

CHEMISTRY NOTES FOR CLASS 10TH (FOR SINDH)

CHAPTER

4

Sulphur and its Compounds

You will learn in this chapter about:

- ✦ Sulphur and its allotropic forms, Rhombic, Monoclinic and plastic sulphur, their preparations and properties.
- ✦ Occurrence and extraction of sulphur by Frasch process.
- ✦ Manufacture of sulphuric acid by contact process.
- ✦ Physical and chemical properties of H_2SO_4 , uses of sulphuric acid.

Section - A

Multiple Choice Questions (M.C.Qs.)

Choose the correct answer for each from the given options:

1. The formula of iron pyrite :
(a) FeS (b) Fe_2S_3 (c) FeS_2 (d) Fe_2S_2
2. The non crystalline form of sulphur is :
(a) Plastic sulphur (b) Rhombic sulphur
(c) Monoclinic sulphur (d) Ordinary sulphur.
3. The specific gravity of 98.3% conc. H_2SO_4 is :
(a) 1.5 (b) 1.84 (c) 1.80 (d) 1.91
4. The density of rhombic sulphur is :
(a) 1.96 (b) 1.92 (c) 2.4 (d) 2.08
5. Rhombic sulphur has structure of shape :
(a) Square planar (b) Octahedral (c) Tetrahedral, (d) Prismatic
6. The temperature for the maximum yield of SO_3 in contact process is :
(a) $350^\circ C$ (b) $450^\circ C$ (c) $1700^\circ C$ (d) $900^\circ C$
7. Sulphur burns in oxygen with blue flame to produce :
(a) SO_3 (b) H_2S (c) S_2Cl_2 (d) SO_2
8. Sulphur is the member of Group VI A of the periodic table.
(a) first (b) second (c) third (d) fourth
9. The atomic number of sulphur is:
(a) 14 (b) 16 (c) 28 (d) 32.
10. The atomic mass of sulphur is:
(a) 14 (b) 16 (c) 28 (d) 32.

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11. Who recognized sulphur as an element in 1787?
(a) Lavoisier (b) Scheele (c) Dalton (d) John
12. The existence of an element in two or more different forms in the same physical state is called:
(a) isomorphism (b) polymorphism (c) allotropy (d) entropy
13. Monoclinic sulphur is also called :
(a) rhombic sulphur (b) prismatic sulphur (c) plastic sulphur (d) octahedral sulphur
14. The most stable crystalline form of sulphur at ordinary condition is:
(a) rhombic (b) monoclinic (c) prismatic (d) plastic
15. The melting point of rhombic sulphur is :
(a) 96°C (b) 113 °C (c) 119 °C (d) 444 °C
16. The crystalline allotropes of sulphur are:
(a) 2 (b) 3 (c) 4 (d) 5.
17. The density of rhombic sulphur is :
(a) 1.46 g/cc (b) 1.96 g/cc (c) 2.08 g/cc (d) 2.46 g/cc
18. The melting point of monoclinic sulphur is :
(a) 96 °C (b) 113 °C (c) 119 °C (d) 444 °C
19. The density of monoclinic sulphur is :
(a) 1.46 g/cc (b) 1.96 g/cc (c) 2.08 g/cc (d) 2.46 g/cc
20. The transition temperature of sulphur is :
(a) 96 °C (b) 113 °C (c) 119 °C (d) 444 °C
21. The shape of rhombic sulphur is :
(a) needle shaped (b) octahedral (c) tetrahedral (d) polyhedral
22. The shape of monoclinic or prismatic sulphur :
(a) needle shaped (b) octahedral (c) tetrahedral (d) polyhedral
23. The colour of Plastic sulphur is :
(a) pale yellow (b) dark yellow (c) dark (d) red
24. The crystals of monoclinic sulphur are of :
(a) dark yellow (b) pale yellow (c) dark (d) red
25. S₈ molecules of sulphur are made up of :
(a) 4 atoms (b) 5 atoms (c) 7 atoms (d) 8 atoms
26. The arrangement of sulphur atoms in Plastic sulphur is:
(a) zigzag (b) haphazard (c) complex (d) simple
27. The percentage of Sulphur in the earth's crust is.
(a) 0.1 % (b) 0.6 % (c) 1 % (d) 2 %
28. Sulphur is extracted by which Process?
(a) Haber (b) Frasch (c) Ostward (d) Herman
29. The sulphur obtained by Frasch Process is:
(a) 94.5 % pure (b) 96.5 % pure (c) 97.5 % pure (d) 99.5 % pure
30. The melting point of sulphur is between 113°C and :
(a) 119°C (b) 144 °C (c) 344 °C (d) 444 °C
31. The boiling point of sulphur is :
(a) 344 °C (b) 444 °C (c) 544 °C (d) 644 °C
32. Carbon disulphide is a colourless:
(a) solid (b) liquid (c) gas (d) substance
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33. Sulphur is used in rubber for :
 (a) pickling (b) tarnishing (c) dying (d) vulcanizing
34. Industrially sulphuric acid is prepared by:
 (a) Contact Process (b) Haber Process (c) Ostwald Process (d) Frasch Process
35. The catalyst widely used for preparing sulphuric acid is :
 (a) Pt (b) V_2O_5 (c) Pd (d) Ni
36. Pyrosulphuric acid is also called :
 (a) opium (b) ozone (c) oleum (d) atrium
37. Sulphuric acid is a strong :
 (a) monobasic acid (b) dibasic acid (c) tribasic acid (d) polybasic acid
38. Sulphuric acid is a/an :
 (a) oxidizing agent (b) reducing agent (c) reactive agent (d) unreactive agent
39. Sulphuric acid is mostly used in making:
 (a) rayon (b) paper (c) plastics (d) fertilizers
40. The formula for a sulphur molecule is :
 (a) S (b) S_8 (c) S_{16} (d) S_{12}
41. Sulphur trioxide is never dissolved directly in water because it:
 (a) reacts extremely violently (b) is insoluble in water.
 (c) is reduced to sulphur dioxide. (d) is endothermic
42. The equation for the main stage of the Contact Process is :
 (a) $2SO_{2(g)} + O_{2(g)} \longrightarrow 2SO_{3(g)}$ (b) $SO_{2(g)} + O_{2(g)} \longrightarrow 2SO_{3(g)}$
 (c) $2SO_{2(g)} + O_{2(g)} \longrightarrow SO_{3(g)}$ (d) $SO_{3(g)} + H_2O_{(l)} \longrightarrow H_2SO_{4(aq)}$
43. Which of these is not a use of sulphuric acid?
 (a) in solution as a sterilizer (b) to make acid rain
 (c) as a food preservative (d) as a bleach for wood pulp

