## INORGANIC CHEMISTRY

### p-BLOCK

**1.** The stoichiometric reaction of 516 g of dimethyldichlorosilane with water results in a tetrameric cyclic product **X** in 75% yield. The weight (in g) of **X** obtained is_____. **[JEE(Advanced) 2023]**

[Use, molar mass (g $mol^{-1}$): H = 1, C = 12, O = 16, Si = 28, Cl = 35.5]

**2.** Match the reactions (in the given stoichiometry of the reactants) in List-I with one of their products given in List-II and choose the correct option. **[JEE(Advanced) 2023]**

| List-I | | List-II | |
|---|---|---|---|
| (P) | $P_2O_3 + 3H_2O \rightarrow$ | (1) | $P(O)(OCH_3)Cl_2$ |
| (Q) | $P_4 + 3NaOH + 3H_2O \rightarrow$ | (2) | $H_3PO_3$ |
| (R) | $PCl_5 + CH_3COOH \rightarrow$ | (3) | $PH_3$ |
| (S) | $H_3PO_2 + 2H_2O + 4AgNO_3 \rightarrow$ | (4) | $POCl_3$ |
| | | (5) | $H_3PO_4$ |

(A) P → 2; Q → 3; R → 1; S → 5 (B) P → 3; Q → 5; R → 4; S → 2

(C) P → 5; Q → 2; R → 1; S → 3 (D) P → 2; Q → 3; R → 4; S → 5

**3.** The reaction of Xe and $O_2F_2$ gives a Xe compound **P**. The number of moles of HF produced by the complete hydrolysis of 1 mol of **P** is _____. **[JEE(Advanced) 2022]**

**4.** The compound(s) which react(s) with $NH_3$ to give boron nitride (BN) is(are) **[JEE(Advanced) 2022]**

(A) B (B) $B_2H_6$ (C) $B_2O_3$ (D) $HBF_4$

**5.** The reaction of $HClO_3$ with HCl gives a paramagnetic gas, which upon reaction with $O_3$ produces **[JEE(Advanced) 2022]**

(A) $Cl_2O$ (B) $ClO_2$ (C) $Cl_2O_6$ (D) $Cl_2O_7$

**6.** The reaction $Pb(NO_3)_2$ and NaCl in water produces a precipitate that dissolves upon the addition of HCl of appropriate concentration. The dissolution of the precipitate is due to the formation of **[JEE(Advanced) 2022]**

(A) $PbCl_2$ (B) $PbCl_4$ (C) $[PbCl_4]^{2-}$ (D) $[PbCl_6]^{2-}$

**7.** Ozonolysis of $ClO_2$ produces an oxide of chlorine. The average oxidation state of chlorine in this oxide is _____. **[JEE(Advanced) 2021]**

**8.** With respect to hypochlorite, chlorate and perchlorate ions, choose the correct statement(s). **[JEE(Advanced) 2020]**

(A) The hypochlorite ion is the strongest conjugate base.

(B) The molecular shape of only chlorate ion is influenced by the lone pair of electrons of Cl.

(C) The hypochlorite and chlorate ions disproportionate to give rise to identical set of ions.

(D) The hypochlorite ion oxidizes the sulfite ion.

**9.** At 143 K. the reaction of $XeF_4$ with $O_2F_2$ produces a xenon compound **Y**. The total number of lone pair(s) of electrons present on the whole molecule of **Y** is _____. **[JEE(Advanced) 2019]**

**10.** The compound(s) which generate(s) $N_2$ gas upon thermal decomposition below 300°C is (are)

**[JEE(Advanced) 2018]**

(A) $NH_4NO_3$ (B) $(NH_4)_2Cr_2O_7$ (C) $Ba(N_3)_2$ (D)$Mg_3N_2$

**11.** Based on the compounds of group 15 elements, the correct statement(s) is (are)

**[JEE(Advanced) 2018]**

(A) $Bi_2O_5$ is more basic than $N_2O_5$

(B) $NF_3$ is more covalent than $BiF_3$

(C) $PH_3$ boils at lower temperature than $NH_3$

(D) The N–N single bond is stronger than the P–P single bond

**12.** The colour of the $X_2$ molecules of group 17 elements changes gradually from yellow to violet down the group. This is due to - **[JEE(Advanced) 2017]**

