

Nitrogen

Symbol - N

Molecular formula - N_2

Atomic weight number - 7

Atomic weight - 14 amu.

Valency - 3

Block - P block (non-metals)

Electronic configuration - $1s^2 2s^2 2p^3$

Occurrence

Nitrogen exists about 75% by weight and 78% by volume in earth's atmosphere.

All living matter including plants and animals contain nitrogen in the form of proteins.

In many compounds Nitrogen is present as nitrite (NO_2), ammonium sulphate, Chile saltpetre ($NaNO_3$), sal ammoniac (NH_4Cl)

Reason for inertness of nitrogen and active nitrogen.

- In N_2 molecules nitrogen atoms are attached with triple bond ($N \equiv N$). all the valence electrons are involved in triple bond which is strong, due to this bond enthalphy is high. so bond dissociation energy is also high i.e. large energy is needed to break $N \equiv N$ bond. Thus N_2 is less reactive.

→ High electronegativity leads to small size leads to formation of $N \equiv N$ bond.

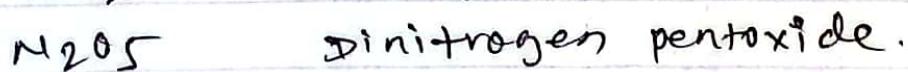
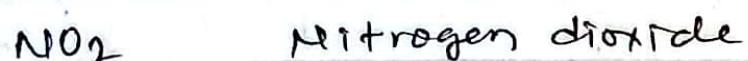
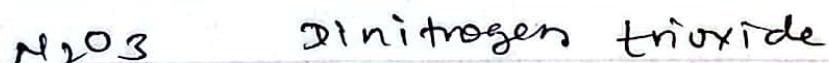
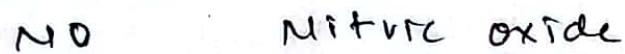
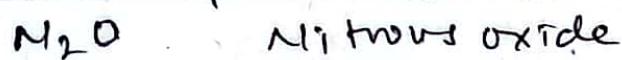
Active nitrogen.

Active nitrogen (free nitrogen atom) can be prepared by passing nitrogen gas at low pressure through high frequency electric discharge.

The active nitrogen may be atomic nitrogen or excited neutral nitrogen molecule.

Active nitrogen is also generated by bombarding the nitrogen gas with energized electrons.

Oxides of Nitrogen.



Uses of Nitrogen.

- i). Used for manufacture of nitric acid, ammonia, nitrates.
- ii). Nitrogen gas is used to fill up electric bulb due to its inertness.
- iii). Used to preserve the freshness of food in food packing.
- iv). Liquid nitrogen is used as refrigerant.

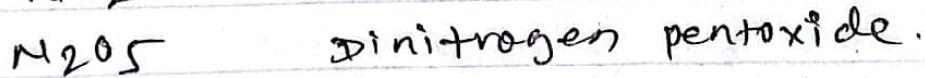
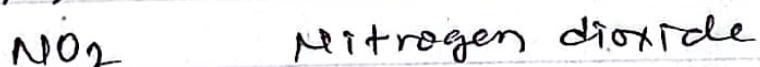
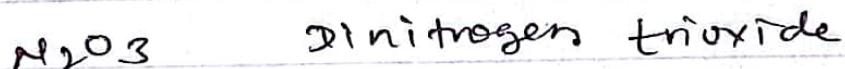
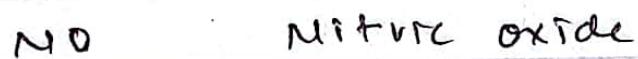
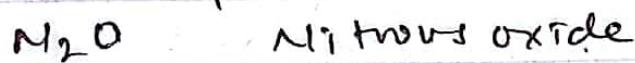
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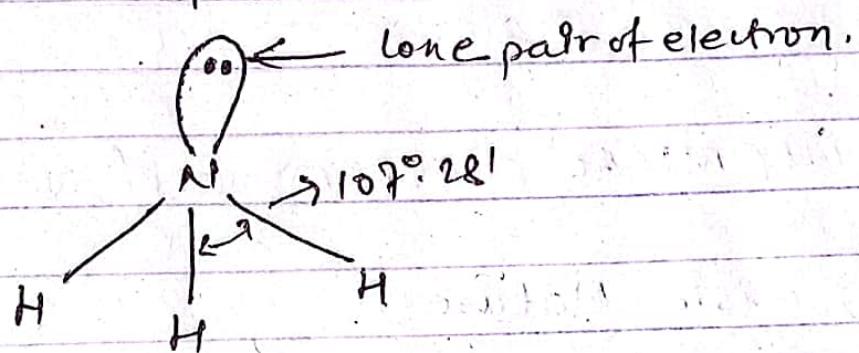
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Ammonia NH_3 .

