Code No. 043

Roll No. ☐☐☐☐☐☐☐

- Please check that this question paper contains **5** printed pages.
- Code number given on the right hand side of the question paper should be written on the title page of the answer-book by the candidate.
- Please check that this question paper contains **33** questions.
- **Please write down the Serial Number of the question before attempting it.**
- 15 minutes time has been allotted to read this question paper. The question paper will be distributed at 10.15 a.m. From 10.15 a.m. to 10.30 a.m., the students will read the question paper only and will not write any answer on the answer-book during this period.

CHEMISTRY–XII

Sample Paper (Solved)

Time allowed: 3 hours *Maximum Marks: 70*

General Instructions:

SECTION A (Objective Type)

1. Read the following passage and answer the following questions. **(1×4=4)**

If accumulation of gas on the surface of a solid occurs on account of weak Vander Waals' force, the adsorption is termed as physical adsorption or physisorption. When the gas molecules or atoms are held to the solid surface by chemical bonds, the adsorption is termed chemical adsorption or chemisorptions. The chemical bonds may be covalent or ionic in nature. Chemisorptions involves a energy of activation and is, therefore often referred to as activated adsorption.

(*i*) Physical adsorption is appreciable at:

(*a*) higher temperature
(*b*) lower temperature
(*c*) room temperature
(*d*) 100°C

(*ii*) The rate of chemisorption:

(*a*) decreases with increase of pressure.
(*b*) is maximum at one atmospheric pressure.
(*c*) is independent of pressure.
(*d*) increases with increase of pressure.

Or

Extent of physiosorption of a gas increases with—

(*a*) increase in temperature
(*b*) decrease in temperature
(*c*) decrease in surface area of adsorbent
(*d*) decrease in strength of Van der Waals forces

(*iii*) Which of the following is not a characteristic of chemisorption?

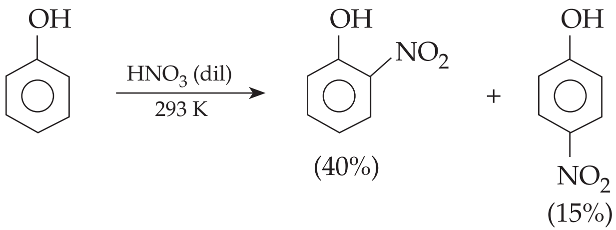
(*a*) Adsorption is irreversible
(*b*) ΔH is of the order of 400 kJ
(*c*) Adsorption is specific
(*d*) Adsorption increases with increase of surface area

(*iv*) Which of the following is the correct statement?

(*a*) Chemisorption is reversible in nature.
(*b*) Chemisorption is high at low pressure.
(*c*) Chemisorption depends on the nature of gas.
(*d*) Chemisorption does not involve activation energy.

2. Read the passage given below and answer the following questions. **(1×4=4)**

Nitration of phenol at 293 K to form ortho and para nitrophenols, but the yield is poor due to oxidation of phenolic group. The —OH group is an activating group, hence nitration is possible with dil. nitric acid.
These both isomers are separated by steam distillation. Moreover the p-isomers have very high boiling points than that of ortho isomer. The mechanism involves formation of nitrophenols which gets further oxidised to nitrophenols in presence of dil. HNO_3 while it gives different product in presence of conc. HNO_3. Ortho and nitrophenol show acidic nature like phenols.



In these questions a statement followed by a statement of reason is given. Choose the correct answer out of the following choices.

(*a*) Assertion and reason both are correct statements and reason is correct explanation for assertion.
(*b*) Assertion and reason both are correct statements but reason is not correct explanation for assertion.
(*c*) Assertion is correct statement but reason is wrong statement.
(*d*) Assertion is wrong statement but reason is correct statement.

(*i*) ***Assertion:*** p-nitrophenol is more acidic than phenol.
Reason: Nitro group helps in the stabilisation of the phenoxide ion by dispersal of negative charge due to resonance.

