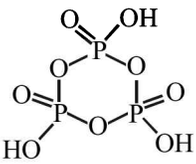
## Chapter-21 : The p-Block Elements (Group 15, 16, 17 & 18)

**1.** **(a)** Sodium thiosulphate is a reducing agent. It is used in volumetric titration (Iodimetry) to reduce $I_2$ to $I^-$.

$$\underset{\text{Sod. thiosulphate}}{2Na_2S_2O_3} + I_2 \longrightarrow \underset{\text{Sod. tetrathionate}}{Na_2S_4O_6} + 2NaI$$

**2.** **(a)** Both white and red phosphorus are not soluble in $CS_2$ only white phosphorus is soluble in $CS_2$.

**3.** **(c)** In cyclic metaphosporic acid number of P–O–P bonds is three.



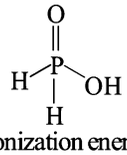
4. **(b)** The order of boiling points of the group 15 hydrides is: $BiH_3 > SbH_3 > NH_3 > AsH_3 > PH_3$

5. **(a)** The order of bond energy is
$Cl-Cl > F-F > Br-Br > I-I$
The small value of bond energy in $F_2$ than $Cl_2$ (anomaly) is due to smaller size of F atom which leads to inter-electronic repulsions.

6. **(d)** $N_2$ molecule contains triple bond between N atoms having very high dissociation energy (946 kJ $mol^{-1}$) due to which it is relatively inactive.

7. **(c)** $SO_2$ is highly soluble in water and therefore cannot be collected over water.

8. **(c)** $H_3PO_2$ is named as hypophosphorous acid. It is monobasic as it contains only one P – OH bond, its basicity is one.

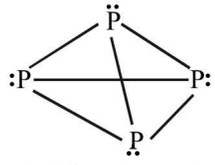


9. **(d)** (i) The first ionization energy of xenon (1, 170 kJ $mol^{-1}$) is quite close to that of dioxygen (1,180 kJ $mol^{-1}$).
(ii) The molecular diameters of xenon and dioxygen are almost identical.
Based on the above similarities Barlett (who prepared $O_2^+[PtF_6]^-$ compound) suggested that since oxygen combines with $PtF_6$, so xenon should also form similar compound with $PtF_6$.

10. **(a)** Nitrogen due to small size is able to show $p\pi$-$p\pi$ lateral overlap forming N ≡ N, rest elements due to bigger size are not able to show $p\pi$-$p\pi$ lateral overlap.

11. **(b)** In $XeOF_4$, Xenon is $sp^3d^2$ hybridised and has one lone pair of electrons.

12. **(c)**

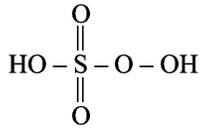


$P_4$ (White phosporus)

$\because$ Each P-atom forms 3 bonds. Thus it has 3 bond pairs of electrons.

13. **(c)** In $KMnO_4$ manganese is already present in its highest possible oxidation state i.e. +7. So no further oxidation is possible.

14. **(d)** Caro's acid is $H_2SO_5$ which contains one S – O – OH peroxy linkage. It is also known as permonosulphuric acid.



15. **(d)** Bleaching action of chlorine is due to oxidation in presence of moisture.

$$Cl_2 + H_2O \longrightarrow HCl + HClO$$
$$HClO \longrightarrow HCl + |O|$$
Colouring matter + | O | ⟶ Colourless matter

16. **(d)** $2H_3PO_4 \xrightarrow[-2H_2O]{600°C} 2HPO_3$

17. **(d)** $N_2H_4$ and $NH_4Cl$ are obtained by reaction of ammonia with hypochlorite anion.

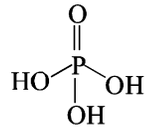
$$3NH_3 + NaOCl \longrightarrow N_2H_4 + NH_4Cl + NaOH$$

18. **(d)** $P_2O_5 + 3H_2O \xrightarrow{\Delta} 2H_3PO_4$

19. **(a)** $NH_4ClO_4 + HNO_3 \longrightarrow HClO_4 + NH_4NO_3$

$$NH_4NO_3 \xrightarrow{\Delta} N_2O + 2H_2O$$

20. **(b)** Orthophosphoric acid, $H_3PO_4$ contains three P – OH bonds and is therefore, tribasic.



