

2. VIA GROUP ELEMENTS

SYNOPSIS

Oxygen, sulphur, selenium, tellurium and polonium constitute group 16 [Chalcogens]

Oxygen exist as diatomic molecules (O_2) whereas sulphur exists as polyatomic molecule (S_8).

Atomic & Physical Properties :

Element	O	S	Se	Te
Atomic Number	8	16	34	52
Atomic Mass	16	32.06	78.96	127.6
Electronic configuration	[He] 2s ² 2p ⁴	[Ne] 3s ² 3p ⁴	[Ar] 3d ¹⁰ 4s ² 4p ⁴	[Kr] 4d ¹⁰ 5s ² 5p ⁴
Covalent Radius/pm	74	103	119	142
Ionic Radius X ⁻² /pm	140	184	198	221
Ionization enthalpy/(kJ mol ⁻¹)	I	1314	1000	941
	II	3388	2251	2045
Electronegativity	3.5	2.44	2.48	2.01
Density/[g cm ⁻³ (293 K)]	1.32	2.06	4.19	6.25
Melting point/K	54	393	490	725
Boiling point/K	90	718	958	1260

The EN of oxygen is very high, it shows only negative oxidation states except in the case of OF_2 (2+) O_2F_2 (1+).

The anomalous behaviour of oxygen is due to its small size and high EN.

The absence of d orbitals in oxygen limits its covalency to four and in practice, rarely exceeds two. In case of other elements max covalency is 6.

Property	H ₂ O	H ₂ S	H ₂ Se	H ₂ Te
m.p./K	273	188	208	222
b.p./K	373	213	232	269
H-E distance/pm	96	134	146	169
HEH angle (°)	104	92	91	90
D _f H/kJ mol ⁻¹	-286	-20	73	100
D _{diss} H (H-E)/kJ mol ⁻¹	463	347	276	238
Dissociation constant ^a	1.8×10^{-16}	1.3×10^{-7}	1.3×10^{-4}	2.3×10^{-3}

Reactivity with oxygen :

EO_2 and EO_3 , where E = S, Se, Te or Po.

Ozone (O_3) and sulphur dioxide (SO_2) are gases while selenium dioxide (SeO_2) is solid.

Reducing property of dioxide decreases from SO_2 to TeO_2

Reactivity toward the halogens :

The stabilities of the halides decrease in the order F > Cl > Br > I.

Amongst hexahalides, hexafluorides are the only stable halides.

SF_6 is exceptionally stable for steric reasons.

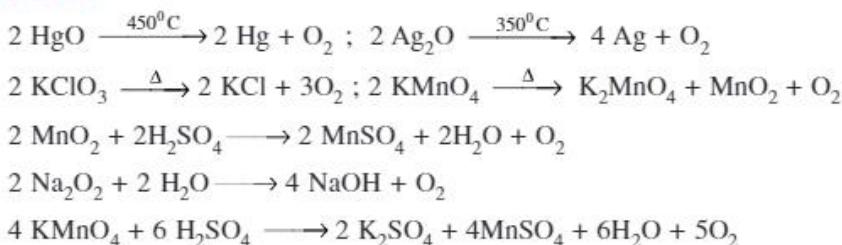
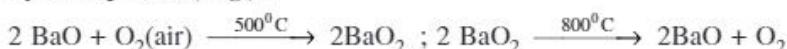
SF_4 is a gas, SeF_4 liquid and TeF_4 a solid. This geometry is also regarded as see-saw geometry [Folded square or Distorted tetrahedron].

S_2F_2 , S_2Cl_2 , S_2Br_2 , Se_2Cl_2 and Se_2Br_2 . These dimeric halides undergo disproportionation as given below : $2Se_2Cl_2 \longrightarrow SeCl_4 + 3Se$.

Dioxygen (O_2) :

It differs from the remaining elements of the VIth group because of the following properties.

- (A) small size (B) high electronegativity and (C) non-availability of d-orbitals.

Preparation:**By Brins process (mfg.) :****From air (mfg.) :**

Oxygen is obtained by liquification of air and then its fractional distillation.

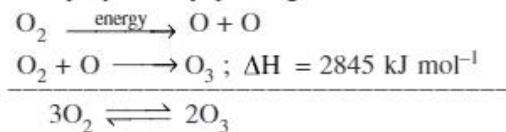
O_2 is paramagnetic according to MOT

Oxides :

- i) Acidic oxides : Ex. Non metal oxides
- ii) Basic oxides : Ex. Metal oxides
- iii) Neutral Oxides : Ex. CO, NO, N_2O
- iv) Amphoteric Oxides : Ex. ZnO , Al_2O_3 , BeO, Sb_2O_3 , Cr_2O_3 , PbO etc.
- v) Mixed Oxides : Ex. Pb_3O_4 , Fe_3O_4 , Mn_3O_4

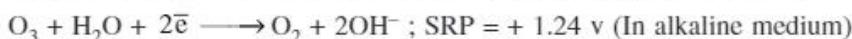
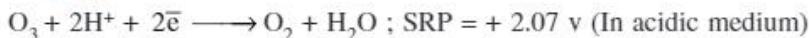
OZONE (O_3) :**Preparation:**

It is prepared by passing silent electric discharge through pure and dry oxygen.



prepared by (i) Simen's and (ii) Brodie's ozonisers

Properties: O_3 molecule is diamagnetic but O_3^- is paramagnetic.

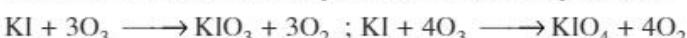
Oxidising agent :

Therefore, ozone is a strong oxidising agent in acidic medium.

- a) It oxidises I^- to I_2 (from neutral solution of KI)



Alkaline KI is oxidised to potassium iodate & periodate.



Similarly $\text{S}^{2-} \longrightarrow \text{SO}_4^{2-}$ (but not H_2S), $\text{NO}_2^- \longrightarrow \text{NO}_3^-$, $\text{SO}_3^- \longrightarrow \text{SO}_4^{2-}$, $\text{AsO}_3^{3-} \longrightarrow \text{AsO}_4^{3-}$, $\text{MnO}_4^{2-} \longrightarrow \text{MnO}_4^-$, $\text{Sn}^{2+} \longrightarrow \text{Sn}^{4+}$ & $[\text{Fe}(\text{CN})_6]^{4-} \longrightarrow [\text{Fe}(\text{CN})_6]^{3-}$ in acidic medium.

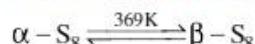
- b) It oxidises moist S, P, As into their oxy acids : $O_3 \longrightarrow O_2 + [O] \times 3$
- c) It oxidises H_2S to S ; $H_2S + O_3 \longrightarrow H_2O + S \downarrow$ (yellow)
- ii) **Reaction with dry I_2** : $2I_2 + 9[O_3] \longrightarrow I_4O_9 + 9O_2$
 I_4O_9 yellow solid has the composition $I^{+3} (IO_3^-)_3$.
- iii) **Reaction with moist iodine** : $O_3 \longrightarrow O_2 + [O] \times 5$
 $5O_3 + I_2 + H_2O \longrightarrow 2HIO_3 + 5O_2$
- iv) **Reaction with Silver** : Silver articles become black in contact with ozone.
 $Ag + O_3 \longrightarrow Ag_2O \downarrow$ (black) + O_2
- v) **Reaction with H_2O_2** : $2e^- + 2H^+ + O_3 \longrightarrow O_2 + H_2O$
 $O_3 + H_2O_2 \longrightarrow 2O_2 + H_2O$
Oxidising agent Reducing agent
- It is supported by the fact that SRP of ozone is higher (+2.07) than SRP of hydrogen peroxide (+1.77). Therefore, ozone is stronger oxidising agent than hydrogen peroxide.
- vi) **Bleaching Action** : O_3 also bleaches coloured substances through oxidation.

Sulphur (S) :**Sulphur Allotropic Forms :**

Sulphur forms numerous allotropes of which the **yellow rhombic** (α -sulphur) and **monoclinic** (β -sulphur) forms are the most important. The stable form at room temperature is rhombic sulphur, which transforms to monoclinic sulphur when heated above 369 K.

Rhombic sulphur (α - sulphur) : yellow, M.P. 385.8 K, specific gravity 2.06, soluble in CS_2

Monoclinic sulphur (β - sulphur) : M.P. 393 K and specific gravity 1.98, soluble CS_2



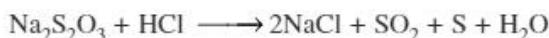
The S_8 ring in both the forms is puckered and has a crown shape.

S_2 is the dominant species and is paramagnetic like O_2 .

Sodium Thiosulphate ($Na_2S_2O_3 \cdot 5H_2O$) : Hypo**Preparation:****Properties:**

i) **As antichlor** : $Na_2S_2O_3 + Cl_2 + H_2O \longrightarrow Na_2SO_4 + 2HCl + S$

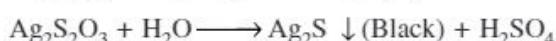
ii) **Reaction with HCl** :



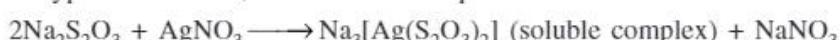
This test is used for distinction between $S_2O_3^{2-}$ and SO_3^{2-} ions as SO_3^{2-} ions give only SO_2 with HCl.

iii) **Complex formation reactions :**

a) **Reaction with silver salts ($AgNO_3$, $AgCl$, $AgBr$ or AgI)** :



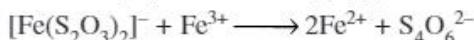
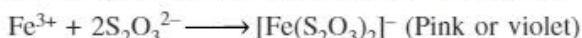
If hypo is in excess, then soluble complex is formed.



This reaction is utilized in photography where hypo is used as fixer.

b) Reaction with FeCl_3 :

It develops a pink or violet colour which soon vanishes according to following reaction.



iv) As reducing agent In iodometric titration :



Uses:

- i) As an ‘antichlor’ to remove excess of chlorine from bleached fabrics. ii) In photography as fixer.

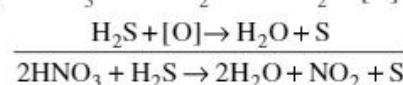
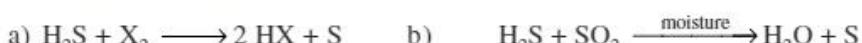
Hydrogen Sulphide (H_2S) :

Preparation: $\text{FeS} + \text{H}_2\text{SO}_4 \longrightarrow \text{FeSO}_4 + \text{H}_2\text{S}$. It is prepared in kipp’s apparatus.

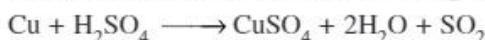
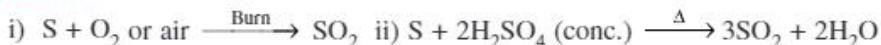
Properties:

- i) Colourless gas with rotten egg smell.

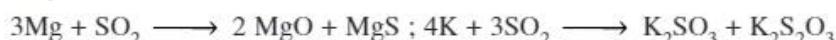
- ii) **Reducing Agent :** Acts as a strong reducing agent as it decomposes evolving hydrogen.



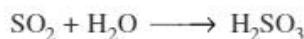
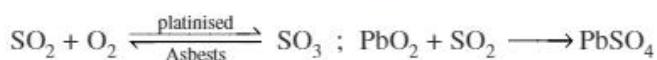
It also reduces $\text{KMnO}_4 \longrightarrow \text{Mn}^{2+}$, $\text{H}_2\text{SO}_4 \longrightarrow \text{SO}_2$ & $\text{K}_2\text{Cr}_2\text{O}_7 \longrightarrow \text{Cr}^{3+}$

Sulphur Dioxide :**Preparation:****Properties:**

- i) Colourless gas with burning sulphur smell.
- ii) It is heavier than air and is highly soluble in water
- iii) Neither burns nor helps in burning but burning magnesium and potassium continue to burn in its atmosphere.



- iv) **Acidic Nature :** Acidic oxide and thus dissolve in water forming sulphurous acid.

v) **Addition Reaction :**vi) **Reducing Nature :**

Reducing character is due to the liberation of nascent hydrogen

- Reduces halogens to corresponding halides
- Reduces acidified iodates to iodine

It also reduces acidified $\text{KMnO}_4 \longrightarrow \text{Mn}^{2+}$ (decolourises),

Acidified $\text{K}_2\text{Cr}_2\text{O}_7 \longrightarrow \text{Cr}^{3+}$ (green coloured solution) & Ferric Sulphate \longrightarrow Ferrous sulphate

vii) Oxidising nature :

Acts as oxidising agent with strong reducing agent

- $2\text{H}_2\text{S} + \text{SO}_2 \xrightarrow{\text{moisture}} 2\text{H}_2\text{O} + 3\text{S}$
- $2\text{SnCl}_2 + \text{SO}_2 + 4\text{HCl} \longrightarrow 2\text{SnCl}_4 + 2\text{H}_2\text{O} + \text{S}$
- $2\text{Hg}_2\text{Cl}_2 + \text{SO}_2 + 4\text{HCl} \longrightarrow 2\text{HgCl}_2 + 2\text{H}_2\text{O} + \text{S}$
- $2\text{CO} + \text{SO}_2 \longrightarrow 2\text{CO}_2 + \text{S}$
- $2\text{Fe} + \text{SO}_2 \longrightarrow 2\text{FeO} + \text{FeS}$

viii) Bleaching Action :

$\text{SO}_2 + 2\text{H}_2\text{O} \longrightarrow \text{H}_2\text{SO}_4 + 2\text{H}$. This is due to the reducing nature of SO_2 bleaching is temporary.