(*ii*) ***Assertion:*** o-Nitrophenol is less soluble in water than m- and p-isomers.
Reason: m- and p-Nitrophenols exist as associated molecules.

(*iii*) ***Assertion:*** Phenols give o- and p-Nitrophenol on nitration with conc. HNO_3 and H_2SO_4 mixture.
Reason: –OH group in phenol is o, p-directing.

(*iv*) ***Assertion:*** o- and p-Nitrophenols can be separated by steam distillation.
Reason: o-isomer is much more volatile in steam due to intramolecular H-bonding while p-isomer is not steam volatile due to intermolecular H-bonding.

Or, ***Assertion:*** Phenol forms 2, 4, 6-tribromophenol on treatment with Br_2 in carbon disulphide at 273 K.
Reason: Bromine Polarises in CS_2.

Following questions (No. 3-11) are Multiple Choice Questions carrying 1 mark each.

3. Λ°_m H_2O is equal to:
(*a*) Λ°_m (HCl) + Λ°_m (NaOH) – Λ°_m (NaCl)
(*b*) Λ°_m (HNO_3) + Λ°_m ($NaNO_3$) – Λ°_m (NaOH)
(*c*) Λ°_m (HNO_3) + Λ°_m (NaOH) – Λ°_m (KNO_3)
(*d*) Λ°_m (NH_4OH) + Λ°_m (KCl) – Λ°_m (NH_4(Cl))

4. Proteins are found to have two different types of secondary structures viz, α-helix and β-pleated sheet structure. α-helix structure of protein is stablised by:
(*a*) Peptide bonds (*b*) Vander Waals' forces
(*c*) Hydrogen bonds (*d*) dipole-dipole interaction

Or, **Nucleic acids are the polymers of**
(*a*) Nucleosides (*b*) Nucleotides (*c*) Bases (*d*) Sugars

5. The unit of ebullioscopic constant is:
(*a*) K kg mol^{-1} or K $(molality)^{-1}$ (*b*) mol kg K^{-1} or K^{-1} (molality)
(*c*) kg mol^{-1} K^{-1} or K^{-1} $(molality)^{-1}$ (*d*) K mol kg^{-1} or K (molality)

6. The electronic configuration of Cu (II) is $3d^9$ whereas that of Cu (I) is $3d^{10}$. Which of the following is correct?
(*a*) Cu (II) is more stable (*b*) Cu (II) is less stable
(*c*) Cu (I) and Cu (II) are equally stable
(*d*) Stability of Cu (I) and Cu (II) depends on nature of copper salts

Or, **Which of the following oxidation state is common for all lanthanoides?**
(*a*) +2 (*b*) +3 (*c*) +4 (*d*) +5

7. **The correct IUPAC name for $CH_2 == CHCH_2\ NHCH_3$ is:**
(*a*) Allylmethylamine (*b*) 2-amino-4-pentene
(*c*) 4-aminopent-1-ene (*d*) N-methylprop-2-ene-1-amine

Or, **The best reagent for converting 2-phenylpropanamide into 1-phenylpropanamine is:**
(*a*) excess H_2/Pt (*b*) $NaOH/Br_2$ (*c*) $NaBH_4$/methanol (*d*) $LiAlH_4$/ether

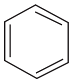
8. **The correct IUPAC name of $[Pt(NH_3)_2\ Cl_2]$ is:**
(*a*) diamminedichloridoplatinum (II) (*b*) diamminedichloridoplatinum (IV)
(*c*) diamminedichloridoplatinum (0) (*d*) dichloridodiammineplatinum (IV)

Or, **Indicate the complex ion which shows geometric isomerism:**
(*a*) $[Cr(H_2O)_4\ Cl_2]^+$ (*b*) $[Pt\ (NH_3)_3\ Cl]$ (*c*) $[Co\ (NH_3)_6]^{3+}$ (*d*) $[Co(CN)_5(NC)]^{3-}$