orthophosphoric acid

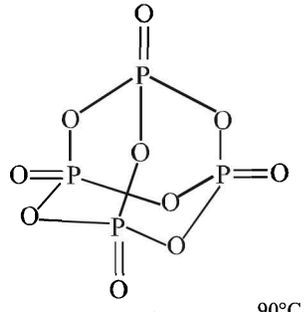
21. **(a)** $\underset{\text{Thiosulphate}}{2S_2O_3^{2-}} + I_2 \longrightarrow \underset{\text{Tetrathionate}}{S_4O_6^{2-}} + 2I^-$

22. **(b)** $PCl_3 + H_2O \longrightarrow POCl_3 + 2HCl$
$POCl_3 + 3H_2O \longrightarrow H_3PO_4 + 3HCl$

23. **(b)** $PbO_2$ is a powerful oxidizing agent and liberate $O_2$ when treated with acids.

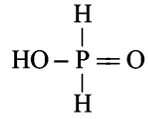
$$2PbO_2 + 4HNO_3 \longrightarrow 2Pb(NO_3)_2 + 2H_2O + O_2 \uparrow$$

24. **(d)**



25. **(c)** $2AgClO_3 + Cl_2(dry) \xrightarrow{90°C} 2AgCl + 2ClO_2 + O_2$

26. **(c)** Structure of hypophosphorous acid



Two H-atoms are attached to P atom.

27. **(b)** $\underset{1\text{ mol}}{Mg_3N_2} + \underset{\text{(excess)}}{6H_2O} \longrightarrow 3Mg(OH)_2 + \underset{2\text{ mol}}{2NH_3}$

28. **(c)** A stronger oxidising agent ($Cl_2$) displaces a weaker oxidising agent ($Br_2$) from its salt solution.

$$2KBr + Cl_2 \longrightarrow 2KCl + Br_2$$

29. **(b)** Alkaline pyrogallol absorbs $O_2$ and oil of cinnamon absorbs $O_3$.

**30.** **(b)** $\overset{-1}{4KI} + 2CuSO_4 \longrightarrow \overset{0}{I_2} + Cu_2I_2 + 2K_2SO_4$

$\overset{0}{I_2} + 2Na_2\overset{2+}{S_2}O_3 \longrightarrow Na_2\overset{+2.5}{S_4}O_6 + 2\overset{-1}{NaI}$

In this $CuI_2$ is **not** formed.

**31.** **(c)** Air is liquified by making use of the joule-Thompson effect (cooling by expansion of the gas) Water vapour and $CO_2$ are removed by solidification. The remaining major constituents of liquid air i.e., liquid oxygen and liquid nitrogen are separated by means of fractional distillation (b.p. of $O_2 = -183°C$ : b. P. of $N_2 = -195.8°C$)

**32.** **(a)** Due to absence of reaction between marble and bromine.

**33.** **(b)** Pseudohalogens have general formula Ps – Ps or Ps – X. Where, Ps – Pseudohalogen group cyanide, cyanate etc. X – True halogen.

Examples : Cyanogen $(CN)_2$. Thiocyanogen $(SCN)_2$

**34.** **(c)** The H–X bond strength decreases from HF to HI. i.e. HF > HCl > HBr > HI. Thus HF is most stable while HI is least stable. The decreasing stability of the hydrogen halide is also reflected in the values of dissociation energy of the H–X bond

| H – F | H – Cl | H – Br | H – I |
|---|---|---|---|
| 135 kcal $mol^{-1}$ | 103 kcal $mol^{-1}$ | 87 kcal $mol^{-1}$ | 71 kcal $mol^{-1}$ |

**35.** **(c)** Acidic strength increases as the oxidation number of central atom increases.

Hence acidic strength order is

$\overset{(+7)}{HClO_4} > \overset{(+5)}{HClO_3} > \overset{(+3)}{HClO_2} > \overset{(+1)}{HClO}$

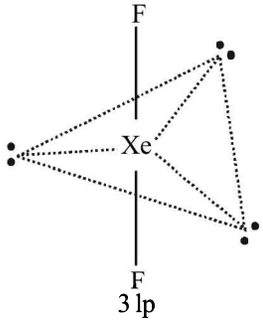
**36.** **(d)** As the oxidation state of the central halogen atom increases, the halogen-oxygen bond becomes more and more covalent. As a result the thermal stability of the oxoacid increases. Thus, $HClO_4$ is most stable to heat, whereas HClO is least stable to heat.