Ammonia is a hydride of Nitrogen with molecular formula NH_3 . In free state it exists in free state in small quantities, in combined state in the form of ammonium salt as NH_4Cl (NH_4)₂SO₄, etc.

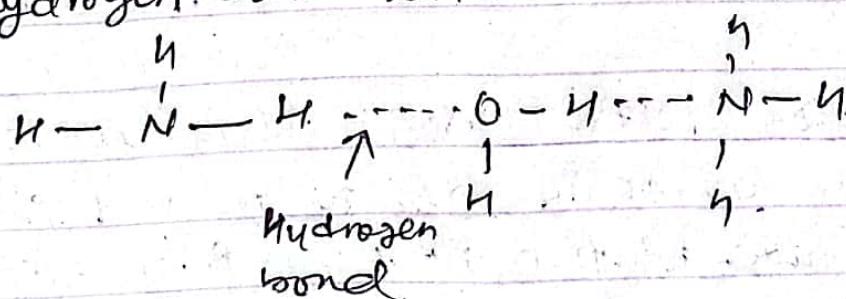
Structure of ammonia.



pyramidal shape of ammonia.

physical properties.

- ① It is a colourless and pungent smelling gas.
- ② Highly soluble in water. It is due to its capacity of formation of intermolecular hydrogen bond with water molecules.



(14) Liquid ammonia boils at -33.4°C . so it produces immense cooling on vapourization. Due to this property, NH_3 is used as a cooling agent in refrigerator.

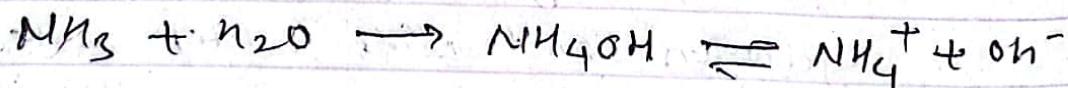
(IV) It is neither combustible nor supporter of combustion.
lighter than air. vapour density 8.5.

CHEMICAL PROPERTIES of NH_3 .

(2) Basic Nature

Ammonia contains lone pair of nitrogen. Thus it acts as Lewis base (lone pair donor).

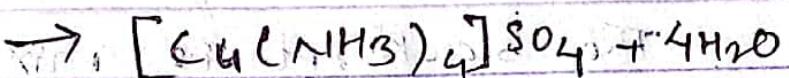
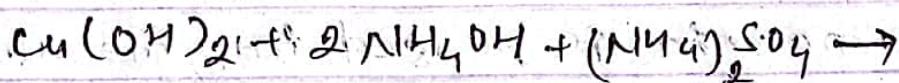
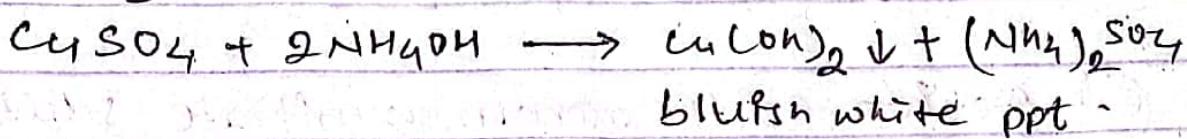
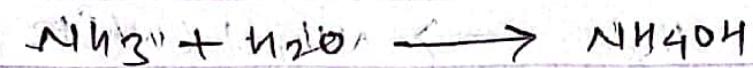
Aqueous solution of ammonia is alkaline (due to NH_4OH), it turns moist red litmus paper to blue and phenolphthalein solution to pink.



