

Chapter#4

Group VA and Group VIA Elements

1. Name the members of VA group.

Ans: Nitrogen (N), Phosphorus (P), Arsenic (As), Antimony (Sb), Bismuth (Bi)

2. Why phosphorus can make three and five covalent bonds?

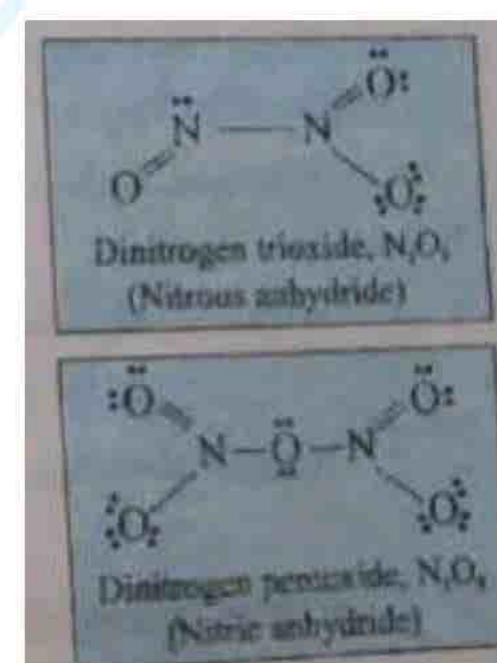
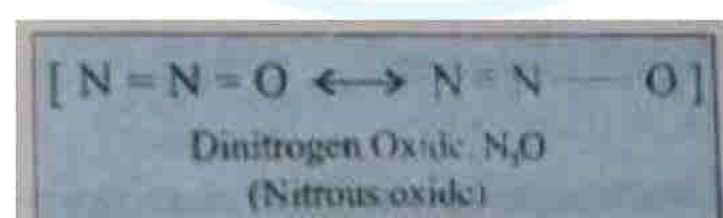
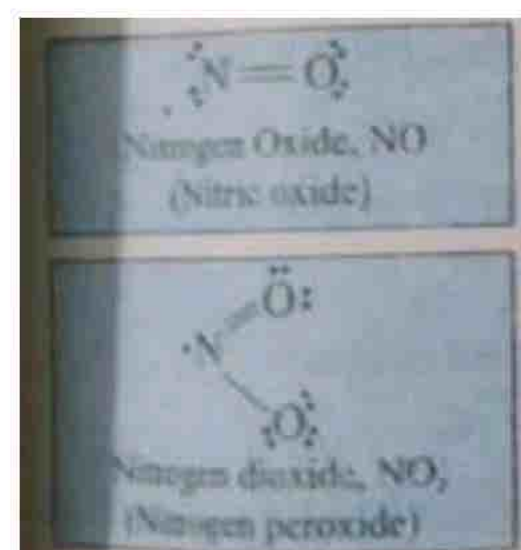
Ans: In phosphorus one of the 3s electrons can be promoted to a vacant 3d orbital giving 5 unpaired electrons in the valence shell. Phosphorus can thus make three or five covalent bonds. Indeed three and five are the common valencies of the group VA elements.

3. Why the elements of VIA other than oxygen show more than two oxidation states?

Ans: Except oxygen the other members of the group show a co-valency of +2, +4, and +6, for example, SCl_2 , SCl_4 , SCl_6 . +2 oxidation state is shown due to 2 unpaired electrons in the p-orbitals. +4 oxidation state is shown when 1 electron from p-orbital is promoted to the next vacant d-orbital, while +6 oxidation state is shown when another electron from s-orbital is also promoted to the next vacant d-orbital.

4. Name the oxides of nitrogen.

Ans: Nitrogen forms several oxides with oxygen. Common oxides of nitrogen are N_2O , NO and NO_2 . It also forms N_2O_3 and N_2O_5 .

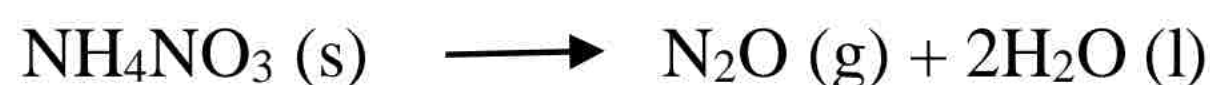


5. How dinitrogen oxide is prepared? OR Give any two methods of preparation of N_2O .

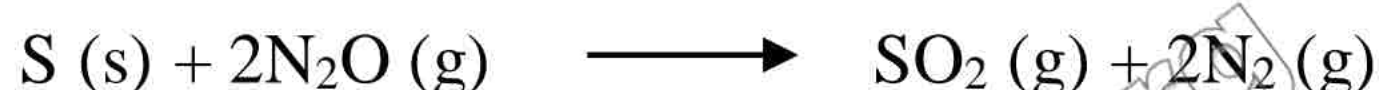
Ans: 1. Dinitrogen oxide can be prepared by the action of dil. HNO_3 , on metallic zinc.



2. It is usually prepared by heating ammonium nitrate to about $200^\circ C$.

**6. How sulphur and phosphorus are burnt using dinitrogen oxide?**

Ans: It is not combustible but resembles oxygen in rekindling a glowing splinter. Similarly, it supports combustion of burning substances, such as sulphur, phosphorus, etc. are taken in the cylinder containing this gas.

**7. How is dinitrogen oxide reduced?**

Ans: When N_2O is passed over red hot copper, it is reduced to nitrogen.

**8. How is nitrogen oxide prepared? OR Give any two methods of preparation of NO .**

Ans: 1. Nitrogen oxide can be prepared by the action of dil HNO_3 on copper.



2. It can also be prepared by passing air through an electric arc.

**9. How nitrogen oxide reacts with oxygen?**

Ans: With oxygen, it forms reddish brown nitrogen dioxide.

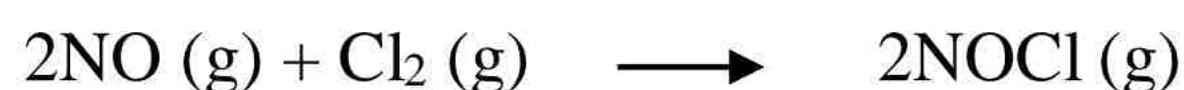


10. How nitrogen oxide decomposes?

Ans: It decomposes into N₂ and O₂ at about 1000°C and supports combustion.

**11. How nitrogen oxide reacts with chlorine?**

Ans: It forms nitrosyl chloride and nitrosyl bromide with chlorine and bromine, respectively in the presence of charcoal.

**12. What is ring test?or Describe "Ring test" for the confirmation of the presence of nitrates in solution.**

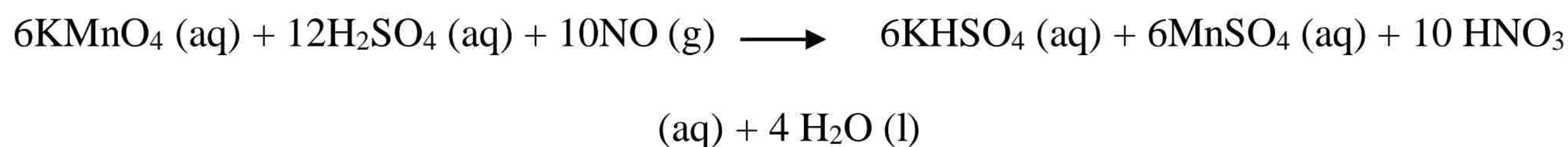
Ans: Nitrogen oxide forms a brown coloured addition compound with FeSO₄. This test is used to confirm the presence of nitrates (Ring Test).