Answers of M.C.Qs.

1. (a)	8. (b)	15. (b)	22. (a)	29. (d)	36. (c)	43. (b)
2. (a)	9. (b)	16. (a)	23. (c)	30. (a)	37. (b)	
3. (b)	10. (d)	17. (c)	24. (a)	31. (b)	38. (a)	
4. (d)	11. (a)	18. (c)	25. (d)	32. (b)	39. (d)	
5. (b)	12. (c)	19. (b)	26. (a)	33. (d)	40. (b)	
6. (b)	13. (b)	20. (a)	27. (a)	34. (a)	41. (a)	
7. (d)	14. (a)	21. (b)	28. (b)	35. (b)	42. (a)	

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Section - B/C Short / Descriptive Answer Questions

Q1. Give introduction about Sulphur and its Compounds.

Ans. An Introduction : Sulphur belongs to Group VI A of the periodic table. Its symbol is S. Its atomic number is 16 and atomic mass 32 a.m.u. Lavoisier recognized it as an element in 1787. Sulphur has been known for its medical and germicidal effects since 1000 B.C.

Q2. Write down the occurrence of sulphur.

Ans. Occurrence of Sulphur : Sulphur exist in the earth's crust to the extent of 0.1%. It is found in the free state in Sicily, Mexico, USA, Japan, New Zealand. In Pakistan some deposits of sulphur occur in Koh-e-Sultan and Qalat. In the combined state, it is largely found as sulphides of iron, zinc, lead, copper and mercury and also as sulphates of magnesium, calcium and barium. Sulphur is an essential constituent of many organic substances of plant and animal origins such as proteins, eggs, onions, garlic and mustard, etc. Fossil fuels such as coal, natural gas and petroleum also contain sulphur compounds.

Q3. Define allotropy. Write down the different allotropes of sulphur. Karachi Board 2010-2012

Ans. Allotropy : The existence of an element in more than one form in the same physical state is called allotropy, and the forms are called allotropes. e.g. The element phosphorous exists as red and white solid allotropes. The element oxygen exists as oxygen gas (O_2) and ozone gas (O_3).