Sulphuric acid (H_2SO_4) :

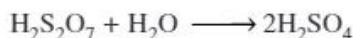
Preparation:

Contact process (Industrial method) :



Catalysts are Pt, Fe_2O_3 , V_2O_5 . H_2SO_4 (58%) + $\text{SO}_3 \longrightarrow \text{H}_2\text{S}_2\text{O}_7$

Sulphuric acid of any desired concentration can be obtained from oleum by dilution with water.



Properties:

i) It fumes strongly in moist air and is highly corrosive in nature.

ii) Acidic Nature : $\text{H}_2\text{SO}_4 \rightleftharpoons \text{H}^+ + \text{HSO}_4^- \rightleftharpoons 2\text{H}^+ + \text{SO}_4^{2-}$

Displaces more volatile acids from their metal salts. $2\text{NaCl} + \text{H}_2\text{SO}_4 \longrightarrow \text{Na}_2\text{SO}_4 + \text{HCl}$

iii) Oxidising Nature :

a) Non-metals (carbon, sulphur etc) are oxidised to their oxides. $\text{C} + 2\text{H}_2\text{SO}_4 \longrightarrow \text{CO}_2 + 2\text{SO}_2 + 2\text{H}_2\text{O}$

b) Iodine is liberated from KI; $2\text{KI} + 2\text{H}_2\text{SO}_4 \longrightarrow \text{K}_2\text{SO}_4 + \text{SO}_2 + \text{I}_2 + 2\text{H}_2\text{O}$

Here HI is oxidised to I_2 . Similarly bromine is liberated from KBr

c) C_{10}H_8 (naphthalene) + $9\text{H}_2\text{SO}_4 \xrightarrow[\text{catalyst}]{\text{Hg as}} \text{C}_8\text{H}_6\text{O}_4$ (phthalic acid) + $10\text{H}_2\text{O} + 9\text{SO}_2 + 2\text{CO}_2$

iv) Dehydrating agent :

Sulphuric acid acts as a powerful dehydrating agent because it has a great affinity for water

a) $\text{C}_{12}\text{H}_{22}\text{O}_{11}$ (cane sugar) $\xrightarrow[-11\text{H}_2\text{O}]{\text{H}_2\text{SO}_4} 12\text{C}$

b) $\begin{array}{c} \text{COOH} \\ | \\ \text{COOH} \end{array} \xrightarrow[\Delta]{\text{H}_2\text{SO}_4} \text{CO} + \text{CO}_2 + \text{H}_2\text{O}$

Uses:

- For the manufacture of fertilizer such as ammonium sulphate and super phosphate of lime.
- In storage batteries.

LECTURE SHEET
EXERCISE-I
(General, Hydrides and Halides)
LEVEL-I (MAIN)
Straight Objective Type Questions

1. The decreasing tendency to exist in puckered 8 - membered ring structure is
 1) S > Se > Te > Po 2) Se > S > Te > Po 3) S > Te > Se > Po 4) Te > Se > S > Po
2. Which of the following bonds has the highest energy?
 1) Se–Se 2) Te–Te 3) S – S 4) O–O
3. Gaseous products formed when zinc react with dil. H_2SO_4 and conc. H_2SO_4 respectively.
 1) H_2S & SO_2 2) H_2 & SO_2 3) SO_2 & H_2 4) SO_2 & H_2S
4. At room temperature H_2O is liquid while H_2S gas the reason is
 1) E.N. of ‘O’ is greater than ‘S’ 2) Difference in the B.A of both molecules
 3) Association takes place in H_2O due to ‘H’ bond 4) ‘O’ and ‘S’ belong to different period
5. Sulphur is soluble in
 1) Water 2) dil. HCl 3) Ether 4) CS_2
6. In the Kipp’s apparatus, the reaction gets stopped on closing the outlet because
 1) Gas starts coming out from top
 2) The contact between sulphide and the acid is broken by the presence of gas collected in the free surface of the middle chamber
 3) The acid becomes weak
 4) A protective film is formed on iron sulphide
7. On adding Na_2S to sodium nitro prusside solution
 1) $Na_4[Fe(CN)_5NOS]$ complex is formed 2) $[Fe(CN)_5NOS]^{4-}$ complex is formed
 3) a violet colour is formed 4) All of the above
8. What is the correct relation ship between the pH values of isomolar solution of $Na_2O(pH_1)$, $Na_2S(pH_2)$, $Na_2Se(pH_3)$ and $Na_2Te(pH_4)$?
 1) $pH_1 < pH_2 < pH_3 < pH_4$ 2) $pH_1 > pH_2 > pH_3 > pH_4$
 3) $pH_1 < pH_2 < pH_3 = pH_4$ 4) $pH_1 > pH_2 = pH_3 > pH_4$
9. Which of the following forms black ppt. with H_2S in acidified solution?
 1) Mg^{2+} 2) Ni^{2+} 3) Cd^{2+} 4) Zn^{2+}
10. (A) : Thermal stability of the hydrides of VIA group elements decreases from H_2O to H_2Po .
 (R) : The heats of dissociation of M – H bond of hydrides of VIA group decreases down the group.
 The correct answer is
 1) Both (A) and (R) are true and (R) is the correct explanation of (A)
 2) Both (A) and (R) are true and (R) is not the correct explanation of (A)
 3) (A) is true but (R) is false 4) (A) is false but (R) is true

11. Which of the following is least covalent hydride?
- H_2O
 - H_2S
 - H_2Se
 - H_2Te

Numerical Value Type Questions

12. What is the maximum number of 'S' atoms in a single plane of S_8 molecule.
13. In the balanced reaction? $\text{XS} + \text{YHNO}_3 \longrightarrow \text{ZH}_2\text{SO}_4 + \text{mNO}_2 + \text{nH}_2\text{O}$. The value of $\frac{\text{Y}^2 - \text{X}^2}{\text{Z} + \text{m}}$ is

LEVEL-II (ADVANCED)**Straight Objective Type Questions**

- The most acidic and thermally stable hydride of chalcogens are respectively
 - $\text{H}_2\text{O}, \text{H}_2\text{Te}$
 - $\text{H}_2\text{Te}, \text{H}_2\text{S}$
 - $\text{H}_2\text{S}, \text{H}_2\text{Te}$
 - $\text{H}_2\text{Te}, \text{H}_2\text{O}$
- Among the following, the weakest conjugate base is
 - OH^-
 - SH^-
 - SeH^-
 - TeH^-
- Oxygen is more electronegative than sulphur, yet H_2S is acidic while H_2O is neutral. This is because
 - Water is a highly associated compound
 - $\text{H}-\text{S}$ bond is weaker than $\text{H}-\text{O}$ bond
 - H_2S is a gas while H_2O is a liquid
 - The molecular weight of H_2S is more
- In which of the following bond angle can not be explained by Valence Bond Theory.
 - H_2O
 - H_2Po
 - H_2S
 - H_2Te
- Which among the following compound cannot be prepared by direct union of elements.
 - SF_6
 - Se_2Br_2
 - S_2Cl_2
 - SF_4
- $\text{S} + 2\text{Cl}_2 \xrightarrow{\text{H}_2\text{O}} \text{X} + \text{HCl}; \text{Y} \rightarrow \text{Z} + \text{H}_2\text{O}$. Oxidation state of S in 'Z' is
 - +1
 - + 4
 - + 6
 - + 2
- The hydrolysis of which compound is an example of disproportionating reaction?
 - SCl_4
 - OF_2
 - S_2Cl_2
 - S_2Cl_2 and OF_2

Column-I

- SF_6
- SF_4
- SF_2
- S_2F_2

Column-II

- angular
- open book
- octahedral
- pyramidal
- distorted tetrahedral

The correct match is

- | | | | |
|------|---|---|---|
| A | B | C | D |
| a) 1 | 2 | 3 | 4 |
| c) 2 | 4 | 1 | 5 |

- | | | | |
|------|---|---|---|
| A | B | C | D |
| b) 4 | 2 | 5 | 3 |
| d) 3 | 5 | 1 | 2 |

- TeCl_4 is expected to be
 - Tetrahedral
 - Square planar
 - Octahedral
 - Trigonal bipyramidal
- $\text{NaOH} + \text{F}_2 \rightarrow$ pale yellow gas (X). The hybridisation and bond angle in X are
 - $\text{sp}^3, 103^\circ$
 - $\text{sp}^3\text{d}^2, 90^\circ$
 - $\text{sp}^3, 109.28^\circ$
 - $\text{sp}^3\text{d}, 120^\circ$

More than One correct answer Type Questions

11. H_2S on incomplete combustion with oxygen forms mainly
 a) H_2 and S b) H_2 and SO_3 c) H_2O d) S
12. Which occur(s) free in nature?
 a) I_2 b) S c) P d) O
13. In SOCl_2 and SO_2Cl_2
 a) The oxidation state of sulphur is different
 b) The hybridisation state of sulphur is same
 c) The shapes of both SOCl_2 and SO_2Cl_2 are same
 d) The $\text{Cl}-\text{S}-\text{Cl}$ angle in both SOCl_2 and SO_2Cl_2 is same
14. Which halide of sulphur that undergoes disproportionation in water?
 a) SCl_4 b) SF_2 c) S_2Cl_2 d) All the above

*Linked Comprehension Type Questions**Passage-I :*

A yellow powder ‘x’ is burnt in a steam of Fluorine to obtain a colourless gas ‘y’ which is thermally stable and chemically inert its molecule has octahedral geometry another colourless gas ‘z’ with same constituent atoms as that of ‘y’ is obtained when sulphur dichloride is heated with sodium fluoride. It’s molecule has trigonal bi-pyramidal geometry.

15. The yellow powder ‘x’ is
 a) $\text{Fe}_2\text{Cr}_2\text{O}_7$ b) FeCl_3 c) K_2CrO_4 d) S
16. The colourless gas ‘y’ is
 a) SF_4 b) SF_6 c) NaF d) S_2F_2
17. The colourless gas ‘z’ is
 a) SF_4 b) SF_6 c) S_4F_4 d) NaF

Passage-II :

Sulphur forms hexahalides, tetrahalides, dihalides and monohalides, sulphur forms only hexa fluorides but not hexachlorides, hexa bromides and hexaiodides. Sulphur halides tend to hydrolyse easily. Sulphur hexa fluorides is an exception. Of the oxohalides, the most important are those of sulphur especially SOCl_2 and SO_2Cl_2 these are also hydrolyse in water

18. SF_6 do not hydrolyse water because
 a) Due to strong S-F bonds which cannot be broken easily
 b) Because of steric hinderance of six fluorine atoms surrounding sulphur H_2O molecules can not approach sulphur
 c) Due to double bond character of ‘S-F’ bonds because of back bonding
 d) All the above
19. SOCl_2 is dissolved in water which of the following statement is wrong about the solution
 a) The solution will give white ppt with baryta water soluble in dil. HCl
 b) The solution turns the lead acetate paper to black
 c) The solution turns orange dichromate to green
 d) The solution is acidic in nature

20. SO_2Cl_2 is dissolved in H_2O which of the following statement is wrong about the solution
- Gives white ppt with BaCl_2 in soluble in any acid
 - The solution contain two different type of acids a monobasic and a dibasic acid
 - The solution can decolourize the permanganate
 - The oxidation states of the elements in SO_2Cl_2 do not change when dissolve in water

Matrix Matching Type Questions

21. **Column-I**

- S_2Cl_2
- SF_6
- SCl_4
- SCl_2

Column-II

- gives mustard gas with C_2H_4
- gives dibasic acid on hydrolysis
- uniform bond angles
- Disproportionates on hydrolysis

22. Match Column-I with Column-II and select the correct answer using the codes given below the lists.

Column-I

- Engle's sulphur
- Sulphur
- Rhombic sulphur
- monoclinic sulphur

Column-II

- Rings, Chair conformation,unstable
- Fibrous or rubber like
- Crystalline form yellow crystals
- Puckered S_8 rings crown conformation