**13. Give reaction of nitrogen oxide with reducing agents OR How NO is reduced?**

Ans: With reducing agents, it is reduced to nitrous oxide or nitrogen.

**14. Give reaction of nitrogen oxide with oxidizing agents OR How NO is oxidized?**

Ans: Oxidizing agents can oxidize NO to NO₂ or HNO₃.

**15. How is nitrogen dioxide prepared? OR How NO₂ is prepared from i. Lead nitrate ii. copper nitrate?**

Ans: It can be prepared in small quantities by heating lead nitrate.

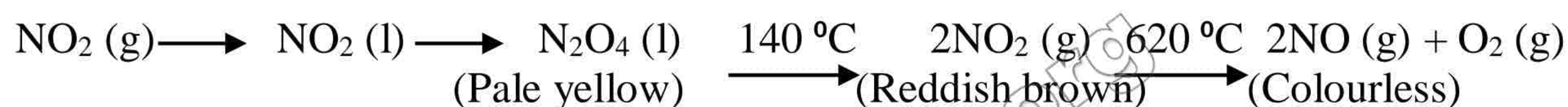


It can also be prepared by reacting conc. HNO_3 with copper.



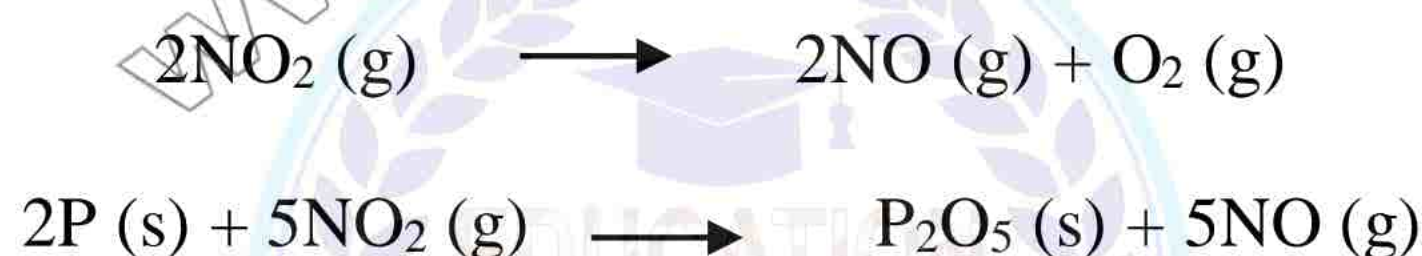
16. What is the effect of heat on nitrogen dioxide (NO_2)?

Ans: On cooling, NO_2 is converted into a yellow liquid which can be frozen to a colourless solid dinitrogen tetroxide (N_2O_4). If this solid is heated to 140°C , the mixture contains NO_2 and N_2O_4 but above 140°C NO_2 is converted to NO and O_2 molecules which are colourless. This decomposition is complete at 620°C .



17. How phosphorus burns in nitrogen dioxide?

Ans: Elements like phosphorus, potassium and carbon continue burning in NO_2 as it yields O_2 on decomposition.



18. How nitrogen dioxide reacts with water?

Ans: In the absence of air, it dissolves in water to form nitric and nitrous acids.



However in the presence of air or oxygen, nitric acid is the final product.



19. How nitrogen dioxide reacts with alkalies?

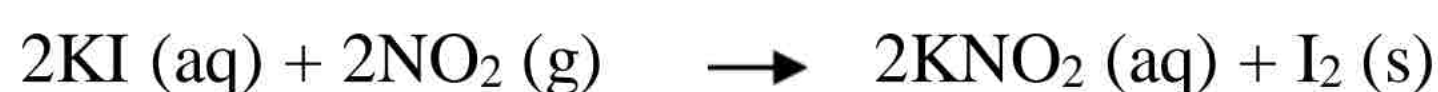
Ans: A mixture of nitrate and nitrite is formed when NO_2 is passed through strong alkalies.





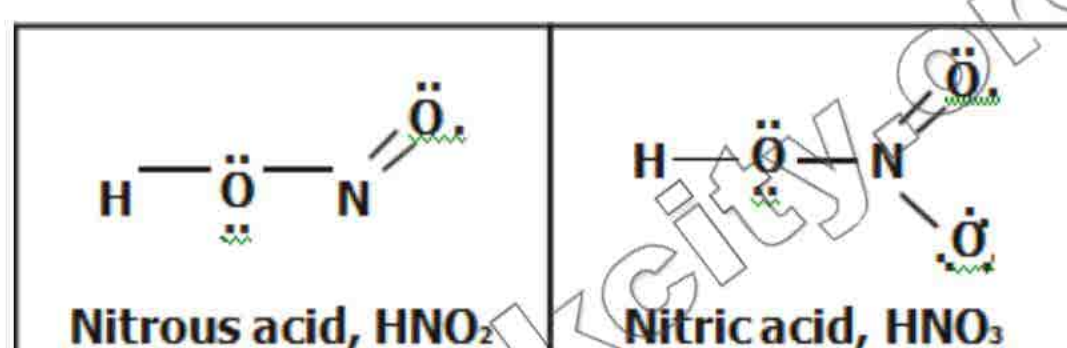
20. How nitrogen dioxide acts as an oxidizing agent?

Ans: It is a strong oxidizing agent and oxidizes H_2S to sulphur, ferrous sulphate to ferric sulphate and KI to I_2 .



21. Name the oxyacids of nitrogen.

Ans: There are two important oxyacids of nitrogen, nitrous acid and nitric acid.



22. How nitrous acid is prepared?

Ans: 1. It can be prepared by dissolving dinitrogen trioxide in water at 0°C .



2. Pure nitrous acid solution can be prepared by reaction between ice cold barium nitrite solution and ice cold dilute sulphuric acid.



23. How is nitrous acid decomposed?

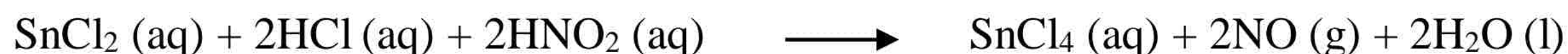
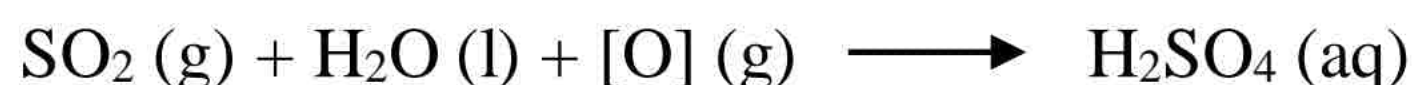
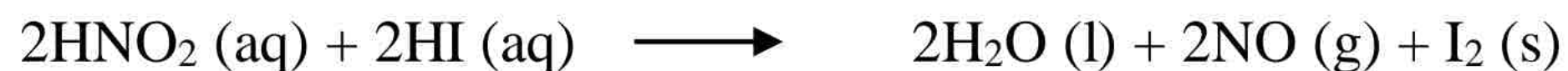
Ans: It begins to decompose almost as soon as it is formed even at ordinary temperature.



