNO_3 = HAuCl_4 + NO + 2H_2O$$

(soluble chloro auric acid)

Use of aqua regia : It dissolves gold and platinum.

Q.31. What is ring test experiment of nitric acid ?

Ans. **Ring test experiment of nitric acid** : A little amount of dilute nitric acid is taken in a test tube. Freshly prepared ferrous sulphate is added to it. Now conc. H_2SO_4 is taken in another test tube. conc. H_2SO_4 taken in a tube is carefully poured into the above liquid mixture so as to form a heavy layer at the bottom. A brown ring is formed at the junction of two liquids.

Thus, the reaction involved in ring tests as :

(i) $FeSO_4 + 2HNO_3 + 3H_2O = 3Fe_2(SO_4)_3 + 4H_2O + 2NO$

(ii) $FeSO_4 + 6H_2O = [Fe(H_2O)_6]SO_4$

(iii) $[Fe(H_2O)_6]SO_4 + NO = [Fe(NO)(H_2O)_5]SO_4 + H_2O$

(Brown-ring)

Q.32. State uses of nitric acid.

Ans. **Uses of nitric acid :**

(a) It is used in the production of explosives such as dynamite, gun cotton, nitro-glycerine, picric acid, and trinitro toluene (TNT).

(b) It is used to prepare aqua regia in electroplating and in battery.

(c) It is also used to prepare rayon, artificial silk and dyes.

Q.33. What is acid rain ?

Ans. **Acid rain** : The oxides NO_2 and SO_2 reacting with moisture and oxygen of air correspondingly produce HNO_3 and H_2SO_4. The acids dissolve in rain water. The rain coming down on earth carrying these acids is known as acid rain.

Function of acid rain : The acids present in the rain water damage buildings monuments, statues by corrosion. Soil also becomes acidic which causes degradation of soil that in turn causes decline in forest area and agricultural productivity.

Q.34. Sulphuric acid is not prepared directly by adding water to SO_3—why ?

Ans. **Explanation** : It is because of the fact that water is not used for absorbing SO_3 as the reaction is exothermic. Result is this that large amount of heat evolved will be a cause of most of SO_3 to be volatilised, the rest amount of it does not form any homogeneous mixture but a dense fog of H_2SO_4 particles is formed. H_2SO_4 is not easily available from the fog. Beside this at high temperature some parts of H_2SO_4 decompose to SO_2 and O_2. Hence water is not directly added to SO_3.

Q.35. What is fumming sulphuric acid or oleum ?

Ans. **Fumming sulphuric acid or oleum** : Fumming sulphuric acid or oleum is obtained when SO_3 is passed over 98% (approximately) sulphuric acid.

Equation : $H_2SO_4 + SO_3 = H_2S_2O_7$

(oleum)

Q.47. *What is the identification reaction of sulphuric acid ?*

Ans. Identification reaction of sulphuric acid : When barium chloride solution is added to dilute sulphuric acid, a white precipitate of barium sulphate insoluble in dilute or concentrated hydrochloric acid or nitric acid is obtained.

Equation : $H_2SO_4 + BaCl_2 = \underset{\substack{\text{(Barium}\\\text{sulphate)}\\\text{[White precipitate]}}}{BaSO_4\downarrow} + 2HCl$

Q.48. *State the uses of sulphuric acid.*

Ans. Uses of sulphuric acid :

(a) It is used for the preparation of different chemical compounds like HCl, HNO_3, ether, alcohol. etc.

(b) It is used as an important raw material for dyes, medicine, plastic industries.

(c) It is used to prepare different explosives like trinitrotoluene (TNT) nitroglecerine etc.

Q.49. *Explain the following :*
Concentrated nitric acid turns yellow in sun light.

Ans. Explanation : Nitric acid turns yellow because of its decomposition forming nitrogen dioxide (NO_2) gas.

Equation : $4HNO_3 = 4NO_2 + 2H_2O + O_2$

C. Broad Answer Type Questions — Marks for each 3

Q.1. *State the contact process for the manufacture of sulphuric acid.*

Ans. Contact process for the manufacture of sulphuric acid :

Principle : (a) Formation of SO_2 : SO_2 is prepared by burning sulphur or iron pyrites in excess of air.

Equation : $S + O_2 = SO_2\uparrow$ or, $\underset{\text{(Iron pyrities)}}{4FeS_2} + 11O_2 = 2Fe_2O_3 + 8SO_2\uparrow$

(b) Formation of Sulphur trioxide (SO_3) : SO_3 is prepared by the oxidation of sulphur dioxide with oxygen (from air) in presence of platinised asbestos or, V_2O_5 as catalyst at 450°C.

Equation : $2SO_2 + O_2 \rightleftharpoons 2SO_3 + 192{\cdot}5\ KJ$

(c) Formation of oleum : Now sulphur trioxide thus produced are not allowed to react with water directly. Sulphur trioxide absorbs concentrated sulphuric acid (98%) turning it as fumming sulphuric acid or oleum.

Equation : $SO_3 + H_2SO_4 = \underset{\text{(Oleum)}}{H_2S_2O_7}$

(d) Dilution of oleum to sulphuric acid : Pure and concentrated sulphuric acid is produced by adding slowly requisite amount of water in fumming sulphuric acid.

Equation : $H_2S_2O_7 + H_2O = 2H_2SO_4$