Allotropes (allotropic forms) of Sulphur :

There are three common allotropes of sulphur given as under:

1. Rhombic sulphur (octahedral sulphur) which is crystalline.
2. Monoclinic sulphur (α sulphur), also called prismatic sulphur, which is also crystalline.
3. Plastic sulphur (γ sulphur), which is amorphous.

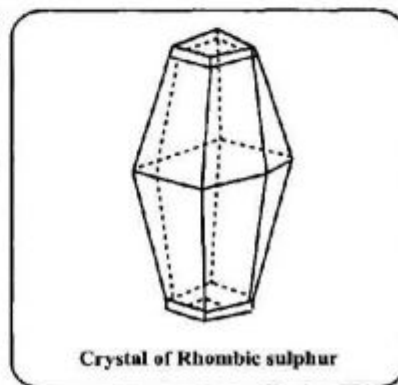
Q.4 How is rhombic sulphur prepared? Write down the structure and physical properties of rhombic sulphur.

Ans. Preparation of Rhombic Sulphur : Dissolve powdered sulphur in cold carbon disulphide (CS_2) or in disulphur dichloride (S_2Cl_2). Filter the solution through a filter paper. Allow the solution for evaporation in the air. The filtrate on evaporation forms transparent lemon yellow octahedral crystals of rhombic sulphur.

Structure of Rhombic Sulphur : Rhombic sulphur consists of S_8 molecules having eight sulphur atoms bound to each other through single covalent bonds forming octahedral crystals.

Physical Properties of Rhombic Sulphur :

1. It is the most stable crystalline form of sulphur. Free sulphur exists in nature as rhombic sulphur.
2. Its melting point is $113^\circ C$.
3. Its density is 2.08 g/cm^3 at $20^\circ C$.
4. Its colour is pale yellow.
5. It is insoluble in water. However, it dissolves in carbon disulphur (CS_2), benzene (C_6H_6), disulphur dichloride (S_2Cl_2), turpentine, toluene, xylene, etc.



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Q5.

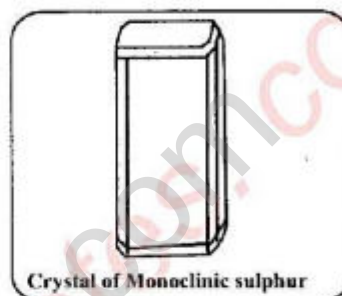
How is monoclinic sulphur prepared? Write down the structure and physical properties of monoclinic sulphur.

Ans. Preparation of Monoclinic Sulphur : Sulphur is melted first in a dish. The molten sulphur is allowed to cool slowly until a crust forms on its surface. Pierce two holes through the crust and pour off the remaining molten sulphur. On removing the crust, the long needle shaped crystals are found on the sides of the dish.

Structure of Monoclinic Sulphur : Monoclinic sulphur also consists of S_8 molecules having eight sulphur atoms. In monoclinic sulphur, S_8 molecules unite together to give needle-shaped crystals.

Physical Properties of Monoclinic Sulphur :

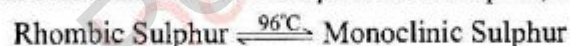
1. Monoclinic sulphur is a dark yellow crystalline form of sulphur.
2. It is stable between 96°C and 119°C . It changes slowly to rhombic sulphur below 96°C .
3. Its melting point is 119°C .
4. Its density is 1.96g/cm^3 .
5. It is soluble in carbon disulphide (CS_2).



Q6.

Write a brief account of the relationship between rhombic and monoclinic sulphur.

Ans. Relationship between Rhombic and Monoclinic Sulphur : Both rhombic and monoclinic sulphur are crystalline. Their crystals are however of different shapes. Rhombic sulphur has octahedral crystals while monoclinic sulphur has needle-shaped crystals. Both these allotropes of sulphur exist in equilibrium at 96°C , which is called the transition temperature of sulphur. Below 96°C rhombic sulphur is stable and above 96°C monoclinic sulphur is stable. The transformation of monoclinic sulphur to rhombic sulphur is reversible. Both these crystalline allotropes of sulphur can change from one form to another above or below the transition temperature of sulphur, which is 96°C .



Q7.