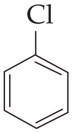
9. **The magnetic moment is associated with its spin angular momentum and orbital angular momentum. Spin only magnetic moment value of Cr^{3+} ion is**
(*a*) 2.87 BM (*b*) 3.87 BM (*c*) 3.47 BM (*d*) 3.57 BM

10. **Arrange the following compounds in the increasing order of their densities :**

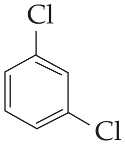
(*i*)



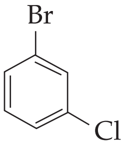
(*ii*)



(*iii*)



(*iv*)



(*a*) (*i*) > (*ii*) > (*iii*) > (*iv*) (*b*) (*iv*) > (*iii*) > (*ii*) > (*i*) (*c*) (*iii*) > (*iv*) > (*i*) > (*ii*) (*d*) (*iv*) > (*i*) > (*ii*) > (*iii*)

11. **Which of the following is an amorphous solid?**
(*a*) Graphite (C) (*b*) Quartz glass (SiO_2)
(*c*) Chrome alum (*d*) Silicon carbide (SiC)

In the following question (Q. No. 12-16) a statement assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

(*a*) Assertion and reason both are correct statements and reason is correct explanation for assertion.
(*b*) Assertion and reason both are correct statements but reason is not correct explanation for assertion.
(*c*) Assertion is correct statement but reason is wrong statement.
(*d*) Assertion is wrong statement but reason is correct statement.

12. ***Assertion:*** All naturally occurring α-amino acids except glycine are optically active.
Reason: Most naturally occurring amino acids have L-configuration.

13. ***Assertion:*** Picric acid does not contain –COOH group.
Reason: Picric acid is 2, 4, 6-trinitrophenol.

14. ***Assertion:*** Benzaldehyde is less reactive than ethanol towards nucleophilic attack.
Reason: The overall effect of –I and +R effect of phenyl group decreases the electron density on the carbon atom of >C=O group in benzaldehyde.

Or, ***Assertion:*** Boiling points of aldehydes lie in between parent alkanes and corresponding alcohols.
Reason: Aldehydes cannot form intermolecular hydrogen bonds like alcohols.

15. ***Assertion:*** Molarity and normality of a solution change with temperature but molality and mole fraction do not.
Reason: Volume of solution changes with temperature but mass does not.

16. ***Assertion:*** SF_6 cannot be hydrolysed but SF_4 can be.
Reason: Six F atoms in SF_6 prevent the attack of H_2O on sulphur atom of SF_6.

SECTION B

The following questions, Q. No. 17-25 are Short Answer Type I and carry 2 marks each.

17. **Give reasons for the following observations:**
(*i*) p-dichlorobenzene has higher melting point than those of o and m-isomers.
(*ii*) Haloarenes are less reactive than haloalkanes towards nucleophillic substitution reaction.

Or, (*a*) The treatment of alkyl chloride with aqueous KOH leads to the formation of alcohol but in the presence of alcoholic KOH, alkene is the major product. Give reason.
(*b*) How many methyl bromide be preferentially converted to methyl isocyanide?

18. Calculate the boiling point of a 1M aqueous solution (density 1.04 g mL^{-1}) of Potassium chloride (K_b for water = 0.52 K kg mol^{-1}, Atomic masses: K = 39 u, Cl = 35.5 u). Assume, Potassium chloride is completely dissociated in solution.

19. $[Fe(H_2O)_6]^{3+}$ is strongly paramagnetic whereas $[Fe(CN)_6]^{3-}$ is weakly paramagnetic. Explain. (**Given:** At. no. Fe = 26)

Or, (*i*) **Write down the IUPAC name of the following complex:**
$[Cr(NH_3)_2Cl_2(en)]Cl$ (en = ethylenediamine)

(*ii*) **Write the formula for the following complex:**
Pentaamminenitrito-o-Cobalt (III)

20. For a reaction: $2NH_3(g) \xrightarrow{Pt} N_2(g) + 3H_2(g)$**, Rate = k**

(*i*) Write the order and molecularity of this reaction.

