DCAM classes
Dynamic Classes for Academic Mastery

p-block elements(o,s,se,te)-CBSE

1 Mark Questions

1. Give reason for the following:

   Ozone is thermodynamically less stable than oxygen.

2. Give reason for the following

Above 1000 K sulphur shows paramagnetism.

3. Complete the following reaction.

$$PbS(s) + O_3 \longrightarrow$$

4. Assign suitable reason for the following

SF_6 is inert towards hydrolysis.

5. Draw the structure of $H_2S_2O_8$.

6. Sulphur in vapour state exhibits paramagnetic behaviour. Give reason.

7. Complete the following chemical equation :

$$Fe^{3+} + SO_2 + H_2O \longrightarrow$$

8. Oxygen is a gas but sulphur is a solid. Explain.

Or Dioxygen is a gas while sulphur is a solid at room temperature.

9. Write the formulae of any two oxoacids of sulphur.

10. Which allotrope of sulphur is thermally stable at room temperature?

11. Draw the structure of the following

H_2SO_4

12. Complete the following chemical equation :

$$Cu + H_2SO_4 \text{ (conc.)} \longrightarrow$$

13. Draw the structure of the following compound :

H_2SO_3

14. Give reason for the following :

Oxygen has less electron gain enthalpy with negative sign than sulphur.

15. Account for the following :

Oxygen shows catenation behaviour less than sulphur.

Or Sulphur has a greater tendency for catenation than oxygen. Why?

Or Sulphur exhibits tendency for catenation but oxygen does not do so. Give reason.

16. Predict the shape and the asked angle (90° or more or less) in the following case : SO_3^{2-} and the angle in O—S—O

17. Of PH_3 and H_2S, which is more acidic and why?

18. All the bonds in SF_4 are not equivalent. Explain, why?

19. Give reason: H_2S is more acidic than H_2O.

20. Draw the structure of $H_2S_2O_7$.

21. SF_6 is kinetically inert substance. Explain.

22. Complete the following chemical equation:

$$SO_3 + H_2SO_4\text{(conc.)} \longrightarrow$$

23. What happens when sulphur dioxide gas is passed through an aqueous solution of a Fe(III) salt?

24. Complete the following equation :

$$C + H_2SO_4\text{(conc.)} \longrightarrow$$

25. Explain: The two oxygen-oxygen bond lengths in ozone (O_3) molecule are same.

26. Elements of group 16 generally show lower value of first ionisation enthalpy as compared to the corresponding elements in the period of group 15. Explain why?

27. O_3 acts as a powerful oxidising agent. Give reason.

28. The value of electron gain enthalpy with negative sign for sulphur is higher than that for oxygen. Give reason.

29. Draw the structure of O_3 molecule.

30. H_2S is less acidic than H_2Te. Why?

31. OF_6 compound is not known. Why?

32. Write the balanced chemical equation for the following reaction:

Excess of SO_2 reacts with sodium hydroxide solution.

33. Sulphur hexafluoride is less reactive than sulphur tetrafluoride. Why?

34. Why are the two S—O bonds in SO_2 molecule of equal strength?

2 Marks Questions

35. Write a chemical reaction to test sulphur dioxide gas. Write chemical equation involved.

36. What happens when
    (i) conc. H_2SO_4 is added to Cu?
    (ii) SO_3 is passed through water?

    Write the equations.

37. Name the two most important allotropes of sulphur. Which one of the two is stable at room temperature? What happens when the stable form is heated above 370 K?

38. (i) Write the conditions to maximise the yield of H_2SO_4 by contact process.
    (ii) Why is $K_{a_2} << K_{a_1}$ for H_2SO_4 in water?

39. Account for the following :
    (i) Decomposition of O_3 molecule is a spontaneous process.
    (ii) SF_6 is inert towards hydrolysis.

40. Account for the following:
    (i) H_2S is less acidic than H_2Te.
    (ii) SO_2 is an air pollutant.

41. Draw the structures of O_3 and S_8 molecules.

42. (i) Assign reasons for the following :
    (a) H_2S is more acidic than H_2O.
    (b) Sulphur has a greater tendency for catenation than oxygen.