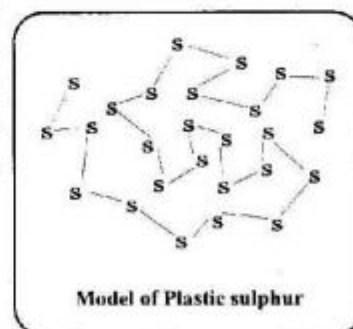
How is plastic sulphur prepared? write down the structure and physical properties of plastic sulphur.

Ans. Preparation of Plastic Sulphur : On heating the ordinary sulphur to its boiling points (444°C) and then pouring it into cold water plastic sulphur is obtained. It is elastic and can be stretched like rubber. Plastic sulphur is generally not considered to be a true allotrope of sulphur because it is not stable and changes to rhombic sulphur on standing.

Structure of Plastic Sulphur : The sulphur atoms in plastic sulphur are arranged in chains and not in rings. Plastic sulphur is therefore called a super cooled liquid having a zigzag arrangement of atoms in its structure.

Physical Properties of Plastic Sulphur :

1. Usually the plastic sulphur is black. However, the pure form is pale yellow.
2. It is not crystalline. It is amorphous.
3. It is elastic and can be stretched like rubber.
4. It is insoluble in water but soluble in carbon disulphide (CS_2).
5. Plastic sulphur is a super cooled form of sulphur.

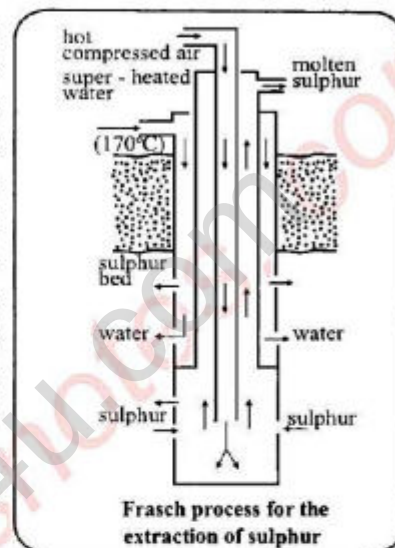


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Q8. How is sulphur extracted from underground deposits? Write down the Frasch method for the extraction of sulphur.

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Ans. Extraction of Sulphur (Frasch Method) : An American engineer, Herman Frasch, developed an ingenious method for the extraction of sulphur. In this method a hole about 30cm diameter is drilled in to the sulphur bed. Three concentric iron pipes are sunk into the hole. The outermost pipe of 20 cm diameter is sunk to the sulphur deposits. The next inner pipe of 10cm diameter is held a little above the sulphur deposits. The innermost pipe is of 5cm diameter. Superheated water at 170°C under 100 atmospheres is pumped down the outermost pipe to melt the sulphur (melting point of sulphur is 115°C). Hot compressed air is pumped down the innermost pipe. A frothy mixture of air, water and molten sulphur rises up the middle pipe. The molten sulphur, 99.5% pure, is pumped into large storage vats where it cools and solidifies into huge blocks.



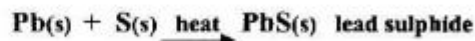
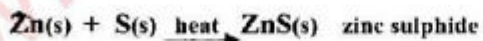
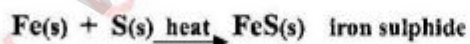
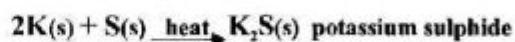
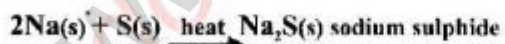
Q9. Write down the physical and chemical properties of sulphur.

Ans. Physical Properties of Sulphur :

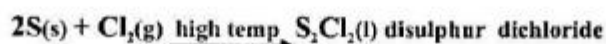
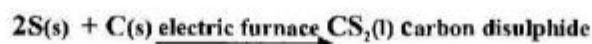
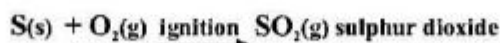
1. Sulphur has a yellow colour.
2. It is insoluble in water but soluble in carbon disulphide (CS₂).
3. It melts at a temperature between 113°C and 119°C.
4. Its boiling point is 444°C.
5. It is a nonmetal and a bad conductor of heat and electricity.

Chemical Properties of Sulphur :

1. **Reaction with Metals :** Sulphur combines with many metals like sodium, potassium, iron, lead, copper, zinc, etc. to form the respective sulphides on heating.