24. How nitrous acid acts as an oxidizing agent?

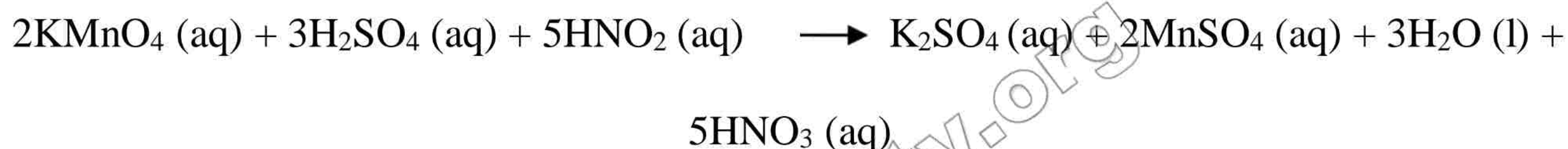
Ans: It acts as an oxidizing agent and oxidizes HI, SO_2 and SnCl_2 into I_2 , H_2SO_4 and SnCl_4 ,

respectively.



25. Give reaction of nitrous acid with acidified KMnO_4 and bromine water. OR How nitrous acid acts as a reducing agent?

Ans: Nitrous acid decolourizes acidified KMnO_4 and bromine water. It readily gets oxidized to nitric acid, so it also behaves as a reducing agent.



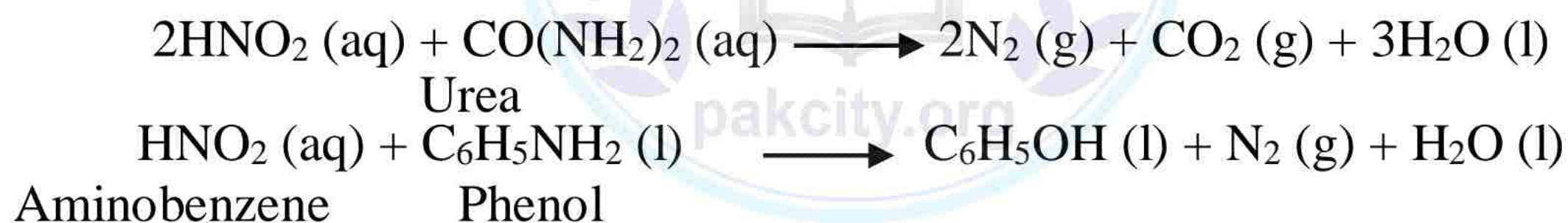
26. How nitrous acid reacts with alkalies?

Ans: As an acid it reacts with alkalies producing salts.



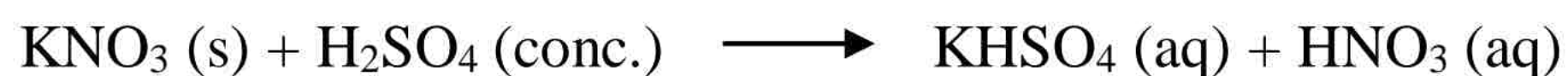
27. How nitrous acid reacts with organic compounds?

Ans: It also reacts with organic compounds containing NH_2 group and produces nitrogen.



28. How is nitric acid prepared?

Ans: In the laboratory, nitric acid is prepared by heating potassium nitrate crystals with concentrated sulphuric acid.



29. Which steps are involved in Birkeland and Eyde's process?

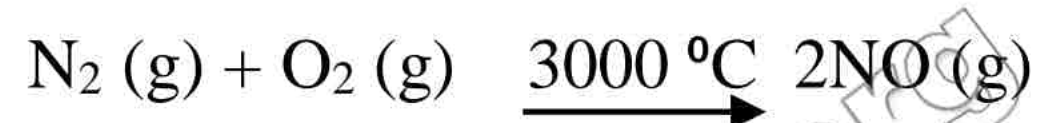
Ans: Following steps are involved in Birkeland and Eyde's process:

1. Formation of nitric oxide
2. Formation of nitrogen dioxide
3. Formation of nitrous acid
4. Formation of nitric acid

30. Give the reactions involved in Birkeland and Eyde's process.

Ans: Following reactions are involved in Birkeland and Eyde's process:

1. Formation of nitric oxide



2. Formation of nitrogen dioxide



3. Formation of nitrous acid



4. Formation of nitric acid

**31. How is nitric acid decomposed?**

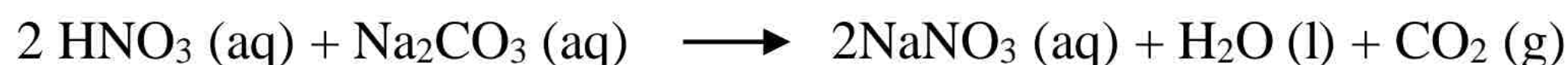
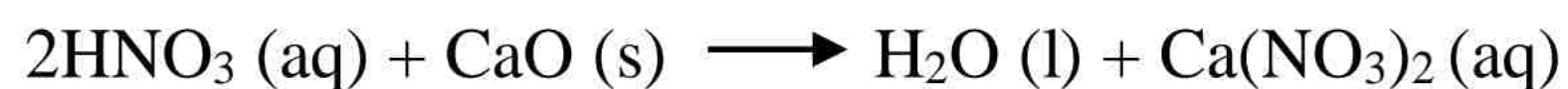
Ans: Nitric acid is decomposed in the presence of light even at ordinary temperature.

**32. Mention reaction of nitric acid with bases.**

(All These reactions can come as separate short questions also. Learn any two reactions as answer to this)

Ans: It is a very strong acid. It exhibits all the usual general properties of acids in all reactions

where its oxidizing properties are not shown. It reacts in normal way with basic oxides, hydroxides and carbonates forming respective salts.



33. Mention action of nitric acid as an oxidizing agent. (Mention any four reactions for answer to short question. All reactions mentioned can come as separate short question)

Ans: (i) It acts as a strong oxidizing agent due to the ease with which it is decomposed.



(ii) It oxidizes non-metals to their corresponding oxides.



(iii) Metalloids like arsenic and antimony can be oxidized to their corresponding acids.



34. How nitric acid reacts with metals?

(All These reactions can come as separate short questions also. Learn any four reactions as answer to this)

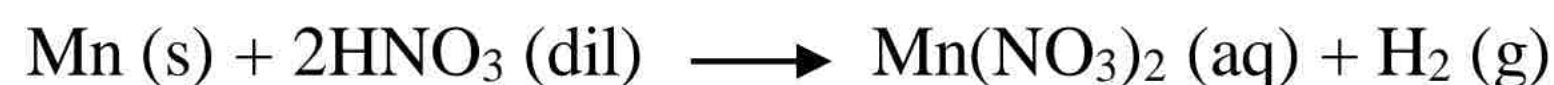
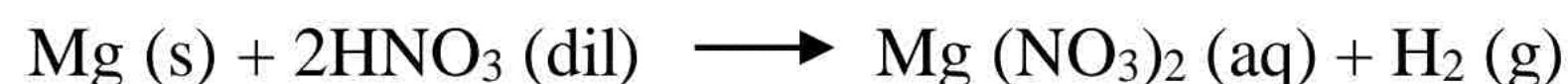
Ans: Nitric acid behaves differently with different metals.

(a) Gold, platinum, iridium and titanium do not react.

(b) Iron, cobalt, nickel, chromium, aluminium are rendered passive by acid due to the formation of a film of their oxides over them.

(c) Tungsten and uranium are changed into their oxides.

(d) Magnesium, calcium and manganese give hydrogen with dilute nitric acid.



