CBSE
Class XII Chemistry
Sample Paper 4 - Solution

Time: 3 Hrs Total Marks: 70

Section A

1. Interstitial defect

2. Brownian movement

OR

The scattering of light by colloidal particles is known as the Tyndall effect.

3. The maximum oxidation state shown by actinoids is +7.

OR

The transition element which does not exhibit variation in the oxidation state in its compounds is zinc (Zn).

4. 2, 4, 6-Trinitrophenol is more acidic than phenol because of the electron-withdrawing or –I effect of three $-NO_2$ groups. Thus, it gives a salt with Na_2CO_3 which is a weak base. So, this makes 2, 4, 6-trinitrophenol soluble in aqueous Na_2CO_3.

5. Elastomers are polymers in which polymer chains are held together by weak intermolecular forces and hence are stretchable. Fibres are polymers with strong intermolecular forces like hydrogen bonding and hence possess high tensile strength.

Section B

6. Henry's law states that solubility of a gas in a liquid at a given temperature is directly proportional to the pressure of a gas. If we use mole fraction of a gas in the solution as a measure of its solubility, then it can be said that the mole fraction of a gas in the solution is proportional to the partial pressure of the gas over the solution.

$$p = K_H \cdot x$$

Application: Soft drinks contain dissolved carbon dioxide. In the preparation of these beverages, carbon dioxide is passed at high pressure to increase its solubility.

OR

Using the relation, $T_{b.p.(solution)} = T_{b.p.(l)} + k_{b.p.} \times m$

Solving for m, we get $m = \dfrac{T_{b.p.(solution)} - T_{b.p.(l)}}{k_{b.p.}}$

$$m = \frac{\Delta T_{b.p.}}{k_{b.p.}} = \frac{1.00\,K}{0.512\,K\,kg\,mol^{-1}} = 1.95\,mol\,kg^{-1}$$

7. $Fe + 2H^{+} \rightarrow Fe^{2+} + H_2$

$$E = E^{\theta} - \frac{0.059}{n}\log\frac{[Fe^{2+}]}{[H^{+}]^{2}}$$

$$E^{\theta} = E^{\theta}_{cathode} - E^{\theta}_{anode}$$

$$= 0 - (-0.44V)$$

$$= 0.44\ V$$

$$E = E^{\theta} - \frac{0.059}{2}\log\frac{0.001}{1}$$

$$= 0.44 - \frac{0.059}{2}\log\frac{0.001}{1}$$

$$= 0.5285\ V$$

8. Hexagonal
Example: Graphite

9.

(a) $4HCl + MnO_2 \longrightarrow MnCl_2 + Cl_2 + 2H_2O$

(b) $H_2 + Cl_2 \xrightarrow{\text{Diffused sunlight}} 2HCl$

10. Compound (a) reacts faster than compound (b).
This is due to the formation of a more stable (3^{o}) carbocation in compound (a) in the rate-determining step than (2^{o}) carbocation in compound (b).

11. The increasing order of the acidic character of the given species is as follows:
$CF_3COOH > CCl_3COOH > CH_2ClCOOH > HCOOH$

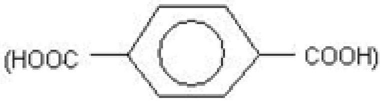
OR

(a) pent-2-enal
(b) 3-phenyl prop-2-enol

12.

(a) Monomers of Dacron:

ethylene glycol $(HOCH_2CH_2OH)$ and terephthalic acid



(b) Monomers of Buna-N:

1, 3-butadiene $(CH_2 = CH - CH = CH_2)$ and acrylonitrile $(CH_2 = CH - CN)$

Section C

13. $N_A = 6.023 \times 10^{23}$

Atomic mass of mercury = 200

∴Number of atoms present in 200 g of Hg = 6.023×10^{23}

So, the number of atoms of Hg present in 1 g of Hg = $\frac{6.023\times10^{23}}{200} = 3.0115\times10^{21}$

The given density of mercury is 13.6 g/cc.

∴ Volume of 1 atom of mercury (Hg) = $\frac{1}{3.0115\times10^{21}\times13.6} = 2.44\times10^{-23}$ cc

Each mercury atom occupies a cube of edge length equal to its diameter.

