CW 14-dec-

Unit #11: Nitrogen & Sulphur

Nitrogen:-

Nitrogen has many properties, including:

Physical properties:

Nitrogen is a colorless, odorless and tasteless gas that is slightly lighter than air. It has a melting point of -210°C and boiling point of -196°C. Nitrogen is non-poisonous, but animals can die from suffocation by N.

Chemical properties:

Nitrogen is a noncombustible gas that doesnot support burning. It is chemically inert under normal conditions but it can react with certain metals to form metal nitrides. Nitrogen also combines with oxygen to form oxides of N.

Isotopes:

Nitrogen has two stable isotopes, ^{14}N and ^{15}N where ^{14}N is most abundant and the relative abundance of 99.63 of naturally occuring nitrogen on Earth.

Uses of nitrogen:

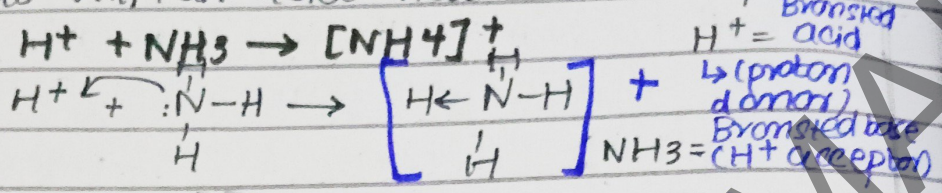
Following are the uses of nitrogen:

* Fertilizers: Nitrogen is used in industrial fertilizer.
* Food preservation: Liquid nitrogen is used in to freeze and transport food.
* Medicine: Nitrogen is used in medicine.
* Construction: Nitrogen is used in construction application.
* Electronics: Nitrogen is used to combine two components of electronic devices during soldering.
* Temperature control: Nitrogen is used to control temperature in laboratories.

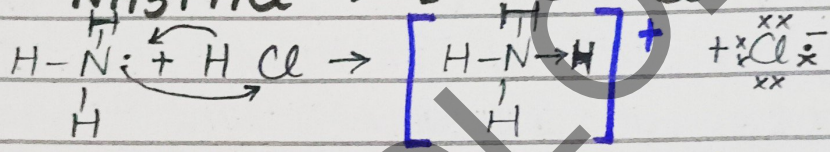
* steel production: Nitrogen is used to produce stainless or aluminised steel.

Formation of Ammonium ion:-

The ammonium ion (NH_4^+) is formed when ammonia (NH_3), a weak base, reacts with an acid that donates a proton.



The ammonium ion is positively charged because it has an extra H-bonded atom. It has a tetrahedral shape as it has 4 bonds and no lone pair electrons.



where according to lewis concept, NH_3 is electron pair donor while HCl is electron pair acceptor and base, acid respectively.

(i) Difference between nitrification & de-nitrification.

Nitrification: Nitrification is a two step biological process in which soil bacteria converts ammonia (NH_3) into nitrates (NO_3^{-1}). Firstly, ammonia-oxidizing bacteria (Nitrosomonas converts NH_3 into nitrites NO_2^{-1}.

$$2NH_4^+ + 3O_2 \longrightarrow 2NO_2^- + 4H^+ + 2H_2O$$

Then nitrite oxidizing bacteria converts nitrites into nitrates which plants use nutrien

$$2NO_2^{-1} + O_2 \longrightarrow 2NO_3^{-1}$$

Denitrification: It is the process by which bacteria converts nitrates (NO_3^{-1}) in the soil into nitrogen gas (N_2) by releasing it back into the environment.

$$2NO_3^{-1} + 10e^- + 12H^+ \rightarrow N_2 + 6H_2O.$$

This helps complete the nitrogen cycle and reduces soil nitrogen levels.

Difference between fog and humidity?

(ii) **Fog and humidity:**

Fog is formed when high humidity combines with low air pressure and low temperature. This causes moisture in the atmosphere to condense into very tiny droplets, which are suspended in the cool air.

(iii) What is smog?

Photochemical smog: The photochemical smog is a type of air pollutant formed when sunlight reacts with pollutants like NOx and VOC, creating harmful ozones and other chemicals.

smog = fog + smoke.

It mostly occurs in the summer as a brown haze and PAN are mostly forms.