(A) the physical state of $X_2$ at room temperature changes from gas to solid down the group

(B) decrease in HOMO-LUMO gap down the group

(C) decrease in $\pi^*$-$\sigma^*$ down the group

(D) decrease in ionization energy down the group

**Paragraph for Q.13 & Q.14**

Upon heating $KClO_3$ in the presence of catalytic amount of $MnO_2$ , a gas **W** is formed. Excess amount of **W** reacts with white phosphorus to give **X.** The reaction of **X** with pure $HNO_3$ gives **Y** and **Z**.

**[JEE(Advanced) 2017]**

**13.** **W** and **X** are, respectively

(A) $O_3$ and $P_4O_6$ (B) $O_2$ and $P_4O_{10}$ (C) $O_3$ and $P_4O_{10}$ (D) $O_2$ and $P_4O_6$

**14.** **Y** and **Z** are , respectively

(A) $N_2O_4$ and $H_3PO_3$ (B) $N_2O_4$ and $HPO_3$ (C) $N_2O_5$ and $HPO_3$ (D) $N_2O_3$ and $H_3PO_4$

**15.** The crystalline form of borax has **[JEE(Advanced) 2016]**

(A) Tetranuclear $[B_4O_5(OH)_4]^{2-}$ unit

(B) All boron atoms in the same plane

(C) Equal number of $sp^2$ and $sp^3$ hybridized boron atoms

(D) One terminal hydroxide per boron atom

**16.** The nitrogen containing compound produced in the reaction of $HNO_3$ with $P_4O_{10}$

**[JEE(Advanced) 2016]**

(A) can also be prepared by reaction of $P_4$ and $HNO_3$

(B) is diamagnetic

(C) contains one N-N bond

(D) reacts with Na metal producing a brown gas

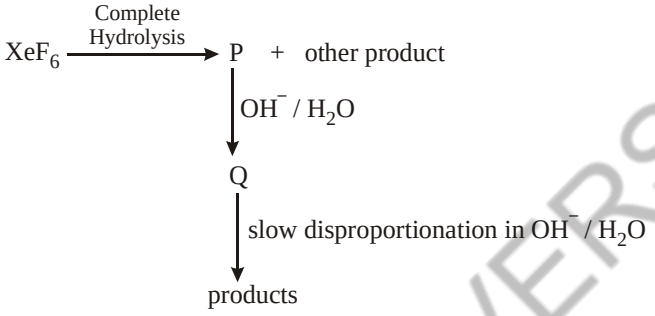
**17.** Three moles of $B_2H_6$ are completely reacted with methanol. The number of moles of boron containing product formed is – **[JEE(Advanced) 2015]**

**18.** Under hydrolytic conditions, the compounds used for preparation of linear polymer and for chain termination, respectively, are **[JEE(Advanced) 2015]**

(A) $CH_3SiCl_3$ and $Si(CH_3)_4$ (B) $(CH_3)_2SiCl_2$ and $(CH_3)_3SiCl$

(C) $(CH_3)_2SiCl_2$ and $CH_3SiCl_3$ (D) $SiCl_4$ and $(CH_3)_3SiCl$

**19.** Under ambient conditions, the total number of gases released as products in the final step of the reaction scheme shown below is **[JEE(Advanced) 2014]**