5 Marks Questions

43. (i) Elements of group 16 generally show lower value of first ionisation enthalpy compared to the corresponding periods of group 15. Why?
    (ii) What happens when
    (a) concentrated H_2SO_4 is added to CaF_2?
    (b) sulphur dioxide reacts with chlorine in the presence of charcoal?
    (c) ammonium chloride is treated with $Ca(OH)_2$? All India 2015 C

answers

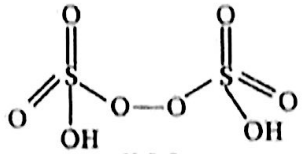
1. Ozone is thermodynamically less stable than oxygen because its decomposition into oxygen results in the liberation of heat (ΔH is negative) and increase in entropy (ΔS is positive). These two effects reinforce each other that results in large negative Gibbs energy change (ΔG) for its conversion into oxygen. Hence, high concentration of ozone can be dangerously explosive. (1)

2. Above 1000 K, sulphur show paramagnetism due to its existence in vapour state as S_2 (i.e. diatomic state). (1)

3. $PbS(s) + 4O_3(g) \longrightarrow PbSO_4(s) + 4O_2(s)$ (1)

4. SF_6 is sterically protected by six F-atoms and hence does not allow H_2O molecule to attack the S-atom. Thus, SF_6 is inert towards hydrolysis. (1)

5. Structure of $H_2S_2O_8$ is given below:



$H_2S_2O_8$
Peroxodisulphuric acid (1)

6. In vapour state, sulphur partly exists as S_2 molecule which has two unpaired electrons in the antibonding π-orbitals like O_2 and hence, exhibits paramagnetism. (1)

7. $2Fe^{3+} + SO_2 + 2H_2O \longrightarrow 2Fe^{2+} + SO_4^{2-} + 4H^+$ (1)

8. Oxygen atoms, owing to small size, form $p\pi$-$p\pi$ bond between atoms and exist as diatomic (O_2) molecules. As a result van der Waals' forces acting on these molecules are very less and the molecules exist in gaseous state.

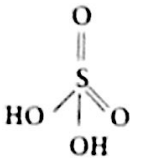
On the other hand, sulphur atoms, unable to form π-bonds due to large size, form single covalent bond between atoms which results in formation of cyclic molecules comprising of 8 atoms (S_8). Hence, van der Waals' forces act on these molecules to larger extent and as a result sulphur exists in solid state. (1)

9. (i) H_2SO_4 (Sulphuric acid) (1/2)

(ii) H_2SO_3 (Sulphurous acid) (1/2)

10. Rhombic sulphur is thermally stable at room temperature. (1)

11. (i) The structure of H_2SO_4 is



Sulphuric acid (H_2SO_4)

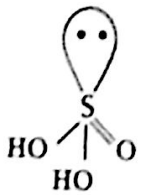
(1)

12. When conc. H_2SO_4 is added to Cu, then $CuSO_4$ and SO_2 are formed.

In this reaction, hot conc. H_2SO_4 acts as a moderately strong oxidising agent. Here, metal is oxidised by conc. H_2SO_4 and itself it is reduced to SO_2.

$$Cu + 2H_2SO_4 \text{ (conc.)} \longrightarrow CuSO_4 + SO_2 + 2H_2O$$ (1)

13.



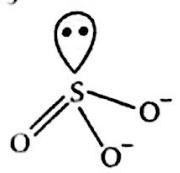
Sulphurous acid (H_2SO_3)

(1)

14. Because of the compact nature (small size) of oxygen atom, it has less negative electron gain enthalpy than sulphur. (1)

15. Bond energy of S—S bond (213 kJ mol^{-1}) is greater than O—O bond (138 kJ mol^{-1}). Due to small size of oxygen atom, there is greater *lp-bp* repulsion in O—O, resulting in weakening of O—O bond more than in S—S bond. Therefore, the tendency of catenation in oxygen is lower than sulphur. (1)