So,

Diameter of an atom of mercury = $(2.44 \times 10^{-23})^{1/3}$cm = 2.905×10^{-8}cm = 2.91A°

14.

π = 4.6 atm   n = 2

T = 300 K

c = 0.1 M

$$\pi = icRT$$

$$i = \frac{\pi}{cRT} = \frac{4.6}{0.1\times0.0821\times300} \qquad (1)$$

$$i = 1.87$$

$$NaCl \longrightarrow Na^+ + Cl^-$$

	NaCl	Na^+	Cl^-
Initial	1	0	0
After dissociation	1 - α	α	α

$$i = \frac{1 - \alpha + \alpha + \alpha}{1}$$

$$= \frac{1 + \alpha}{1} = 1 + \alpha$$

$$1.87 = 1 + \alpha$$

$$\alpha = 1.87 - 1$$

$$= 0.87$$

OR

(a) Vapour pressure is the pressure of the vapour at the equilibrium state when the rate of evaporation becomes equal to the rate of condensation. Equilibrium constant does not change at a particular temperature, and therefore, the vapour pressure remains constant.

(b) As the solution becomes cool, heat gets absorbed; hence, enthalpy change is positive. Thus, the solution shows positive deviation.

(c) B will show greater lowering of vapour pressure because $\frac{P^0 - P^s}{P^0} = \frac{w_2M_1}{w_1M_2}$

15.

(a) Observing the graph, there is a decrease in the concentration of A in the time period of four hours from 1 hr to 5 hr, i.e. 0.5 – 0.3 = 0.2 M.
In this same period of time, an increase in the concentration of B is twice the decrease in concentration of A. Thus, n = 2.

(b) $k = \frac{[B_{eq}]^2}{[A_{eq}]} = \frac{(0.6)^2}{(0.3)} = 1.2$

(c) Initial rate of conversion of A = change in conc. of A during 1 hour

$= \frac{0.6 - 0.5}{1} = 0.1\,\text{mol litre}^{-1}\,\text{hour}^{-1}$

16.

(a) It causes peptisation leading to the formation of a reddish brown colloidal solution of $Fe(OH)_3$.

(b) Scattering of light by colloidal particles takes place and the path of light becomes illuminated. This is called Tyndall effect.

(c) Under the influence of current, the colloidal particles start moving towards the oppositely charged electrode. This is called electrophoresis.

17.

(a) Reduction reaction is feasible only at a high temperature; thus, it is not economically and practically viable.

(b) This is done to remove basic impurities by the formation of slag.

Example:

$$FeO + SiO_2 \rightarrow \underset{\text{(Slag)}}{FeSiO_3}$$

(c) In electrometallurgy of Al, graphite rods act as the anode and get burnt away as CO and CO_2 during electrolysis.

18.

(a) Mischmetal

(b) Composition: 95% lanthanoid metal, 5% Fe and traces of S, C, Ca and Al.

(c) $La(OH)_3$ is more basic than $Lu(OH)_3$.

Due to lanthanoid contraction, La is bigger in size than Lu. Larger the M-OH bond, weaker is the M-OH bond. This makes $La(OH)_3$ more basic.

This is due to lanthanoid contraction because of the poor screening effect of f electrons. As a consequence of this, elements of the second and third transition series have similar size. Therefore, Zr and Hf have similar atomic radii.

OR

(a) Cr^{2+} is strongly reducing because it changes to Cr^{3+} which is more stable as Cr^{3+} has higher hydration energy. Manganese (III) is strongly oxidising because it changes from Mn(III) to Mn(II) which is more stable due to half-filled d-orbitals.

(b) Co(III) has greater tendency to form coordination complexes than Co (II). Thus, in the presence of ligands, Co (II) changes to Co (III), i.e. it is easily oxidised.

(c) The ions in d^1 configuration have great tendency to lose one electron and acquire d^0 configuration and hence act as reducing agents. All elements with d1 configuration are either reducing or undergo disproportionation.

Example: $$3\underset{3d^1}{\overset{+6}{Mn}}O_4^{2-} + 4H^+ \longrightarrow 2\underset{3d^0}{\overset{+7}{Mn}}O_4^- + \overset{+4}{Mn}O_2 + H_2O$$

19.