(A) 0 (B) 1 (C) 2 (D) 3

**20.** The product formed in the reaction of $SOCl_2$ with white phosphorous is **[JEE(Advanced) 2014]**

(A) $PCl_3$ (B) $SO_2Cl_2$ (C) $SCl_2$ (D) $POCl_3$

## SOLUTIONS

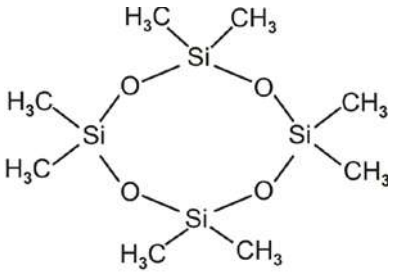
**1. Ans. (222)**

**Sol.** $4(CH_3)_2SiCl_2 + 4H_2O \xrightarrow{75\%} \underset{(X)}{(CH_3)_8Si_4O_4} + 8HCl$

$w = 516\,g$

$n_{(moles)} = \frac{516}{129}$

$= 4$



weight = 296 g

% yield = 75

$\text{The weight of X (in gram)} = 296 \times \frac{75}{100} = 222\,g$

**2. Ans. (D)**

**Sol.** (P) $P_2O_3 + 3H_2O \rightarrow 2\underline{H_3PO_3}$

(Q) $P_4 + 3NaOH + 3H_2O \rightarrow 3NaH_2PO_2 + \underline{PH_3}$

(R) $PCl_5 + CH_3COOH \rightarrow CH_3COCl + \underline{POCl_3} + HCl$

(S) $H_3PO_2 + 2H_2O + 4AgNO_3 \rightarrow 4Ag + 4HNO_3 + \underline{H_3PO_4}$

**3. Ans. (2 or 4 or 6)**

**Sol.** $Xe + 2O_2F_2 \rightarrow XeF_4 + 2O_2$

$3XeF_4 + 6H_2O \rightarrow 2Xe + XeO_3 + \frac{3}{2}O_2 + 12HF$

$\therefore$ One mole of $XeF_4$ gives 4 moles of HF on hydrolysis

**4. Ans. (B, C or A, B, C)**

**Sol.** **(A)** $2B + 2NH_3 \rightarrow 2BN + 3H_2$

Boron produced BN with ammonia but **Boron is element not compound.** So that this option not involve in answer.

**(B)** $3B_2H_6 + 6NH_3 \rightarrow 3[BH_2(NH_3)_2]^+[BH_4^-] \xrightarrow{T = 200°C} 2B_3N_3H_6 + 12H_2$

$B_3N_3H_6 \xrightarrow{T > 200°C} (BN)_x$

**(C)** $B_2O_3(\ell) + 2NH_3 \xrightarrow{1200°C} 2BN_{(s)} + 3H_2O_{(g)}$

**(D)** $HBF_4 + NH_3 \rightarrow NH_4[BF_4]$

**5. Ans. (C)**

**Sol.** $HClO_3 + HCl \rightarrow \underset{\text{(Paramagnetic)}}{ClO_2} + \frac{1}{2}Cl_2 + H_2O$

$2ClO_2 + 2O_3 \rightarrow Cl_2O_6 + 2O_2$

**6. Ans. (C)**

**Sol.** $Pb(NO_3)_2 + 2NaCl \longrightarrow PbCl_2 + 2NaNO_3$

$PbCl_2 \xrightarrow{\text{excess HCl}} [PbCl_4]^{2-}$

**7. Ans. (6)**

**Sol.** $2ClO_2 + 2O_3 \longrightarrow Cl_2O_6 + 2O_2$

**$Cl_2O_6$**

$2x + 6(-2) = 0$

$x = +6$

Average oxidation state of Cl in $Cl_2O_6$ is 6.

**8. Ans. (A, B, D)**

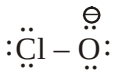
**Sol.** Hypochlorite ion : $ClO^{\ominus}$

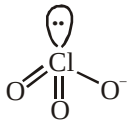
Chlorate ion : $ClO_3^{\ominus}$

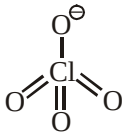
Per chlorate ion : $ClO_4^{\ominus}$

(A) Acidic order : $\overset{+1}{H}ClO < \overset{+5}{H}ClO_3 < \overset{+7}{H}ClO_4$

Conjugate base order : $ClO^- > ClO_3^- > ClO_4^-$

(B) Hypochlorite ion ($ClO^{\ominus}$):  Linear shape

Chlorate ion $(ClO_3^{\ominus})$:  Trigonal pyramidal shape

Perchlorate ion $(ClO_4^{\ominus})$ :  Perfect tetrahedral shape due to resonance

In chlorate ion bond angle changes due to presence of lone pair on chlorine atom. While hypochlorite ion is linear and perchlorate ion is tetrahedral and there is no effect of lone pair on hypochlorite ion.