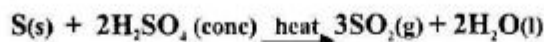
2. **Reaction with Nonmetals :** Many nonmetals react with sulphur at different conditions.



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3. Reaction with Acids :

- (i) **Reaction with Sulphuric Acid:** sulphur is readily oxidized to sulphur dioxide when warmed with concentrated sulphuric acid.



- (ii) **Reaction with Nitric Acid :** On heating with concentrated nitric acid, sulphur is oxidized to sulphuric acid.



However, dilute acids and concentrated hydrochloric acid do not have any action on sulphur.

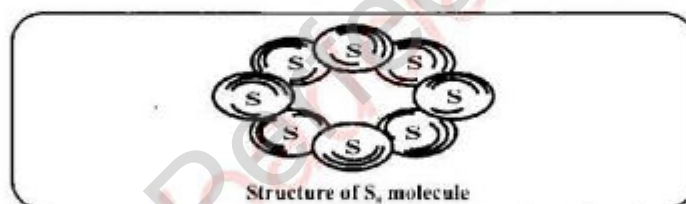
Q10. Write down the uses of sulphur.

Ans. Uses of Sulphur :

1. It is mainly used in the preparation of sulphuric acid.
2. It is used in vulcanizing rubber for tyre manufacture.
3. It is used making antibiotic drugs and sulphur - base fungicides.
4. It is used in making matches and fireworks.
5. It is also used as a bleaching agent in the pulp and paper industry.

Q11. Write down the structure of S₈ sulphur molecule.

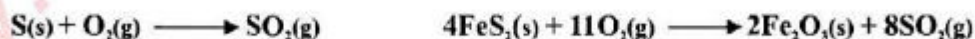
Ans.



Q12. Write down the various stages in the preparation of sulphuric acid by the Contact Process.

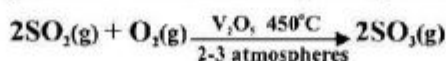
Ans. Preparation of Sulphuric Acid (Contact Process) : Sulphuric acid is prepared on a large scale by the Contact Process. The raw materials are sulphur or sulphide ores and air. The process involves various stages given as under.

1. **Production of Sulphur Dioxide :** Sulphur dioxide is produced by burning either sulphur or ores which contain sulphur such as iron pyrite (FeS₂).



2. **Purification of Impure Sulphur Dioxide :** Sulphur dioxide and air must be free from all sorts of impurities which poison the catalyst. The mixture of SO₂ and air is passed through dust chamber and washing chamber for purification. Then this mixture is dried in the drying towers where H₂SO₄ is sprayed from the top.

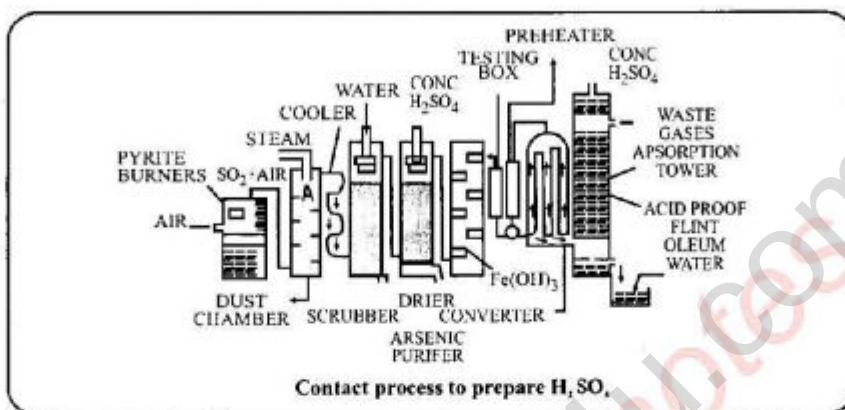
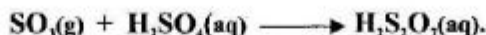
3. **Oxidation of Sulphur Dioxide to Sulphur Trioxide :** Dried SO₂ is passed in the catalytic chamber over vanadium pentaoxide (V₂O₅) at 450°C and 2-3 atmosphere pressure to get SO₃ gas.



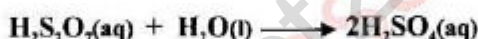
The reaction is exothermic and no external heat is required once it has started.

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4. **Production of Oleum** : Sulphur trioxide (SO_3) is then dissolved in concentrated sulphuric acid to form oleum ($\text{H}_2\text{S}_2\text{O}_7$), or fuming sulphuric acid.



5. **Production of Sulphuric Acid** : The oleum is then diluted with water to the required strength of sulphuric acid.



SO_3 can not be dissolved directly in water as it reacts too violently and is less soluble in water.

Q13. Write down the physical properties of sulphuric acid.

Ans. Physical Properties of Sulphuric Acid :

1. Pure sulphuric acid is a colourless oily liquid without any odour.
2. Its specific gravity is 1.84.
3. It freezes at 10.5°C .
4. Its boiling point is 338°C .
5. It is extremely corrosive to skin and causes very serious burns.

Q14. Write down the chemical properties of sulphuric acid.

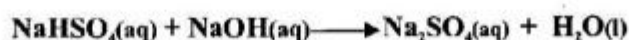
Ans. Chemical Properties of Sulphuric Acid :

1. **As an Acid :**

- (i) Sulphuric acid is a strong dibasic acid and ionizes in water in two stages.



- (ii) Sulphuric acid reacts with alkalis to give two types of salts hydrogen sulphate and sulphate.



- (iii) Sulphuric acid also reacts with basic oxides (metal oxides) like MgO to form salts and water.



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2. **As an Oxidizing Agent :** The oxidizing properties of H_2SO_4 depend on :

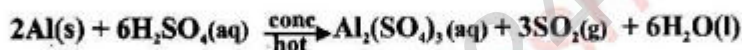
(i) the concentration of the acid (ii) nature of the metal or reducing agent (iii) temperature

Oxidation of Metals :

(i) Less electropositive metals like Mg, Al, Zn, Fe, Sn react with dilute sulphuric acid to liberate hydrogen and forming the respective sulphates.



(ii) Hot concentrated sulphuric acid oxidizes some metals to their sulphates liberating SO_2 gas.

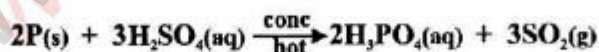
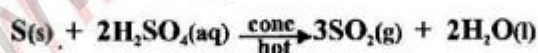


(iii) Zinc reacts with 90% concentrated H_2SO_4 liberates hydrogen sulphide gas. Reactive metals with conc H_2SO_4 form different products.



Oxidation of Nonmetals :

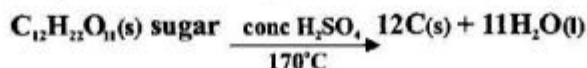
Hot concentrated sulphuric acid oxidizes some nonmetals like carbon, sulphur, phosphorous, etc into their oxides and oxyacids.



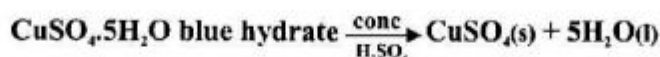
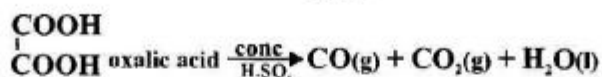
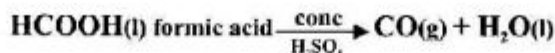
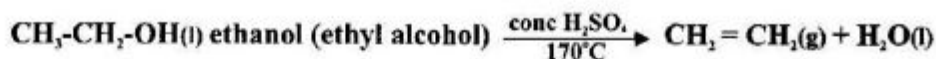
Oxidation of Certain Compounds : Concentrated sulphuric acid oxidizes hydrogen sulphide (H_2S) to sulphur and hydroiodic acid (HI) is oxidized to iodine (I_2) vapours.



3. **As a Dehydrating (Drying) Agent :** As a Dehydrating (Drying) Agent concentrated sulphuric acid has a great affinity for water, it removes water from sugar, ethanol, formic acid oxalic acid. The process of removing water from a compound is called dehydration. The hot concentrated sulphuric acid, therefore, acts as a powerful dehydrating or drying agent. Concentrated H_2SO_4 also removes water of crystallization from hydrated ionic compounds to make the compound anhydrous.



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Q15. Write down the uses of sulphuric acid.

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Ans. *Uses of Sulphuric Acid :*

1. It is used in the manufacture of fertilizers especially dihydrogen calcium phosphate or super phosphate $\text{Ca}(\text{H}_2\text{PO}_4)_2$ and ammonium sulphate $(\text{NH}_4)_2\text{SO}_4$.
2. It is used in the manufacture of rayon, paper, plastics and detergents.
3. It is used in the manufacture of paints and pigments.
4. It is used in motor batteries and lead accumulators.
5. It is used in the refining of petroleum.