(a) Ambidentate ligand: A unidentate ligand which can bind to the central metal atom through any of the two donor atoms present in it is called ambidentate ligand.

Example: NO_2^-, SCN^-

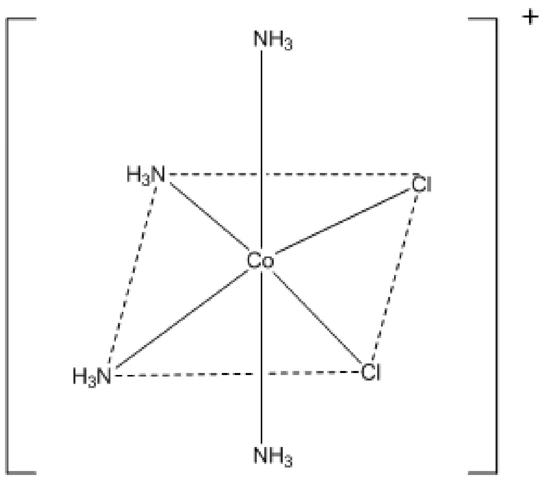
$M \leftarrow SCN$	$M \leftarrow NCS$
Thiocynato	Isothiocynato

(b)

(i) Potassium trioxalatochromate (III)

(ii) Diamminedichloridoplatinum (II)

(c)



20.

(a)

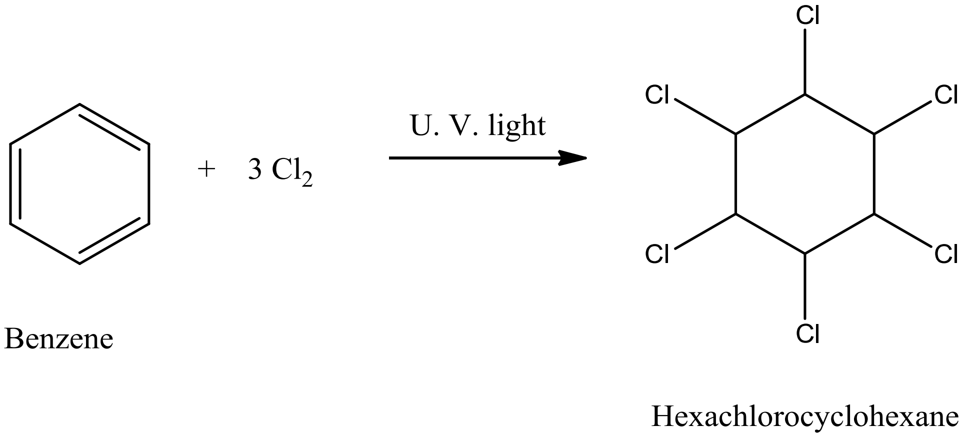
(i) Dow's process

(ii) Finkelstein reaction

(b) Iodobenzene has a higher boiling point than chlorobenzene. Due to the larger size of the halogen iodine, van der Waals forces are stronger in iodobenzene than chlorobenzene, making the boiling point of iodobenzene higher than chlorobenzene.

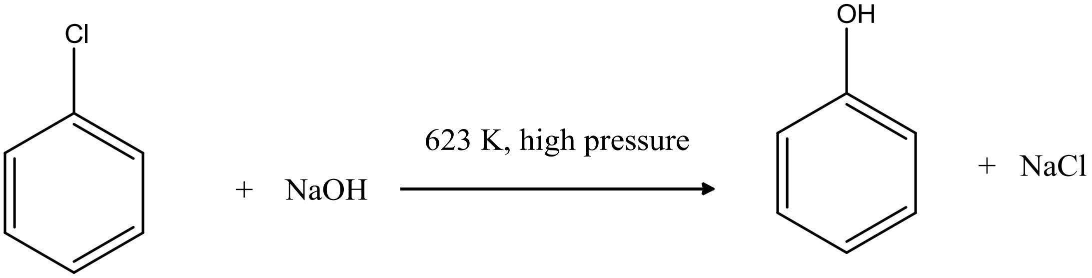
OR

(a)



(b) $\underset{\text{Propene}}{CH_3-CH=CH_2} + HBr \xrightarrow[\text{peroxide}]{\text{Benzoyl}} \underset{\text{1–Bromopropane}}{CH_3CH_2CH_2Br}$

(c)



21.