(C) Disproportionation reaction of

(i) hypochlorite ion : $3ClO^{\ominus} \rightarrow 2Cl^- + ClO_3^{\ominus}$

(ii) Chlorate ion : $4ClO_3^{\circ} \rightarrow 3ClO_4^{\ominus} + Cl^{\ominus}$

(D) $ClO^- + SO_3^{2-} \rightarrow SO_4^{2-} + Cl^{\ominus}$

**9. Ans. (19.00)**

**Sol.** $XeF_4 + O_2F_2 \rightarrow \underset{Y}{XeF_6} + O_2$

Y has 3 lone pair of electron in each fluorine and one lone pair of electron in xenon.

Hence total lone pair of electrons is 19.

**10. Ans. (B, C)**

**Sol.** (A) $NH_4NO_3 \xrightarrow[\text{below } 300^\circ C]{\Delta} N_2O + 2H_2O$

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

(C) $Ba(N_3)_2 \xrightarrow{\Delta} Ba + 3N_2$

(D) $Mg_3N_2$ (it does not decompose into $N_2$)

**11. Ans. (A, B, C)**

**Sol.** (A) $Bi_2O_5$ is metallic oxide but $N_2O_5$ is non metallic oxide therefore $Bi_2O_5$ is basic but $N_2O_5$ is acidic.

(B) In $NF_3$, N and F are non metals but $BiF_3$, Bi is metal but F is non metal therefore $NF_3$ is more covalent than $BiF_3$.

(C) In $PH_3$ hydrogen bonding is absent but in $NH_3$ hydrogen bonding is present therefore $PH_3$ boils at lower temperature than $NH_3$.

(D) Due to small size in N–N single bond l.p. – l.p. repulsion is more than P–P single bond therefore N–N single bond is weaker than the P–P single bond.

**12. Ans. (B, C)**

**Sol.** Halogens are coloured due to HOMO-LUMO transition of electrons.

M.O. $\rightarrow F_2 = \sigma 1s^2, \overset{*}{\sigma} 1s^2, \sigma 2s^2, \overset{*}{\sigma} 2s^2, \sigma 2p_z^2, \pi 2p_x^2 = \pi 2p_y^2, \overset{*}{\pi} 2p_x^2 = \overset{*}{\pi} 2p_y^2, \overset{*}{\sigma} 2p_z$

(configuration)

filled (HOMO) Vacant (LUMO)

On moving down the group HOMO-LUMO energy gap decreases so transition of electrons become easier $\overset{*}{\pi} 2p$ to $\overset{*}{\sigma} 2p$ therefore colour intensify.

**Solution for paragraph Q.13 & 14**

$$2KClO_3 \xrightarrow[\Delta]{MnO_2} 2KCl + \underset{(W)}{3O_2}$$

$$\underset{\text{white phosphorous}}{P_4} + \underset{\text{(excess) (W)}}{5\,O_2} \longrightarrow \underset{(X)}{P_4O_{10}}$$

$$\underset{(X)}{P_4O_{10}} + 4\,HNO_3 \longrightarrow \underset{(Y)}{2N_2O_5} + \underset{(Z)}{(HPO_3)_4}$$

**13 Ans. (B)**

**Sol.** W and X are respectively

W = $O_2$ and X = $P_4O_{10}$

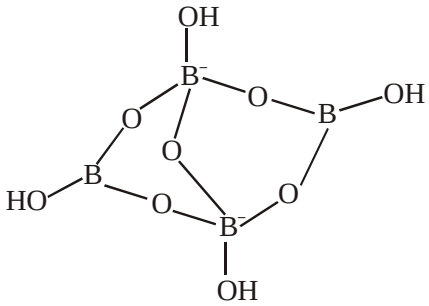
**14. Ans. (C)**

**Sol.** Y and Z are respectively

Y = $N_2O_5$ and Z = $HPO_3$

**15. Ans. (A, C, D)**

**Sol.**



(A) Having $[B_4O_5(OH)_4]^{2-}$ tetranuclear (boron) unit

(B) All boron atoms not in same plane

(C) Two boron are $sp^2$ hybridised and two boron are $sp^3$ hybridised

(D) One terminal hydroxide per boron atom is present.