(B) Action with CuSO_4 solution

when ammonia gas is passed into copper sulphate solution it turns into bluish-white precipitate of copper hydroxide ($\text{Cu}(\text{OH})_2$)

is formed which, upon treatment with ~~excess~~ of ammonia, forming deep blue coloured complex compound of tetraammine copper(II) sulphate.



deep blue colour

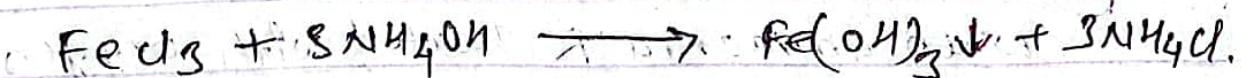
② Action with FeCl_3 (precipitation rxn)

ammonia gas dissolves in water to form ammonium hydroxide

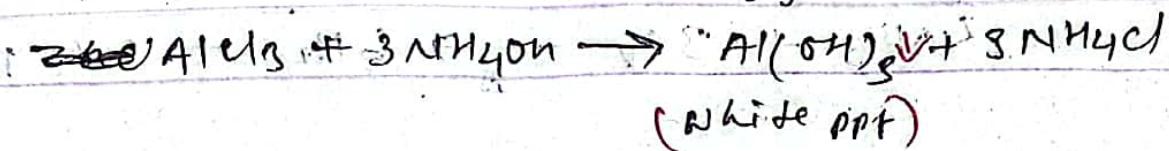
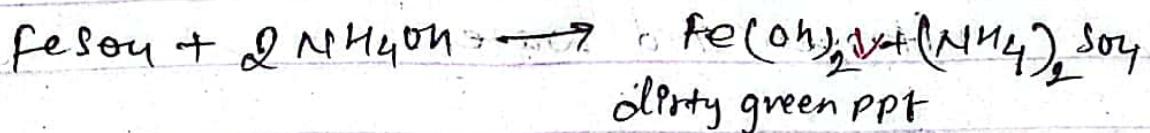


when ammonium hydroxide solution is

added in salts like FeCl_3 , AlCl_3 , etc corresponding hydroxides are formed,

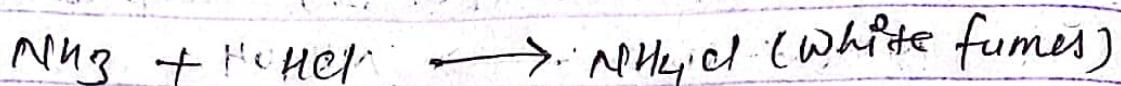


reddish brown ppt



(d) with HCl.

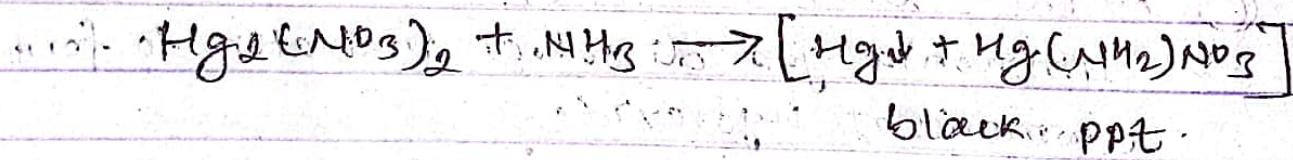
When ammonia reacts with concentrated HCl, it produces white fumes.



(e) Action with mercurous nitrate solution or paper.

When ammonia is passed into mercurous nitrate solution, black ppt is formed.

The black ppt is a mixture of mercury metal and basic mercuric (II) amidonitrate ~~BMAN~~ (BMAN).

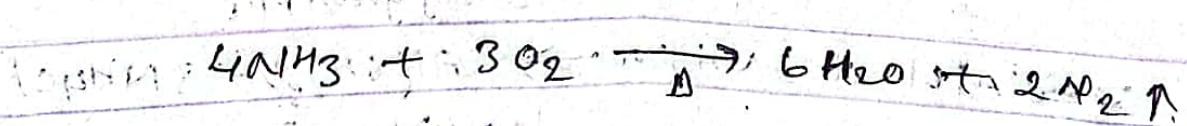


or ammonia is passed through NH_4NO_3 .

or it turns mercurous nitrate paper into black.

(f) Reaction with O_2 .

When ammonia is heated with oxygen, it produces greenish yellow flame produces nitrogen and water.



