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

Solution:

The reaction between water and concentrated H_2SO_4 is an exothermic reaction. If water is added to the concentrated acid, the temperature increases suddenly. As the acid is in larger quantity, it gushes out enormously with severe repercussions.

2. What is the name given to the salts of:
(a) Sulphorous acid (b) Sulphuric acid

Solution:

The name given to salts are:
(a) Sulphorous acid - Its salt is known as Sulphite salt. Example – Na_2SO_3: Sodium Sulphite
(b) Sulphuric acid – Its salt is known as sulphate. Example – $CuSO_4$: Copper sulphate

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

Solution:

The gas that is evolved when sodium sulphide is added to solution of HCl is Hydrogen sulphide. The odour of Hydrogen sulphide is that if rotten eggs.

4. Which property of sulphuric acid accounts for its use as a dehydrating agent?

Solution:

The property of sulphuric acid accounting for its property of a dehydrating agent is its strong affinity towards water.

5. (a) Name the acid formed when sulphur dioxide dissolves in water
(b) Name the has released when sodium carbonate is added to a solution of sulphur dioxide.

Solution:

(a) When sulphur dioxide is dissolved in water, sulphourous acid is formed
(b) When sodium carbonate is added to a solution of sulphur dioxide, carbon dioxide is released.

6. Comment, sulphuric acid is referred to as
(a) King of chemicals
(b) Oil of vitriol

Solution:

(a) King of chemicals – Sulphuric acid is often referred to as the king of chemicals. It is a highly corrosive, strong acid and has a myriad of applications. It is involved in some or the other way to manufacture everything practically. As no other synthetic compound is used by so many industries on this big a scale, it is referred to as the king of chemicals.
(b) Sulphuric acid is referred to as oil of vitriol as the process of its attainment was as an oily viscous liquid when crystals of green vitriol was heated.

7. Why the impurity of arsenic oxide must be removed before passing the mixture of SO_2 and air through the catalytic chamber?

Solution:

Impurities of arsenic oxides must be removed before it is passed through the mixture of SO_2 and air through the catalytic chamber as these impurities is toxic to the catalyst. It poisions thereby deactivating the catalyst.

8. Give a chemical test to distinguish between:
(a) dilute sulphuric acid and dilute hydrochloric acid,

(b) dilute sulphuric acid and conc. Sulphuric acid

Solution:

(a)The test that can be used to distinguish dilute sulphuric acid and dilute hydrochloric acid is $BaCl_2$ test – Barium chloride test.

When a solution of $BaCl_2$ is added to dilute sulphuric acid and dilute hydrochloric acid, it forms a white precipitate with H_2SO_4 to produce $BaSO_4$. On the other hand, dilute HCl does not react at all.

(b) When zinc is treated with dilute sulphuric acid, it releases hydrogen gas that bums out with a sound and when zinc reacts with concentrated sulphuric acid, it releases SO_2 gas which inturn turns the acidified potassium dichromate paper into green colour.

9. 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:

The completed table is as follows:

Column 1 **Substance reacted with acid**	**Column 2** **Dilute or concentrated acid**	**Column 3** **Gas**
Zinc	Dilute sulphuric acid	Hydrogen
Calcium carbonate	Concentrated sulphuric acid	Carbon dioxide
Bleaching powder	Dilute sulphuric acid	Only chlorine

10. 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:

Concentrated sulphuric acid - an oxidizing agent:

This is because concentrated sulphuric acid upon thermal decomposition produces nascent oxygen [O]. The equation illustrating the same is as follows:

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

Concentrated sulphuric acid – a non-volatile acid:

It is referred to as a non-volatile compound as it has a high boiling point, approximately 338˚C. This property of concentrated sulphuric acid is made use to prepare volatile acids such as nitric acids, hydrochloric acids from their salts through double decomposition.

The equation illustrating the same is as follows:

$$H_2SO_4 + NaCl \longrightarrow NaHSO_4 + HCl$$

11. 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

(c) Name the catalyst used

(d) Why H_2SO_4 is not obatined by directly reacting SO_3 with water
(e) Name the chemical used to dissolve SO_3 and also name the product formed
(f) Name a gas that can be oxidized to sulphur

Solution:

(a) Following are two reactions to obtain SO_2 from the contact process:

$$4FeS_2 + 11O_2 \longrightarrow 2Fe_2O_3 + 8SO_2$$
$$S + O_2 \longrightarrow SO_2$$

(b) Oxidation of SO_2 requires the following conditions:
- Catalyst to be used – platinized asbestos or vanadium pentoxide(V_2O_5)
- Production of sulphur trioxide increases as a result of excess oxygen
- As the formed product has a lesser volume than the reactant, a high pressure of 2 atm is required
- A low temperature should be maintained. The temperature range of 410˚C - 450 ˚C is known to produce maximum yield

(c) The catalyst that is used in the contact process is vanadium pentoxide(V_2O_5)
(d) This is because, it is an exothermic reaction. This produces small misty droplets of sulphuric acid which is not absorbed directly by water
(e) Concentrated sulphuric acid is the chemical used to dissolve SO_3. The resultant is oleum.
(f) A gas that can be used to oxidize sulphur is hydrogen sulphide