(iv) How PAN is formed?

Formation of PAN:

In atmosphere, NO_2 takes place photo dissociation in presence of sunlight.

$$NO_2 \rightarrow NO + O$$

The VOC's present in atmosphere reacts with atomic oxygen to form PAN-radical. VOC's (unburnt HC).

$$(VOC's)\ HC + O \rightarrow R\dot{C}O_3$$

Now this radical reacts with NO, then forming peroxyacyl nitrate (PAN).

$$NO + R\dot{C}O_3 \rightarrow R\text{-}CO_2ONO_2 \text{ (PAN)}$$

PAN is a secondary pollutant, stable and highly reactive. It causes the respiratory diseases.

(v) Why ammonia is basic in nature?

Ammonia is basic or alkaline in nature as it has nitrogen atom which has electron pair that readily accepts a proton. So according to Bronsted lowery it is proton acceptor and in lewis concept it is lone pair donor which refers to it's basic nature.

$$NH_3 + H^+ \rightarrow NH_4^+$$

Ammonium ion is alkaline. (p^+ acceptor)

$$:NH_3 + HCl \rightarrow \overset{+}{N}H_4 + Cl^-$$

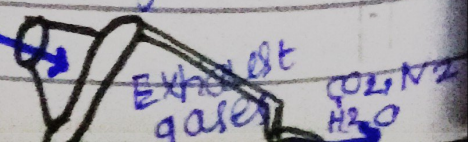
So Ammonium ion is basic. (lone pair donor)

(vi) Why catalystic converter is called as 3 way catalytic converter?

Converter installed in automobiles exhaust so that they convert CO to CO_2, and oxides of nitrogen NO x to N_2, before it enters the air. When hot gases pass through converters, the harmful pollutants are converted to harmless substances. Such as hydrocarbons and CO_2 are produced by oxidation of CO, which are then oxidized to water and CO_2, while oxides of nitrogen are reduced to nitrogen.

$$2NO + 2CO \rightarrow N_2 + 2CO$$

$$2NO + 2HC \rightarrow N_2 + 2H_2O + CO_2$$



(vii) Why +6 oxidation state of sulphur is most stable amongst others?

Stable oxidation state:

The +6 oxidation state of sulfur is most stable due to some reasons:

* Sulfur uses all its valence electrons in bonding.
* Oxygen's high electronegativity stabilizes it
* Sulfur can expand its octet for more bond
* +6 is common in H_2SO_4 and SO_4^{2-}
* stable electronic configuration and complete octet. So it is now left with 10 electrons such as of Ne_{10}

(viii) Why sulphur acts as both oxidizing and reducing agents?

Dual nature of sulfur:

Sulfur acts as both because:

* Oxidizing agent can gain electrons such as in S (0 → -2). Reduction
* Reducing agent can lose electrons such as in S (0 → +4 or +6). Oxidation.

This is due to ability of sulphur to exist in multiple oxidation states.

(ix) What are uses of sulphur?

Uses of sulfur:

Following are its uses:

* Sulfuric acid production (H_2SO_4) for industries.
* Fertilizers such as ammonium sulfate.
* Rubber vulcanization for making tires
* Medicines such as ointments for skin.
* Gunpowder and fireworks.

* Pesticides and fungicides.

(x) What is oleum?

Oleum:

Fuming sulfuric acid is a solution of sulfur trioxide (SO_3) in conc. H_2SO_4.

* It is highly corrosive, reactive.
* Used in the production of sulfuric acid and in industrial processes.
* It is formulae as $H_2S_2O_7$, though exact composition depends on SO_3 content

(xi) Write sulfuric acid as dehydrating agents?

Dehydrating agent as H_2SO_4:

Sulfuric acid is strong dehydrating agent as it removes water molecules from substances.

Example:

* Sugar dehydration:

$$C_{12}H_{22}O_{11} \xrightarrow{H_2SO_4} 12C + 11H_2O$$

Leaves black carbon behind.

* Dehydrates ethanol to ethene:

$$C_2H_5OH \xrightarrow{H_2SO_4} C_2H_4 + H_2O$$

This property makes it useful in chemical reactions and drying gases. Because of this property, when H_2SO_4 is dropped on skin it readily absorbs water and burns/oxidizes skin, so highly corrosive.