Test of NH_3 .

- (i) \rightarrow It has characteristic pungent smell.
- (ii) It gives dense fumes of NH_4Cl ~~with~~ when react with conc. HCl .
- (iii) ~~Also~~ it turns moist red litmus paper to blue.
- (iv) It turns mercurous nitrate paper into black.

Application of Ammonia.

- i). Nearly 80% of manufactured ammonia is used to manufacture fertilizer.
- ii). Liquid ammonia is used as a refrigerant.
- iii). Used in manufacture of HNO_3 by Ostwald's process.
- iv). Used for making dyes, plastics, explosives,
- v). Aqueous ammonia is used as laboratory reagent.
- vi). Used as cleansing agent for removing oil and grease.

Harmful effects of Ammonia.

The harmful effects of ammonia are as follows:

(2) Ammonia is corrosive and causes toxicity to the sites of contact (skin, respiratory tract, eyes, lungs, etc).

At least 50 ppm ammonia causes this problem.

(3) Inhalation of lower concentration causes, nausea, coughing, ~~and~~, dizziness and throat irritation.

(4) Chronic exposure of ammonia lead, pneumonitis, kidney damage, cataracts, ulceration etc.

(5) Ammonia excess will lead to increase nitrification and denitrification, contributing gases emission.

(6) Even, ammonia exists into two forms.

Ammonia (NH_3) and Ammonium (NH_4^+) ion.

Ammonia is toxic to aquatic organism.

Oxyacids of Nitrogen

(Name and formula)

Nitrous acid $\rightarrow \text{HNO}_2$

Nitric acid $\rightarrow \text{HNO}_3$

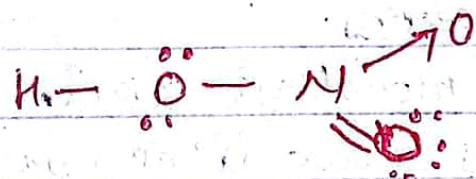
Pernitric acid $\rightarrow \text{HNO}_4$

Hyponitrous acid $\rightarrow \text{H}_2\text{N}_2\text{O}_2$.

Nitric acid $\rightarrow \text{HNO}_3$.

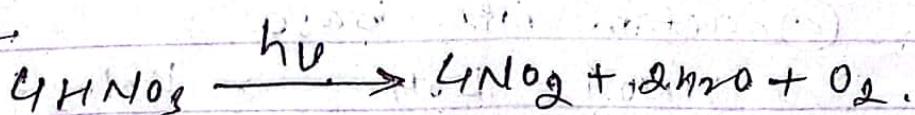
It is also called aquafortis.

Nitric acid is a colourless liquid in pure form.



Physical properties of HNO_3 .

- ① It is colourless liquid, But on long storing, it slightly turn to brown colour due to decomposition into NO_2 and O_2 . NO_2 gas gets dissolved to yield yellow tinge.



- ② It is soluble in water and forms a constant boiling mixture with water containing 68% of nitric acid.

(ii) commercial HNO_3 is 68% by mass having 16 N strength.

(iv) It is highly corrosive to skin.

It attacks the skin protein causes yellow blisters of xanthoproteic acid.

CHEMICAL PROPERTIES OF HNO_3

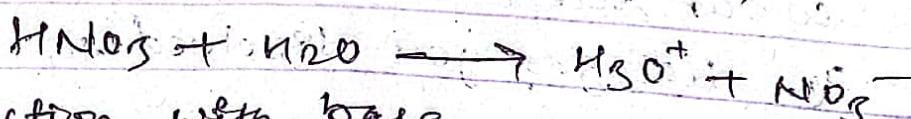
Due to replaceable hydrogen atom HNO_3 act as an acid.

① Acidic properties.