(e) Copper and lead give nitric oxide with dilute acid and nitrogen dioxide with concentrated acid.



(f) Mercury gives mercurous nitrate and nitric oxide with dilute nitric acid.



With concentrated acid, it gives mercuric nitrate and NO_2



(g) Silver reacts with nitric acid to give silver nitrate and nitric oxide



(h) Dilute nitric acid gives ammonium nitrate, when it reacts with tin. With concentrated acid meta-stannic acid is produced.

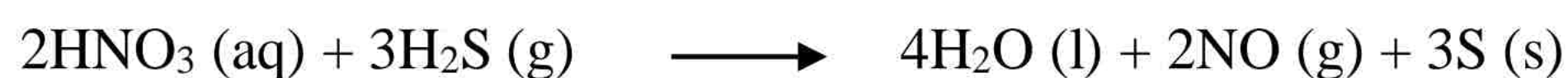
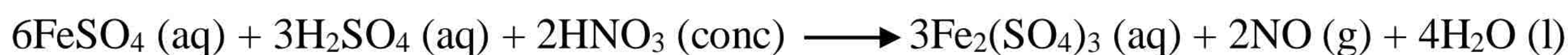


(i) Zinc gives different products depending upon the concentration of acid and temperature. Very dilute nitric acid gives NH_4NO_3 . Moderately dilute nitric acid gives nitrous oxide while concentrated nitric acid gives NO_2 .



35. How nitric acid reacts with reducing agents?

Ans: Reducing agents like FeSO_4 , H_2S and HI are converted to $\text{Fe}_2(\text{SO}_4)_3$, S and I_2 , respectively, when they react with conc. HNO_3



36. What is meant by fuming nitric acid?

Ans: Concentrated HNO_3 is a colourless volatile liquid and it fumes strongly in air to evolve NO_2 gas. Therefore, mixture of $\text{HNO}_3 + \text{NO}_2$ is called fuming nitric acid.

37. What is aqua regia? OR How aqua regia dissolves gold?



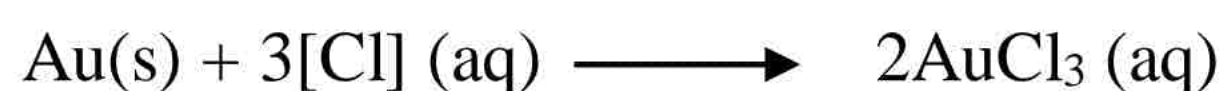
Ans: When one volume of concentrated HNO_3 is mixed with 3 volumes of concentrated HCl , aqua regia is formed. It is employed to dissolve gold and platinum.



NOCl formed is decomposed giving NO and Cl_2



This liberated chlorine gas converts noble metals such as gold and platinum into their water soluble chlorides.



38. Give the names of four elements which do not react with nitric acid.

Ans: Gold, platinum, iridium and titanium do not react as they are noble metals and are not

oxidized by nitric acid.

39. What are the uses of nitric acid?

Ans: It is used:

1. for making varnishes and organic dyes.
2. in the manufacture of explosives.
3. in the manufacture of nitrogen fertilizers.
4. as a laboratory reagent.

40. Name the minerals of phosphorus.

Ans: The two ores of phosphorus are impure $\text{Ca}_3(\text{PO}_4)_2$ and apatite $\text{Ca}_5\text{F}(\text{PO}_4)_3$.

41. Name three allotropic forms of phosphorus.

Ans: The three allotropes of phosphorus are:

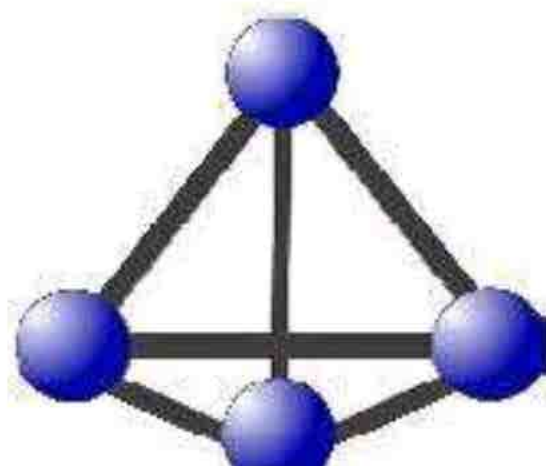
Whitephosphorus

Red phosphorus

Black phosphorus

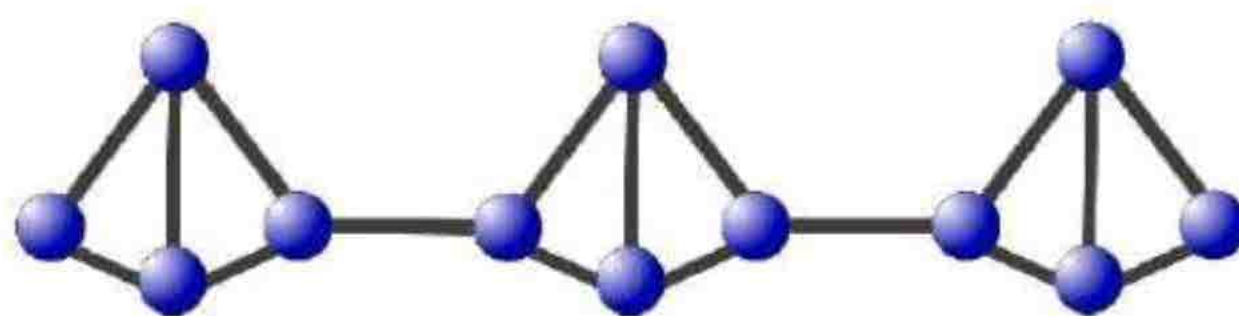
42. What are the characteristics of white phosphorus?

Ans: White phosphorus is a very reactive, poisonous, volatile, waxy, yellowish white substance, which is soluble in benzene and carbon disulphide. It exists in the form of tetraatomic molecules (P_4) which have a tetrahedral structure. It boils at 280°C to P_4 vapours which dissociate above 700°C to form P_2 molecules.



43. What are the characteristics of red phosphorus?

Ans: Red phosphorus is much less reactive and less poisonous than white phosphorus. It is prepared by heating white phosphorus in the presence of a little iodine or sulphur as a catalyst up to 250 °C in vacuum. The tetra-atomic molecules of red phosphorus combine to form macromolecules.



44. What are the characteristics of black phosphorus?

Ans: Black phosphorus is the third form which is most stable under ordinary conditions. Black phosphorus is prepared by heating red phosphorus to high temperature and pressure.

45. How phosphorus trichloride is prepared? OR Give any two methods of preparation of PCl_3 .

Ans: 1. It is usually prepared by melting white phosphorus in a retort in an inert atmosphere of CO_2 and current of dried chlorine is passed over it. The vapours of PCl_3 are collected in a flask kept in an ice-bath.



2. It may also be prepared by the action of phosphorus with thionyl chloride.



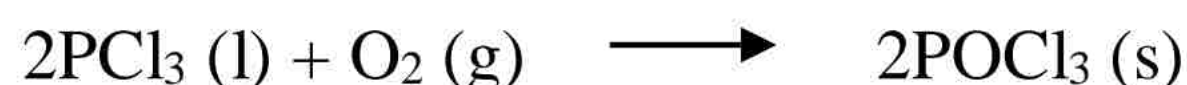
46. How phosphorus trichloride reacts with chlorine?

Ans: It combines with chlorine to form phosphorus pentachloride.