(a) The acidic character of alcohols is due to the polar nature of the O–H bond. An electron-releasing group increases electron density on oxygen tending to decrease the polarity of the O–H bond. This decreases the acid strength. Hence, alcohols act as weak acids.

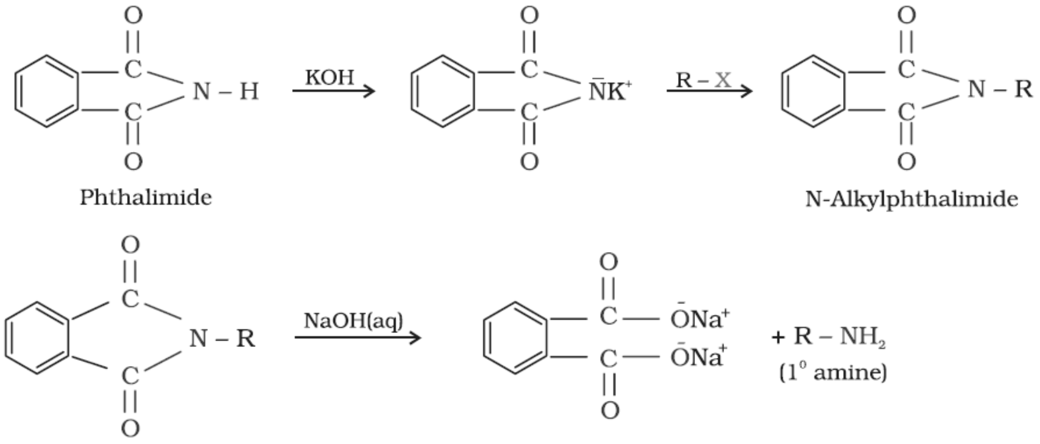
(b) Due to the electron-withdrawing inductive effect of the phenyl group, the C–O bond in phenol is less polar, whereas due to the electron-releasing inductive effect of the alkyl group, the C–O bond in alcohols is more polar. Hence, phenol has a smaller dipole moment than alcohols.

(c) Alcohols react with sodium metal leading to the evolution of H_2 gas, while ethers do not react with sodium metal.

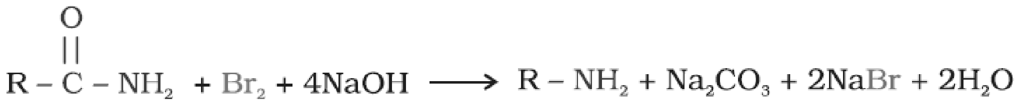
(d)
$$C_2H_5OH + Na \rightarrow C_2H_5ONa + \frac{1}{2}H_2$$
$$(C_2H_5)_2O + Na \rightarrow \text{No reaction}$$

22.

(a) **Gabriel phthalimide synthesis:** Gabriel synthesis is used for the preparation of primary amines. Phthalimide on treatment with ethanolic potassium hydroxide forms potassium salt of phthalimide which on heating with alkyl halide followed by alkaline hydrolysis produces the corresponding primary amine.



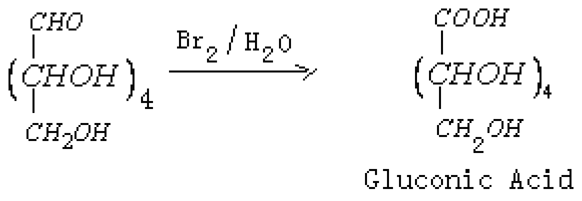
(b) **Hoffmann bromamide degradation method:** Hoffmann developed a method for the preparation of primary amines by treating an amide with bromine in an aqueous or ethanolic solution of sodium hydroxide.



$$R-\overset{\overset{O}{||}}{C}-NH_2 + Br_2 + 4NaOH \longrightarrow R-NH_2 + Na_2CO_3 + 2NaBr + 2H_2O$$

23.

(a) When D-glucose is made to react with Br_2 water, gluconic acid is formed.



$$\underset{CH_2OH}{\overset{CHO}{(CHOH)_4}} \xrightarrow{Br_2/H_2O} \underset{CH_2OH}{\overset{COOH}{(CHOH)_4}}$$

(b) Carbohydrates are generally optically active because they have one or more chiral carbon atoms.