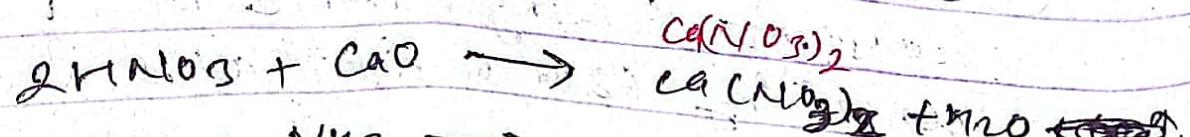
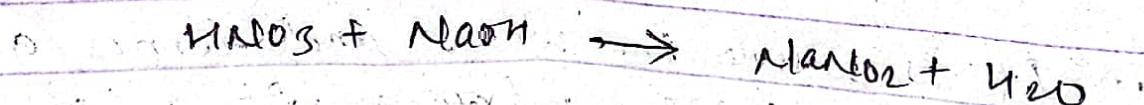
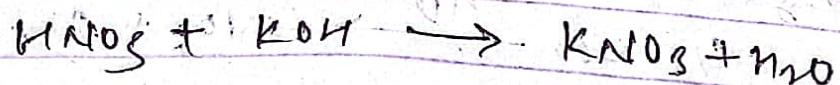
It is monobasic acid.

(a) It turns blue litmus paper into red, light yellow colour methyl orange into pink.

(b) It completely dissociates in water and shows acidic acidic property



(c) action with base.



Q) Oxidizing agent

Nitric acid is an oxidizing agent as it gives nascent oxygen in dilute and concentrated conditions.

B) Depending upon the concentration HNO_3 nitrate ion gets reduced to different products.

Concentration	Reduced product	Oxidation no of N.
Cone. HNO_3	NO_2	+4
Moderately conc. HNO_3	NO	+2
Dil. HNO_3	H_2O	+1
very dil. HNO_3	NH_3	-3

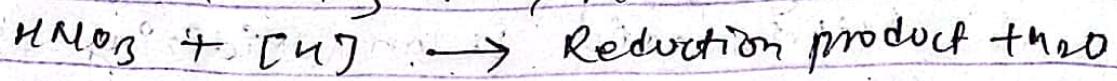
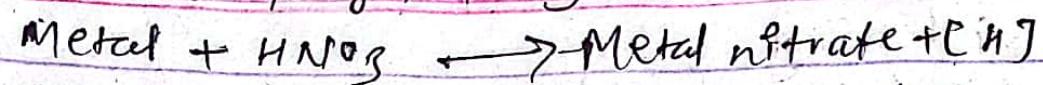
B) Oxidation of metal

Nitric acid dissolves all metals except inert metals. Au, Pt, Ir etc.

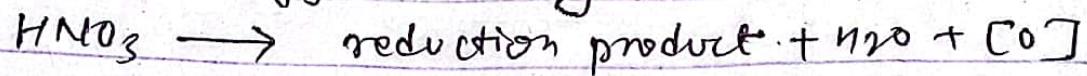
The reaction of nitric acid with metal can take place by nascent hydrogen or oxygen based on the nature of metals. More electropositive than hydrogen produce nascent hydrogen, less electro positive than hydrogen produce nascent oxygen.

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Nascent hydrogen theory

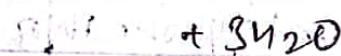
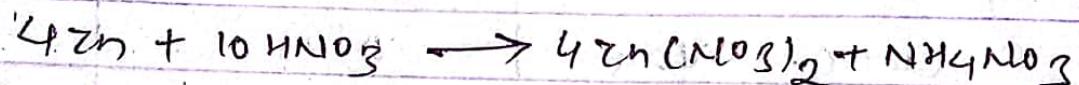


Nascent oxygen theory

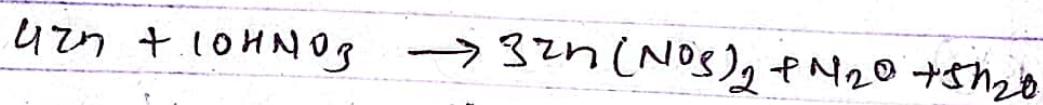


① Action with zinc

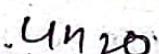
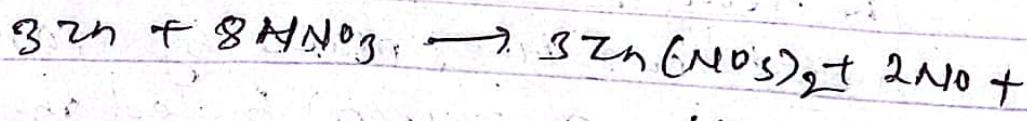
② Action with very dil. HNO_3



