Question 1:

Comment, sulphuric acid is referred to as:

(a) King of chemicals (b) Oil of vitriol

Solution 1:

(a) Sulphuric acid is called King of Chemicals because there is no other manufactured compound which is used by such a large number of key industries.

(b) Sulphuric acid is referred to as Oil of vitriol as it was obtained as an oily viscous liquid by heating crystals of green vitriol.

Question 2:

Sulphuric acid is manufactured by contact process

(a) Give two balanced equations to obtain SO_2 in this process.

(b) Give the conditions for the oxidation of SO_2

Solution 2:

(a) Two balanced equations to obtain SO_2 is:

(i) $4FeS_2 + 11O_2 \rightarrow 2Fe_2O_3 + 8SO_2$

(ii) $S + O_2 \rightarrow SO_2$

(b) The conditions for the oxidation of SO_2 are:

(i) The temperature should be as low as possible. The yield has been found to be maximum at about $410^0C - 450^oC$

(ii) High pressure (2 atm) is favoured because the product formed has less volume than reactant.

(iii) Excess of oxygen increases the production of sulphur trioxide.

(iv) Vanadium pentoxide or platinised asbestos is used as catalyst.

(c) Sulphuric acid is not obtained directly by reacting SO_3 with water because the reaction is highly exothermic which produce the fine misty droplets of sulphuric acid that is not directly absorbed by water.

(d) The chemical used to dissolve SO_3 is concentrated sulphuric acid. The product formed is oleum.

(e) Main reactions of this process are:

$$S + O_2 \rightarrow SO_2$$

$$2SO_2 + O_2 \underset{450^\circ C}{\overset{V_2O_5}{\rightleftharpoons}} 2SO_3$$

$$SO_3 + H_2SO_4 \rightarrow H_2S_2O_7$$

$$H_2S_2O_7 + H_2O \rightarrow 2H_2SO_4$$

Question 3:

Why is water not added to concentrated H_2SO_4 in order to dilute it?

Solution 3:

Water is not added to concentrated acid since it is an exothermic reaction. If water is added to the acid, there is a sudden increase in temperature and the acid being in bulk tends to spurt out with serious consequences.

Question 4:

Why the impurity of arsenic oxide must be removed before passing the mixture of SO_4 and air through the catalytic chamber?

Solution 4:

Impurity of ARSENIC poisons the catalyst [i.e. deactivates the catalyst]. So, it must be removed before passing the mixture of SO_2 air through the catalytic chamber.

Question 5:

Give two balanced reactions of each type to show the following properties of sulphuric acid:

(a) Acidic nature. (b) Oxidising agent,

(c) Hygroscopic nature, (d) Non-volatile nature

Solution 5:

Balanced reactions are:

(a) Acidic nature:

(i) Dilute H_2SO_4 reacts with basic oxides to form sulphate and water.

$2\ NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$

(ii) $CuO + H_2SO_4 \rightarrow CuSO_4 + H_2O$

(iii) It reacts with carbonate to produce CO_2.

$Na_2CO_3 + H_2SO_4 \rightarrow Na_2SO_4 + H_2O + CO_2 \uparrow$

(b) Oxidising agent:

$H_2SO_4 \rightarrow H_2O + SO_2 + [O]$

Nascent oxygen oxidizes non-metals, metals and inorganic compounds.

For example,

Carbon to carbon dioxide

$C + H_2SO_4 \rightarrow CO_2 + H_2O + 2SO_2$

Sulphur to sulphur dioxide

$S + H_2SO_4 \rightarrow 3SO_2 + 2H_2O$

(c) **Hygroscopic nature:**

It has great affinity for water. It readily absorbs moisture from atmospheric air.

$HCOOH \xrightarrow{conc.H_2SO_4} CO + H_2O$

$C_6H_{12}O_6 \xrightarrow{conc.H_2SO_4} 6C + 6H_2O$

(d) Non-volatile nature:

It has a high boiling point (356°C) so it is considered to be non-volatile. Therefore, it is used for preparing volatile acids like hydrochloric acid, nitric acid from their salts by double decomposition reaction.

$NaCl + H_2SO_4 \rightarrow NaHSO_4 + HCl$

$KCl + H_2SO_4 \rightarrow KHSO_4 + HCl$

Question 6:

Give a chemical test to distinguish between:

(a) dilute sulphuric acid and dilute hydrochloric acid

(b) dilute sulphuric acid and conc. Sulphuric acid

Solution 6:

(a) Bring a glass rod dipped in Ammonia solution near the mouth of each test tubes containing dil. Hel and dil. H_2SO_4each.

Dil HCl	Dil. H_2SO_4
White fumes of ammonium chloride	No such fumes

(b)

1. Dilute sulphuric acid treated with zinc gives Hydrogen gas which bums with pop sound. Concentrated H_2SO_4 gives SO_2 gas with zinc and the gas turns Acidified potassium dichromate paper green.
2. Barium chloride solution gives white ppt. with dilute H_2SO_4, This white ppt. is insoluble in all acids.
   Concentrated H_2SO_4 and NaCl mixture when heated gives dense white fumes if glass rod dipped in Ammonia solution is brought near it.

Question 7:

Name the products formed when hot and concentrated sulphuric acid reacts with the following:

(a) Sulphur (b) NaOH,

(c) Sugar (d) Carbon

(e) Copper.

Solution 7:

(a) When sulphuric acid reacts with sulphur the product formed is Sulphur dioxide is formed.

$S + 2H_2SO_4 \rightarrow 3SO_2 + 2H_2O$

(b) When sulphuric acid reacts with sodium hydroxide it neutralizes base to form sodium sulphate.

$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$

(c) When sulphuric acid reacts with sugar it forms carbon

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

(d) When sulphuric acid reacts with carbon it forms carbon dioxide and sulphur dioxide gas.

$C + 2H_2SO_4 \rightarrow CO_2 + 2H_2O + 2SO_2 \uparrow$

(e) When sulphuric acid reacts with copper it forms copper sulphate and sulphur dioxide.

$Cu + H_2SO_4 \rightarrow CuSO_4 + 2H_2O + SO_2 \uparrow$

Question 8:

Why is:

(a) Concentrated sulphuric acid kept in air tight bottles?

(b) H_2SO_4 not a drying agent for H_2S?

(c) Sulphuric acid used in the preparation of HCI and HNO_3? Give equations in both cases.

Solution 8:

(a) Concentrated sulphuric acid is hygroscopic substance that absorbs moisture when exposed to air. Hence, it is stored in air tight bottles.

(b) Sulphuric acid is not a drying agent for H_2S because it reacts with H_2S to form sulphur.

$H_2SO_4 + H_2S \rightarrow 2H_2O + SO_2 + S \downarrow$

(c) Concentrated sulphuric acid has high boiling point (356^oC). So, it is considered to be non-volatile. Hence, it is used for preparing volatile acids like Hydrochloric acid and Nitric acids from their salts by double decomposition.

$NaCl + H_2SO_4 \rightarrow NaHSO_4 + HCl$

$NaNO_3 + H_2SO_4 \rightarrow NaHSO_4 + HNO_3$

Question 9:

What property of conc. H_2SO_4 is made use of in each of in each of the following cases? Give an equation for the reaction on each case:

(a) in the production of HCI gas when it reacts with a chloride,

(b) in the preparation of CO and HCOOH,

(c) as a source of hydrogen by diluting it and adding a strip of magnesium.
(d) in the preparation of sulphur dioxide by warming a mixture of conc. Sulphuric acid and copper – turnings,
(e) Hydrogen sulphide gas is passed through concentrated sulphuric acid.

Solution 9:

(a) Due to its reducing property. i.e, it is a non-volatile acid.

$NaCl + H_2SO_4 \rightarrow NaHSO_4 + HCl$
(Conc.)

(b) It is a dehydrating agent.

$HCOOH \xrightarrow{conc.H_2SO_4} CO + H_2O$

(c) Magnesium is present above hydrogen in the reactivity series so sulphuric acid is able to liberate hydrogen gas by reacting with magnesium strip.

$Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$

(d) Due to its oxidizing character

$Cu + H_2SO_4 \rightarrow CuSO_4 + 2H_2O + SO_2$

(e) Due to its oxidizing property Hydrogen sulphide gas is passed through concentrated sulphuric acid to liberate sulphur dioxide and sulphur is formed.

$H_2S + H_2SO_4 \rightarrow S + 2H_2O + SO_2$

Question 10:

What is the name given to the salts of:
(a) sulphurous acid (b) sulphuric acid?

Solution 10:

The name of the salt of
(a) Hydrogen sulphites and Sulphites.
(b) Sulphate and bisulphate.

Question 11:

Give reasons for the following:
(a) Sulphuric acid forms two types of salts with NaOH,
(b) Red brown vapours are produced when concentrated sulphuric acid is added to hydrogen bromide.
(c) A piece of wood becomes black when concentrated sulphuric acid is poured on it,
(d) Brisk effervescence is seen when oil of vitriol is added to sodium carbonate.

Solution 11:

(a) Two types of salts are formed when sulphuric acid reacts with NaOH because sulphuric acid is dibasic.

$NaOH + H_2SO_4 \rightarrow NaHSO_4 + H_2O$

$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$

(b) When hydrogen bromide reacts with sulphuric acid the bromine gas is obtained which produce red brown vapours.

$2KBr + 3H_2SO_4 \rightarrow 2KHSO_4 + SO_2 + Br_2 \uparrow + 2H_2O$

(c) A piece of wood becomes black when concentrated sulphuric acid is poured on it because it gives a mass of carbon.

(d) When sulphuric acid is added to sodium carbonate it liberates carbon dioxide which produces brisk effervescence.

$Na_2CO_3 + H_2SO_4 \rightarrow Na_2SO_4 + H_2O + CO_2 \uparrow$

Question 12:

Copy and complete the following table:

Column 1 Substance reacted with acid	**Column 2 Dilute or concentrated acid**	**Column 3 Gas**
		Hydrogen
		Carbon dioxide
		only chlorine

Solution 12:

Column 1 Substance reacted with acid	**Column 2 Dilute or concentrated acid**	**Column 3 Gas**
Substance reacted with acid	Dilute or concentrated sulphuric acid	Gas
Zinc	Dilute sulphuric acid	Hydrogen
Calcium carbonate	Concentrated sulphuric acid	Carbon dioxide
Bleaching power $CaOCl_2$	Dilute sulphuric acid	only chlorine

Question 1(2004):

Name a gas that can be oxidized to sulphur.

Solution 1(2004):

Hydrogen sulphide (H_2S) can be oxidized to sulphur.

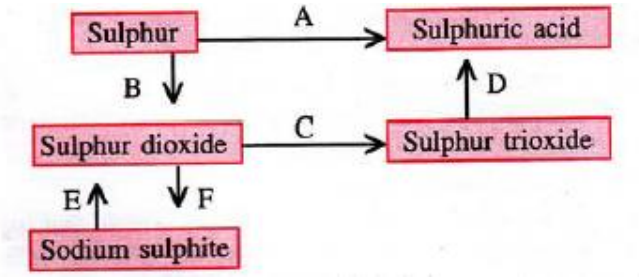
Question 2(2004):

Give the odour of the gas evolved and name the gas produced when sodium sulphide is added to solution of HCI in water.

Solution 2(2004):

When sodium sulphide is added to solution of HCl, Hydrogen sulphide gas is produced. It has rotten egg like smell.

Question 3(2004):



(a) Name the catalyst which helps in the conversion of sulphur dioxide to sulphur trioxide in step C.

(b) In the contact process for the manufacture of sulphuric acid, sulphur trioxide is not converted to sulphuric acid by reacting it with water. Instead a two-steps procedure is used. Write the equations for the two steps involved in D.

(c) What type of substance will liberate sulphur dioxide from sodium sulphite in step E?

(d) Write the equation for the reaction by which sulphure dioxide is converted to sodium sulphite in step F.

Solution 3(2004):

(a) The catalyst which helps in the conversion of sulphur dioxide to sulphur trioxide in step C is Vanadium pentoxide.

(b) The two steps for the conversion of sulphur trioxide to sulphuric acid is:

(i) $SO_3 + H_2SO_4 \rightarrow H_2S_2O_7$

(ii) $H_2S_2O_7 + H_2O \rightarrow 2H_2SO_4$

(c) The substance that will liberate sulphur dioxide in step E is dilute H_2SO_4.

(d) The equation for the reaction by which sulphur dioxide is converted to sodium sulphite in step F is:

$SO_2 + 2NaOH \rightarrow Na_2SO_3 + H_2O$ Or

$Na_2O + SO_2 \rightarrow Na_2SO_3$

Question 1(2006):

(a) Name the process used for the large-scale manufacture of sulphuric acid.

(b) Which property of sulphuric acid accounts for its use as a dehydrating agent?

(c) Concentrated sulphuric acid is both an oxidizing agent and a non-volatile acid. Write one equation each to illustrate the above mentioned properties of sulphuric acid.

Solution 1(2006):

(a) The process used for the large-scale manufacture of sulphuric acid is Contact process.

(b) Sulphuric acid has great affinity for water. It readily removes element of water from other compound. Thus it acts as a dehydrating agent.

(c) Concentrated acid is non-volatile thus it is used for the preparation of volatile acids:

$NaCl + H_2SO_4 \rightarrow NaHSO_4 + HCl$

Concentrated acid act as an oxidizing agent:

$C + 2H_2SO_4 \rightarrow CO_2 + 2H_2O + 2SO_2$

Question 1(2007):

Some properties of sulphuric acid are listed below. Choose the property A, B, C or D which is responsible for the reactions (i) to (v) some properties may be repeated.

A. Acid B. Dehydrating agent

C. Non-volatile acid D. Oxidizing agent

(i) $C_{12}H_{22}O_{11} + NH_2SO_4 \rightarrow 12C + 11H_2O + nH_2SO_4$

(ii) $S + 2H_2SO_4 \rightarrow 3SO_2 + 2H_2O$

(iii) $NaCI + H_2SO_4 \rightarrow NaHSO_4 + HCI$

(iv) $CuO + H_2SO_4 \rightarrow CuSO_4 + H_2O$

(v) $Na_2CO_3 + H_2SO_4 \rightarrow Na_2SO_4 + H_2O + CO_2$

Solution 1(2007):

(i) B

(ii) D

(iii) C

(iv) A

(v) A

Question 2(2007):

(a) Name the acid formed when sulphur dioxide dissolves in water

(b) Name the gas released when sodium carbonate is added to a solution of sulphur dioxide.

Solution 2(2007):

(a) The acid formed when sulphur dioxide dissolves in water is sulphurous acid.

(b) Carbondioxide gas is released when sodium carbonate is added to solution of sulphur dioxide.

Question 1(2008):

(a) What is the property of concentrated sulphuric acid which allows it to be used in the preparation of hydrogen chloride and nitric acid?

(b) What property of concentrated sulphuric acid is in action when sugar turns black in its presence?

Solution 1(2008):

(a) Concentrated sulphuric acid is non-volatile; hence it is used for the preparation of higher volatile acids.

(b) Due to its dehydrating nature sugar turns black in the presence of concentrated sulphuric acid.