(c) Vitamin C is water soluble. It is excreted along with urine; hence, it cannot be stored in the body.

OR

(a) Insulin: It is a globular protein in which polypeptide chains fold and coil to give a spherical shape.

Myosin: It is a fibrous protein in which polypeptide chains run parallel and are held by H-bonds or disulphide bonds.

(b) In DNA, adenine pairs with thymine and cytosine pairs with guanine. The sequence of bases in one base automatically determines that of the other. Thus, the two strands are complementary.

(c) Sucrose is dextrorotatory. But on hydrolysis, it gives fructose ($\alpha = -92.4^\circ$) and glucose $\left(\alpha = +52.5^\circ\right)$. Hence, the resulting solution is laevorotatory. Thus, due to the inversion of configuration, it is called an invert sugar.

24.

(a) Saccharin is an artificial sweetener.
It adds sweetness to food without adding calories. It is useful for diabetic patients who need to control their caloric intake.

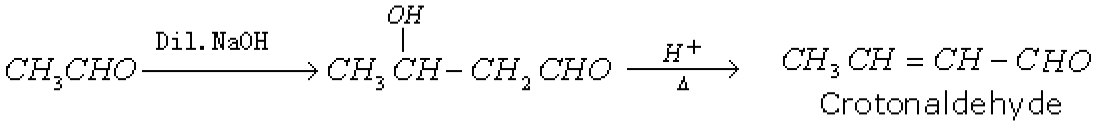
(b) Aspartame: It is a methyl ester of dipeptide formed by aspartic acid and phenylanaline. Aspartame is unstable at cooking temperature and hence is used in cold food items or soft drinks.

Section D

25.

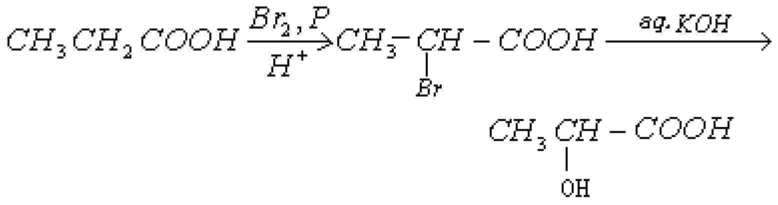
(a)

(i)



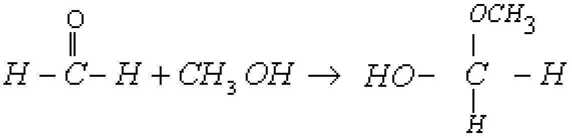
$$CH_3CHO \xrightarrow{\text{Dil. NaOH}} CH_3\overset{\overset{OH}{|}}{C}H-CH_2CHO \xrightarrow[\Delta]{H^+} \underset{\text{Crotonaldehyde}}{CH_3CH=CH-CHO}$$

(ii)



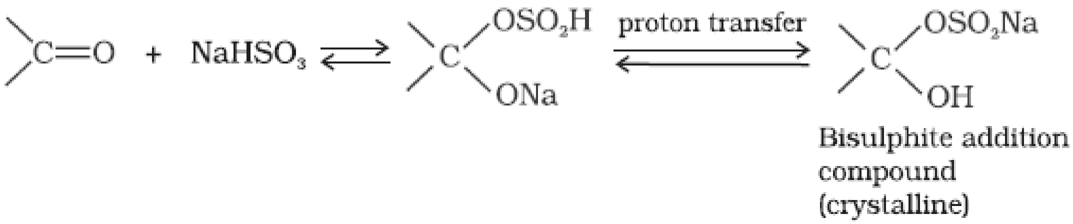
$$CH_3CH_2COOH \xrightarrow[H^+]{Br_2,\,P} CH_3-\underset{\underset{Br}{|}}{CH}-COOH \xrightarrow{aq.\,KOH} CH_3\underset{\underset{OH}{|}}{CH}-COOH$$

(b)