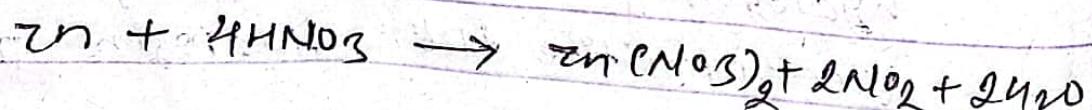
③ Action with dilute HNO_3



④ Action with moderately conc. HNO_3

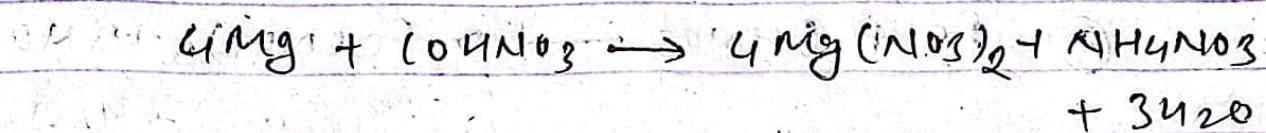


⑤ Action with hot and conc. HNO_3

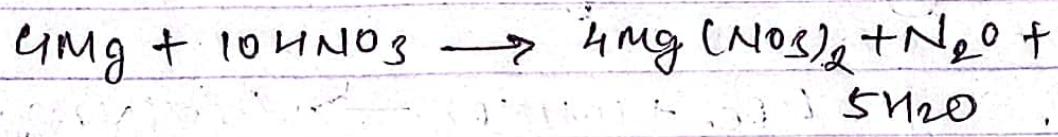


II). Action with magnesium:

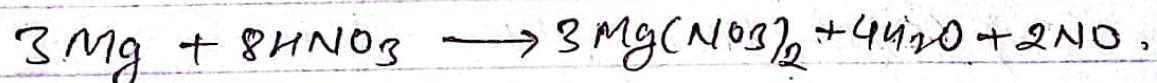
(2) with very dilute HNO_3 ,



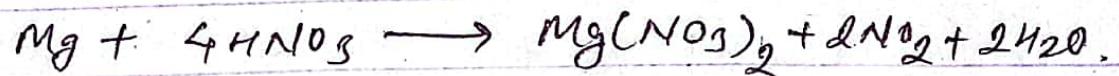
(3) with cold and dilute HNO_3 ,



(4) with moderately conc. HNO_3 .

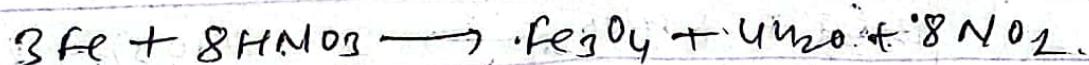


(5) with hot and conc. HNO_3 .

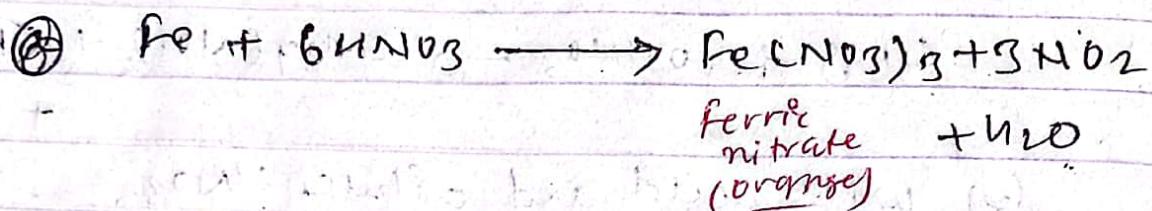
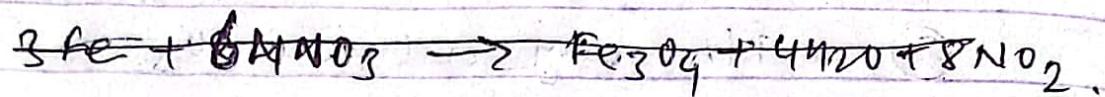


III). Action with iron.

