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 π^*-σ^* 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

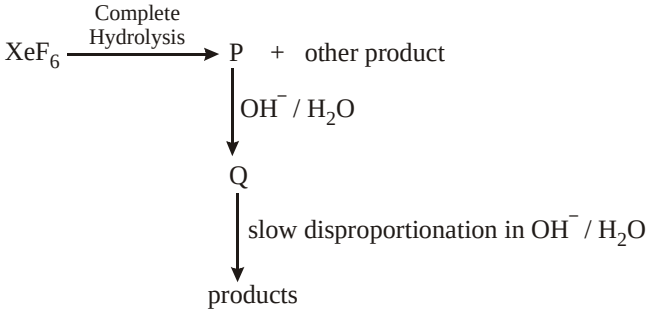
17. Three moles of B_2H_6 are completely reacted with methanol. The number of moles of boron containing product formed is – **[JEE(Advanced) 2015]**

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

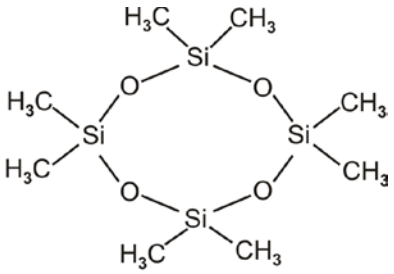
1. Ans. (222)

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)

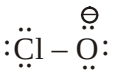
Sol. Hypochlorite ion : $ClO^{\ominus}$

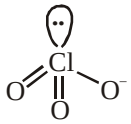
Chlorate ion : $ClO_3^{\ominus}$

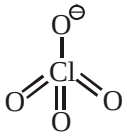
Per chlorate ion : $ClO_4^{\ominus}$

(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) $NH_4NO_3 \xrightarrow[\text{below } 300°C]{\Delta} N_2O + 2H_2O$

(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

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

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

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

13 Ans. (B)

Sol. W and X are respectively

W = O_2 and X = P_4O_{10}

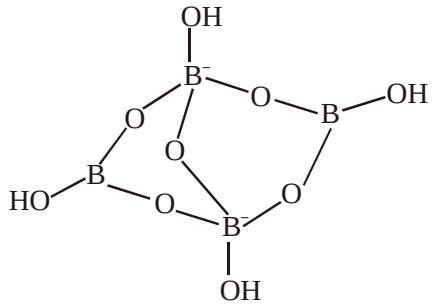
14. Ans. (C)

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.

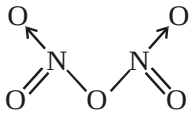
16. Ans. (B, D)

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) $Na + N_2O_5 \rightarrow NaNO_3 + NO_2$

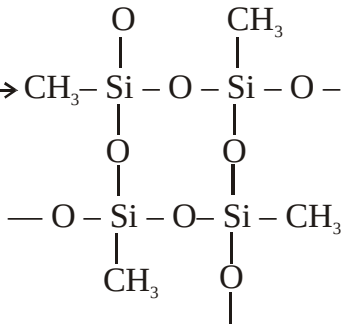
(Brown gas)

17. Ans. (6)

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

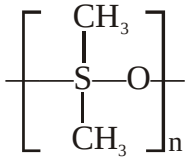
1 mole of B_2H_6 is completely reacted with methanol then 2 mole of product $[B(OMe)_3]$ is formed & hence when 3 moles of B_2H_6 are completely reacted with methanol then 6 mole of product $[B(OMe)_3]$ is formed.

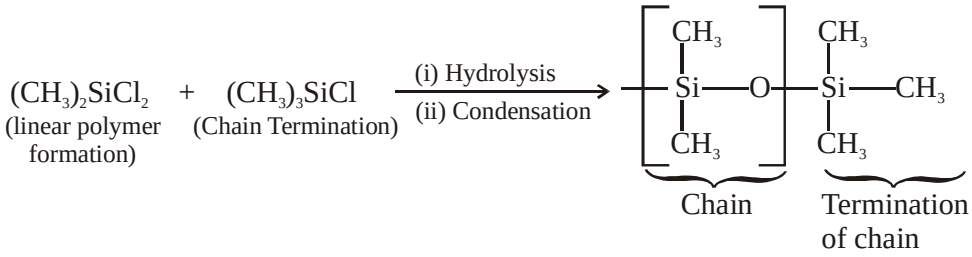
18. Ans. (B)

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