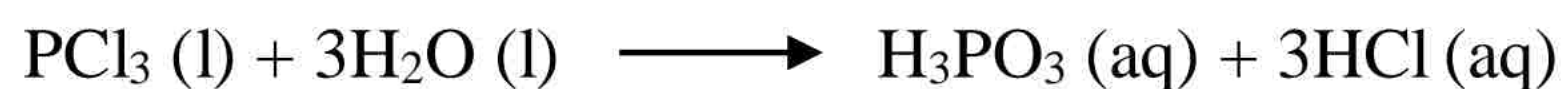
47. How phosphorus trichloride reacts with oxygen?

Ans: It combines with atmospheric oxygen slowly to form phosphorus oxychloride.

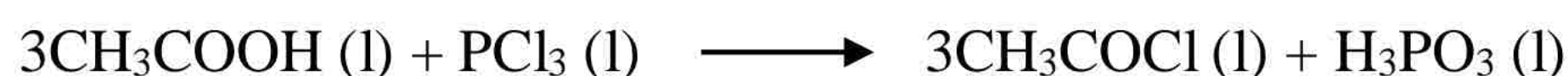


48. How phosphorus trichloride reacts with water?

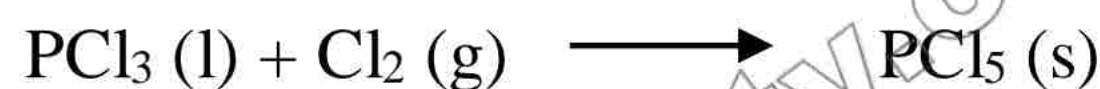
Ans: It is soluble in organic solvents, but readily reacts with water to form phosphorus acid.

**49. How phosphorus trichloride reacts with alcohol and carboxylic acid?**

Ans: It reacts with alcohols and carboxylic acids forming the respective chloro derivatives and H_3PO_3 .

**50. How phosphorus pentachloride is prepared?**

Ans: 1. By passing dry chlorine through phosphorus trichloride.



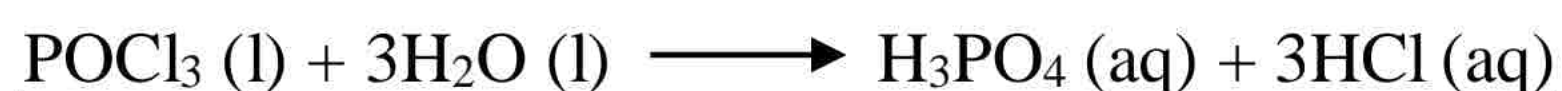
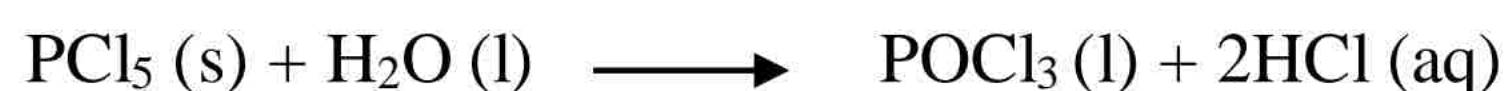
2. It may also be prepared by passing dry chlorine in a well cooled solution of phosphorus in carbon disulphide

**51. How phosphorus pentachloride is decomposed on heating?**

Ans: It decomposes on heating producing PCl_3 and chlorine.

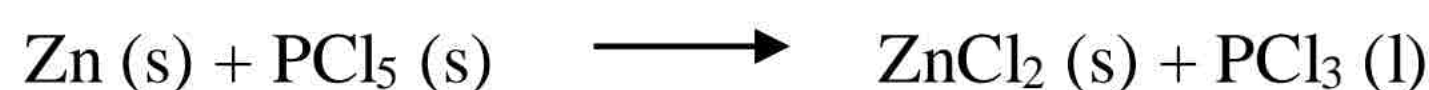
**52. How phosphorus pentachloride reacts with water?**

Ans: It gets decomposed by water forming phosphorus oxychloride which further reacts with water to produce orthophosphoric acid.



53. How phosphorus pentachloride reacts with metals?

Ans: It converts metals into their chlorides.

**54. How phosphorus trioxide is prepared?**

Ans: P_2O_3 can be prepared by burning white phosphorus in a limited supply of air.

**55. How phosphorus trioxide reacts with air?**

Ans: When heated in the presence of air or oxygen, it is converted into phosphorus pentoxide.

**56. How phosphorus trioxide reacts with cold water?**

Ans: It reacts with cold water to give phosphorus acid.



With hot water, it forms phosphine and phosphoric acid.

**57. How phosphorus pentaoxide is prepared in lab?**

Ans: It is prepared by burning phosphorus in excess of dry air.

**58. How phosphorus pentaoxide reacts with water? OR How P_2O_5 reacts with hot and cold water?**

Ans: With cold water phosphorus pentoxide forms metaphosphoric acid.

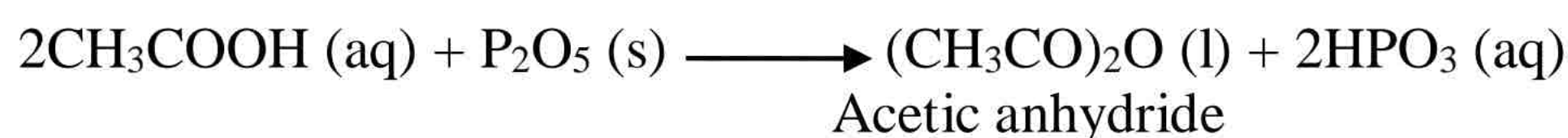
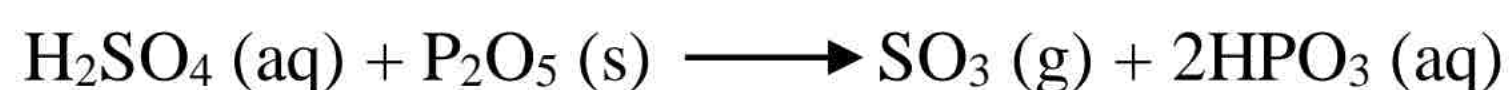


With hot water, it forms orthophosphoric acid



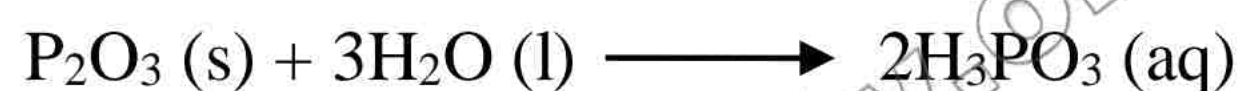
59. What is the role of phosphorus pentaoxide as a dehydrating agent? OR P_2O_5 is a powerful dehydrating agent. Prove giving example.

Ans: It is a powerful dehydrating agent, thus, with HNO_3 , H_2SO_4 , CH_3COOH and C_2H_5OH , it gives N_2O_5 , SO_3 , $(CH_3CO)_2O$ and C_2H_4 , respectively.



60. How is phosphorus acid prepared?

Ans: It is prepared by dissolving phosphorus trioxide in cold water.



It is also obtained by the hydrolysis of phosphorus trichloride.