Integer Type Questions

23. The total no. of oxidation states of sulphur (only magnitude) in S_8 , SF_2 , H_2S is
24. When fluorine react with H_2S a product (X) of sulphur is formed. The difference in the oxidation state of sulphur in H_2S and the product (X) is

 EXERCISE-II

(Oxygen, ozone, oxides)

LEVEL-I (MAIN)

Straight Objective Type Questions

- The hybridization of sulphur in SO_2 is
 - sp
 - sp^3
 - sp^2
 - dsp^2
- Magnetic moment of O_2 is nearly
 - 1.8 BM
 - 2.8 BM
 - 3.8 BM
 - Zero
- In solid cyclic form of SO_3 , each sulphur atom is surrounded by ____ oxygen atoms
 - 4
 - 3
 - 5
 - 6
- Which of the following is least soluble in water is
 - TeO_2
 - SO_2
 - PoO_2
 - SeO_2
- The acidic character of dioxides of members of oxygen family decreases in the order
 - $\text{SeO}_2 > \text{SO}_2 > \text{TeO}_2 > \text{PoO}_2$
 - $\text{SO}_2 > \text{SeO}_2 > \text{TeO}_2 > \text{PoO}_2$
 - $\text{PoO}_2 > \text{TeO}_2 > \text{SeO}_2 > \text{SO}_2$
 - $\text{TeO}_2 > \text{PoO}_2 > \text{SeO}_2 > \text{SO}_2$

6. Number of ‘ σ ’ and ‘ π ’ bonds in solid SO_3 cyclic structure are
 1) 12σ and 6π 2) 12σ and 12π 3) 6σ , and 12π 4) 6σ and 6π
7. In γ - form of SO_3 , the hybridisation of sulphur is
 1) sp 2) sp^3d 3) sp^2 4) sp^3
8. The electrolyte used in the preparation of ozone by Brodie’s ozoniser is
 1) AgNO_3 solution 2) CuSO_4 solution 3) NaCl solution 4) MgCl_2 solution
9. Regarding ozone the wrong statement is
 1) The bond angle is $116^{\circ}49'$ 2) O_3 acts as both oxidant and reductant
 3) O-O bond lengths are equal 4) It is paramagnetic
10. Reagent used to distinguish H_2O_2 and O_3 is
 1) PbS 2) Starch iodide 3) KMnO_4 4) Bleaching powder
11. The incorrect statement among the following is
 1) O_3 is soluble in glacial CH_3COOH 2) O_3 is a poisonous gas
 3) O_3 is highly soluble in water 4) ozone is present in stratosphere
12. Select the wrong statement
 1) Ozone is a pale blue gas 2) O_3 acts as both oxidant and reductant
 3) Ozone is used as an antiseptic inhaler 4) Ozone is used in sterilization of water
13. The compound that cannot be oxidised by ozone is
 1) KMnO_4 2) PbS 3) KI 4) SO_2

Numerical Value Type Questions

14. Ozonolysis of 1 mole of benzene requires how many number of moles of ozone?
15. Oxygen is a gas while other are solids and S, Se, Te exist as staggered rings in normal condition. Howmany number of atoms are present in one ring.

LEVEL-II (ADVANCED)***Straight Objective Type Questions***

1. The number of S-S bonds in sulphur trioxide trimer (S_3O_9) is
 a) Three b) Two c) One d) Zero
2. In SO_2 two oxygen atoms are linked to the sulphur atom through double bonds. The two π bonds are
 a) both $\text{p}\pi - \text{p}\pi$ b) both $\text{p}\pi - \text{d}\pi$
 c) both $\text{d}\pi - \text{d}\pi$ d) one $\text{p}\pi - \text{p}\pi$ and one $\text{p}\pi - \text{d}\pi$
3. Which of the following dissolves in water but does not give any oxyacid solution ?
 a) SO_2 b) OF_2 c) SCl_4 d) SO_3
4. In which of the following reactions, ozone acts as a reducing agent
 a) $\text{BaO}_2 + \text{O}_3 \rightarrow \text{BaO} + 2\text{O}_2$ b) $2\text{HCl} + \text{O}_3 \rightarrow \text{Cl}_2 + \text{H}_2\text{O} + \text{O}_2$
 c) $\text{PbS} + 4\text{O}_3 \rightarrow \text{PbSO}_4 + 4\text{O}_2$ d) $2\text{KI} + \text{O}_3 + \text{H}_2\text{O} \rightarrow 2\text{KOH} + \text{I}_2 + \text{O}_2$

5. With respect to both oxygen and ozone, which one of the following statements is not correct
 a) They are allotropes together
 b) oxygen is colourless while ozone is coloured
 c) valency of oxygen is 2 in both
 d) oxygen has 2 bonds and ozone has 3 bonds
6. Dry bleaching agent is
 a) O_3 b) SO_2 c) Cl_2 d) H_2O_2
7. Ozone uses all oxygen atoms in the oxidation reaction with
 a) SO_2 only b) Acidified $SnCl_2$ only c) PbS only d) Both (1) and (2)
8. Which of the following conversion is not brought about by ozone
 a) HF to F_2 b) Moist KI to I_2 c) Ag_2O to Ag d) $SnCl_2$ to $SnCl_4$
9. Which is a mutual reduction reaction
 A) $KMnO_4 + O_3$ B) $H_2O_2 + O_3$ C) $Ag_2O + O_3$ D) $KI + H_2O + O_3$
 a) A, B b) A, C c) A, D d) B, C
10. Starch paper moistened with KI solution turns blue in ozone because of
 a) Iodine liberation b) Oxygen liberation c) Alkali formation d) Ozone is acidic

More than One correct answer Type Questions

11. Which of the following gases can be collected by downward displacement of water?
 a) N_2 b) O_2 c) PH_3 d) SO_2
12. Oxygen is not evolved when :
 a) ZnO is heated with $NaOH$ b) NH_4NO_3 is heated
 c) Na_2O_2 reacts with water d) $KClO_3$ is heated
13. In the reaction $H_2S + O_3 \rightarrow$ _____ the products are :
 a) H_2O b) S c) O_2 d) $SO_2 + H_2$
14. Which reagent does not give oxygen as one of the product during oxidation with ozone ?
 a) SO_2 b) $SnCl_2/HCl$ c) H_2S d) PbS

Linked Comprehension Type QuestionsPassage-I :

The binary compounds of oxygen with other elements are called oxides. They are classified either depending upon their acid - base characteristics or on the basis of oxygen content.

- a) Normal oxides : Normal oxide may be acidic, basic, amphoteric or neutral.
 b) Superoxides c) Suboxides d) Mixed oxides e) Peroxides

15. Which pair of species is referred to as suboxides?
 a) CO , NO b) SO_2 , CaO c) N_2O , CO d) S_2O , C_3O_2 .
16. Which of the following pairs contains neutral oxides?
 a) SO_2 , SO_3 b) N_2O_3 , N_2O_5 c) CO , NO d) Na_2O , CaO
17. Which of the following pairs contains mixed oxides?
 a) Pb_3O_4 , Fe_3O_4 b) MnO_2 , BaO_2 c) KO_2 , Na_2O_2 d) Mn_3O_4 , N_2O_5

18. Which of the following oxides is paramagnetic in nature?

- a) KO_2 b) BaO_2 c) H_2O d) CO_2

Passage-II :

In this passage five observations are given. Questions are asked with reference to the given observations

Observation (i) Gaseous oxygen is colourless whereas liquid and solid oxygen are coloured substance.

Observation (ii) When O_2 is cooled below a certain temperature its paramagnetic character decreases.

Observation (iii) In ice H_2O molecules are H bonded

Observation (iv) Ozone is responsible for tailing of Hg(l)

Observation (v) $\text{O}_3(\text{g})$ is almost unavailable in lower atmosphere

19. Which of the following explain the observation (i)?

- a) in liquid and solid oxygen there is a transition of bonding electrons from the triplet state to the singlet state
 b) in liquid and solid oxygen there is a transition of antibonding electrons from the triplet state to the singlet state
 c) in liquid and solid oxygen the two unpaired electrons of gaseous oxygen are paired up
 d) (a) and (c)

20. Which of the following explain the observation (ii)?

- a) because below a certain temperature $\text{O}_2(\text{g})$ is partially dimerized
 b) the unpaired electrons of $\text{O}_2(\text{g})$ are paired up in some O_2 molecules
 c) $\text{O}_2(\text{g})$ is partially dissociated to atomic oxygen
 d) $\text{O}_2(\text{g})$ is converted partially to ozone

21. O_3 on reaction with Hg(l) as per observation (iv) produce

- a) HgO b) Hg_2O c) HgO_2 d) Hg_2O_3

Matrix Matching Type Questions

22. **Column-I**

- A) Crown shape
 B) Angular shape
 C) Planar trigonal
 D) H_2O_2 like structure

Column-II

- p) S_2Cl_2
 q) S_8 molecule
 r) O_3 molecule
 s) SO_3 molecule

23. **Column-I**

- A) Sulphur dioxide
 B) Oxygen
 C) Ozone
 D) Hydrogen sulphide

Column-II

- p) Laboratory reagent used during salt analysis
 q) Detection of position double bond in organic compound
 r) Antichlor
 s) Paramagnetic

Integer Type Questions

24. Ozone tarnishes silver metal. How many number of moles of O_2 are evolved?

EXERCISE-III

(SO₂, Oxoacids, H₂SO₄, Hypo)

LEVEL-I (MAIN)

Straight Objective Type Questions

1. During the bleaching action of SO₂, it is converted to
 1) H₂SO₃ 2) SO₃ 3) H₂S 4) H₂SO₄
2. Reducing property of SO₂ is shown in the reaction
 A) 2H₂S + SO₂ → 3S + 2H₂O B) I₂ + SO₂ + 2H₂O → SO₄²⁻ + 2I⁻ + 4H⁺
 C) 3Fe + SO₂ → 2FeO + FeS
 1) A 2) B 3) A, B 4) A,C
3. When moist coloured flowers are added into SO₂ gas the flowers are decolourised because
 1) SO₂ absorbs colouring matter 2) SO₂ oxidised vegetable colouring matter
 3) SO₂ reduces vegetable colouring matter 4) SO₂ gives colourless product
4. Bond angle, bond length and hybridisation in SO₂ molecule respectively are
 1) 119.5°, 143 nm, sp² 2) 119.5°, 143 pm, sp²
 3) 119.5°, 143 pm, sp³ 4) 119.5, 143 Å°, sp²
5. Sulphurous anhydride is
 1) SO₂ 2) SO₃ 3) HSO₃⁻ 4) SO₃²⁻
6. X and Y are anhydrides of sulphurous and sulphuric acid respectively. The hybridisation state and the shape of X and Y are
- | X | Y |
|------------------------------|-------------------------------------|
| 1) sp ² , angular | sp ² , tetrahedral |
| 2) sp ² , angular | sp ² , angular |
| 3) sp ² , angular | sp ² , planar triangular |
| 4) sp ³ , planar | sp ³ , planar |

Oxy acids :

- S
7. In HO-S-OH the oxidation states of S are
 1) +4, -2 2) +4, 0 3) +2, -2 4) +4, -4
8. Acid that contains S-O-S linkage is
 1) H₂S₂O₇ 2) H₂S₂O₅ 3) H₂S₂O₆ 4) H₂S₂O₄
9. Which of the following has S-S bond
 1) H₂S₂O₈ 2) H₂S₂O₇ 3) mustard gas 4) H₂S₂O₆
10. Peroxy linkage is present in
 1) H₂S₂O₂ 2) H₂S₂O₃ 3) H₂S₂O₆ 4) H₂S₂O₈

11. Pyrosulphurous acid is
 1) $\text{H}_2\text{S}_2\text{O}_5$ 2) $\text{H}_2\text{S}_2\text{O}_2$ 3) $\text{H}_2\text{S}_2\text{O}_3$ 4) $\text{H}_2\text{S}_2\text{O}_4$
12. Two tautomeric structures are possible for
 1) H_2SO_4 2) $\text{H}_2\text{S}_2\text{O}_8$ 3) $\text{H}_2\text{S}_2\text{O}_7$ 4) H_2SO_3
13. Hybridisation of central sulphur in all oxo anions of sulphur is
 1) sp^3d 2) sp^3 3) sp^3d^2 4) sp^2d
14. What is the number of sigma and pi bonds present in H_2SO_4 molecule
 1) 6σ and 2π 2) 6σ and 0π 3) 2σ and 4π 4) 2σ and 2π
15. An oxyacid of sulphur contained S=S linkage and the oxidation number of S in it is +6 and -2. It belongs to
 1) -ous series 2) -ic series 3) peroxy series 4) thionic acid series
16. When hypo is reacted with dil.acid, the gas liberated is
 1) SO_2 2) SO_3 3) H_2S 4) Sulphur vapour
17. In photography hypo is used as a fixing agent. Here the compound formed is
 1) $\text{Na}_3[\text{Ag}(\text{S}_2\text{O}_3)_2]$ 2) $\text{Na}_2\text{S}_4\text{O}_6$ 3) $\text{Ag}_2\text{S}_2\text{O}_3$ 4) Ag_2S
18. When dil. hypo is treated with excess AgNO_3 the chemical finally formed is
 1) $\text{Na}_3[\text{Ag}(\text{S}_2\text{O}_3)_3]$ 2) $\text{Na}_3[\text{Ag}(\text{S}_2\text{O}_3)_2]$ 3) Ag_2S 4) $\text{Ag}_2\text{S}_2\text{O}_3$
19. In the reaction of hypo with I_2 to form $\text{Na}_2\text{S}_4\text{O}_6$ and NaI , the equivalent weight of hypo is _____
 (M is mol.wt. of hypo)
 1) M 2) M/2 3) M/4 4) M/6
20. In the reaction where hypo acts as antichlor, hypo undergoes
 1) oxidation 2) reduction 3) disproportionation 4) halogenation

Numerical Value Type Questions

21. How many S-S bond in polythionic acid having molecular formula $\text{H}_2\text{S}_5\text{O}_6$?
22. The total no. of diprotic acids among the following is H_3PO_4 , H_2SO_4 , H_3PO_3 , $\text{H}_2\text{S}_2\text{O}_7$, H_3BO_3 , H_3PO_2 , H_2CrO_4 , H_2SO_3 , H_2CO_3
23. How many hydroxyl groups are present in pyrosulphuric acid

LEVEL-II (ADVANCED)***Straight Objective Type Questions***

1. Oxidation state of S in H_2SO_5 and $\text{H}_2\text{S}_2\text{O}_8$ respectively are
 a) +6, +6 b) +6, +4 c) +8, 7 d) +4, +4
2. Iron sulphide is heated in air to form A, an oxide of sulphur. A is dissolved in water to give an acid. The basicity of this acid is
 a) 2 b) 3 c) 1 d) zero

3. Identify the correct sequence of increasing number of π -bonds in the structures of the following molecules.
- I) $H_2S_2O_6$ II) H_2SO_3 III) $H_2S_2O_5$
- a) I, II, III b) II, III, I c) II, I, III d) I, III, II
4. The number of sigma and pi bonds in peroxy-disulphuric acid are respectively
- a) 9 and 4 b) 11 and 4 c) 4 and 8 d) 4 and 9
5. In the preparation of H_2SO_4
- a) SO_2 is dissolved in H_2SO_4 b) SO_2 is dissolved in water
- c) SO_3 is dissolved in conc. H_2SO_4 d) SO_3 is dissolved in dilute H_2SO_4
6. In contact process impurities of arsenic are removed by :
- a) $Al(OH)_3$ b) $Fe(OH)_3$ c) $Cr(OH)_3$ d) Fe_2O_3
7. (A) : The formation of SO_3 by contact process is an example of heterogeneous catalysis.
(R) : The reactants and product are in different phase in the formation of SO_3 by contact process.
- a) Both (A) and (R) are true and (R) is the correct explanation of (A)
b) Both (A) and (R) are true and (R) is not the correct explanation of (A)
c) (A) is true but (R) is false
d) (A) is false but (R) is true
8. On treating PCl_5 with conc. H_2SO_4 , SO_2Cl_2 is formed as the final product this shows that H_2SO_4
- a) is a derivative of SO_2 b) is a monobasic acid
c) has great affinity for H_2O d) has two hydroxyl groups in its structure
9. What is the hybrid state and oxidation state of sulphur in Caro's acid.
- a) $sp^2, +10$ b) $sp^3, +10$ c) $sp^2, +6$ d) $sp^3, +6$
10. In which of the following reaction does SO_2 acts as oxidising agent?
- a) Acidified $KMnO_4$ b) Acidified $K_2Cr_2O_7$
c) Acidified C_2H_5OH d) H_2S
11. Which of the following reaction depict the oxidising behaviour of H_2SO_4
- a) $2HI + H_2SO_4 \longrightarrow I_2 + SO_2 + 2H_2O$
b) $2NaCl + H_2SO_4 \longrightarrow NaHSO_4 + HCl$
c) $2NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + 2H_2O$
d) $2PCl_5 + H_2SO_4 \longrightarrow 2POCl_3 + 2HCl + SO_2Cl_2$
12. In thiosulphuric acid
- a) Each sulphur atom is in identical oxidation state is +3
b) There is a S = S linkage present
c) One 'S' atom is in +2 and other 'S' atom is in +4 oxidation state
d) There is only one replaceable 'H' atom
13. One gas bleaches the colour of flower by reduction. While the other by oxidation, the two gases respectively are
- a) CO and Cl_2 b) H_2S and Br_2 c) NH_3 and SO_3 d) SO_2 and Cl_2

More than One correct answer Type Questions

14. Which of the following statement(s) is (are) correct?
- SO_2 dissolves in water and forms sulphurous acid
 - SO_2 acts as a bleaching agent
 - SO_2 has pungent odour
 - SO_2 acts only as oxidizing agent
15. Which of the following statement(s) is (are) true for SO_2 ?
- It is a V-shaped molecule
 - The O–S–O bond angle is $119^{\circ}30'$
 - The S–O bond length is 143 pm
 - It is a linear molecule
16. In which of the following reactions, SO_2 acts as an oxidising agent?
- $\text{I}_2 + \text{SO}_2 + 2\text{H}_2\text{O} \rightarrow \text{SO}_4^{2-} + 4\text{H}^+ + 2\text{I}^-$
 - $\text{SO}_2 + 2\text{H}_2\text{S} \rightarrow 3\text{S} + 2\text{H}_2\text{O}$
 - $3\text{Fe} + \text{SO}_2 \rightarrow \text{FeS} + 2\text{FeO}$
 - $\text{K}_2\text{Cr}_2\text{O}_7 + 3\text{SO}_2 + \text{H}_2\text{SO}_4 \rightarrow \text{Cr}_2(\text{SO}_4)_3 + \text{K}_2\text{SO}_4 + \text{H}_2\text{O}$
17. Sulphuric acid is a dibasic acid in nature: hence, it forms:
- | | |
|----------------|--------------------------|
| a) Normal salt | b) Acidic and basic salt |
| c) Acidic salt | d) Double salt |
18. The catalyst used in the manufacture of H_2SO_4 by contact process is (are):
- | | | | |
|------------------------|-------|-------|---------------------------|
| a) Platinized asbestos | b) CO | c) NO | d) V_2O_5 |
|------------------------|-------|-------|---------------------------|
19. Na_2SO_3 is prepared by
- Boiling Na_2SO_3 solution with elemental sulphur in alkaline medium
 - Boiling Na_2SO_3 solution with elemental sulphur in acidic medium
 - Oxidation of Na_2S_5 with air
 - Heating sulphur with NaOH

*Linked Comprehension Type Questions**Passage-I :*

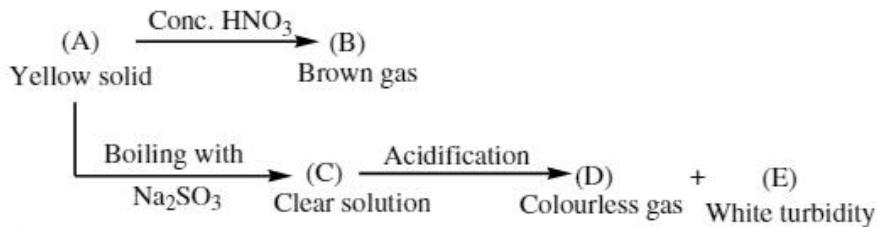
An aqueous solution of a gas (x) gives the following reactions

- It decolourises an acidified $\text{K}_2\text{Cr}_2\text{O}_7$ solution
- On Boiling with H_2O_2 cooling it and then adding on aqueous solution of BaCl_2 , a precipitation insoluble in dilute HCl is obtained
- On passing H_2S in the solution white turbidity (y) is obtained
- When gas 'x' is heated with concentrated HNO_3 evolves a brown coloured gas (A)
- When 'x' also dissolves in Na_2SO_3 solution on heating a clear solution (C) is formed.

20. Gas 'x' is

- SO_3
- S
- SO_2
- H_2S

21. y is
 a) SO_2 b) H_2SO_4 c) BaCl_2 d) S
22. The brown coloured gas is
 a) NO b) NO_2 c) SO_2 d) H_2S
23. "C" is
 a) Na_2SO_3 b) $\text{Na}_2\text{S}_2\text{O}_3$ c) Na_2SO_4 d) $\text{Na}_2\text{S}_4\text{O}_6$

Passage-II :

24. Yellow solid 'A' is
 a) H_2SO_5 b) S c) S_2O_7 d) None of these
25. Brown gas 'B' is
 a) H_2S b) NH_3 c) NO_2 d) All of these
26. Solution 'C' is
 a) SO_2Cl_2 b) $\text{Na}_2\text{S}_2\text{O}_3$ c) H_2SO_3 d) None of these

Matrix Matching Type Questions**27. Column-I
(Compound)**

- A) SO_2
 B) Hypo
 C) Ozone
 D) H_2SO_4

**Column-II
(Use)**

- p) Antichlor
 q) reducing agent
 r) Purification of water
 s) Dehydrating agent

28. Column-I

- A) $\text{Na}_2\text{S}_2\text{O}_3 + \text{HCl}$
 B) $\text{Na}_2\text{S}_2\text{O}_3 + \text{AgNO}_3$
 C) $\text{Na}_2\text{S}_2\text{O}_3 + \text{Cl}_2 + \text{H}_2\text{O}$
 D) $\text{Na}_2\text{S}_2\text{O}_3 + \text{I}_2$

Column-II

- p) NaCl
 q) $\text{Na}_3[\text{Ag}(\text{S}_2\text{O}_3)_2]$
 r) Na_2SO_4
 s) $\text{Na}_2\text{S}_4\text{O}_6$

Integer Type Questions

29. The oxidation of naphthalene in presence of catalyst $\text{Hg}/\text{H}_2\text{SO}_4$ to Phthalicacid. How many moles of SO_2 is formed ? (CO_2 evolved)
30. How many S-S bond are there in $\text{S}_2\text{O}_7^{-2}$

KEY SHEET (LECTURE SHEET)

EXERCISE-I

LEVEL-I

- 1) 1 2) 3 3) 2 4) 3 5) 4 6) 2 7) 4 8) 2
 9) 2 10) 1 11) 1 12) 4 13) 5

LEVEL-II

- 1) d 2) d 3) b 4) a 5) d 6) b 7) c 8) d
 9) d 10) a 11) cd 12) abc 13) ab 14) bc 15) d 16) b
 17) a 18) b 19) b 20) c 21) A-ps; B-r; C-q; D-p
 22) A-p; B-q; C-rs; D-s 23) 2 24) 8

EXERCISE-II

LEVEL-I

- 1) 3 2) 2 3) 1 4) 3 5) 2 6) 1 7) 4 8) 2
 9) 4 10) 3 11) 3 12) 3 13) 1 14) 3 15) 8

LEVEL-II

- 1) d 2) d 3) b 4) a 5) c 6) a 7) d 8) a
 9) d 10) a 11) abc 12) ab 13) abc 14) a 15) d 16) c
 17) a 18) a 19) b 20) b 21) b 22) A-q; B-r; C-s; D-p
 23) A-r; B-s; C-q; D-p 24) 3

EXERCISE-III

LEVEL-I

- 1) 4 2) 2 3) 3 4) 2 5) 1 6) 3 7) 1 8) 1
 9) 4 10) 4 11) 1 12) 4 13) 2 14) 1 15) 1 16) 1
 17) 1 18) 3 19) 1 20) 1 21) 3 22) 6 23) 2

LEVEL-II

- 1) a 2) a 3) c 4) b 5) c 6) b 7) c 8) d
 9) d 10) c 11) a 12) b 13) d 14) abc 15) abc 16) bc
 17) ac 18) ad 19) abcd 20) c 21) d 22) b 23) b 24) b
 25) c 26) b 27) A-pq; B-pq; C-qr; D-s 28) A-p; B-q; C-r; D-s
 29) 9 30) 0

 PRACTICE SHEET 
 EXERCISE-I 

(General Hydrides and Halides)

LEVEL-I (MAIN)

Straight Objective Type Questions

1. The second most electronegative element in periodic table is
1) F 2) O 3) Cl 4) N
2. The chalogen containing equal number of 's' and 'p' electrons is
1) O 2) S 3) Mg 4) Te
3. **Column-I** **Column-II**
 A) Pyrolusite 1) FeS_2
 B) Heamatite 2) ZnS
 C) Iron Pyrities 3) Fe_2O_3
 D) Zinc blende 4) MnO_2
 5) Fe_3O_4

