

## Nitric Acid

## IMPORTANT POINTS TO REMEMBER

1. Nitric acid is commonly called as **aqua fortis**, i.e., **strong water**. **Glauber** first prepared Nitric acid by distilling mixture of **nitre** and **concentrated Sulphuric acid**.

2. Traces of Nitric acid come on to the earth in the form of **Acid rain**.

3. In laboratory, Nitric acid is prepared by distilling either **Sodium nitrate ( $\text{NaNO}_3$ )** or **Potassium nitrate ( $\text{KNO}_3$ )** with **concentrated Sulphuric acid**. (Fig.1)

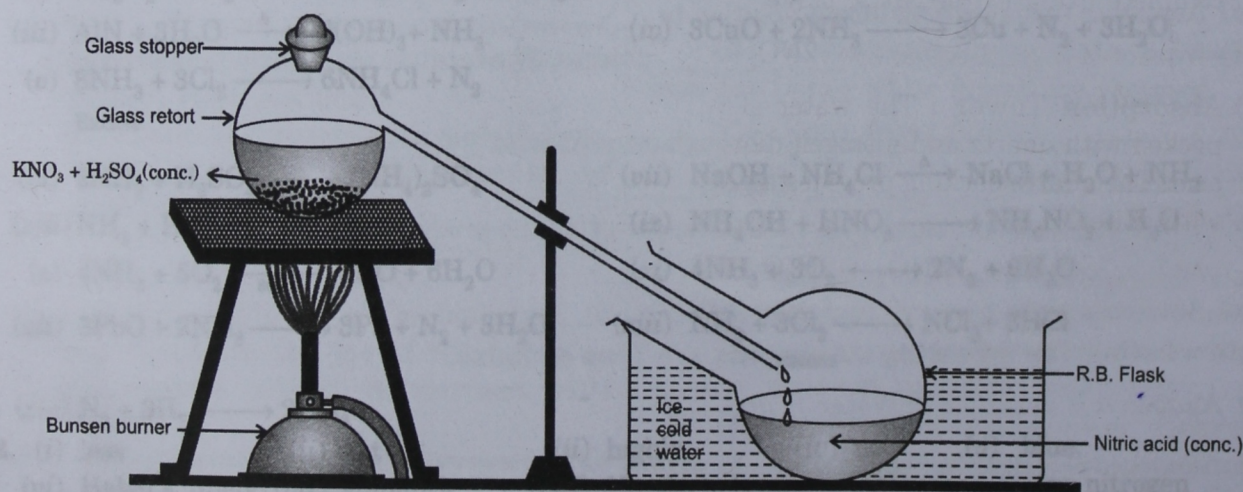
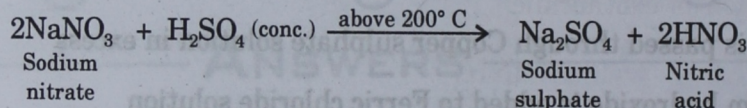
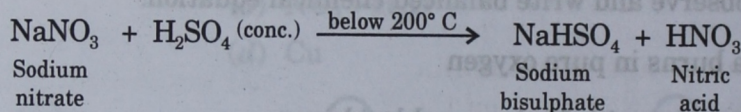
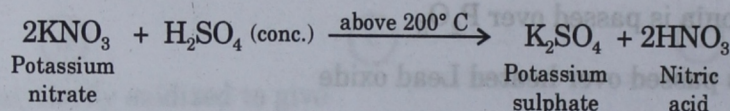
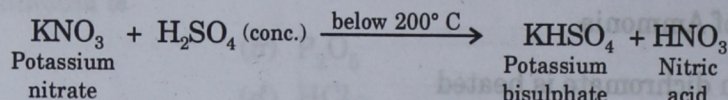
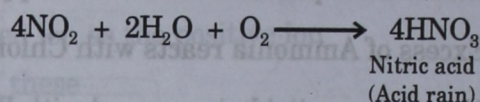
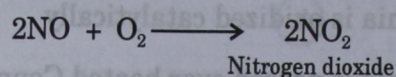
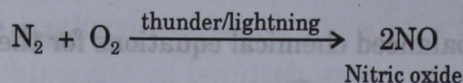
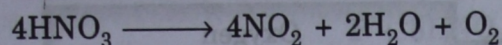


Fig. 1. Laboratory preparation of Nitric acid

4. The reaction mixture should **not** be heated beyond **200 °C** because Nitric acid **decomposes** at higher temperatures. Above 200 °C sodium sulphate forms a hard crust which sticks to the wall of apparatus and is very difficult to remove and apparatus gets damaged.



5. The **apparatus** used for the **preparation of Nitric acid** must be made of all **glass** as the **vapours of Nitric acid** are **corrosive**, therefore, it **damages** the **rubber and cork**.

Vapours of nitric acid get condensed into pale yellow liquid by cooling the receiver with the cold water in this way the nitric acid gets collected.