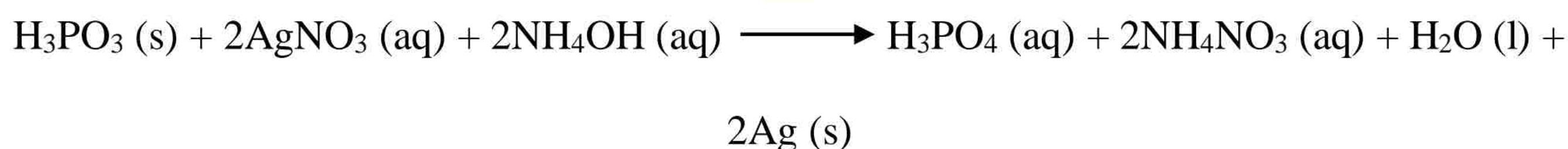
61. How phosphorus acid is decomposed?

Ans: It decomposes into phosphine and orthophosphoric acid on heating.



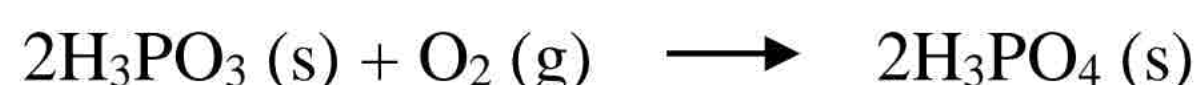
62. Phosphorus trioxide acts as a reducing agent. Justify.

Ans: It is a powerful reducing agent and reduces $CuSO_4$, $AgNO_3$, etc. to the metallic state.



63. How does phosphorus acid react with oxygen?

Ans: It reacts with oxygen to form orthophosphoric acid.



64. How phosphorus acid is reduced?

Ans: Nascent hydrogen produced by Zn/HCl reduces H_3PO_3 to phosphine

**65. How is orthophosphoric acid prepared? (For short question learn any two methods well)**

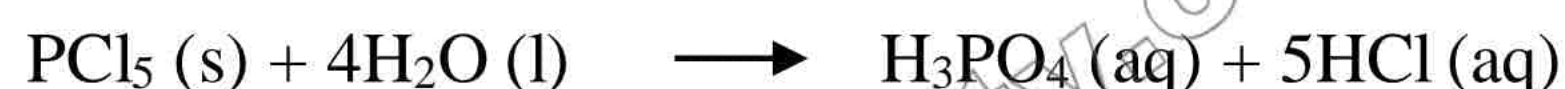
Ans: 1. It is prepared by dissolving phosphorus pentoxide in hot water.



2. It is also obtained by heating red phosphorus with concentrated HNO_3 .



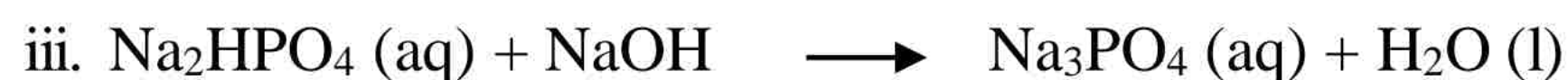
3. Hydrolysis of phosphorus pentachloride also gives orthophosphoric acid.



4. On large scale, it can be prepared by heating a mixture of phosphorite (bone ash) and sand in an electric furnace. The phosphorus pentoxide formed is treated with hot water to obtain phosphoric acid.

**66. Prove that phosphoric acid is a tribasic acid.**

Ans: It is a weak tribasic acid. It reacts with NaOH to give three series of salts.

**67. What is the effect of heat on phosphoric acid?**

Ans: On heating, it loses water and converted into pyro and metaphosphoric acid.



68. Name the elements of group VI A. Why are they called chalcogens?

Ans: The group VIA of the periodic table consists of oxygen, sulphur, selenium, tellurium and polonium. These elements are called chalcogens from the Greek for “copper giver”, because they are often found in copper ores.

69. Name the ores of sulphur (Formulae of individual ores can be asked separately)

Ans: Following are the ores of sulphur:

Sulphides, e.g, galena (PbS), Zinc blende (ZnS), cinnabar (HgS), stibnite (Sb₂S₃), copper pyrite (Cu₂S.Fe₂S₃), iron pyrite (FeS₂), etc. Some important sulphates are also found in nature, e.g. gypsum (CaSO₄), heavy spar (BaSO₄)

70. Mention the similarities of oxygen and sulphur.

(Mention any four as answer to short question)

- Ans:**
- Both oxygen and sulphur have same outer electronic configuration of ns²p⁴.
 - Both oxygen and sulphur are usually divalent.
 - Both oxygen and sulphur exhibit allotropic forms.
 - Both have polyatomic molecules. Oxygen has diatomic O₂, while sulphur has S₂ and S₈ molecules.
 - Both combine with metals in the form of O⁻² and S⁻² with oxidation state -2.
 - Both combine with non-metals and form covalent compounds, e.g, H₂O and H₂S, CO₂ and CS₂, etc.
 - Both are typical non-metals.
 - Both are found in free and combined states on earth.

71. Mention the differences between oxygen and sulphur. (For short learn any four differences)

Ans:

Oxygen	Sulphur
1. There are two allotropic forms of oxygen O_2 and O_3	1. There are three allotropic forms of sulphur, rhombic, monoclinic and plastic
2. It is gas at ordinary temperature	2. It is solid at ordinary temperature
3. Oxygen is sparingly soluble in water	3. Sulphur is not soluble in water
4. Oxygen helps in combustion	4. Sulphur is itself combustible
5. It is paramagnetic in nature	5. It is diamagnetic in nature
6. It does not react with water	6. When steam is passed through boiling sulphur a little hydrogen sulphide and sulphur dioxide are formed
7. It does not react with acids	7. It is readily oxidized by conc. Sulphuric acid or nitric acid
8. It does not react with alkalies	8. It reacts with alkali solution and forms sulphides and thiosulphates
9. It shows -2 oxidation state	9. It shows oxidation states of -2, +2, +4 and +6

72. Mention the principle of contact process.

Ans: SO_2 obtained by burning sulphur or iron pyrites is oxidized to SO_3 in the presence of V_2O_5 which acts as a catalyst. The best yield of SO_3 can be obtained by using excess of oxygen or air

and keeping the temperature between 400-500°C. SO_3 formed is absorbed in concentrated H_2SO_4 and "Oleum" ($\text{H}_2\text{S}_2\text{O}_7$) formed can be converted to sulphuric acid of any strength by mixing adequate quantities of water.

73. Name the stages of contact process.

Ans: Following are the steps/stages in contact process:

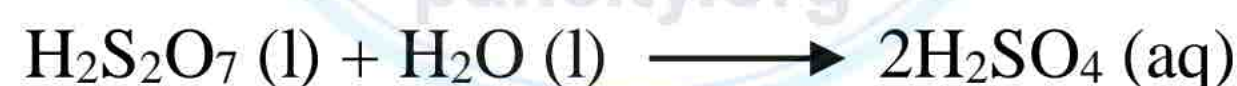
- a. Sulphur burner
- b. Purifying unit
 - i. Dust remover
 - ii. Cooling Pipes
 - iii. Scrubbers
 - iv. Drying Tower
 - v. Arsenic Purifier
 - vi. Testing box
 - vii. Contact tower

74. Why SO_3 is dissolved in sulphuric acid and not in water?

Ans: When SO_3 is dissolved in 98% H_2SO_4 , we obtain Pyrosulphuric acid or (Oleum).



Oleum can be converted to sulphuric acid of any required concentration by adding water.



If SO_3 is dissolved in water directly, a highly exothermic reaction occurs in which heat energy is released and it vaporizes sulphuric acid to make mist or fog. This fog does not condense easily.