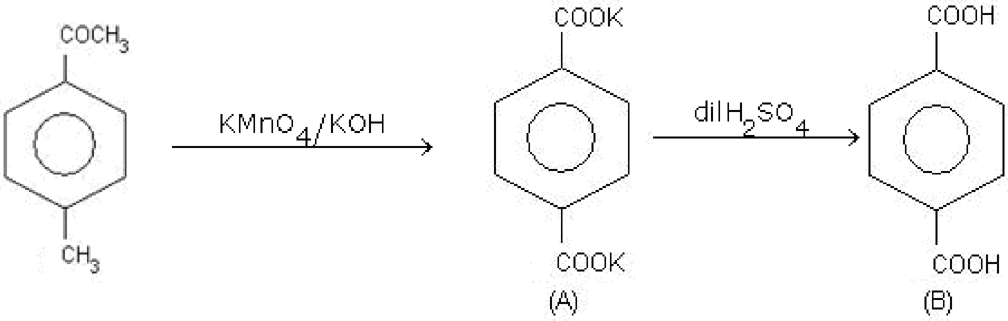
$$H-\overset{\overset{O}{\|}}{C}-H + CH_3OH \rightarrow HO-\overset{\overset{OCH_3}{|}}{\underset{\underset{H}{|}}{C}}-H$$

(c) Carbonyl compounds react with $NaHSO_3$ to give a crystalline bisulphite addition product which on hydrolysis with dilute acid gives original carbonyl compound.

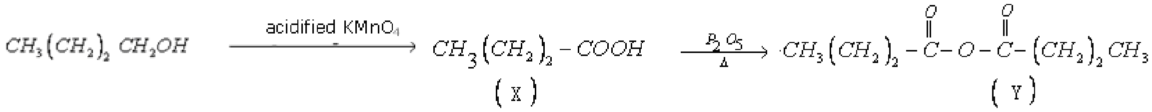


OR

(a)

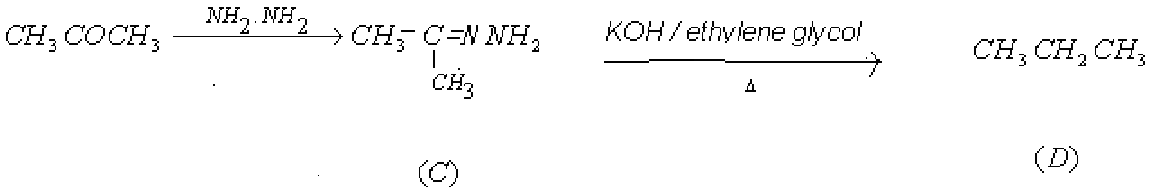


(b)



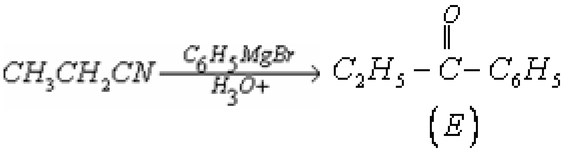
$$CH_3(CH_2)_2CH_2OH \xrightarrow{\text{acidified KMnO}_4} \underset{(X)}{CH_3(CH_2)_2-COOH} \xrightarrow[\Delta]{P_2O_5} \underset{(Y)}{CH_3(CH_2)_2-\overset{O}{\overset{\|}{C}}-O-\overset{O}{\overset{\|}{C}}-(CH_2)_2CH_3}$$

(c)



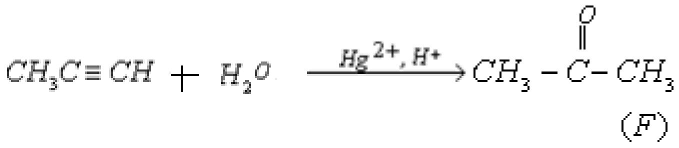
$$CH_3COCH_3 \xrightarrow{NH_2.NH_2} \underset{(C)}{CH_3-\underset{CH_3}{\underset{|}{C}}=N\,NH_2} \xrightarrow[\Delta]{\text{KOH / ethylene glycol}} \underset{(D)}{CH_3CH_2CH_3}$$

(d)



$$CH_3CH_2CN \xrightarrow[H_3O+]{C_6H_5MgBr} \underset{(E)}{C_2H_5-\overset{O}{\overset{\|}{C}}-C_6H_5}$$

(e)



$$CH_3C\equiv CH + H_2O \xrightarrow{Hg^{2+}, H+} \underset{(F)}{CH_3-\overset{O}{\overset{\|}{C}}-CH_3}$$

26.

(a) $HClO_4$ is a stronger acid than H_2SO_4 due to the higher electronegativity of Cl than S making the O–H bond in $HClO_4$ more polar.

(b) Noble gases contain a fully filled p-subshell. This leads to interelectronic repulsions leading to an increase in size. Therefore, noble gases are bigger in size than the corresponding halogens.

(c) In the solid state, PCl_5 exists as $[PCl_4]^+$ $[PCl_6]^-$, thus exhibiting ionic character.

(d) Due to very small size of O, addition of an electron leads to interelectronic repulsions, hence lowering the value of electron gain enthalpy.

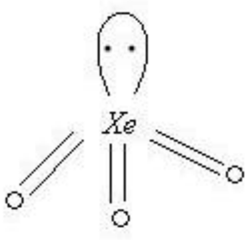
(e) Due to the $N \equiv N$ triple bond, N_2 is chemically inert. Flushing packaged foods with high purity nitrogen retards oxidative deterioration by typically reducing the oxygen level in packaged foods. Hence, it is used in food packaging.

OR

(a) Aqua regia is three parts of conc. HCl and one part of conc. HNO_3. It is used to dissolve noble metals.

$$Au + 4H^+ + NO_3^- + 4Cl^- \rightarrow AuCl_4^- + NO + 2H_2O$$

(b)



Hybridisation is sp^3.

(c) No, PCl_5 cannot act as both oxidising and reducing agent.

The oxidation state of P in PCl_5 is + 5, which is maximum for P. P^{+5} can only reduce itself, hence serving as an oxidising agent.

27.

(a)

$$2N_2O_5(g) \rightleftharpoons 4NO_2(g) + O_2(g)$$

2 moles of gaseous N_2O_5 on complete decomposition gives 5 moles of gaseous product (4 moles of NO_2 and 1 mole of O_2).

Initial pressure of N_2O_5, $p_0 = 584.5 \times \frac{2}{5}$

$= 233.8$ mm Hg

Let the pressure of N_2O_5 decrease by x atm

So, after 30 minutes, the pressure due to $N_2O_5 = 233.8 - x$

Pressure due to $NO_2 = 2x$

Pressure due to $O_2 = x/2$

Total pressure after 30 min = 284. 5 mmHg

$$233.8 - x + 2x + \frac{x}{2} = 284.5$$

$$x = 33.8\ mm\ Hg$$

Pressure of N_2O_5 after 30 min = 233.8 − 33.8

= 200 mmHg

For a first-order reaction,

$$k = \frac{2.303}{t} \log \frac{(p_0)}{(p_t)}$$

$$= \frac{2.303}{30} \log \frac{233.8}{200}$$

$= 5.2 \times 10^{-3}\ \text{min}^{-1}$.

(b)

$$\log \frac{k_2}{k_1} = \frac{E_a}{2.303R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

$k_2 = 4k_1$

$$\log 4 = \frac{E_a}{2.303 \times 8.314}\left(\frac{1}{293} - \frac{1}{313}\right)$$

$E_a = 52.85$ kJ/mol

OR

(a) For a first-order reaction,

$$k = \frac{0.693}{t_{1/2}} = \frac{0.693}{28.1} = 0.0247\,\text{years}^{-1}$$

After 20 years,

$$t = \frac{2.303}{k}\log\frac{N_0}{N}$$

$$20 = \frac{2.303}{0.0247}\log\frac{10^{-6}}{N}$$

$$N = 6.1 \times 10^{-7}\ \text{g}$$

(b) $\text{Rate} = k[A]^2$

(i) $\text{Rate} = k[0.6]^2$

$= 0.5 \times 0.6 \times 0.6$

$= 0.18$

(ii) The rate depends only on the concentration of A and is independent of B.

Therefore, if the concentration of A is reduced to one-fourth, it becomes $\frac{0.6}{4}$.

Now, the rate becomes

$$\text{Rate} = 0.5 \times \left(\frac{0.6}{4}\right)^2$$

$$= \frac{0.5 \times 0.6 \times 0.6}{4 \times 4} = 0.011$$