6. **Pure Nitric acid** is **colourless** however **commercial sample** of **Nitric acid** is **pale yellow** in colour due to the presence of **dissolved Nitrogen dioxide**.

7. Nitric acid is manufactured by **Ostwald's process**. (Fig. 2)

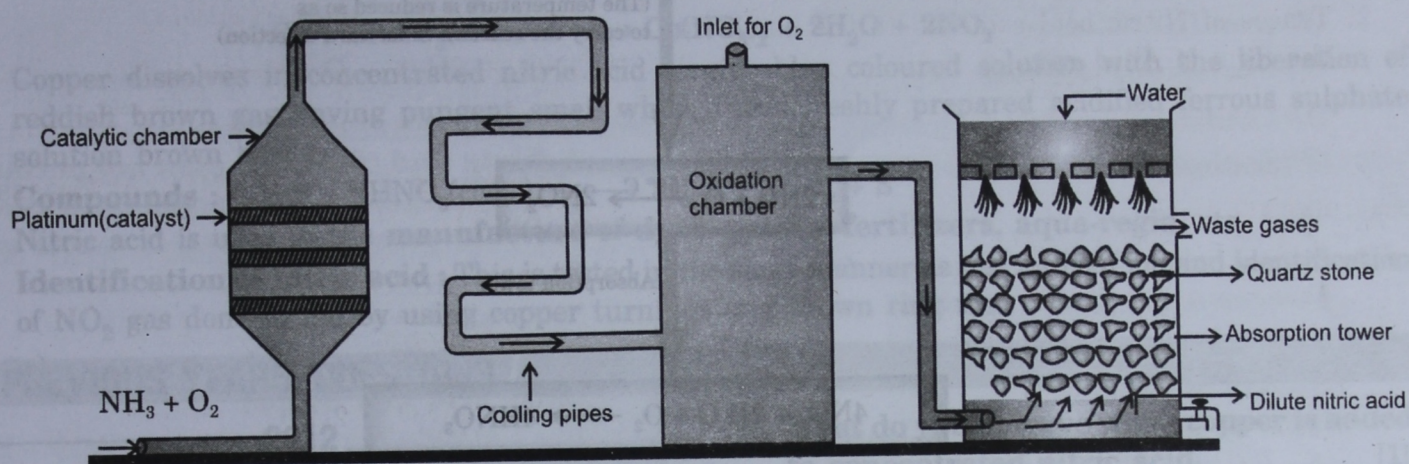
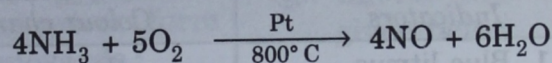
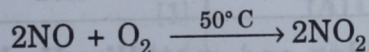


Fig. 2. Manufacture of Nitric acid by Ostwald's process

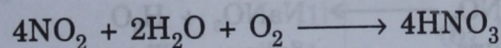
- (a) **Catalytic oxidation of Ammonia** : The gases entering the catalytic chamber must be absolutely pure otherwise it would poison the catalyst. Only the initial heating of the catalyst is required as the reaction is exothermic.



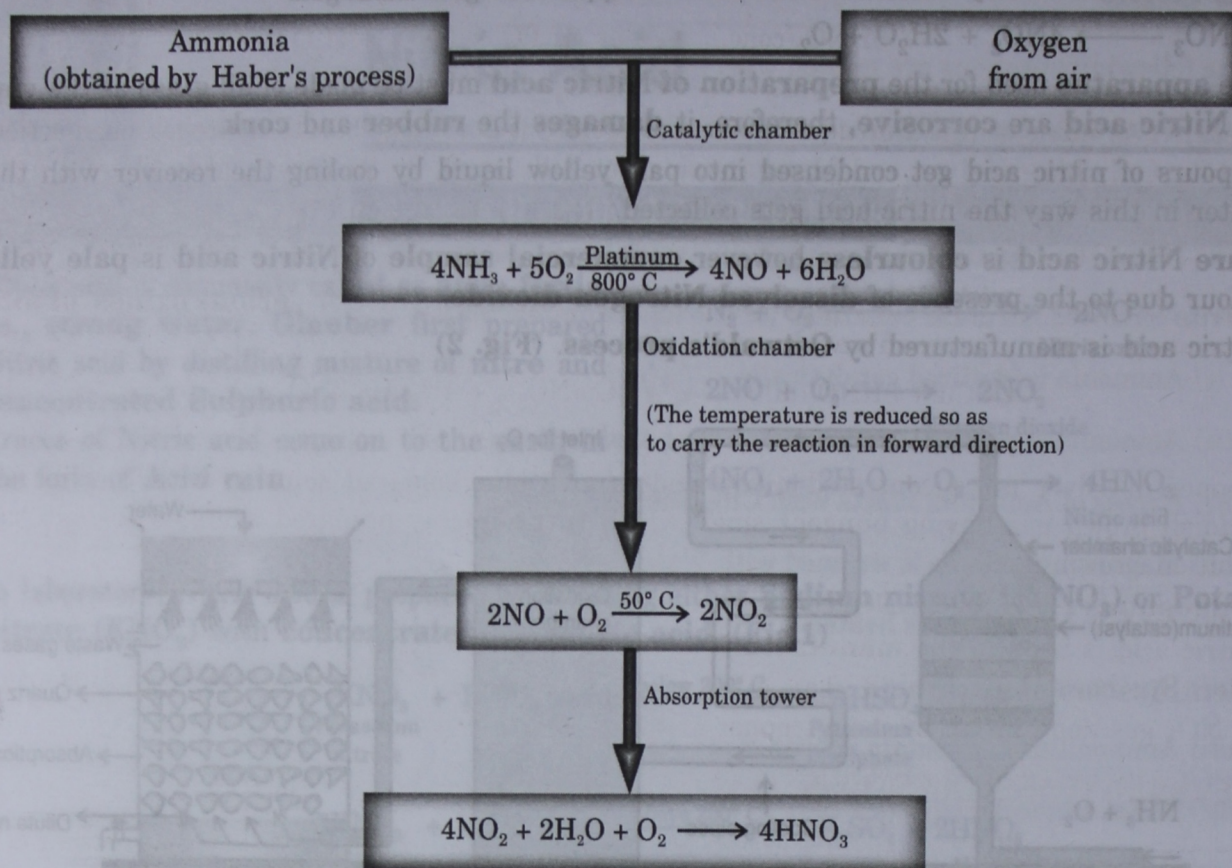
- (b) **Oxidation Chamber** : Before entering the oxidation chamber the gases must be cooled so that complete oxidation of Nitric oxide takes place.



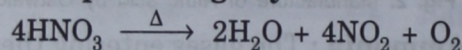
- (c) **Absorption Tower** : The water slowly trickles down through the absorption tower, which is packed with quartz and nitrogen dioxide slowly rises up and get merged with water to form nitric acid. The quartz packing provides a greater surface area in which nitrogen dioxide comes in contact with water.



### Flow Chart for the Manufacture of Nitric acid By Ostwald's Process



8. Nitric acid is **unstable** and it **decomposes slightly** even at **room temperature**.

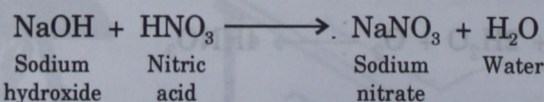
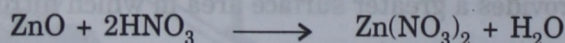
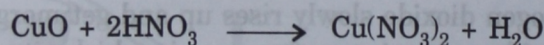


9. Nitric acid is a **typical monobasic acid**. It gives all the properties of a dilute acid.

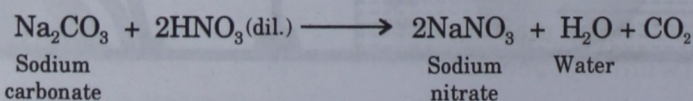
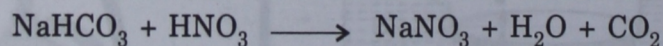
(a) Dilute nitric acid shows characteristic colour change with indicators

Indicators	Colour change
1. Blue litmus	Red
2. Phenolphthalein	Colourless
3. Methyl orange	Red

(b) It reacts with **metallic Oxides** and **metallic Hydroxides** to form **salt and water (neutralization)**.

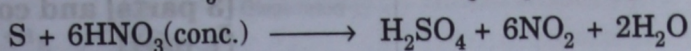
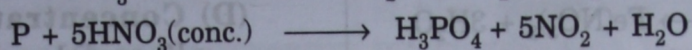
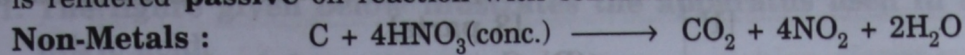


(c) It reacts with **metallic Carbonates** and **metallic Bicarbonates** to liberate **Carbon dioxide**.

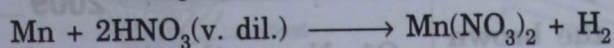
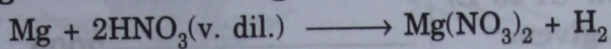


Pure nitric acid is colourless however the commercial sample of nitric acid is pale yellow in colour due to the presence of dissolved nitrogen dioxide.

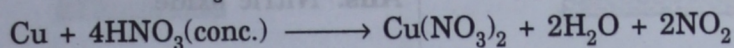
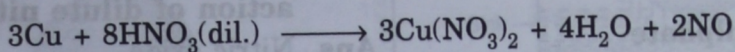
10. Nitric acid is a strong **oxidizing agent**. It oxidises non-metals, metals and other compounds. **Iron** is rendered **passive** on reaction with concentrated Nitric acid.



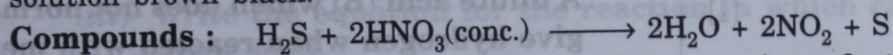
**Metals :** As nitric acid is an oxidizing agent therefore it does not liberate hydrogen on reaction with metals. Only **Magnesium** and **Manganese** react with very dilute nitric acid to liberate hydrogen.



Nitric acid reacts with metals to produce either **Ammonium nitrate** or **various oxides of nitrogen** depending upon the **concentration of nitric acid**.



Copper dissolves in concentrated nitric acid to give blue coloured solution with the liberation of reddish brown gas having pungent smell which turns freshly prepared acidified ferrous sulphate solution brown black.



11. Nitric acid is used in the **manufacture of dyes, paints, fertilizers, aqua-regia**, etc.

12. **Identification of nitric acid :** This is tested in the same manner as test for  $NO_3^-$  ion and identification of  $NO_2$  gas done in lab by using copper turnings and brown ring test.

## PREVIOUS YEARS' QUESTIONS

2012

Q1. Name the gas in each of the following :

The gas produced when copper reacts with concentrated nitric acid. [1]

Ans. Nitrogen dioxide

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

Aqua regia contains one part by volume of nitric acid and three parts by volume of hydrochloric acid. [1]

Ans. Aqua regia contains one part of concentrated nitric acid and three parts of concentrated hydrochloric acid.

Q3. Give reasons for the following :

Iron is rendered passive with fuming nitric acid. [1]

Ans. A coating of thin oxide is formed or an oxide coating of iron is formed on the surface.

2011

Q1. Name the catalyst used in the manufacture of nitric acid by Ostwald's process.

Ans. Platinum

Q2. What do you observe when copper is added to concentrated nitric acid. [1]

Ans. Pinkish red metal dissolves to give blue or bluish green solution with the liberation of reddish brown coloured gas having pungent suffocating smell.

Q3. Choose the correct answer from the options given below

The brown ring test is used for detection of [1]

(A)  $CO_3^{2-}$  (B)  $NO_3^-$

(C)  $SO_3^{2-}$  (B)  $Cl^-$

Ans. B or  $NO_3^-$

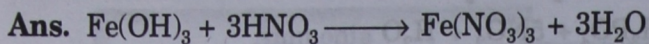
Q4. (a) What is the special feature of the apparatus that is used in the laboratory preparation of nitric acid ?

(b) Why should the temperature of the reaction mixture of nitric acid not allowed to rise above  $200^\circ\text{C}$ . [2]

Ans. (a) The apparatus must be made of all glass.

(b) Nitric acid decomposes at higher temperature and the sodium sulphate formed sticks to the glass apparatus and cannot be removed.

**Q5. Write balanced chemical equation for the reaction of ferric hydroxide with nitric acid.** [1]



2010

**Q1. Select from the list given below (A to E) which matches the description given.**

The compound responsible for the brown ring during the brown ring test of nitrate ion.

- (A) Nitrosoiron(II) sulphate
- (B) Iron(III) chloride
- (C) Chromium sulphate
- (D) Lead(II) chloride
- (E) Sodium chloride

[1]

**Ans.** (A)

**Q2. Select the correct answer from the choices A, B, C and D which are given.**

Write only the letter corresponding to the correct answer.

Aqua regia is a mixture of :

- (A) Dilute hydrochloric acid and concentrated nitric acid
- (B) Concentrated hydrochloric acid and dilute nitric acid

(C) Concentrated hydrochloric acid [1 part] and concentrated nitric acid [3 parts]

(D) Concentrated hydrochloric acid [3 parts] and concentrated nitric acid [1 part] [1]

**Ans.** (D)

2009

**Q1. Name the gas evolved (formula is not acceptable). The gas produced by the action of dilute nitric acid on copper.**[1]

**Ans.** Nitric oxide

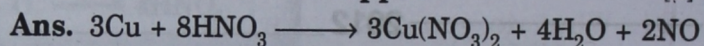
2008

**Q1. Identify the substance :**

A dilute acid (B) which does not normally give hydrogen when reacted with metals but does give a gas when it reacts with copper. [1]

**Ans.** Nitric acid

**Q2. Write equations for the reaction : Dilute nitric acid and copper** [1]



**Q3. Copy and complete the table relating to important industrial processes. Output refers to the product of the process not the intermediate steps.** [3]

Name of process	Inputs	Catalyst	Equation for catalysed reaction	Output
-----	Ammonia + air	-----	-----	Nitric acid

**Ans.**

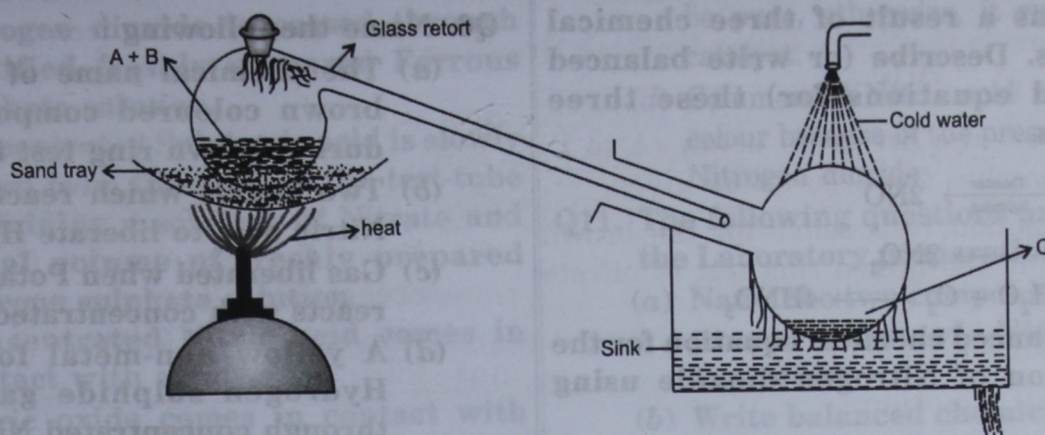
Name of process	Inputs	Catalyst	Equation for catalysed reaction	Output
Ostwald's process	Ammonia + air	Platinum	$4\text{NH}_3 + 5\text{O}_2 \xrightarrow[800^\circ\text{C}]{\text{Pt}} 4\text{NO} + 6\text{H}_2\text{O}$	Nitric acid

**Q4. What is the property of nitric acid which allows it to react with copper ?** [1]

**Ans.** Oxidizing agent.

2007

**Q1.** The figure given below illustrates the apparatus used in the laboratory preparation of nitric acid.

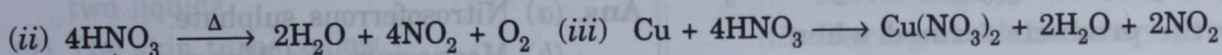


(i) Name A (a liquid), B (a solid) and C (a liquid). (Do not give the formulae)

(ii) Write an equation to show how nitric acid undergoes decomposition.

(iii) Write the equation for the reaction in which copper is oxidized by concentrated nitric acid. [5]

**Ans.** (i) A – Concentrated sulphuric acid B – Potassium nitrate C – Nitric acid



2006

**Q1.** What do you observe when :

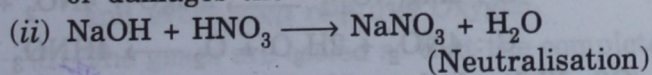
nitric acid is kept in a reagent bottle for a long time ? [1]

**Ans.** It turns brown in colour.

**Q2.** (i) Explain why only all glass apparatus should be used for the preparation of nitric acid by heating concentrated sulphuric acid and potassium nitrate.

(ii) Write a chemical equation to illustrate the acidic nature of nitric acid. [2]

**Ans.** (i) The vapours of nitric acid are highly corrosive in nature, therefore, it destroys or damages the rubber cork.



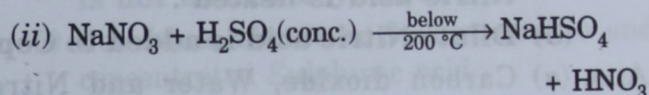
2005

**Q1.** Write balanced chemical equations for the following reactions :

(i) Sulphur and hot concentrated nitric acid

(ii) Sodium nitrate and concentrated sulphuric acid [2]

**Ans.** (i)  $\text{S} + 6\text{HNO}_3(\text{conc.}) \longrightarrow \text{H}_2\text{SO}_4 + 6\text{NO}_2 + 2\text{H}_2\text{O}$

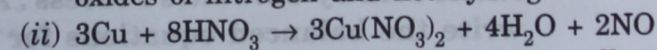


**Q2.** (i) Dilute nitric acid is generally considered a typical acid except for its reaction with metals. In what way is dilute nitric acid different from other acids when it reacts with metals ?

(ii) Write the equation for the reaction of dilute nitric acid with copper.

(iii) Account for the yellow colour that appears in concentrated nitric acid when it is left standing in an ordinary glass bottle. [3]

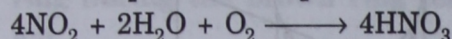
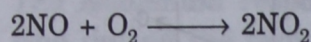
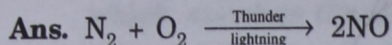
**Ans.** (i) Dilute nitric acid is an oxidizing agent, therefore, it reacts with metals to produce oxides of nitrogen and not hydrogen.



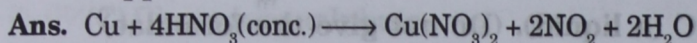
(iii) Concentrated nitric acid appears yellow because of the presence of dissolved Nitrogen dioxide.

## IMPORTANT QUESTIONS

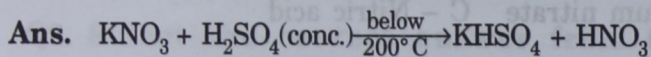
**Q1.** During thunder storm, the rain water contains Nitric acid. The Nitric acid is formed as a result of three chemical reactions. Describe (or write balanced chemical equations for) these three reactions.



**Q2.** Write balanced chemical equation for the production of Nitrogen dioxide using Copper.



**Q3.** Write equations for the laboratory preparation of :  
Nitric acid from Potassium nitrate.



**Q4.** Name the products formed when :

(a) A mixture of Carbon and concentrated Nitric acid is heated .

(b) Dilute Nitric acid is added to Copper.

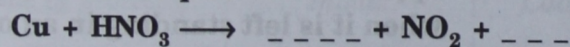
**Ans.** (a) Carbon dioxide, Water and Nitrogen dioxide.

(b) Copper nitrate, Water and Nitric oxide.

**Q5. (a)** Give reasons for the following :

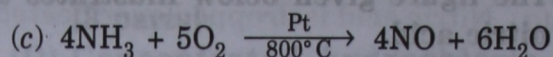
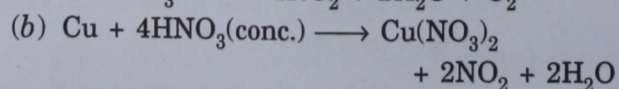
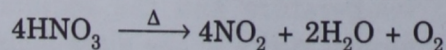
In the laboratory preparation of Nitric acid, the mixture of concentrated Sulphuric acid and Sodium nitrate should not be heated very strongly above  $200^\circ\text{C}$ .

(b) Complete and balance the following chemical equations



(c) State the conditions for the oxidation of Ammonia to Nitrogen monoxide (Nitric oxide) in the manufacture of Nitric acid by Ostwald's Process . Also write the balanced equations for the reactions which take place.

**Ans.** (a) The reaction mixture should not be heated strongly as the Nitric acid formed decomposes to give Nitrogen dioxide.



**Q6.** Name the following :

(a) The chemical name of an unstable brown coloured compound formed during brown ring test for nitrates.

(b) Two metals which react with dilute Nitric acid to liberate Hydrogen.

(c) Gas liberated when Potassium iodide reacts with concentrated Nitric acid.

(d) A yellow non-metal formed when Hydrogen sulphide gas is passed through concentrated Nitric acid.

(e) A metallic Nitrate that decipitates on heating.

(f) A colourless gas which becomes reddish brown when it comes in contact with atmosphere.

**Ans.** (a) Nitrosoferrous sulphate.

(b) Magnesium and Manganese.

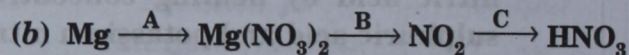
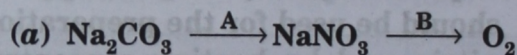
(c) Iodine.

(d) Sulphur.

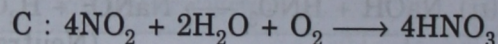
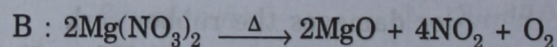
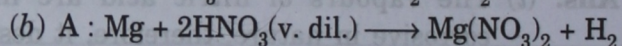
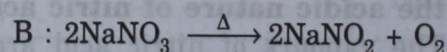
(e) Lead nitrate.

(f) Nitric oxide.

**Q7.** How are the following conversions carried out ? Give equations only.



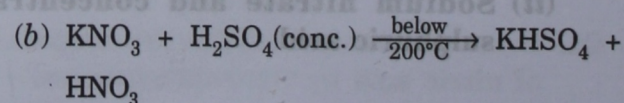
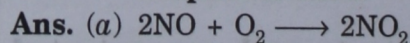
**Ans.** (a) A : 
$$\text{Na}_2\text{CO}_3 + 2\text{HNO}_3 \rightarrow 2\text{NaNO}_3 + \text{H}_2\text{O} + \text{CO}_2$$



**Q8.** Write balanced chemical equations for the following :

(a) Nitric oxide comes in contact with atmosphere.

(b) Nitre reacts with concentrated Sulphuric acid.



**Q9. What do you observe when :**

- Nitric acid is dropped over heated saw dust.
- Nitrogen dioxide is passed through acidified freshly prepared Ferrous sulphate solution.
- Concentrated Sulphuric acid is slowly added from the sides of the test-tube containing a solution of Nitrate and equal volume of freshly prepared Ferrous sulphate solution.
- Concentrated Nitric acid comes in contact with skin.
- Nitric oxide comes in contact with atmosphere.

- Ans.** (a) Heated saw dust catches fire, i.e., bursts into flame.  
 (b) The solution turns brown black.  
 (c) A brown ring is formed at the junction of two liquids.  
 (d) The skin turns yellow.  
 (e) Colourless Nitric oxide immediately changes to Reddish brown coloured gas.

**Q10. Give reasons for the following :**

- During the manufacture of Nitric acid by Ostwald's process excess of Oxygen is taken.
- Before the gases are allowed to enter the oxidation chamber the gases are sufficiently cooled.
- The gases entering the catalytic chamber must be pure.
- Commercial Nitric acid is pale yellow in colour.

- Ans.** (a) Excess of Oxygen is taken because each and every step requires Oxygen.  
 (b) The gases are cooled so that the complete oxidation of Nitric oxide takes place or the rate of forward reaction increases or to

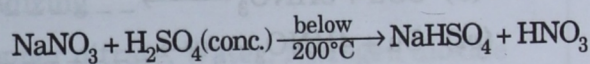
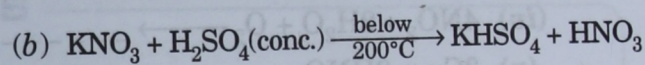
minimize the decomposition of Nitrogen dioxide.

- Gases entering the catalytic chamber must be pure, otherwise, it would poison the catalyst.
- Commercial Nitric acid is pale yellow in colour because of the presence of dissolved Nitrogen dioxide.

**Q11. The following questions are related with the Laboratory preparation of Nitric acid**

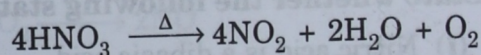
- Name the two compounds used for the preparation of Nitric acid in laboratory.
- Write balanced chemical equation for the laboratory preparation of Nitric acid from the above named compounds.
- What is the special feature of the apparatus used for the preparation of Nitric acid in laboratory ?
- During the laboratory preparation of Nitric acid, why the reaction mixture is not heated beyond 200 °C ?

- Ans.** (a) Potassium nitrate or Sodium nitrate and concentrated Sulphuric acid.



- The apparatus used for the preparation of Nitric acid must be made of all glass.
- The reaction mixture is not heated beyond 200 °C because,

(i) Nitric acid decomposes above 200 °C



(ii) Sodium sulphate or Potassium sulphate formed above 200 °C is a sticky mass and destroys the glass apparatus.



## LET'S RECALL

Fill Your Answer in the Space Given for Each Question.

## Q1. Fill in the blanks

- (i) \_\_\_\_\_ and \_\_\_\_\_ react with v. dil.  $\text{HNO}_3$  to liberate Hydrogen.
- (ii) Nitric acid is a strong \_\_\_\_\_ agent therefore it does not liberate Hydrogen on reaction with metals.
- (iii) Nitric acid is manufactured by \_\_\_\_\_ process and the catalyst employed is \_\_\_\_\_.
- (iv) Copper on reaction with concentrated nitric acid produces \_\_\_\_\_, \_\_\_\_\_ and \_\_\_\_\_.
- (v) Copper on reaction with dilute Nitric acid produces \_\_\_\_\_, \_\_\_\_\_ and \_\_\_\_\_.
- (vi) Nitric acid is a \_\_\_\_\_, \_\_\_\_\_ acid
- (vii) The salts of nitric acid are called \_\_\_\_\_.
- (viii) Rain water contains the traces of \_\_\_\_\_ acid.
- (ix) Sulphur on reaction with concentrated Nitric acid produces \_\_\_\_\_ acid.
- (x) Nitric acid in laboratory is prepared by the reaction of \_\_\_\_\_ and \_\_\_\_\_ acid.

## Q2. Copy, complete and balance the following equations.

- (i)  $\text{KNO}_3 + \text{H}_2\text{SO}_4$  (conc.)  $\xrightarrow[200^\circ\text{C}]{\text{below}}$  \_\_\_\_\_ + \_\_\_\_\_
- (ii)  $\text{N}_2 + \text{O}_2 \longrightarrow$  \_\_\_\_\_
- (iii)  $2\text{NO} + \text{O}_2 \longrightarrow$  \_\_\_\_\_
- (iv)  $4\text{NO}_2 + 2\text{H}_2\text{O} + \text{O}_2 \longrightarrow$  \_\_\_\_\_
- (v)  $3\text{Cu} + 8\text{HNO}_3 \longrightarrow$  \_\_\_\_\_ + \_\_\_\_\_ + \_\_\_\_\_
- (vi)  $\text{Cu} + 4\text{HNO}_3 \longrightarrow$  \_\_\_\_\_ + \_\_\_\_\_ + \_\_\_\_\_
- (vii)  $\text{C} + 4\text{HNO}_3 \longrightarrow$  \_\_\_\_\_ + \_\_\_\_\_ + \_\_\_\_\_
- (viii)  $\text{S} + 6\text{HNO}_3 \longrightarrow$  \_\_\_\_\_ + \_\_\_\_\_ + \_\_\_\_\_
- (ix)  $\text{P} + 5\text{HNO}_3 \longrightarrow$  \_\_\_\_\_ + \_\_\_\_\_ + \_\_\_\_\_
- (x)  $\text{NaOH} + \text{HNO}_3 \longrightarrow$  \_\_\_\_\_ + \_\_\_\_\_

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

- (i) Nitric acid is a dibasic acid.
- (ii) Nitric acid is a strong oxidizing agent.
- (iii) Nitric acid is manufactured by Ostwald's process.
- (iv) In oxidation chamber, high temperature is maintained.
- (v) Nitric acid on heating gives nitrogen dioxide, water and oxygen.

## Q4. Choose the correct answer

- (i) Nitric acid is manufactured by
- (a) Contact process (b) Ostwald's process
- (c) Haber's process (d) none of these

Ans.

(a)

(b)

(c)

(d)

(ii) Sulphur on reacting with concentrated Nitric acid produces

- (a) Sulphur dioxide (b) Sulphur trioxide  
(c) Sulphuric acid (d) all of the above

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

(iii) Copper on reaction with dilute Nitric acid produces the following oxide of Nitrogen

- (a) Nitrogen dioxide (b) Nitric oxide  
(c) Nitrous oxide (d) none of these

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

(iv) The gaseous reactants used during Ostwald's process are

- (a) Nitrogen and Oxygen (b) Oxygen and Carbon dioxide  
(c) Chlorine and Nitrogen (d) Ammonia and Oxygen

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

(v) Commercial sample of Nitric acid is pale yellow in colour due to the presence of dissolved

- (a) Sulphur (b) Sulphuric acid  
(c) Oxygen (d) Nitrogen dioxide

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

## ANSWERS

1. (i) Magnesium, Manganese

(iii) Ostwald, Platinum

(v) Copper nitrate, Water, Nitric oxide

(vii) nitrate

(ix) sulphuric

(x) Potassium nitrate, concentrated Sulphuric

(ii) oxidizing

(iv) Copper nitrate, Water, Nitrogen dioxide

(vi) strong, monobasic

(viii) nitric

2. (i)  $\text{KNO}_3 + \text{H}_2\text{SO}_4 (\text{conc.}) \xrightarrow[200^\circ\text{C}]{\text{below}} \text{KHSO}_4 + \text{HNO}_3$

(iii)  $2\text{NO} + \text{O}_2 \longrightarrow 2\text{NO}_2$

(v)  $3\text{Cu} + 8\text{HNO}_3 \longrightarrow 3\text{Cu}(\text{NO}_3)_2 + 4\text{H}_2\text{O} + 2\text{NO}$

(vii)  $\text{C} + 4\text{HNO}_3 \longrightarrow \text{CO}_2 + 4\text{NO}_2 + 2\text{H}_2\text{O}$

(ix)  $\text{P} + 5\text{HNO}_3 \longrightarrow \text{H}_3\text{PO}_4 + 5\text{NO}_2 + \text{H}_2\text{O}$

(ii)  $\text{N}_2 + \text{O}_2 \longrightarrow 2\text{NO}$

(iv)  $4\text{NO}_2 + 2\text{H}_2\text{O} + \text{O}_2 \longrightarrow 4\text{HNO}_3$

(vi)  $\text{Cu} + 4\text{HNO}_3 \longrightarrow \text{Cu}(\text{NO}_3)_2 + 2\text{H}_2\text{O} + 2\text{NO}_2$

(viii)  $\text{S} + 6\text{HNO}_3 \longrightarrow \text{H}_2\text{SO}_4 + 6\text{NO}_2 + 2\text{H}_2\text{O}$

(x)  $\text{NaOH} + \text{HNO}_3 \longrightarrow \text{NaNO}_3 + \text{H}_2\text{O}$

3. (i) False

(ii) True

(iii) True

(iv) False

(v) True

4. (i) b

(ii) c

(iii) b

(iv) d

(v) d

# SELF EVALUATION Test

Time : 30 Minutes

Marks : 25

- Fill Your Answer in the space given for each question.
- Q1.** Name the acid which directly converts Sulphur to Sulphuric acid. Write balanced chemical equation in support of your answer. 2
- Q2.** Why commercial sample of Nitric acid is pale yellow in colour ? 2
- Q3.** What is the effect of adding dilute Nitric acid to
- Blue litmus solution
  - Phenolphthalein
  - Methyl orange
- 3
- Q4.** Rain water contains traces of Nitric acid. Write three balanced chemical equations in support of your answer. 3
- Q5.** Name the process by which Nitric acid is manufactured. Write balanced chemical equation in support of your answer. 4
- Q6.** Write balanced chemical equations for the following.
- Nitric acid reacts with metal to produce Hydrogen
  - Nitric acid reacts with metal to produce Nitrogen dioxide
  - Nitric acid reacts with metal to produce Nitric oxide
  - Nitric acid reacts with carbon to form Carbon dioxide
- 4
- Q7.**
- Name the reactants used for the preparation of Nitric acid in laboratory
  - Write balanced chemical equation for the above reaction taking place.
  - Why the apparatus used for the preparation of Nitric acid made of glass ? 5
  - For the laboratory preparation of nitric acid why the reaction mixture should not be heated beyond 200°C ? (Give two reasons). 2