75. Give the advantages of contact process for the manufacture of sulphuric acid.

Ans: Solid catalyst V_2O_5 is used and nitrogen oxide impurities are not present. Sulphuric acid is

produced up to 100% in this process.

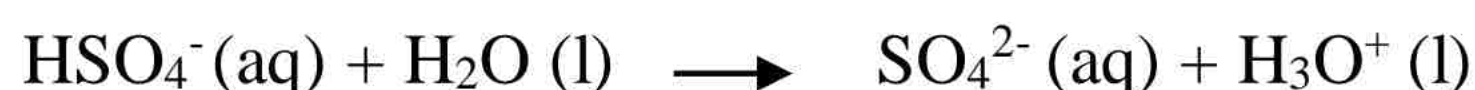
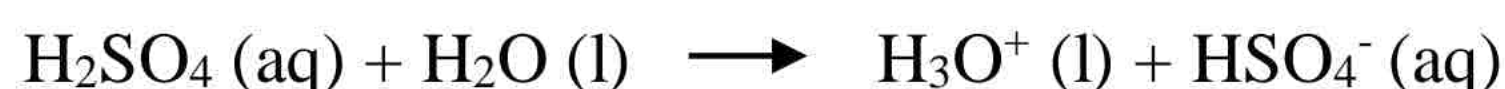
76. Tell about the stability of sulphuric acid

Ans: It is stable at ordinary temperature but on strong heating it dissociates into SO_3 and H_2O .



77. Prove that sulphuric acid is a strong acid.

Ans: It is a strong acid. In an aqueous solution it completely ionizes to give hydrogen, hydrogen sulphate and sulphate ions. The dissociation takes place in two steps.



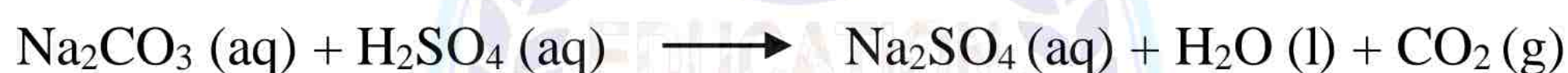
78. Mention the reaction of sulphuric acid with alkalies.

Ans:



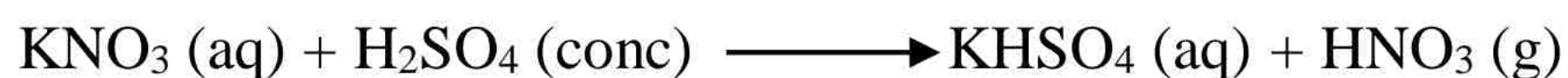
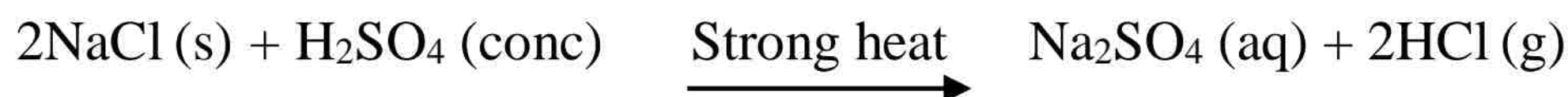
79. How sulphuric acid reacts with carbonates and bicarbonates?

Ans:



80. How sulphuric acid reacts with salts?

Ans:

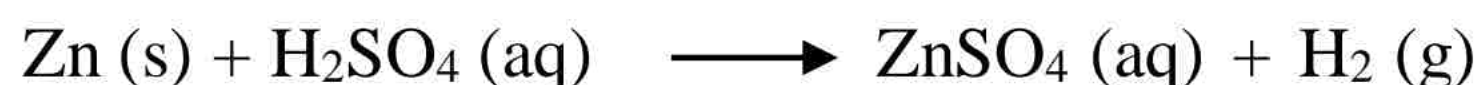
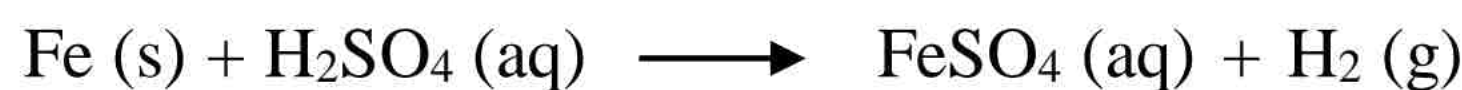


81. How sulphuric acid reacts with metals?

(These reactions can come separately as individual short questions. Mention any four as

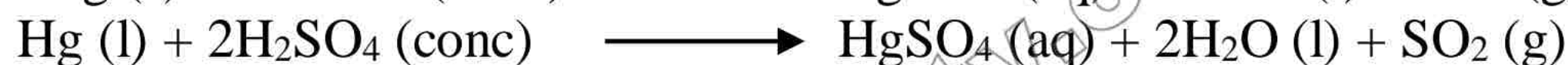
answer to this question)

Ans: (a) Cold dilute acid reacts with almost all metals to produce hydrogen gas and sulphate salts.



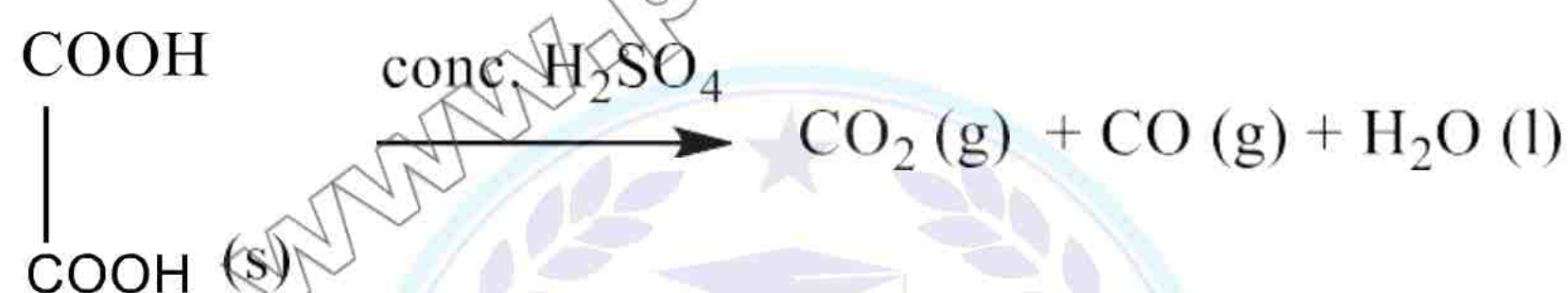
(b) Cold concentrated H_2SO_4 does not react with most of the metals like Cu, Ag, Hg, Pb, Au.

(c) With certain metals hot concentrated sulphuric acid gives metal sulphates, water and SO_2 .