The correct match is

- | | | | |
|------|---|---|---|
| A | B | C | D |
| 1) 4 | 5 | 1 | 3 |
| 3) 4 | 3 | 1 | 2 |

- | | | | |
|------|---|---|---|
| A | B | C | D |
| 2) 3 | 5 | 1 | 2 |
| 4) 3 | 4 | 1 | 2 |

4. Oxygen cannot exhibit higher oxidation states due to
1) small size 2) more electronegativity
3) less density 4) absence of 'd' orbitals
5. Oxygen exhibits least oxidation state in
1) OF_2 2) KO_2 3) H_2O 4) H_2O_2
6. The oxidation numbers of sulphur in S_8 , S_2F_2 and H_2S respectively are
1) 0, +1 and -2 2) +2, +1 and -2 3) 0, +1 and +2 4) -2, +1 and -2
7. Oxygen is always divalent while sulphur can form 2, 4 and 6 bonds because
1) Oxygen is more electronegative than sulphur
2) Sulphur has vacant d-orbitas while oxygen does not
3) Sulphur has large atomic radius than oxygen
4) Sulphur is more electronegative than oxygen
8. If X is a member of chalcogen family, the highest stability of X^{-2} is exhibited by
1) Oxygen 2) Selenium 3) Tellurium 4) Sulphur
9. The pair of exothermic hydrides of VI A group are
1) H_2O , H_2S 2) H_2O , H_2Se 3) H_2Se , H_2Te 4) H_2S , H_2Te
10. A stronger reducing agent is
1) H_2O 2) H_2S 3) H_2Se 4) H_2Te

11. Correct decreasing order of volatility is
 1) $\text{H}_2\text{O} > \text{H}_2\text{S} > \text{H}_2\text{Se}$
 2) $\text{H}_2\text{S} > \text{H}_2\text{O} > \text{H}_2\text{Se}$
 3) $\text{H}_2\text{Se} > \text{H}_2\text{O} > \text{H}_2\text{S}$
 4) $\text{H}_2\text{S} > \text{H}_2\text{Se} > \text{H}_2\text{O}$
12. In the hydrides of VIA elements largest bond angle and bond length is observed respectively in
 1) $\text{H}_2\text{O}, \text{H}_2\text{O}$
 2) $\text{H}_2\text{Po}, \text{H}_2\text{O}$
 3) $\text{H}_2\text{O}, \text{H}_2\text{Po}$
 4) $\text{H}_2\text{S}, \text{H}_2\text{Se}$
13. When sulphur is treated with F_2 , the main product formed is
 1) SF_6
 2) SF_2
 3) SF_4
 4) S_2F_2
14. The hybridization of S in SF_4 is
 1) sp^3d^2
 2) sp^3d
 3) sp^3d^3
 4) sp^3
15. Which of the following has open book-structure
 1) SCl_2
 2) S_2Cl_2
 3) SF_4
 4) SF_2

Numerical Value Type Questions

16. The most common oxidation state of VI A group elements is
 17. In SF_6 molecule, is formed in n^{th} excited state of 's'. What is n ?

LEVEL-II (ADVANCED)**Straight Objective Type Questions**

- SF_4 is obtained by treating sulphur with
 a) F_2
 b) CoF_2
 c) CoF_3
 d) CoF_6^{3-}
- SCl_4 on hydrolysis gives
 a) $\text{H}_2\text{SO}_4, \text{HCl}$
 b) $\text{H}_2\text{S}, \text{HClO}$
 c) $\text{SOCl}_2, \text{HCl}$
 d) $\text{H}_2\text{SO}_3, \text{HCl}$
- The hybridisation of sulphur atom in SCl_4 and the shape of the molecule are
 a) sp^3 and tetrahedral
 b) sp^3d and distorted tetrahedral
 c) sp^3d and trigonal bipyramidal
 d) sp^3d and tetrahedral
- When S_2Cl_2 is hydrolysed, the product formed is
 a) HCl
 b) SO_2
 c) S
 d) All
- The effect of repulsion between the two lone pairs of electrons present on oxygen in H_2O molecule is
 a) no change in H-O-H bond angle
 b) increase in H-O-H bond angle
 c) decrease in H-O-H bond angle
 d) all atoms will be in one plane
- The element of VI A group which cannot form hexahalides is
 a) O
 b) S
 c) Se
 d) Te
- Bond angles in SCl_2 and OF_2 respectively are
 a) $107^\circ, 101.5^\circ$
 b) $103^\circ, 109.5^\circ$
 c) $101.5^\circ, 105^\circ$
 d) $103^\circ, 103^\circ$
- The total number of bond pairs and lone pairs in Se_2Br_2 molecule are respectively
 a) 3,10
 b) 3,8
 c) 2,6
 d) 2,10

9. Sulphur uses ____ orbitals for bonding in H_2S
 a) sp^3 b) sp^2 c) one s and one p d) pure p orbitals
10. Chair form of S_6 rings are present in
 a) α - sulphur b) β - sulphur c) Engle's sulphur d) γ -sulphur

More than One correct answer Type Questions

11. Which of the following statements are correct?
 a) $SF_4 + BF_3 \rightarrow [BF_2]^+[SF_5]^-$ b) $SF_4 + PF_5 \rightarrow [SF_3]^+[PF_6]^-$
 c) $SF_4 + CSF \rightarrow [CS]^+[SF_5]^-$ d) $BF_3 + LiF \rightarrow [Li]^+[BF_4]^-$
12. The correct statement about sulphur hexa fluoride
 a) There are 12F-S-F 90° bond angle
 b) S in SF_6 has an expanded octet
 c) With H_2O , SF_6 can accept lonepair of electron in the empty 3d atomic orbital and gets hydrolysed
 d) SF_6 has a distorted octahedral geometry
13. $SOCl_2$ can act as Lewis acid as well as Lewis base because
 a) sulphur has a pair of electrons to donate b) it has empty d-orbital to accept electrons
 c) sulphur is a non metal d) chlorine is more electronegative
14. Weak dibasic acids among the following.
 a) H_2SO_4 b) H_2S c) H_2O_2 d) H_2SO_5

Linked Comprehension Type Questions***Passage :***

Sulphur forms hexahalides, tetrahalides, dihalides and monohalides, sulphur forms only hexa fluorides but not hexachlorides, hexa bromides and hexaiodides. Sulphur halides tend to hydrolyse easily. Sulphur hexa fluorides is an exception.

Of the oxohalides, the most important are those of sulphur especially sulphur dichloride oxide (Thionyl chloride) $SOCl_2$ and sulphurdichloride dioxide (Sulphuryl chloride) SO_2Cl_2 these are also hydrolyse in water.

15. In $SOCl_2$ and SO_2Cl_2
 a) The oxidation stats of sulphur are same b) The hybridization states of sulphur are same
 c) The shapes of both $SOCl_2$ and SO_2Cl_2 are same d) The Cl-Cl angle in both $SOCl_2$ and SO_2Cl_2 is same
16. Which halide of sulphur undergoes disproportionation in water
 a) SCl_4 b) SF_2 c) S_2Cl_2 d) Both SF_2 and S_2Cl_2

Matrix Matching Type Questions

- | | |
|----------------------------|-----------------------------------|
| 17. Column-I | Column-II |
| A) Thermal stability | p) $H_2Te > H_2Se > H_2S > H_2O$ |
| B) Acidic nature | q) $H_2O > H_2S > H_2Se > H_2Te$ |
| C) Boiling points | r) $H_2S < H_2Se < H_2Te < H_2O$ |
| D) $\angle MMH$ Bond angle | s) $H_2S > H_2Se > H_2Te = H_2Po$ |

Integer Type Questions

18. The atomicities of oxygen and sulphur are different. What is the ratio of the atomicities of sulphur to oxygen?
19. The maximum number of hydrogen bonds around each H_2O molecule in Ice?

EXERCISE-II

(Oxygen, ozone, oxides)

LEVEL-I (MAIN)Straight Objective Type Questions

- The product x in the following equation : $2\text{KMnO}_4 \rightarrow \text{K}_2\text{MnO}_4 + \text{MnO}_2 + x$, is :
 - Mn_3O_4
 - O_2
 - MnO
 - All
- The oxide which on strong heating evolves oxygen is :
 - Na_2O
 - Al_2O_3
 - CaO
 - BaO_2
- A black sulphide when treated with ozone becomes white. The white compound is :
 - ZnSO_4
 - CaSO_4
 - BaSO_4
 - PbSO_4
- At T(K), 100L of dry O_2 is present in a sealed container. It is subjected to silent electric discharge, till the volumes of O_2 and O_3 become equal. The volume (in litres) of O_3 formed at T(K)
 - 50
 - 60
 - 30
 - 40
- Ozone readily dissolves in :
 - H_2O
 - CH_3OH
 - turpentine oil
 - ammonia
- In which of the compounds oxygen does exhibit oxidation state -2?
 - CsO_2
 - K_2O_2
 - OF_2
 - Cl_2O

Numerical Value Type Questions

- O_3 reacts with dry iodine to form an oxide having 'x' number of oxygen atoms in its molecule 'x' is
- Cyclic trimer structure of SO_3 contains ___ no. of "S = O" bonds
- How many of the following is not oxidised by O_3 ? KI, FeSO_4 , KMnO_4 , K_2MnO_4

LEVEL-II (ADVANCED)Straight Objective Type Questions

- Which of the following compounds is obtained by passing O_3 gas into Hg metal?
 - HgO
 - Hg_2O
 - Both
 - HgS
- The pair that acts as both oxidizing and as well as reducing agent is
 - NO, SO_3
 - $\text{NO}_2, \text{H}_2\text{O}_2$
 - CO_2, SO_2
 - $\text{N}_2\text{O}_5, \text{O}_3$

3. Selecting from each set the molecule or ion having the smallest bond angle, pick out the correct option
- I) NH_3 , PH_3 or AsH_3
 - II) O_3 , O_3^-
 - III) NO_2 , O_3
 - IV) X – S – X angle in SOCl_2 and SOF_2
 - a) NH_3 , O_3^+ , O_3 , SOCl_2
 - b) PH_3 , O_3^+ , NO_2^- , SOF_2
 - c) AsH_3 , O_3 , NO_2^- , SOF_2
 - d) AsH_3 , O_3 , SOF_2
4. Liquid oxygen and liquid nitrogen are allowed to flow between the poles of an electro magnet choose the correct option
- a) Both will be attracted but to opposing poles
 - b) Both will be attracted to the same pole
 - c) Liquid oxygen will be attracted and liquid nitrogen will be repelled
 - d) Liquid oxygen will be attracted but liquid nitrogen unaffected
5. A silver foil turning black in the presence of ozone involves
- a) oxidation reaction
 - b) reduction reaction
 - c) both oxidation and reduction
 - d) neither oxidation nor reduction
6. The increasing order of the thermal stability of dioxides of Group 16 element is
- a) $\text{PoO}_2 < \text{SeO}_2 < \text{TeO}_2 < \text{SO}_2$
 - b) $\text{SO}_2 < \text{SeO}_2 < \text{TeO}_2 < \text{PoO}_2$
 - c) $\text{SeO}_2 < \text{PoO}_2, \text{TeO}_2 < \text{SO}_2$
 - d) $\text{PoO}_2 < \text{TeO}_2 < \text{SeO}_2 < \text{SO}_2$

More than One correct answer Type Questions

7. Permanent bleaching is possible by :
- a) Cl_2
 - b) SO_2
 - c) O_3
 - d) CaCl_2
8. The CORRECT statement(s) about O_3 is (are) :
- a) O – O bond lengths are equal
 - b) Thermal decomposition of O_3 is endothermic
 - c) O_3 is diamagnetic in nature
 - d) O_3 has a bent structure
9. When a compound X reacts with ozone in aqueous medium a substance Y is produced. Ozone also reacts with Y to alkaline medium and produces compound Z which can act as an oxidizing agent. then X, Y and Z are
- a) $\text{X} = \text{HI}$, $\text{Y} = \text{I}_2$ and $\text{Z} = \text{IO}_3^-$
 - b) $\text{X} = \text{KI}$, $\text{Y} = \text{I}_2$ and $\text{Z} = \text{IO}_3^-$
 - c) $\text{X} = \text{KI}$, $\text{Y} = \text{I}_2$ and $\text{Z} = \text{IO}_4^-$
 - d) $\text{X} = \text{HI}$, $\text{Y} = \text{I}_2$ and $\text{Z} = \text{IO}_4^-$
10. Identify the correct statement(s).
- a) Ozone is a powerful oxidizing agent as compared to O_2
 - b) Ozone reacts with KOH and gives an orange coloured solid KO_3
 - c) There is a decrease in volume when ozone decomposes to form O_2
 - d) The decomposition of O_3 to O_2 is exothermic
11. Both H_2O_2 and O_3 act as oxidizing agents. The oxidizing action in which they are similar is
- a) PbS to PbSO_4
 - b) Fe^{2+} to Fe^{3+}
 - c) $\text{K}_4(\text{Fe}(\text{CN})_6)$ to $\text{K}_3[\text{Fe}(\text{CN})_6]$
 - d) Decolourizing of acidified KMnO_4

*Linked Comprehension Type Questions**Passage:*

When a gas 'A' is passed through dry KOH at low temperature a deep red coloured compound, B and a gas 'C' are obtained. The gas A, on reaction with but -2-ene, followed by treatment with Zn/H₂O yields acetaldehyde. Identify A, B & C.

12. What is A

- a) O₂ b) O₃ c) SO₂ d) CO₂

13. What is deep red coloured compound

- a) KO₃ b) O₃ c) CH₃CHO d) None of these

14. What is C

- a) SO₂ b) O₂ c) H₂S d) O₃

Matrix Matching Type Questions

15. Column-I

- A) SO₂
B) SO₃
C) O₃
D) O₂⁻²

Column-II

- p) Acidic nature
q) Oxidising agent
r) Reducing agent
s) Bleaching agent

*Integer Type Questions*16. Find the formal charge on the central oxygen atom in O₃ molecule17. How many S-S bond are present in SO₃ trimer18. Bond order O₂⁻² is ____

◆ EXERCISE-III ◆

(SO₂, Oxoacids, H₂SO₄, Hypo)

LEVEL-I (MAIN)

*Straight Objective Type Questions*1. When SO₂ is passed through cupric chloride solution :

- 1) the solution becomes colourless and a white ppt. of CuCl₂ is obtained
2) a white ppt. is obtained
3) the solution becomes colourless
4) no visible change take place

2. Which of the following statements are correct for SO₂ gas?

- I) It acts as bleaching agent in moist conditions
II) Its molecule has linear geometry
III) Its dilute solution is used as disinfectant
IV) It can be prepared by the reaction of dilute H₂SO₄ with Metal sulphide
1) I and III 2) II and IV 3) I and IV 4) II and III

3. $2\text{NaOH} + \text{SO}_2 \rightarrow \text{A} + \text{H}_2\text{O}$
 $\text{B} + \text{H}_2\text{O} + \text{SO}_2 \rightarrow 2\text{NaHSO}_3$, A and B are
 1) A – Na_2SO_3 , B – Na_2SO_3
 2) A – NaHSO_3 , B – Na_2SO_3
 3) A – Na_2SO_4 , B – Na_2O
 4) A – NaHSO_3 , B – Na_2SO_4
4. Which of the following can converts acidified $\text{Cr}_2\text{O}_7^{2-}$ to green product?
 1) SO_2 , H_2SO_3 and H_2SO_4
 2) SO_3 , H_2S and H_2SO_3
 3) SO_3 , H_2S and Fe^{+3}
 4) SO_3^{-2} , H_2S and Fe^{+2}
5. $\text{C}_{12}\text{H}_{22}\text{O}_{11} \xrightarrow{\text{H}_2\text{SO}_4}$ product, products of the reaction is/are
 1) $12\text{C} + 11\text{H}_2\text{O}$
 2) $11\text{C} + 12\text{H}_2\text{O}$
 3) $5\text{CO} + 7\text{CO}_2 + \text{H}_2\text{O}$
 4) $\text{CO}_2 + \text{H}_2\text{O}$
6. The anhydride of pyrosulphuric acid is
 1) SO_2
 2) $\text{S}_2\text{O}_3^{2-}$
 3) SO_3
 4) $\text{S}_2\text{O}_7^{2-}$
7. **Column-I**
- | | |
|---------------------------------------|-----------|
| A) H_2SO_4 | 1) +4 |
| B) $\text{H}_2(\text{S})_n\text{O}_6$ | 2) +3 |
| C) H_2SO_3 | 3) +2, -2 |
| D) $\text{H}_2\text{S}_2\text{O}_4$ | 4) +6 |
| | 5) +5, 0 |
- Column-II (Oxidation state)**
- | | |
|---------------------------------------|-----------|
| A) H_2SO_4 | 1) +4 |
| B) $\text{H}_2(\text{S})_n\text{O}_6$ | 2) +3 |
| C) H_2SO_3 | 3) +2, -2 |
| D) $\text{H}_2\text{S}_2\text{O}_4$ | 4) +6 |
| | 5) +5, 0 |
- The correct match is
- | | | | |
|------------|------------|------------|------------|
| A B C D | A B C D | A B C D | A B C D |
| 1) 2 5 2 4 | 2) 3 2 1 4 | 3) 4 5 1 2 | 4) 2 3 1 5 |
8. Which of the following does not contain a symmetrical structure
 1) $\text{H}_2\text{S}_2\text{O}_4$
 2) $\text{H}_2\text{S}_2\text{O}_5$
 3) $\text{H}_2\text{S}_2\text{O}_7$
 4) $\text{H}_2\text{S}_2\text{O}_6$
9. The acid containing S–O–O–S bond is
 1) H_2SO_5
 2) $\text{H}_2\text{S}_2\text{O}_7$
 3) $\text{H}_2\text{S}_2\text{O}_6$
 4) $\text{H}_2\text{S}_2\text{O}_8$
10. In the following oxyacid of sulphur the two sulphur atoms exhibit the oxidation numbers of + IV and -II
 1) $\text{H}_2\text{S}_2\text{O}_2$
 2) $\text{H}_2\text{S}_2\text{O}_7$
 3) $\text{H}_2\text{S}_2\text{O}_3$
 4) $\text{H}_2\text{S}_2\text{O}_6$
11. Hypo never acts as a
 1) Antichlor
 2) Fixing agent
 3) Reductant
 4) Bleaching agent
12. The products obtained by passing chlorine through hypo solution are
 1) S, HCl, Na_2S
 2) S, HCl, Na_2SO_3
 3) S, HCl, Na_2SO_4
 4) S, NaCl, H_2SO_4

Numerical Value Type Questions

13. What is the oxidation number of sulphur in $\text{Na}_2\text{S}_4\text{O}_6$
14. When very dilute hypo is added to AgNO_3 solution gives 'X'. The oxidation state of central metal atom in 'X' is
15. Iodine oxidises $\text{S}_2\text{O}_3^{2-}$ ion to 'X', change in oxidation state of sulphur

LEVEL-II (ADVANCED)Straight Objective Type Questions

1. H_2SO_4 is a
 - 1) Dehydrating agent
 - 2) Sulphonating agent
 - 3) Reducing agent
 - 4) Highly viscous liquid

Choose the correct set of choice from the options give below

- a) (1), (2) & (3) b) (2), (3) and (4) c) (1), (3) and (4) d) (1), (2) and (4)
2. It is advised to add H_2SO_4 while preparing a standard solution of Mohr's salt to avoid
 - a) Hydration
 - b) Oxidation
 - c) Reduction
 - d) Hydrolysis
3. H_2SO_4 has great affinity for water because
 - a) It hydrolyses the acid
 - b) It decomposes the acid
 - c) Acid decomposes water
 - d) Acid forms hydrates with water
4. When conc. H_2SO_4 comes in contact with sugar, it becomes black due to
 - a) Hydration
 - b) Decolorisation
 - c) Dehydration
 - d) Hydrolysis
5. Formic acid on heating with con. H_2SO_4 gives __
 - a) CO
 - b) CO_2
 - c) C_3O_2
 - d) SO_2
6. H_2SO_4 is used in
 - a) Petroleum refining
 - b) Manufacture of paints, pigments and dye stuff
 - c) detergent industry
 - d) all of the above are the uses of H_2SO_4
7. An example of acid sulphate is
 - a) NaHSO_4
 - b) CuSO_4
 - c) Na_2SO_4
 - d) None of the above
8. On adding of conc. H_2SO_4 to a chloride salt colourless fumes are evolved but in case of iodide salt. Violet fumes come out. This is because
 - a) HI is of violet colour
 - b) HI gets oxidised to I_2
 - c) HI changes to HIO_3
 - d) H_2SO_4 reduces HI to I_2
9. Hot conc. H_2SO_4 acts as moderately strong oxidising agent. It oxidises both metal and non-metals. Element which gets oxidised by conc. H_2SO_4 into two gaseous products is
 - a) Cu
 - b) Zn
 - c) S
 - d) C

10. Which of the following shows wrong matching.

- a) $\text{H}_2\text{C}_2\text{O}_4 \xrightarrow{\text{conc. H}_2\text{SO}_4} \text{CO} + \text{CO}_2 + \text{H}_2\text{O} - \text{H}_2\text{SO}_4$ as dehydrating agent
- b) $\text{Cu} + 2\text{H}_2\text{SO}_4 \rightarrow \text{CuSO}_4 + 2\text{H}_2\text{O} + \text{SO}_2 - \text{H}_2\text{SO}_4$ as oxidizing agent
- c) $\text{Na}_2\text{S} + \text{H}_2\text{SO}_4 \rightarrow \text{Na}_2\text{SO}_4 + \text{H}_2\text{S} - \text{H}_2\text{SO}_4$ as an acid
- d) $2\text{HBr} + \text{H}_2\text{SO}_4 \rightarrow 2\text{H}_2\text{O} + \text{SO}_2 + \text{Br}_2 - \text{H}_2\text{SO}_4$ as reducing agent

More than One correct answer Type Questions

11. A gas X turns lime water milky. The milkiness disappears if excess of 'X' is passed. Milkiness reappears on heating the colourless solution. The gas is

- a) CO_2
- b) NO_2
- c) NH_3
- d) SO_2

12. In the bleaching action of SO_2 _____

- a) SO_2 is reduced
- b) SO_2 is oxidised into H_2SO_4
- c) H_2S is formed
- d) coloured matter is reduced

13. Which of the following does not give hydrogen peroxide on hydrolysis?

- a) $\text{H}_2\text{S}_2\text{O}_3$
- b) H_2SO_5
- c) $\text{H}_2\text{S}_2\text{O}_7$
- d) $\text{H}_2\text{S}_4\text{O}_6$

14. The correct oxidation state of sulphur atoms in $\text{H}_2\text{S}_2\text{O}_3$ is/are

- a) + 6
- b) -2
- c) +2
- d) -3

15. Select the correct statement about $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$?

- a) It is also called as hypo
- b) It is used in photography to form complex with AgBr
- c) It can be used as antichlor
- d) It is used to remove stains of I_2

16. Gas A + $\text{Na}_2\text{CO}_3 + \text{H}_2\text{O} \longrightarrow \text{B} + \text{C}$ (gas)



Which of the following are correct ?

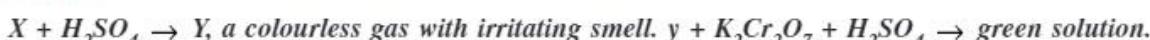
- a) A is SO_2
- b) D is Na_2SO_3
- c) C is CO_2
- d) E is $\text{Na}_2\text{S}_2\text{O}_3$

17. Which of the following statements regarding thiosulphate ion is/are correct ?

- a) Shape of thiosulphate ion is tetrahedral
- b) The two sulphur atoms in thiosulphate ion are equivalent
- c) There is S-S bond in thiosulphate ion
- d) With I_2 thiosulphate ion gives tetrathionate ion

Linked Comprehension Type Questions

Passage-I :



18. What is X ?

- a) SO_3
- b) SO_3^{2-}
- c) SO_2
- d) OF_2

19. What is Y ?

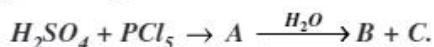
- a) SO_2
- b) SO_3
- c) O_3
- d) O_2

20. The compound present in green solution

- a) H_2SO_4 b) $MnSO_4$ c) $Cr_2(SO_4)_3$ d) None of these

Passage -II :

Sulphuric acid is a substance of very great commercial importance as it is used practically in every important industry. This due to the chemical properties of sulphuric acid. This very reaction with metals & non-metals. It has properties of dehydration, oxidation, reduction and sulphonation etc. for example:



Where B & C are two strong acids.

21. The compound A is

- a) SO_2Cl_2 b) SO_2Cl c) $ClSO_3H$ d) $POCl_3$

22. The compound B is

- a) $POCl_5$ b) $HOCl_4$ c) $POCl_3$ d) H_2SO_4

23. The compound C is

- a) H_2SO_4 b) HCl c) $HOCl_4$ d) $H_2S_2O_7$

Matrix Matching Type Questions

24. **Column-I**
(Oxy-acid of S)

- A) H_2SO_3
B) $H_2S_2O_6$
C) $H_2S_2O_3$
D) $H_2S_2O_4$

Column-II
(Oxidation state of 'S')

- p) +2
q) +3
r) +4
s) +5

25. **Column-I**

- A) $H_2S_2O_5$
B) $H_2S_2O_4$
C) $H_2S_4O_6$
D) $H_2S_2O_7$

Column-II

- p) Dibasic
q) S–O–S bond
r) S–S bond with same oxidation state of sulphur
s) S–S bond with different oxidation state of sulphur
t) Atleast one 'S' in in +6 oxidation state

Integer Type Questions

26. The number of sp^3 hybrid atoms in the product fromed by oxidation to hypo with Iodine.
27. When Thio sulphate ion is oxidized by iodine, new product 'X' is formed. The number of s-s linkage is/are present in 'X'?

KEY SHEET (PRACTICE SHEET)

EXERCISE-I

LEVEL-I

- 1) 2 2) 1 3) 3 4) 4 5) 3 6) 1 7) 2 8) 1
 9) 1 10) 4 11) 4 12) 3 13) 1 14) 2 15) 2 16) -2
 17) 2

LEVEL-II

- 1) c 2) d 3) b 4) d 5) c 6) a 7) d 8) a
 9) d 10) c 11) bcd 12) abc 13) ab 14) bc 15) b 16) d
 17) A-q; B-p; C-r; D-s 18) 4 19) 4

EXERCISE-II

LEVEL-I

- 1) 2 2) 4 3) 4 4) 4 5) 3 6) 4 7) 9 8) 6
 9) 3

LEVEL-II

- 1) b 2) b 3) c 4) c 5) c 6) a 7) bc 8) accd
 9) abcd 10) abd 11) abc 12) b 13) a 14) b
 15) A-prqs; B-pq; C-qr; D-qr 16) 1 17) 0 18) 1

EXERCISE-III

LEVEL-I

- 1) 3 2) 1 3) 1 4) 2 5) 1 6) 3 7) 3 8) 2
 9) 4 10) 1 11) 4 12) 3 13) 2.5 14) 1 15) 0.5

LEVEL-II

- 1) d 2) d 3) d 4) c 5) b 6) b 7) a 8) b
 9) d 10) d 11) ac 12) bd 13) acd 14) ab 15) abc 16) abd
 17) acd 18) b 19) a 20) c 21) a 22) d 23) b
 24) A-r; B-s; C-p; D-q 25) A-ps; B-pr; C-prs; D-pqt 26) 4
 27) 3

ADDITIONAL PRACTICE EXERCISE

LEVEL-I (MAIN)

Straight Objective Type Questions

1. Compounds A and B are treated with dil HCl separately. The gases liberated are Y and Z respectively, Y turns acidified dichromate paper green while Z turns lead acetate paper black. So A and B compounds are respectively.

- 1) Na_2SO_3 , Na_2 , S 2) NaCl , Na_2CO_3 3) Na_2S , Na_2SO_3 4) Na_2SO_3 , K_2SO_4

2. PCl_5 and excess of sulphuric acid are allowed to react. The main product formed along with POCl_3 , and HCl is
 1) ClSO_2OH 2) SOCl_2 3) SO_2Cl_2 4) S_2Cl_2
3. In H_2SO_4 there are
 1) Two sp^3 hybridized centres and $2(\text{p}\pi - \text{d}\pi)$ bonds
 2) Three sp^3 hybridized centres and $2(\text{p}\pi - \text{d}\pi)$
 3) Four sp^3 hybridized centres and $2(\text{p}\pi - \text{d}\pi)$ bonds
 4) Only one sp^3 hybridized centre and $2(\text{p}\pi - \text{d}\pi)$ bonds
4. A yellow powder is reacted with F_2 to form a colourless gas X which is used as gaseous insulator in high power generators. It does not get hydrolyzed. Another compound is obtained by reaction of SCl_2 with NaF . It can be easily hydrolyzed and has a see-saw shape. X and Y respectively are
 1) AgI, AgBr 2) SF_6, SF_4 3) SF_4, SF_6 4) $\text{SCl}_4, \text{SCl}_6$
5. $\text{SF}_4, \xrightarrow{\text{Hydrolysis}} \text{A} + \text{B}, \text{A} + \text{H}_2\text{S} \longrightarrow \text{C}$ The 'C' is
 1) Solid sulphur 2) Colloidal sulphur 3) SO_3 4) Gaseous sulphur
6. An oxide of a non-metal has the following properties.
 I) It acts both as a proton donor as well as a proton acceptor
 II) It reacts readily with basic and acidic oxides
 III) It oxidizes Fe at its boiling point
 IV) It is a poor conductor of electricity. The oxide is
 1) H_2O 2) SO_2 3) NO_2 4) CO_2
7. The increasing order of acid character of the oxides, CO_2 , N_2O_5 , SiO_2 and SO_3 follows the sequence.
 1) $\text{CO}_2 > \text{N}_2\text{O}_5 > \text{SiO}_2 > \text{SO}_3$ 2) $\text{SiO}_2 < \text{CO}_2 < \text{N}_2\text{O}_5 < \text{SO}_3$
 3) $\text{SO}_3 < \text{N}_2\text{O}_5 < \text{CO}_2 < \text{SiO}_2$ 4) $\text{N}_2\text{O}_5 < \text{SO}_3 < \text{SiO}_2 < \text{CO}_2$
8. Which of the following statements regarding the manufacture of H_2SO_4 by contact process is not true.
 1) Sulphur is burnt in air to form SO_2
 2) SO_2 is catalytically oxidized to SO_3
 3) SO_3 is dissolved in water to get 100 per cent sulphuric acid.
 4) H_2SO_4 obtained by contact process is of higher purity than that obtained by lead chamber process
9. The oxidation states of sulphur atoms in the anions SO_3^{2-} , $\text{S}_2\text{O}_4^{2-}$ and $\text{S}_2\text{O}_6^{2-}$ follow the order.
 1) $\text{S}_2\text{O}_4^{2-} < \text{SO}_3^{2-} < \text{S}_2\text{O}_6^{2-}$ 2) $\text{SO}_3^{2-} < \text{S}_2\text{O}_4^{2-} < \text{S}_2\text{O}_6^{2-}$
 3) $\text{S}_2\text{O}_4^{2-} < \text{S}_2\text{O}_6^{2-} < \text{SO}_3^{2-}$ 4) $\text{S}_2\text{O}_6^{2-} < \text{S}_2\text{O}_4^{2-} < \text{SO}_3^{2-}$
10. Which of the following statements is incorrect ?
 1) SO_3 is a stronger oxidizing agent and more acidic than SO_2
 2) Selenium forms only two oxoacids, i.e., selenous acid (H_2SeO_3) and selenic acid (H_2SeO_4)
 3) Acidic strength and oxidizing power of oxo acids are greater in +6 than in +4
 4) The thermal stability of oxides of group 16 decreases in the order $\text{SO}_2 > \text{SeO}_2 > \text{TeO}_2 > \text{PoO}_2$

11. Read the following statements about sulphur hexafluoride, and pick the correct option for answer.
- All S – F bonds are equivalent
 - SF_6 is a planar molecule
 - The oxidation number of sulphur is the same as the number of electrons it uses in bonding
 - Sulphur has acquired the electronic structure of the inert gas argon.
- I, II, III only correct
 - I, III only correct
 - II, IV only correct
 - I, III, IV only correct
12. The addition of Con H_2SO_4 to potassium iodide is not suitable for making hydrogen iodide because
- The reaction is a redox reaction instead of double decomposition reaction
 - Hydrogen iodide is contaminated by reduction products of sulphuric acid
 - Hydrogen iodide is oxidized to iodine
 - Sulphuric acid is too weak to displace hydrogen iodide from its salt
- I, II and III only correct
 - I and III only correct
 - It and IV only correct
 - I and II only correct
13. Cyclic trimeric structure of SO_3 contains.
- Six S = O bonds and three S – O – S bonds
 - Three S = O bonds and six S – O – S bonds
 - Six S = O bonds and two S– O – S bonds
 - Three S = O bonds and three S – O – S bonds
14. Consider the following reactions.
- | | |
|--|---|
| I) $\text{Na}_2\text{S}_2\text{O}_3 + \text{dil HCl} \xrightarrow{\Delta}$ | II) $\text{Na}_2\text{S}_2\text{O}_3 \text{ (aq.)} + \text{I}_2 \xrightarrow{\Delta}$ |
| III) $\text{SO}_2 + \text{H}_2\text{S} \xrightarrow{\Delta}$ | IV) $\text{H}_2\text{S} + \text{H}_2\text{O}_2 \xrightarrow{\Delta}$ |
- The reaction(s) which give(s) yellow turbidity is/are
- II, III and IV
 - III and IV only
 - I, III and IV
 - I, II, III and IV
15. Acidic $\text{K}_2\text{S}_2\text{O}_8$ can oxidize MnO_2 to MnO_4^- and acidic $\text{K}_2\text{S}_2\text{O}_8$ and acidic MnO_2 oxidize I^- , Br^- , Cl^- to I_2 , Br_2 and Cl_2 respectively. From this information, the sequence that represents the correct order of increasing oxidation ability as
- $\text{I}_2 > \text{K}_2\text{S}_2\text{O}_8 > \text{Br}_2$
 - acidic $\text{K}_2\text{S}_2\text{O}_8 >$ acidic $\text{MnO}_2 > \text{Cl}_2$
 - $\text{K}_2\text{S}_2\text{O}_8 > \text{I}_2 > \text{Br}_2$
 - $\text{Cl}_2 > \text{K}_2\text{S}_2\text{O}_8 > \text{Br}_2$
16. Which of the following statements is false for polythionic acid series.
- The average oxidation state of S-atom increases with decrease in number of S atoms
 - The absolute oxidation state of S-atom increases with decrease in number of S-atoms
 - The average oxidation state of S-atom decreases with increase in number of S-atoms
 - The absolute oxidation state os S-atoms remains constant wth increase or decrease in the number of S – atoms
17. In the reaction of hypo with dil acids.
- One sulphur is oxidized
 - One sulphur is oxidized, one sulphur is reduced
 - One sulphur is reduced
 - Sulphur is neither oxidized nor reduced

18. When an equimolar mixture of Na_2S and Na_2SO_3 is treated with excess iodine, the products formed are
 1) $\text{Na}_2\text{S}_2\text{O}_3$ and NaI 2) Na_2SO_4 , S and HI
 3) NaI and S 4) $\text{Na}_2\text{S}_4\text{O}_6$ and NaI
19. In which of the following reaction change of oxidation state of Br is more than unity
 I) $\text{H}_2\text{SO}_4 + 2\text{KBr} \longrightarrow$ II) $\text{KBr} + \text{H}_3\text{PO}_4 \longrightarrow$
 III) $\text{Cl}_2 + \text{KBr} + \text{OH}^- \longrightarrow$ IV) $\text{Br}_2 + \text{NaClO}_3 \longrightarrow$
 1) I, II and III 2) III and IV 3) II, III and IV 4) I and IV
20. Urea reacts with SO_3 in the presence of H_2SO_4 to produce
 1) $\text{NH}_2\text{SO}_3\text{H}$ (Sulphamic acid) 2) NH_2OH
 3) NH_2CSNH_2 (Thio urea) 4) $(\text{NH}_4)_2\text{CO}_3$

Numerical Value Type Questions

21. Find the number of ions having S-S bond from the following
 $\text{S}_2\text{O}_4^{2-}$, $\text{S}_2\text{O}_6^{2-}$, $\text{S}_2\text{O}_2^{2-}$, $\text{S}_2\text{O}_3^{2-}$, $\text{S}_2\text{O}_7^{2-}$
22. Sulphuric acid acts as a powerful dehydrating agent. How many no of carbons are formed when glucose molecule is dehydrated by H_2SO_4 as reagent
23. One molecule of H_2SO_4 forms how many no of series of salt's

LEVEL-II**LECTURE SHEET (ADVANCED)****Straight Objective Type Questions**

1. Hypo is used to remove excess chlorine from fabric in textile industry where chlorine oxidizes hypo to a single product. In this reaction the change in the oxidation state of terminal sulphur of hypo is
 a) 4 units b) 6 units c) 8 units d) no change
2. The increasing order of the thermal stability of dioxides of Group 16 element is
 a) $\text{PoO}_2 < \text{SeO}_2 < \text{TeO}_2 < \text{SO}_2$ b) $\text{SO}_2 < \text{SeO}_2 < \text{TeO}_2 < \text{PoO}_2$
 c) $\text{SeO}_2 < \text{PoO}_2 < \text{TeO}_2 < \text{SO}_2$ d) $\text{PoO}_2 < \text{TeO}_2 < \text{SeO}_2 < \text{SO}_2$
3. SO_2 gas is passed into lime water. Which of the following does not take place.
 a) In the beginning lime water turns milky due to formation of insoluble CaSO_3
 b) If excess SO_2 is passed milkeness disappears due to formation of soluble $\text{Ca}(\text{HSO}_3)_2$
 c) On boling the solution obtained by passing excess SO_2 , its milkeness reappears due to decompostion of $\text{Ca}(\text{HSO}_3)_2$ to CaSO_3
 d) Crystallization from the solution obtained by passing excess SO_2 forms solid CaS_2O_5
4. The correct order of oxidation power of SO_3^{2-} , SO_4^{2-} and $\text{S}_2\text{O}_8^{2-}$ is
 a) $\text{SO}_3^{2-} > \text{SO}_4^{2-} > \text{S}_2\text{O}_8^{2-}$ b) $\text{SO}_3^{2-} < \text{SO}_4^{2-} < \text{S}_2\text{O}_8^{2-}$
 c) $\text{SO}_4^{2-} < \text{SO}_3^{2-} < \text{S}_2\text{O}_8^{2-}$ d) $\text{SO}_3^{2-} < \text{S}_2\text{O}_8^{2-} < \text{SO}_4^{2-}$

5. When ferric chloride is added to excess hypo solution a violet colour appears and disappears immediately. The disappearance of violet colour is due to

 - formation of ferric sulphide
 - conversion into colourless complex
 - reduction of ferric chloride to ferrous chloride
 - The violet complex is unstable and dissociates immediately

6. When KHSO_4 is added to a concentrated solution of H_2SO_4 , the acidity of the solution.

 - Increases
 - decreases
 - remains constant
 - cannot be predicted

7. Which of the following statements is wrong ?

 - Dithionic acid is not considered as polythionic acid
 - All thionic acids must contain a S – S bond
 - Polythionates are decomposed by alkali sulphides and sulphites but dithionates are not
 - Polythionates are not oxidized easily in solution relative to dithionates

More than One correct answer Type Questions

8. Which of the following statement(s) is/are correct for polythionic acids.

 - a) The average oxidation state of S-atom increases with decrease in number of sulphur atoms
 - b) The absolute oxidation state of S- atom increases with decrease in number of S- atoms
 - c) The average oxidation state of S-atom decreases with increase in number of S-atoms
 - d) The absolute oxidation state of S-atom remains constant with increase or decrease in number of S-atoms

9. Among the following the correct statements are

 - a) The metal that loses its meniscus after reaction with ozone is mercury
 - b) Tailed mercury regains its original properties by washing with water
 - c) On heating ozone its volume increases to 0.5 times
 - d) Ozone oxidises mercury to mercurous oxide

10. In S_8 molecule

 - a) Sulphur atom is involved in sp^3 hybridization
 - b) Sulphur exhibit enantiotropic allotropy
 - c) Four sulphur atoms are in one plane and the other four sulphur atoms are in another plane
 - d) The valency and the covalency of sulphur is 2

11. When conc. H_2SO_4 is added to fluorospar a product (X) is formed. (X) when treated with sand gives another (Y). Among the following which will have the same geometry as (Y).

 - a) SiF_6
 - b) $TeCl_6^{2-}$
 - c) SeF_4
 - d) PCl_6^-

Linked Comprehension Type Questions

Passage:

Sulphuric acid is considered as the king of chemicals. The prosperity of any country is measured by the amount of sulphuric acid it consumes. Sulphuric acid is, thus a substance of very great commercial importance as it is used practically in every important industry. This is due to the following properties of sulphuric acid:

12. Which of the following reactions depict the oxidising behaviour of H_2SO_4 ?
- $2HI + H_2SO_4 \rightarrow I_2 + SO_2 + 2H_2O$
 - $NaCl + H_2SO_4 \rightarrow NaHSO_4 + HCl$
 - $2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$
 - $2PCl_5 + H_2SO_4 \rightarrow 2POCl_3 + 2HCl + SO_2Cl_2$
13. Concentrated H_2SO_4 cannot be used to prepare HBr or HI from KBr or KI because it
- reacts too slowly with KBr or KI
 - Reduces HBr or HI
 - Oxidises HBr or HI
 - Oxidises KBr to $KBrO_3$ or KI to KIO_3

Matrix Matching Type Questions

- | 14. Column - I | Column - II |
|--------------------------|--|
| A) $CuCl_2 + Na_2S_2O_3$ | p) Metal ion acts as an oxidizing agent |
| B) $AgBr + Na_2S_2O_3$ | q) Formation of tetrathionate anion |
| C) $AuCl_3 + Na_2S_2O_3$ | r) Dissolves in excess of $Na_2S_2O_3$ solution due to complex formation |
| D) $BaCl_2 + Na_2S_2O_3$ | s) Precipitate formed does not dissolve in excess not dissolve in excess of Na_2SO_3 |

Integer Type Questions

15. The number of following substance that can form ozonides is KOH, CsOH, $Ba(OH)_2$, C_2H_2 , C_2H_4 , C_6H_6
16. The number of substances that can liberates oxygen under suitable conditions.
 $K_2Cr_2O_7$, $KMnO_4$, MnO_2 , $NaNO_3$, $KClO_3$, Pb_3O_4 , Na_2SO_4 , $MnSO_4$, Mn_2O_7 , HgO
17. How many of the following are peroxides H_2O_2 , Na_2O_2 , MnO_2 , PbO_2 , BaO_2 , KO_2 , CrO_5

PRACTICE SHEET (ADVANCED)**Straight Objective Type Questions**

- Which of the following is amphoteric oxide
 - SnO_2
 - Al_2O_3
 - PbO
 - All are amphoteric
- Which of the following can convert acidified $Cr_2O_7^{2-}$ to green coloured product ?
 - SO_2
 - H_2S
 - Fe^{+2}
 - All
- Select the correct statement , among the following
 - When Na_2S is added to sodium Nitroprusside solution,a violet coloured complex of $[Fe(CN)_5NO]^{4-}$ is formed
 - SO_4^{2-} has two $d_{\pi} - p_{\pi}$ bonds
 - SO_2 acts as bleaching agent and reducing agent
 - All statement are correct
- What is the oxidation state of Fluorine in O_2F_2 respectively
 - 2,-2
 - 1,-1
 - +2,+1
 - +1,+2
- Among the following, which one produces O_2 as well as solid metal by their thermal decomposition
 - Ag_2O
 - Pb_3O_4
 - HgO
 - (1) and (3)

6. Among the following properties of SO_2 , incorrect one
- $2\text{KMnO}_4 + 5\text{SO}_2 + 2\text{H}_2\text{O} \rightarrow \text{K}_2\text{SO}_4 + 2\text{MnSO}_4 + 2\text{H}_2\text{SO}_4$
 - $\text{Fe}_2(\text{SO}_4)_3 + \text{SO}_2 + 2\text{H}_2\text{O} \rightarrow 2\text{FeSO}_4 + 2\text{H}_2\text{SO}_4$
 - $\text{K}_2\text{Cr}_2\text{O}_7 + 4\text{SO}_2 + \text{H}_2\text{SO}_4 \rightarrow \text{K}_2\text{SO}_4 + \text{Cr}_2(\text{SO}_4)_3 + \text{H}_2\text{O} + \text{S} \downarrow$
 - $2\text{KIO}_3 + 5\text{SO}_2 + 4\text{H}_2\text{O} \rightarrow \text{K}_2\text{SO}_4 + 4\text{H}_2\text{SO}_4 + \text{I}_2$
7. Which of the following is a correct statement ?
- S_α and S_β are monotropic allotropes
 - O_2 and O_3 are enantiotropic allotrops
 - both (a) and (b)
 - O_2 and O_3 are monotropic allotropes
8. SO_3 may be obtained by heating
- $\text{S} + \text{H}_2\text{SO}_4$
 - $\text{H}_2\text{SO}_4 + \text{PCl}_3$
 - $\text{C} + \text{MgSO}_4$
 - $\text{Fe}_2(\text{SO}_4)_3$
9. If x and y are boiling point and dielectric constant of water, respectively, a and b are those of D_2O (heavy water) then
- $x > a, y < b$
 - $x > a, y > b$
 - $x < a, y < b$
 - $x < a, y > b$

More than One correct answer Type Questions

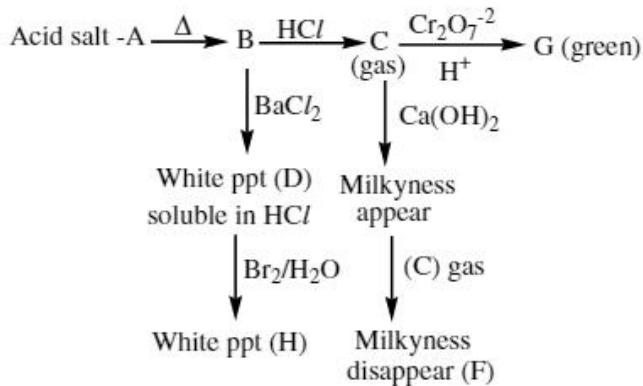
10. Ozone
- Is endothermic substance
 - Has bond order 1.5
 - Is Blackish violet in solid state
 - Has central oxygen in sp^2 hybridization
11. The correct statements among the following
- In gaseous SO_3 , sulphur is in sp^2 hybridization.
 - In β and γ SO_3 sulphur is in sp^3 hybridization
 - In cyclic isomer of SO_3 all S–O bond lengths are equal
 - In cyclic isomer of SO_3 the number of σ S–O bonds are equal both with in the ring and outside the ring
12. Sulphur dioxide is
- A reducing agent
 - An oxidising agent
 - Lewis acid
 - Lewis Base
13. Among the following the acidic oxides are
- Mn_2O_7
 - CrO_3
 - V_2O_5
 - FeO
14. When SO_2 gas is passed through an aqueous solution of Na_2S a product (X) is formed. The (X) can also be obtained
- By boiling sulphur with NaOH
 - By adding calculated amount of iodine to a mixture of Na_2S and Na_2SO_3
 - By passing SO_2 gas through an aqueous solution of Na_2SO_3 containing sulphur
 - By boiling sodium sulphite with flowers of sulphur

15. When a compound X reacts with ozone in aqueous medium a substance Y is produced. Ozone also reacts with (X) in alkaline medium and produces ion Z which can act as an oxidizing agent. Then X, Y and Z are

- a) X = KI, Y = I₂ and IO₃⁻
 b) X = HI, Y = I₂ and Z = IO₃⁻
 c) X = KI, Y = I₂, and Z = IO₄⁻
 d) X = HI, Y = I₂, and Z = IO₄⁻

Linked Comprehension Type Questions

Passage - I :



16. 'C' is
 a) CO₂ b) SO₂ c) Cl₂ d) H₂S
17. 'D' is
 a) BaSO₄ b) BaSO₃ c) BaCO₃ d) Ba₃(PO₄)₂
18. 'G' is
 a) CrO₄⁻² b) Cr⁺³ c) CrO₅ d) CrO₃

Matrix Matching Type Questions

- | 19. Column - I
(elements) | Column - II
(Covalency) |
|--|----------------------------|
| A) 'O' atom in O ₃ | p) One |
| B) 'S' atom in hyposulphurous acid | q) Two |
| C) 'N' atom in NO ⁺ and N ₂ O ₄ | r) Three |
| D) 'N' atom in hydrazoic acid | s) Four |

Integer Type Questions

20. Among the following, the number of thio acids.
 H₂S₂O₂, H₂S₂O₃, H₂S₂O₄, H₂S₂O₅, H₂S₂O₆, H₂S₂O₇, H₂S₂O₈
21. When Na₂SO₃ is heated with sulphur in alkaline medium a product (X) is formed. The number of lone pairs on all sulphur atoms in the product formed by the oxidation of (X) with iodine.
22. Black lead sulphide is oxidized to white lead sulphate by ozone. The number of electrons involved in the reaction per mole of lead sulphide is

KEY SHEET (ADDITIONAL PRACTICE EXERCISE)

LEVEL-I (MAIN)

- 1) 1 2) 1 3) 2 4) 2 5) 2 6) 1 7) 2 8) 3 9) 1 10) 4
 11) 2 12) 1 13) 1 14) 3 15) 2 16) 2 17) 2 18) 4 19) 2 20) 1
 21) 4 22) 6 23) 2

LEVEL-II

LECTURE SHEET (ADVANCED)

- 1) c 2) a 3) c 4) b 5) c 6) a 7) d 8) acd 9) abcd
 10) abc 11) abd 12) a 13) c 14) A-pqr; B-r; C-pqr; D-s 15) 6 16) 8 17) 4

PRACTICE SHEET (ADVANCED)

- 1) d 2) d 3) d 4) b 5) d 6) c 7) d 8) d 9) d 10) abcd
 11) abd 12) abcd 13) abc 14) abcd 15) abcd 16) b 17) d 18) b
 19) A-pqr; B-s; C-rs; D-qr 20) 5 21) 4 22) 8