12. Some properties of sulphuric acid are lsited 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) $C_{12}H_{22}O_{11} + nH_2SO_4 \longrightarrow 12C + 11H_2O + nH_2SO_4$
(ii) $S + 2H_2SO_4 \longrightarrow 3SO_2 + 2H_2O$
(iii) $NaCl + H_2SO_4 \longrightarrow NaHSO_4 + HCl$
(iv) $CuO + H_2SO_4 \longrightarrow CuSO_4 + H_2O$
(v) $Na_2CO_3 + H_2SO_4 \longrightarrow Na_2SO_4 + H_2O + CO_2$

Solution:

(i) B
(ii) D
(iii) C
(iv) A
(v) A

13. Why is:
(a) Concentrated sulphuric acid kept in air tight bottles?
(b) H_2SO_4 is not a drying agent for H_2S?
(c) Sulphuric acid is used in the preparation of HCl and HNO_3? Give equation in both cases.

Solution:

(a) Concentrated sulphuric acid is stored in air tight bottles as it is a hygroscopic substance absorbing

moisture on being exposed to air.

(b) H_2SO_4 forms sulphur upon reacting with H_2S hence is not used as a drying agent.

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

(c) Concentrated sulphuric acid is considered as non-volatile as it has a high boiling point. This is the reason why it is used to prepare volatile acids such as Hydrochloric acid and nitric acids from their salts through the process of double decomposition.

$$NaNO_3 + H_2SO_4 \longrightarrow NaHSO_4 + HNO_3$$

14. What property of conc. H_2SO_4 is made use of in each of the following cases? Give an equation for the reaction on each case
(a) In the production of HCl gas when it reacts with a chlorine
(b) In the preparation of CO from 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 sulphides gas is passed through concentrated sulphuric acid
(f) Its reaction with (i) ethanol (ii) carbon

Solution:

(a) On heating with NaCl, concentrated sulphuric acid evolves pungent fumes of HCl gas.

$$NaCl + \underset{\text{(Conc.)}}{H_2SO_4} \xrightarrow{\Delta} NaHSO_4 + HCl$$

Property: It's reducing property.

(b) Preparation of CO from HCOOH: Property - as a dehydrating agent.

$$HCOOH \xrightarrow{\text{Conc. } H_2SO_4} CO + H_2O$$

(c) Acidic property: As per the reactivity series, magnesium is present above hydrogen hence sulphuric acid is able to release hydrogen gas upon reacting with magnesium strips

$$Mg + H_2SO_4 \longrightarrow MgSO_4 + H_2$$

(d) Oxidizing property – this property of concentrated sulphuric acid is due to thermal decomposition.

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

(e) When hydrogen sulphide is passed through concentrated sulphuric acid, it releases sulphur dioxide to form sulphur.

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

(f) Conc. H_2SO_4 when reacts with ethanol and carbon produces the following:

(i) Reaction with Ethanol

$$C + 2\,H_2SO_4 \longrightarrow CO_2 + 2H_2O + 2SO_2\uparrow$$

(ii) Reaction with carbon

$$C_2H_5OH \xrightarrow[170^\circ C]{\text{Conc. } H_2SO_4} \underset{\text{Ethylene}}{C_2H_4\uparrow} + H_2O$$

15. (a) Give the equation for:

(i) Heat on sulphur with conc.sulphuric acid
(ii) Reaction of – sugar with conc.sulphuric acid
(b) Give a balanced equation for the conversion of zinc oxide to zinc sulphate
(c) Select the correct answer from A,B, C
A. Sodium hydroxide solution
B. A weak acid
C. Dilute sulphuric acid
The solution which liberates sulphur dioxide gas, from sodium sulphite

Solution:

(a) The equation is as follows:
(i) $S + H_2SO_4 \longrightarrow 3SO_2 + 2H_2O$
(ii) $C_{12}H_{22}O_{11} + \text{Conc. } H_2SO_4 \longrightarrow 6C + 6H_2O$
(b) The balanced equation for the conversion of zinc oxide to zinc sulphate is as follows:
$ZnO + H_2SO_4 \longrightarrow ZnSO_4 + H_2O$
(c) Option C. Dilute sulphuric acid solution liberates sulphur dioxide gas from sodium sulphite

16. (a)In the manufature of sulphuric acid by contact process, give the equation for the conversion of sulphur trioxide to sulphuric acid
(b) Give equations for the action of sulphuric acid on
(i) Potassium hydrogen carbonate
(ii) Sulphur
(d) Identify the acid in each case
(i) Acid which produces sugar charcoal from sugar
(ii) Acid on mixing with lead nitrate solution produces white ppt. which is insoluble even on heating

Solution:

(a) The equations for the conversion of sulphur trixoide to sulphuric acid are:
$SO_3 + H_2SO_4 \longrightarrow H_2S_2O_7$
(oleum or pyrosulphuric acid)
$H_2S_2O_7 + H_2O \longrightarrow 2H_2SO_4$
(b) The equations for the action of sulphuric acid is as follows:
(i) On Potassium hydrogen carbonate
$2KHCO_3 + H_2SO_4 \longrightarrow K_2SO_4 + 2H_2O + 2CO_2\uparrow$
(ii) On Sulphur
$S + 2H_2SO_4 \longrightarrow 3SO_2 + 2H_2O$
(c) The acid that produces sugar charcoal from sugar is concentrated sulphuric acid
(d) The acid on mixing with lead nitrate solution is concentrated sulphuric acid producing white precipitate that is insoluble even on heating

17. 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 suphuric acid is poured on it
(d) Brisk effervescence is seen when oil of vitriol is added to sodium carbonate

Solution:

(a) When sulphuric acid reacts with NaOH, it produces two types of salts as sulphuric acid is dibasic in nature. The reactions are as follows:

$NaOH + H_2SO_4 \longrightarrow NaHSO_4 + H_2O$

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

(b) When concentrated sulphuric acid is added to hydrogen bromide, red brown vapours are formed

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

(c) A huge mass of carbon is produced when concentrated sulphuric acid is poured on a piece of wood causing it to turn black.

(d) Brisk effervescence is observed when sulphuric acid is added to sodium carbonate as it releases carbon dioxide

$Na_2CO_3 + H_2SO_4 \longrightarrow Na_2SO_4 + H_2O + CO\uparrow$

18. 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:

Name of the product	**Reaction with hot and concentrated sulphuric acid**	**Produces**	**Reaction**
Sulphur		Sulphur dioxide	$S + 2H_2SO_4 \longrightarrow 3SO_2 + 2H_2O$
NaOH		Sodium sulphate	$2NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + 2H_2O$
Sugar		Carbon	$C_{12}H_{22}O_{11} \xrightarrow{\text{Conc. } H_2SO_4} 12C + 11H_2O$
Carbon		Carbon dioxide and sulphur dioxide gas	$C + 2H_2SO_4 \longrightarrow CO_2 + 2H_2O + 2SO_2\uparrow$
Copper		Copper sulphate and sulphur dioxide	$Cu + H_2SO_4 \longrightarrow CuSO_4 + 2H_2O + SO_2\uparrow$

19. **(a) Name the gas produced on reaction of dilute sulphuric acid with a metallic sulphide**
(b) Some properties of sulphuric acid are listed below. Choose the role played by sulphuric acid as A,B,C or D which is responsible for the reactions (i) to (v). Some role/s may be repeated

1. Dilute acid
2. Dehydrating agent
3. Non-volatile acid
4. Oxidizing agent

$$\text{(i) } CuSO_4 . 5H_2O \xrightarrow{\text{Conc.}H_2SO_4} CuSO_4 + 5H_2O$$
$$\text{(ii) } S + 2H_2SO_4[\text{conc.}] \longrightarrow 3SO_2 + 2H_2O$$

$$\text{(iii) } NaNO_3 + H_2SO_4 \xrightarrow{<200^\circ C} NaHSO_4 + HNO_3[\text{conc.}]$$
$$\text{(iv) } MgO + H_2SO_4 \longrightarrow MgSO_4 + H_2O$$
$$\text{(v) } Zn + 2H_2SO_4[\text{conc.}] \longrightarrow ZnSO_4 + SO_2 + 2H_2O$$

(c) Give balanced equation for the reaction: Zinc sulphide and dilute sulphuric acid

Solution:

(a) The gas produced on reaction of dilute sulphuric acid with a metallic sulphide is Hydrogen sulphide (H_2S)

(b) (i) Dehydrating agent
(ii) Oxidizing agent
(iii) Non-volatide acid
(iv) Dilute acid
(v) Oxidizing agent

(c) The balanced equation for the reaction: Zinc sulphide and dilute sulphuric acid is as follows:

$$ZnS + \text{dil.}H_2SO_4 \longrightarrow ZnSO_4 + H_2S$$

20. (a) State one appopriate observation for: Conc.H_2SO_4 is added to a crystal of hydrated copper sulphate

(b) In the given equation – $S + 2H_2SO_4 \longrightarrow 3SO_2 + 2H_2O$:

Identify the role played by conc.H_2SO_4

(i) Non-colatile acid
(ii) Oxidising agent
(iii) Dehydrating agent
(iv) None of the above

(c) Give a balanced equation for: Dehydration of concentrated sulphuric acid with sugar crystals

(d) Identify the substance underlined: <u>A dilute mineral acid</u> which forms a white precipitate when treated with barium chloride solution

Solution:

(a) Water of crystallization is eliminated from salt when concentrated H_2SO_4 is added to a crystal of hydrated copper sulphate

(b) Conc. H_2SO_4 acts as an oxidizing agent

(c) $C_{12}H_{22}O_{11} + \text{Conc. } H_2SO_4 \longrightarrow 6C + 6H_2O$

(d) The underline substance is sulphuric acid H_2SO_4. When it is treated with barium chloride, it forms a whote precipitate.