82. How sulphuric acid acts as a dehydrating agent?

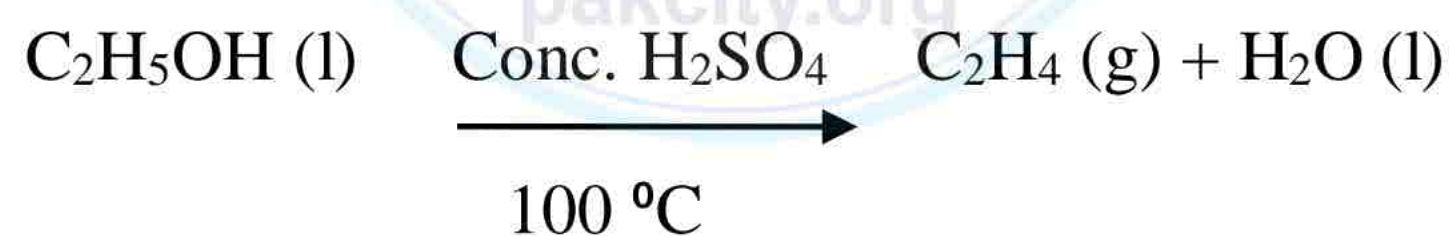
Ans: (i) With oxalic acid it forms CO_2 and CO .



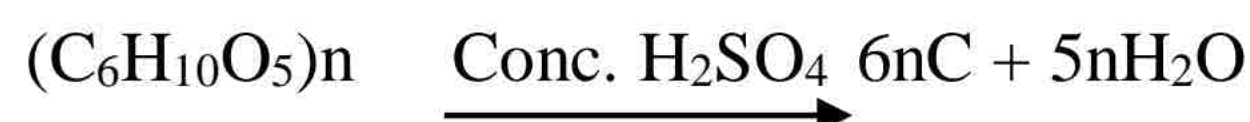
(ii) With formic acid, CO is formed.



(iii) With ethyl alcohol it forms ethylene.



(iv) With wood, paper, sugar and starch it forms carbon and water.

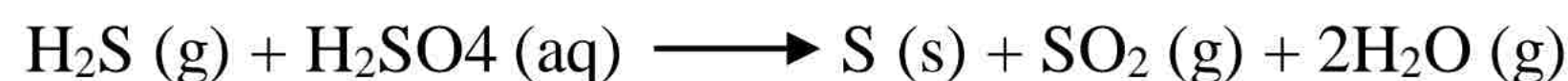


83. How sulphuric acid acts as an oxidizing agent?

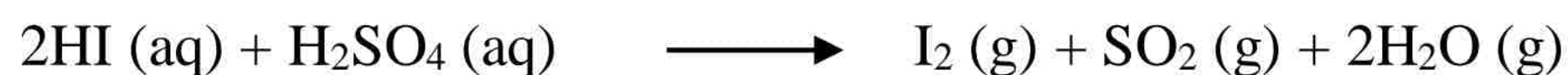
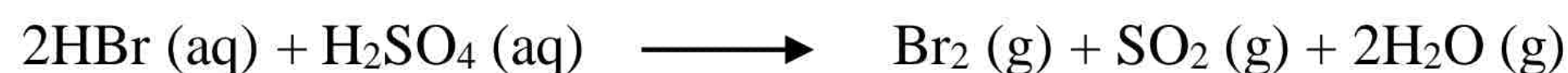
Ans: (i) It oxidizes C and S giving CO₂ and SO₂, respectively.



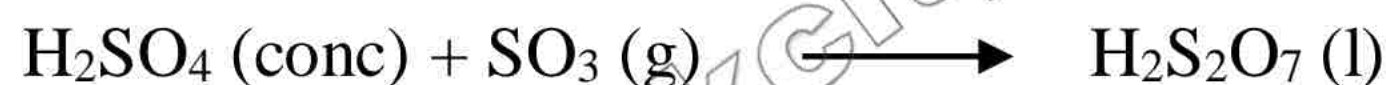
(ii) H₂S is oxidized to S.



(iii) Reactions of H₂SO₄ with HBr and HI produces bromine and iodine respectively.

**84. How sulphuric acid reacts with gases.**

Ans: (i) It absorbs SO₃ and forms oleum

**85. How sulphuric acid reacts with ammonia?**

Ans: It reacts with ammonia forming ammonium sulphate.

**86. How sulphuric acid reacts with benzene?**

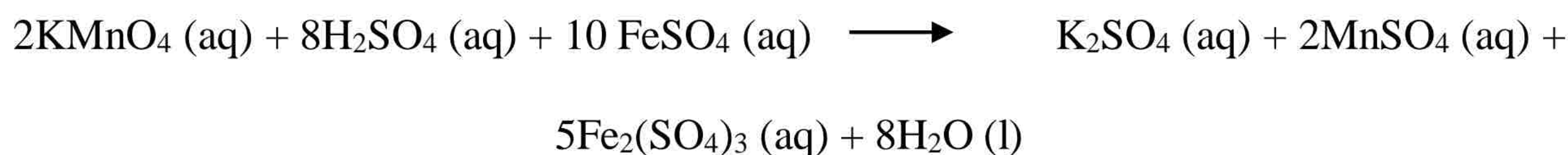
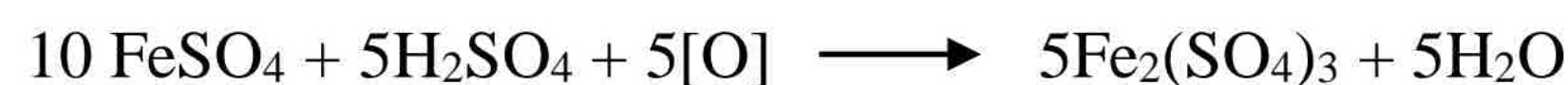
Ans: Benzene sulphonic acid is produced when H₂SO₄ reacts with benzene.

**87. Give precipitation reactions of sulphuric acid.**

Ans: White precipitates are produced when H₂SO₄ reacts with solutions of BaCl₂, Pb(NO₃)₂ and Sr(NO₃)₂.

**88. How sulphuric acid reacts with oxidizing agents?**

Ans: It reacts with oxidizing agents like KMnO_4 and $\text{K}_2\text{Cr}_2\text{O}_7$ to liberate oxygen which may oxidize other compounds.



89. Mention uses of sulphuric acid.

Ans: It is used

1. In the manufacture of fertilizers like ammonium sulphate and calcium superphosphate.
2. In refining of petroleum to remove nitrogen and sulphur compounds.
3. In the manufacture of HCl , H_3PO_4 , HNO_3 and sulphates.
4. In the manufacture of many chemicals, dyes, drugs, plastics, disinfectants, paints, explosives, synthetic fibers, etc.
5. In electrical batteries and storage cells.
6. As a dehydrating agent for drying gases.
7. As a laboratory reagent.
8. In textile, iron, steel, leather and paper industries.

90. Justify that sulphuric acid is king of chemicals.

Ans: Sulphuric acid is called king of chemicals because of its direct and indirect applications in manufacture of many chemicals including fertilizers. It dissolves its own compounds. It replaces salts from weaker acids. It is ideal to call sulphuric acid asking of chemicals. It acts as an oxidizing and dehydrating agent for a variety of compounds.

91. Mention physical properties of sulphuric acid OR Mention any four physical properties of

sulphuric acid.

(In case of short question mention any four properties)

Ans: Following are the physical properties of sulphuric acid:

1. Pure sulphuric acid is a colourless oily liquid without an odour.
2. Its specific gravity is 1.834 at 18°C. 3. It freezes at 10.5°C.
4. Its boiling point is 338°C.
5. It dissolves in water liberating a lot of heat which raises the temperature of the mixture up to 120°C. H_2SO_4 should always be poured in water in a thin stream to avoid any accident.
6. Pure acid is a nonconductor of electricity but the addition of a little water makes it a good conductor.
7. It is extremely corrosive to skin and causes very serious burns to all the tissues.

92. Complete and balance the following equations.

Ans:

