

Chapter 10-Study of Compounds - Nitric Acid

1. Choose the correct answer

a. The nitrate salt which does not give a mixture of NO_2 and O_2 on heating is

- (i) AgNO_3
- (ii) KNO_3
- (iii) $\text{Cu}(\text{NO}_3)_2$
- (iv) $\text{Zn}(\text{NO}_3)_2$

b. The chemical used in brown ring test is

- (i) CuSO_4
- (ii) FeSO_4
- (iii) $\text{Fe}_2(\text{SO}_4)_3$
- (iv) ZnSO_4

c. Lead nitrate decomposes on heating to give

- (i) NO
- (ii) N_2O
- (iii) NO_2
- (iv) N_2O_5

Solution:

- a. KNO_3
- b. FeSO_4
- c. NO_2

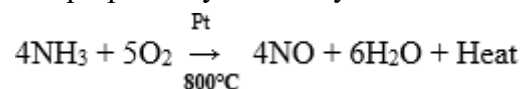
2. Name:

- a. A nitrate on heating which on heating does not give nitrogen dioxide
- b. A nitrate which on heating leaves no residue.
- c. A metal nitrate which on heating is changed to metal oxide.
- d. A metal nitrate which on heating is changed to metal.
- e. A solution which absorbs nitric oxide.
- f. The oxide of nitrogen which turns brown on exposure to air. How is it prepared?

Solution:

- a. Sodium nitrate
- b. Ammonium nitrate
- c. Calcium nitrate
- d. Silver nitrate
- e. Freshly prepared ferrous sulphate
- f. Nitric oxide

It is prepared by the catalytic oxidation of ammonia.



3. Mention three important uses of nitric acid. Give the property of nitric acid involved in the use.

Solution:

The uses of nitric acid along with the property involved include:

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1. It is used in the purification of gold.
Property: Nitric acid dissolves impurities like copper, silver, zinc, etc.
2. It is used to engrave designs on copper.
Property: Nitric acid is a solvent for a large number of metals.
3. It is used to prepare aqua regia.
Property: It helps in dissolving noble metals.

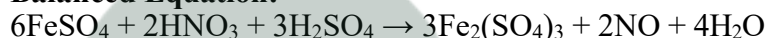
4.

- a. **Explain with the help of a balanced equation, the brown ring test for nitric acid.**
- b. **Why is freshly prepared ferrous sulphate solution used for testing the nitrate radical in the brown ring test?**

Solution:

- a. The brown ring test is carried out in the following steps:
 - Freshly prepared saturated solution of ferrous sulphate is added to the aqueous solution of nitric acid.
 - Conc. sulphuric acid is added carefully from the sides of the test tube.
 - The test tube is cooled in water.
 - We can observe a brown ring at the junction of two liquids.

Balanced Equation:



- b. A freshly prepared ferrous sulphate is used because a pre-prepared ferrous sulphate gets oxidized to ferric sulphate on exposure to the atmosphere which does not form brown ring during the test.

5. From the list of substances, choose a substance in each case which matches the description given below:

Ammonium nitrate, calcium hydrogen carbonate, copper carbonate, lead nitrate, potassium nitrate, sodium carbonate, sodium hydrogen carbonate, zinc carbonate.

- a. **A nitrate which gives off only oxygen when heated.**
- b. **A nitrate which on heating decomposes into dinitrogen oxide and steam.**
- c. **A nitrate which gives off oxygen and nitrogen dioxide when heated.**

Solution:

- a. Potassium nitrate
- b. Ammonium nitrate
- c. Lead nitrate

6.

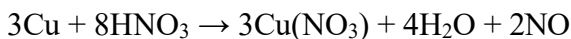
- a. **Dilute nitric acid is generally considered a typical acid except for its reaction with metals. In what way is dilute nitric acid different from other acids when it reacts with metals?**
- b. **Write the equation for the reaction of dilute nitric acid and conc. nitric acid with copper.**

Solution:

- a. Nitric acid does not liberate hydrogen. It is a powerful oxidizing agent and the nascent oxygen oxidises hydrogen in water. That is why dilute nitric acid is considered a typical acid for its reaction with metals.
- b.

Reaction of dilute nitric acid with copper

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Reaction of conc. nitric acid with copper



7. Explain why:

- Only all-glass should be used for the preparation of nitric acid by heating conc. sulphuric acid and potassium nitrate.**
- Nitric acid is kept in a reagent bottle for a long time.**

Solution:

- Only all-glass apparatus is used because nitric acid vapours are highly corrosive. They can corrode cork and rubber stoppers.
- In the presence of sunlight, pure nitric acid decomposes even at room temperature. To avoid decomposition, nitric acid is kept in colourless bottles. The nitric acid kept in a bottle turns yellow due to the dissolved NO_2 in HNO_3 .

8.

- Name the gas produced when copper reacts with conc. HNO_3 .**
- State your observation: Zinc nitrate crystals are strongly heated.**
- Correct the statement: Magnesium reacts with nitric acid to liberate hydrogen gas.**
- Iron is rendered passive with fuming HNO_3 . Give reason.**
- Give the balanced equation for dilute nitric acid and copper carbonate.**

Solution:

- Nitrogen dioxide
- The zinc nitrate crystals decompose to yellow-coloured zinc oxide and nitrogen dioxide, and oxygen is evolved when the crystals are strongly heated.
- Very dilute nitric acid reacts with magnesium at room temperature to produce magnesium nitrate and hydrogen gas.
- This is because of the formation of insoluble metallic oxide which stops the reaction.
- $$\text{CuCO}_3 + 2\text{HNO}_3 \rightarrow \text{Cu}(\text{NO}_3)_2 + \text{H}_2\text{O} + \text{CO}_2\uparrow$$

9.

- Identify the gas evolved when**
 - Sulphur is treated with con. nitric acid**
 - A few crystals of KNO_3 are heated in a hard glass test tube.**
- State two relevant observations for: Lead nitrate crystals are heated in a hard glass test tube.**
- Give a balanced equation for: Oxidation of carbon with conc. HNO_3 .**

Solution:

- Nitrogen dioxide
 - It decomposes to form KNO_2 and evolves oxygen gas.
- Lead nitrate crystals decompose with a slight decrepitation and is reddish-brown when hot. On cooling, it turns yellow and fuses with glass.
- $$\text{C} + 4\text{HNO}_3 (\text{conc.}) \rightarrow \text{CO}_2 + 2\text{H}_2\text{O} + 4\text{NO}_2$$

10. Name the acid:

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- a. The acid used in the preparation of a non-volatile acid
- b. The acid prepared by catalytic oxidation of ammonia

Solution:

- a. Sulphuric acid
- b. Nitric acid

11. State one relevant observation for: When crystals of copper nitrate are heated in a test tube.

Solution:

Nitrogen dioxide, reddish-brown in colour is evolved. The residue of black copper oxide is left behind.

12. Explain the following:

(i) Dilute nitric acid is generally considered a typical acid but not so in its reaction with metals.

(ii) Concentrated nitric acid appears yellow when it is left standing in a glass bottle.

(iii) An all-glass apparatus is used in the laboratory preparation of nitric acid.

Solution:

(i) The action of nitric acid on metals depends on nitric acid concentration and temperature. These conditions are not there in case of sulphuric acid or hydrochloric acid.

(ii) When concentrated nitric acid is left standing in a glass bottle, the reddish-brown nitrogen dioxide gas dissolves in the acid, giving it a yellow colour.

(iii) The nitric acid vapours corrode rubber and cork. That is why an all-glass apparatus is preferred for the preparation of nitric acid.

13.

a. Fill in the blank:

Cold dilute nitric acid reacts with copper to form ____ (hydrogen, nitrogen dioxide, nitric oxide).

b. Give balanced equations for:

(i) Laboratory preparation of nitric acid

(ii) Action of heat on a mixture of copper and nitric acid.

Solution:

a. Nitric oxide

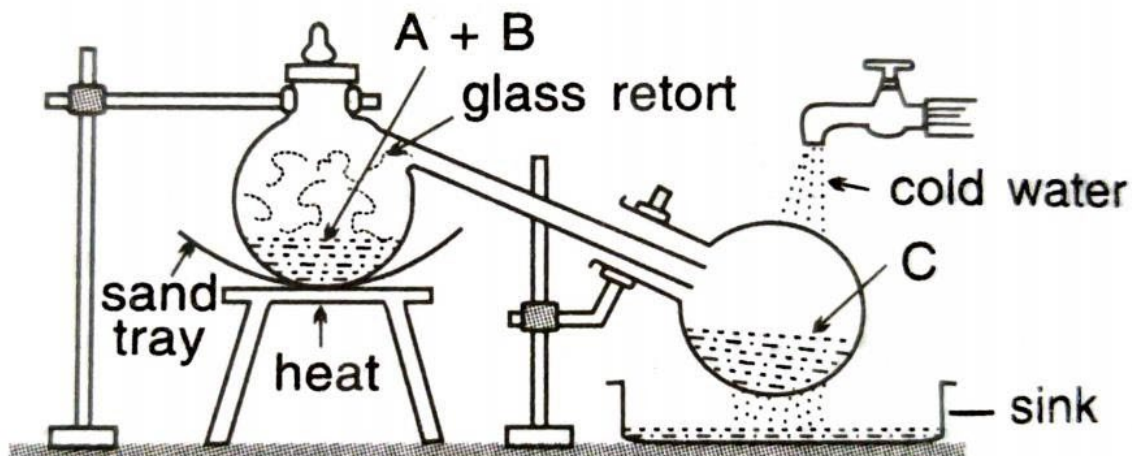
b. (i) $\text{KNO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{KHSO}_4 + \text{HNO}_3$

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

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

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

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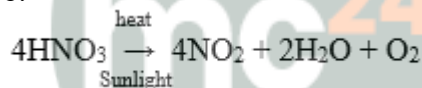


- Name A (a liquid), B (a solid), and C (a liquid). (Do not give the formulae)
- Write an equation to show how nitric acid undergoes decomposition.
- Write an equation for the reaction in which copper is oxidised by concentrated nitric acid.

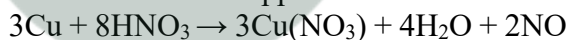
Solution:

- A = Conc. Sulphuric acid
B = Sodium nitrate
C = Nitric acid

b.



c. Dilute nitric acid with copper



15.

a. A dilute acid B does not normally give hydrogen when reacted with metals but does give a gas when reacts with copper. Identify.

Write the equation with copper.

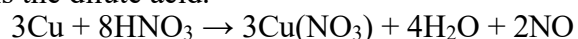
b. Complete the table:

Name of process	Inputs	Equation	Output
	Ammonia + Air		Nitric acid

c. What is the property of nitric acid that allows it to react with copper?

Solution:

a. Nitric acid is the dilute acid.



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b.

Name of process	Inputs	Equation	Output
Ostwald process	Ammonia + Air	$4\text{NH}_3 + 5\text{O}_2 \rightarrow 4\text{NO} + 6\text{H}_2\text{O} + \text{heat}$ $2\text{NO} + \text{O}_2 \rightarrow 2\text{NO}_2$ $4\text{NO}_2 + 2\text{H}_2\text{O} + \text{O}_2 \rightarrow 4\text{HNO}_3$	Nitric acid

c. The oxidising property of nitric acid allows it to react with copper.

16. X, Y and Z are three crystalline solids which are soluble in water and have common anion. To help you identify X, Y and Z, you are provided with the following experimental observations. Copy and complete the following inferences in (a) to (f).

a. A reddish-brown gas is obtained when X, Y and Z are warmed separately with concentrated sulphuric acid and copper turning added to the mixture.

Inference 1: The common anion is the _____ ion.

b. When X is heated, it melts and gives off only one gas which relights a glowing splint.

Inference 2: The cation in X is either _____ or _____.

c. The action of heat on Y produces a reddish brown gas and yellow residue which fuses with the glass of the test tube.

Inference 3: Metal ion present in Y is the _____ ion.

d. When Z is heated, it leaves no residue. Warming Z with sodium hydroxide solution liberates a gas which turns moist red litmus paper blue.

Inference 4: Z contains _____ cation.

e. Write the equations for the following reaction:

(i) X and conc. Sulphuric acid (below 200°C). (One equation only for either of the cations in inference 2).

(ii) Action of heat on Y.

(iii) Conc. nitric acid is added to copper turnings kept in a beaker.

Solution:

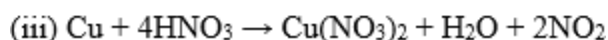
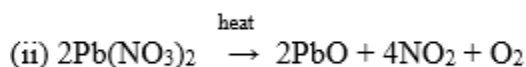
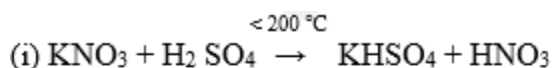
a. Nitrate

b. Sodium or potassium

c. Lead

d. Ammonia

e.



17. The action of heat on blue crystalline solid X gives reddish brown gas Y, a gas which relights a glowing splint and leaves a black residue. When gas Z, which has a rotten egg smell, is passed through a solution of X, a black ppt is formed.

a. Identify X, Y and Z.

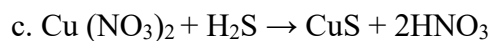
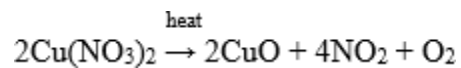
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- b. Write the equation for action of heat on X.
c. Write the equation between solution X and gas Z.

Solution:

- a. X = Copper nitrate
Y = Nitrogen dioxide
Z = Hydrogen sulphate

b.



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