**37.** **(b)** $Na_2SO_3 + S \xrightarrow[\text{medium}]{\text{In alkaline}} Na_2S_2O_3$

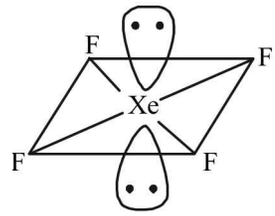
**38.** **(c)** Helium is twice as heavy as hydrogen. It is inflammable but not lighter than hydrogen. Helium has the lowest melting and boiling point of any element which makes liquid helium an ideal coolant for many extremely low temperature application such as super conducting magnet and cryogenic research where temperature close to absolute zero are needed. It is used in gas cooled atomic reactors as a heat transfer agent.

**39.** **(a)** Alkaline solution of pyrogallol absorbs oxygen quickly.

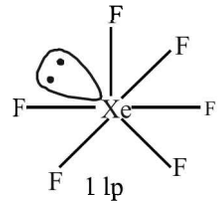
**40.** **(c)** $XeF_2$:



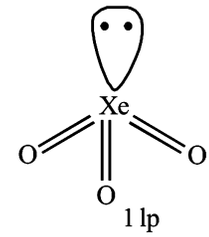

$XeF_4$:




$XeF_6$:




$XeO_3$:




Hence $XeF_2$ has maximum no. of lone pairs of electrons.

**41.** **(d)** (a) $Ba(N_3)_2 \xrightarrow{\Delta} Ba + 3N_2$

(b) $(NH_4)_2Cr_2O_7 \xrightarrow{\Delta} Cr_2O_3 + N_2 + 4H_2O$

(c) $NH_4NO_2 \xrightarrow{\Delta} N_2 + 2H_2O$

(d) $(NH_4)_2SO_4 \xrightarrow{\Delta} 2NH_3 + H_2SO_4$

$NH_3$ is evolved in case of (d) .

**42.** **(a)** $B_2H_6 + 3O_2 \longrightarrow B_2O_3 + 3H_2O$

$B_2H_6 + 6H_2O \longrightarrow 2H_3BO_3 + 6H_2$

**43.** **(a)** Acidic strength of oxyacids increases with increase in oxidation number and on moving from top to bottom in a group acidic strength of oxides also decrease due to decrease in electronegativity down the group.

$\overset{+5}{P_4O_{10}} > \overset{+3}{P_4O_6} > \overset{+5}{As_4O_{10}} > \overset{+3}{As_4O_6}$

**44.** **(d)**

| (Oxide) | (Oxidation state) |
|---|---|
| $N_2O$ | +1 |
| NO | +2 |
| $N_2O_3$ | +3 |
| $NO_2$ | +4 |

So, $N_2O < NO < N_2O_3 < NO_2$

**45.** **(b)** $ClO_2$ contains 7 + 12 i.e. 19 valence electrons which is an odd number, i.e., there is (are) free electron(s). Hence it is paramagnetic in nature.

**46.** **(b)** Number of pentagons in $C_{60}$ (Buckminsterfullerene) = 12

Number of triangles in $P_4$ (White phosphorous) = 4

**47.** **(a)** As size increases, van der Waal's forces of attraction between noble gas atoms also increases. Consequently, ease of their liquefaction increases.

**48.** **(b)** In $BCl_3$, $H = \frac{1}{2}(3+3+0-0) = 3$; $sp^2$ hybridization (bond angle = 120°) similarly $PCl_3$ $AsCl_3$ and $BiCl_3$ are found to have $sp^3$ hybridized central atom with one lone pair of electrons on the central atom. The bond angle $\leq 109°28'$, since the central atoms belong to the same group, the bond angle of the chlorides decreases as we go down the group. Thus the order of bond angle is, $BCl_3 > PCl_3 > AsCl_3 > BiCl_3$.

**49.** **(a)** For oxides of same element higher the oxidation state, more will be acidic character.

$\overset{+5}{N_2O_5} > \overset{+2}{NO} > \overset{+1}{N_2O}$

**50.** **(d)** $H_2O$ is liquid but $H_2S$ is a gas. This can be attributed to the presence of intermolecular hydrogen bonding in case of $H_2O$.