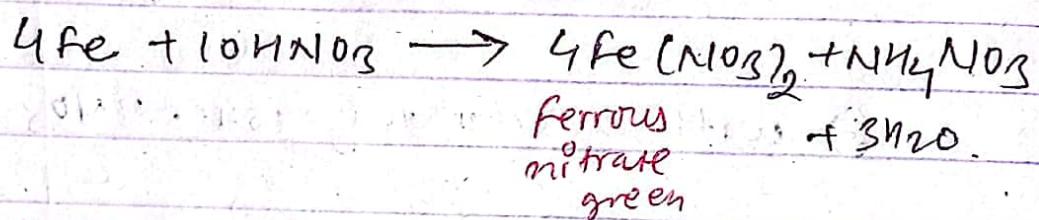
(a) Iron becomes passive with pure conc. HNO_3 . It forms ferrosoferric oxide and gets deposited on the surface of iron. And further reaction doesn't take place, so iron becomes passive.



(i) Action with moderately conc. HNO_3

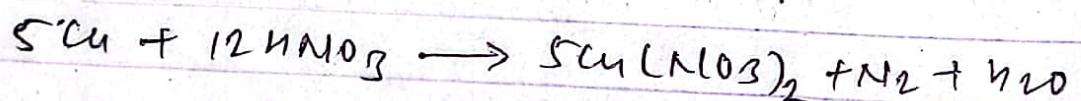


(iii) with very dilute HNO_3 .

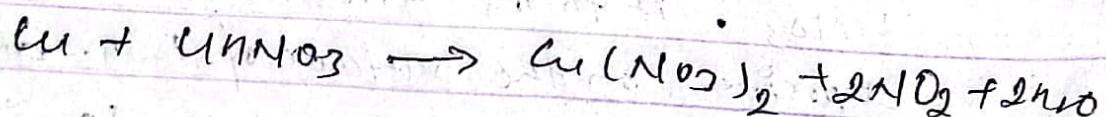


IV). (i) Action with copper.
(metal less electropositive than hydrogen)

(a) with hot and conc. HNO_3 .

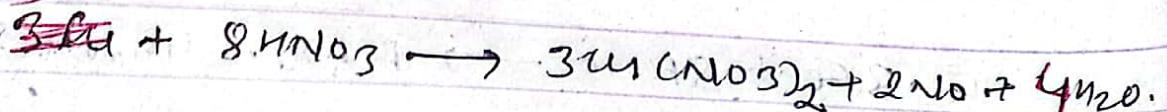


(b) with cold and conc. HNO_3 .



(c) with moderately conc. or dilute acid

~~3Cu~~

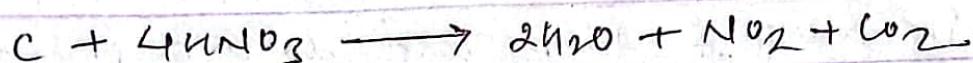


(3) Action with non-metals.

Dilute nitric acid has no action with non-metals. Hot and concentrated HNO_3 oxidizes non-metals like C, S, P, I etc.

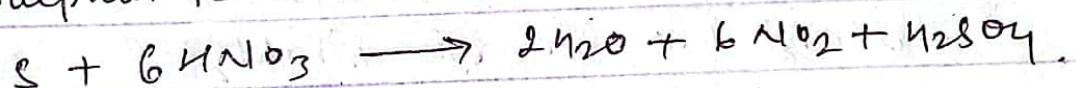
(i) with carbon:

Carbon is oxidized to CO_2 .



(ii) with sulphur

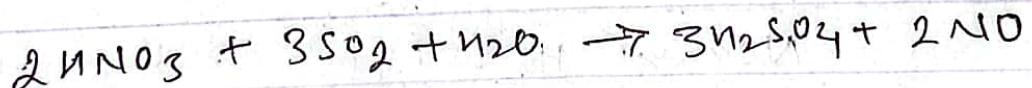
Sulphur is oxidized to sulphuric acid.



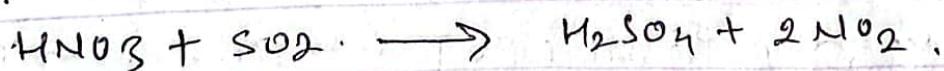
(iv) with SO_2

~~(1)~~ ~~(2)~~ Sulphur dioxide is oxidized to sulphuric acid, & HNO_3 reduced to NO & NO_2 .

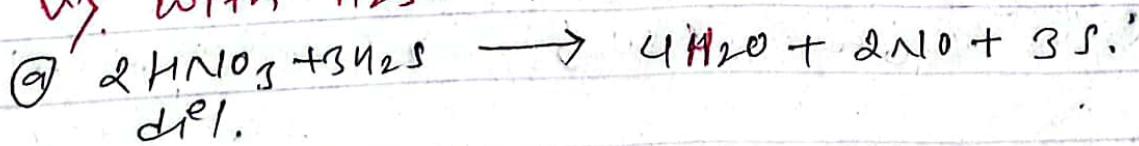
(2) with dilute ~~H_2O_2~~ , HNO_3



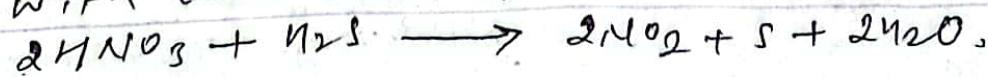
(iii) with cone. HNO_3



(v) with H_2S . \rightarrow oxidized to sulphur.



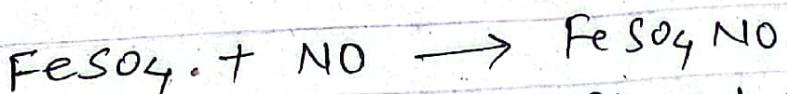
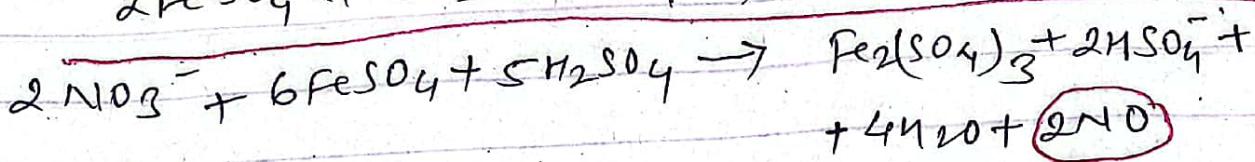
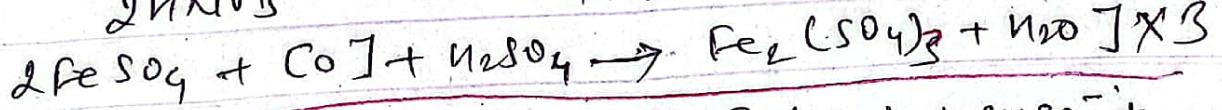
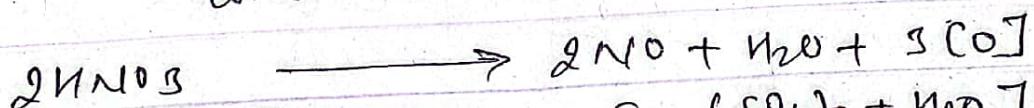
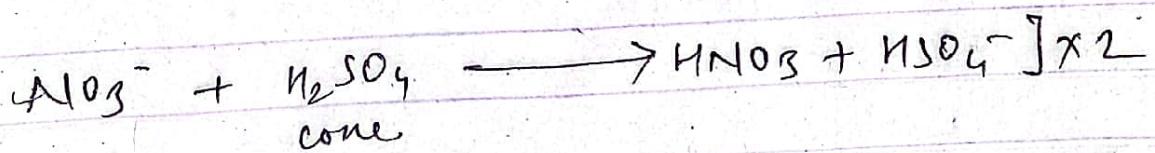
(5) with cone. $\text{HNO}_3 \rightarrow$



Ring Test for Nitrate (NO_3^-) ion

presence of nitrate (HNO_3 , or NO_3^-) in solution can be detected by ring test in wet test of salt analysis.

The ring test is performed in laboratory as, About (2ml) of sample solution is taken in a test tube and double volume (4ml) of conc. H_2SO_4 is added carefully. The solution is cooled and freshly prepared ferrous sulphate solution is added dropwise along the side of slightly inclined test tube. A brown ring is formed at the junction of two liquid layers such that H_2SO_4 at bottom and FeSO_4 as an upper layer.



Nitrosyl iron sulphate
(Brown ring)