16. Structure of SO_3^{2-} is pyramidal as shown below:



SO_3^{2-} (Pyramidal)

Shape : Pyramidal (1/2)

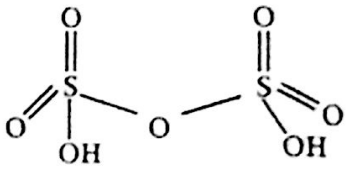
Angle in O—S—O : More than 90°. (1/2)

17. H_2S is more acidic than PH_3 because S is more electronegative than P. So, S—H bond is more polar than P—H bond resulting in easier removal of H^+ ion from H_2S. (1)

18. In SF_4, sulphur is sp^3d-hybridised. It has trigonal bipyramidal structure in which one of the equatorial positions is occupied by a lone pair of electrons (*see-saw* geometry). That's why, all the bonds in SF_4 are not equal. (1)

19. Due to decrease in (E—H) bond dissociation enthalpy down the group, acidic character increases. Thus, H_2S is more acidic than H_2O. (1)

20. Structure of $H_2S_2O_7$ is given below:



$H_2S_2O_7$

Pyrosulphuric acid (Oleum)

(1)

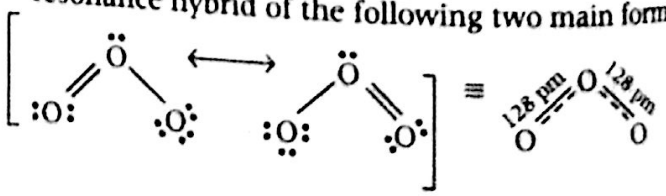
21. In SF_6 molecule the six atoms of fluorine sterically protect the sulphur atom from attack by a reagent. Hence, SF_6 is called kinetically inert substance. (1)

22. $SO_3 + \underset{\text{(conc.)}}{H_2SO_4} \longrightarrow \underset{\text{Oleum}}{H_2S_2O_7}$ (1)

23. Refer to solution 7. (1)

24. $C + 2H_2SO_4 \text{ (conc.)} \longrightarrow CO_2 + 2SO_2 + 2H_2O$ (1)

25. The two oxygen-oxygen bond lengths in the ozone molecule are identical (128 pm). Because it is a resonance hybrid of the following two main forms:



(1)

26. Due to the presence of extra stable half-filled np-orbitals in the electronic configurations of group 15 elements (ns^2np^3 configuration), greater amount of energy is required to remove electrons as compared to group 16 elements ($ns^2\ np^4$ configuration). Thus, ionisation energy of group 16 elements is lower than that of the corresponding elements of group 15. **(1)**

27. Ozone acts as a powerful oxidising agent because it liberates nascent oxygen.

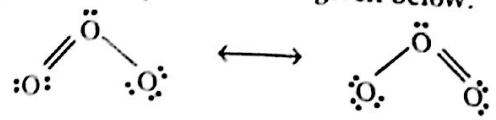
$$O_3 \longrightarrow O_2 + [O]$$

e.g. it oxidises lead sulphide to lead sulphate.

$$PbS(s) + 4O_3(g) \longrightarrow PbSO_4(s) + 4O_2(g)$$ **(1)**

28. Refer to solution 14.

29. Structure of O_3 molecule is given below:

 **(1)**

30. Due to decrease in (E—H) bond dissociation enthalpy down the group, acidic character increases. Thus, H_2S is less acidic than H_2Te. **(1)**

31. Due to the absence of d-orbitals in O, it limits its covalency to four, therefore OF_6 is not formed. **(1)**

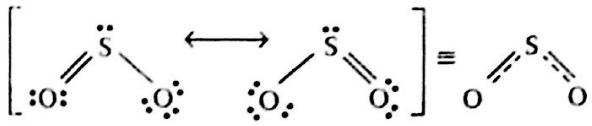
32. The asked reaction results in formation of sodium hydrogen sulphite.

$$2NaOH + SO_2 \longrightarrow Na_2SO_3 + H_2O$$ **(1/2)**

$$Na_2SO_3 + H_2O + SO_2 \longrightarrow \underset{\text{Sodium hydrogen sulphite}}{2NaHSO_3}$$ **(1/2)**

33. SF_6 is sterically protected so, it is less reactive than SF_4. **(1)**

34. Due to resonance, the two S—O bonds in SO_2 are of equal strength.

 **(1)**

35. SO_2 is a pungent smelling gas. Two tests are used to detect the presence of SO_2 that are as follows:

(i) SO_2 turns the pink-violet colour of $KMnO_4$ solution to colourless due to the reduction of MnO_4^- to Mn^{2+}.

$$5SO_2 + 2MnO_4^- + 2H_2O \xrightarrow[\text{(Pink-violet)}]{} 5SO_4^{2-} + 4H^+ + \underset{\text{(Colourless)}}{2Mn^{2+}}$$ **(1)**

(ii) SO_2 turns orange coloured acidified $K_2Cr_2O_7$ solution to green due to the reduction of $Cr_2O_7^{2-}$ to Cr^{3+} ion.

$$3SO_2 + \underset{\text{(Orange)}}{Cr_2O_7^{2-}} + 2H^+ \longrightarrow 3SO_4^{2-} + H_2O + \underset{\text{(Green)}}{2Cr^{3+}}$$ **(1)**

36. (i) Refer to solution 12.

(ii) SO_3 reacts vigorously with water, evolving a large amount of heat and forming H_2SO_4.

$$SO_3 + H_2O \longrightarrow H_2SO_4$$ **(1)**

37. Two most important allotropes of sulphur are

(i) rhombic sulphur (α-sulphur)

(ii) monoclinic sulphur

The stable form at room temperature is rhombic sulphur which transforms to monoclinic sulphur when heated above 370 K. **(1)**

Rhombic sulphur $\xrightarrow{370\ K}$ Monoclinic sulphur **(1)**

38. (i) Low temperature (about 720 K), high pressure about 2 bar and presence of catalyst (V_2O_5) are the favourable conditions for the manufacture of H_2SO_4 by contact process. **(1)**

(ii) H_2SO_4 is very strong acid in water largely because of its ionisation to H_3O^+ and HSO_4^-. Further, ionisation of HSO_4^- to SO_4^{2-} and H_3O^+ is very small as losing H^+ from a negatively charged HSO_4^- is more difficult. That's why, $K_{a_2} << K_{a_1}$. **(1)**

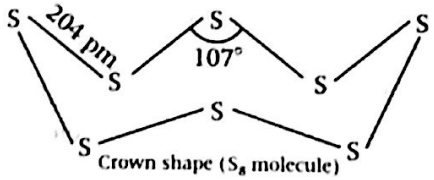
39. (i) For spontaneity of a reaction, ΔG must be negative. Decomposition of O_3 is an exothermic process (ΔH = −ve) and occurs with increase in entropy (ΔS = +ve). These two effects reinforce each other which results in large negative Gibbs energy change. It favours its decomposition into oxygen. **(1)**

(ii) Refer toi solution 4. **(1)**

40. (i) Refer to solution 30. **(1)**

(ii) SO_2 is water soluble, therefore it dissolves in rainwater causing acid rain. Moreover, when released in air, it mixes with it and leads to several diseases like eyes irritation, redness, asthma, bronchitis, etc. Thus, it is considered as an air pollutant. **(1)**

41. Refer to solutions 29 and Structure of S_8 molecule is given below :



Crown shape (S_8 molecule) **(2)**

42. (a) Refer to solution 19. **(1)**

(b) Refer to solution 15. **(1)**

43. (i) Refer to solution 26. (2)

(ii) (a) It forms hydrogen fluoride (HF)

$CaF_2 + H_2SO_4 \longrightarrow CaSO_4 + 2HF$. (1)

(b) It forms sulphuryl chloride (SO_2Cl_2).

$SO_2(g) + Cl_2\ (g) \longrightarrow SO_2Cl_2\ (l)$ (1)

(c) Ammonia is formed.

$2NH_4Cl + Ca(OH)_2 \longrightarrow$

$2NH_3 + 2H_2O + CaCl_2$ (1)