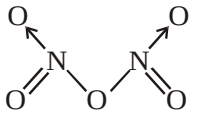
**16. Ans. (B, D)**

**Sol.** $P_4O_{10} + 4HNO_3 \xrightarrow{\text{dehydration of } HNO_3} 4(HPO_3) + 2N_2O_5$

(required product)

(A) $P_4 + 20\,HNO_3 \rightarrow 4H_3PO_4 + 20NO_2 + 4H_2O$

(B) $N_2O_5$ is diamagnetic in nature

(C) $N_2O_5 \rightarrow$ 

$N_2O_5$ contains one N–O–N bond not N–N bond.

(D) $Na + N_2O_5 \rightarrow NaNO_3 + NO_2$

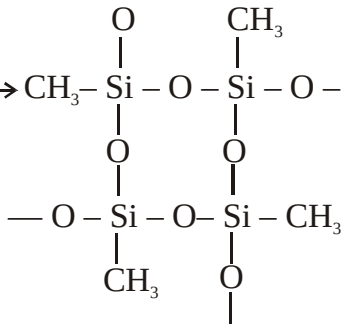
(Brown gas)

**17. Ans. (6)**

**Sol.** $B_2H_6 + 6MeOH \rightarrow 2[B(OMe)_3] + 6H_2$

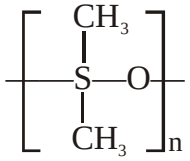
1 mole of $B_2H_6$ is completely reacted with methanol then 2 mole of product $[B(OMe)_3]$ is formed & hence when 3 moles of $B_2H_6$ are completely reacted with methanol then 6 mole of product $[B(OMe)_3]$ is formed.

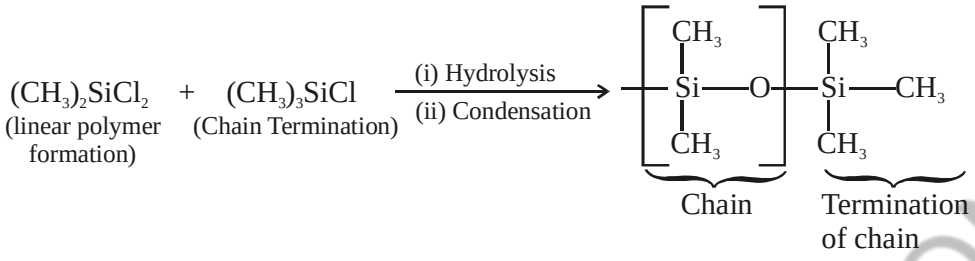
**18. Ans. (B)**

**Sol. (A)** $CH_3SiCl_3 \xrightarrow[\text{(ii) Condensation}]{\text{(i) Hydrolysis}}$ 

Cross linked polymer

$Si(CH_3)_4 \longrightarrow$ NOT hydrolysed

(B) $(CH_3)_2\ SiCl_2 \xrightarrow[\text{(ii) Condensation}]{\text{(i) Hydrolysis}}$  Linear Polymer




(C) $(CH_3)_2SiCl_2 \xrightarrow[\text{(ii) Condensation}]{\text{(i) Hydrolysis}}$ linear polymer formation

$CH_3SiCl_3 \xrightarrow[\text{(ii) Condensation}]{\text{(i) Hydrolysis}}$ Cross linked polymer

(D) $SiCl_4 \xrightarrow{\text{Hydrolysis}} H_4SiO_4 + 4HCl$

**19. Ans. (C)**

**Sol.** $XeF_6 + 3H_2O \longrightarrow XeO_3 + 6HF$

(P)

$XeO_3 + OH^- / H_2O \longrightarrow HXeO_4^-$

(P) (Q)

$2HXeO_4^- \longrightarrow Xe + XeO_6^{4-} + O_2 + H_2O$

(Q)

Hence, there are two gaseous products Xe and $O_2$.

**20. Ans. (A)**

**Sol.** $P_4 + 8SOCl_2 \longrightarrow 4PCl_3 + 4SO_2 + 2S_2Cl_2$