Q16. Make a comparative study of the allotropes of sulphur.

Ans. *Properties of Sulphur Allotropes :*

Characteristics	Rhombic Sulphur	Monoclinic Sulphur	Plastic Sulphur
Shape	octahedral crystals	needle shaped crystals	amorphous rubber like
Colour	pale yellow	yellow	black
Melting point	113°C	119°C	141°C
Density	2.08g / cm ³	1.98 g / cm ³	-----
Stability	stable below 96°C	stable between 96°C and 119°C.	unstable, slowly changes at 119°C. to rhombic sulphur.
Preparation	Crystallizes from CS ₂ solution of sulphur.	Crystallizes from molten sulphur as it cools	By quick cooling very hot liquid sulphur

CHEMISTRY NOTES FOR CLASS 10TH (FOR SINDH)

Textbook Exercise

1. Fill in the blanks :

- (i) Rhombic sulphur is the most stable form of sulphur.
- (ii) Monoclinic sulphur has needle like structure.
- (iii) CS_2 is a good solvent for sulphur.
- (iv) The melting point of monoclinic sulphur is 119°C.
- (v) Pure sulphuric acid on large scale is manufactured by the contact process.
- (vi) Phosphorous with hot conc. H_2SO_4 oxidizes to H_3PO_4 .
- (vii) Ethene gas evolves when ethanol is dehydrated by hot conc. H_2SO_4 .

2. Tick true or false for the following statements :

- (i) Plastic sulphur is hard. (false)
- (ii) Monoclinic sulphur is stable above 96°C. (true)
- (iii) Sulphur is extracted by the direct mining from the earth's deposits. (false)
- (iv) Conc. sulphuric acid has greater affinity for water. (true)
- (v) Conc. sulphuric acid reduces to SC_2 when acting as oxidizing agent. (true)
- (vi) In the manufacture of sulphuric acid, SO_3 is directly dissolved in water to produce oleum. (false)
- (vii) Conc. H_2SO_4 removes water from sugar to leave charred mass. (true)

3. Pick up the correct answer :

Ans: See MCQs 1 to 7.

4. (a) What is allotropy? Describe different allotropic forms of sulphur.

Ans: See Q.3.

(b) What is plastic sulphur? Why is it elastic?

Ans: See Q.7.

(c) What is the action of sulphur on heating with.

- (i) Cu (ii) C (iii) Cl_2 (iv) Na

Ans: See Q.09 (chemical properties).

(d) Give four uses of sulphur.

Ans: See Q.10.

5. (a) Describe and explain, how sulphur is extracted from underground deposits by Frasch process.

Ans: See Q.8.

(b) Describe what happens when :

- (i) Sulphur is heated in the absence of air.

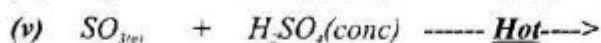
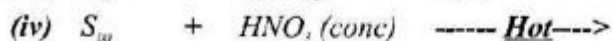
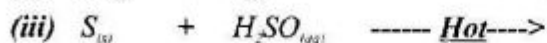
Ans: It melts to molten S.

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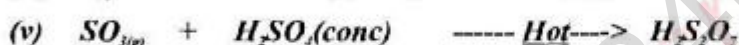
(ii) Sulphur is heated in the presence of air.

Ans: See Q.9 (2).

(c) Complete the following reactions with balanced equations.



Balanced Equation:



6. (a) Discuss various stages in the manufacture of sulphuric acid by the contact process, giving equations of the reactions involved.

Ans: See Q.12.

(b) Explain why SO_2 is purified before it is passed into the contact tower for its oxidation to SO_3 .

Ans: See Q.12 (2).

(c) Show that sulphuric acid acts as :

(i) oxidizing agent (ii) dehydrating agent.

Ans: See Q.14 (2) (3).

(d) With the acid of equation, describe the action of conc. sulphuric acid on :

(i) Al metal (ii) C (iii) $C_{12}H_{22}O_{11}$

(iv) Blue crystals of $CuSO_4 \cdot 5H_2O$

Ans: See Q.14.

(e) Give the importance of sulphuric acid and its uses.

Ans: See Q.15.

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