(*ii*) Write the unit of k.

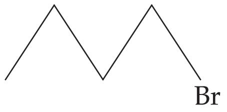
Or, (*i*) What is the order of the reaction whose rate constant has same units as the rate of reaction?

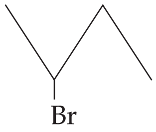
(*ii*) For a reaction $A + H_2O \longrightarrow B$; Rate $\propto$ [A]. What is the order of this reaction?

21. (*a*) For a reaction $A + B \longrightarrow P$, the rate law is given by, $r = k[A]^{1/2}[B]^2$. What is the order of this reaction?

(*b*) A first order reaction is found to have a rate constant $k = 5.5 \times 10^{-14}\ s^{-1}$. Find the half life of the reaction.

22. Which alkyl halide from the following pair is chiral and undergoes faster S_N2 reaction?

(*a*) 

(*b*) 

(*ii*) **Out of S_N1 and S_N2, which reaction occurs with:**

(*a*) Inversion of configuration, (*b*) Racemisation.

23. Write structures of the following molecules: (*i*) BrF_3 (*ii*) XeO_3

24. How will you carry out the following conversions:

(*i*) 2-Bromopropane to 1-bromopropane (*ii*) Benzene to p-chloronitrobenzene

25. An element X crystallizes in f.c.c. structure. 208 g of it has 4.2832×10^{24} atoms. Calculate the edge of the unit cell, if density of X is 7.2 g cm^{-3}.

SECTION C

Q. No. 26-30 are Short Answer Type II carrying 3 marks each.

26. How would you account for the following?

(*i*) The atomic radii of the metals of the third (5d) series of transition elements are virtually the same as those of the corresponding members of the second (4d) series.

(*ii*) The E° value for the Mn^{3+}/Mn^{2+} couple is much more positive than that for Cr^{3+}/Cr^{2+} couple or Fe^{3+}/Fe^{2+} couple.

(*iii*) The highest oxidation state of a metal is exhibited in its oxide or fluoride.

Or, **Give reasons:**

(*a*) There is a gradual decrease in the size of atoms with increasing atomic number in the series of lanthanoids.

(*b*) Sc (21) is a transition element but Ca (20) is not.

(*c*) The Fe^{2+} is much more easily oxidised to Fe^{3+} than Mn^{2+} to Mn^{3+}.

27. An aromatic compound 'A' on treatment with aqueous ammonia and heating forms compound 'B' which on heating with Br_2 and KOH forms a compound 'C' of molecular formula C_6H_7N. Write the structures and IUPAC names of compounds A, B and C.

Or, **How will you convert the following:**

(*i*) Nitrobenzene into aniline (*ii*) Ethanoic acid into methanamine

(*iii*) Aniline into N-phenylethanamide (Write the chemical equations involved).

28. An element crystallises in bcc lattice with cell edge of 400 pm. Calculate its density if 250 g of this element contains 2.5×10^{24} atoms.

29. Define the following as related to proteins:

(*i*) Peptide linkage (*ii*) Primary structure (*iii*) Denaturation

30. Account for the following:

(*i*) Bi(V) is a stronger oxidizing agent than Sb(V).

(*ii*) N—N single bond is weaker than P—P single bond.

(*iii*) Noble gases have very low boiling points.

SECTION D

Q. No. 31 to 33 are Long Answer Type carrying 5 marks each.

31. (*a*) **Complete the following chemical equations:**

(*i*) NaOH (aq) + Cl_2 (g) $\longrightarrow$ (Hot and conc.) (*ii*) XeF_6 (s) + H_2O(l) $\longrightarrow$

(*b*) **How would you account for the following?**

(*i*) The value of electron gain enthalpy with negative sign for sulphur is higher than that for oxygen.

(*ii*) NF_3 is an exothemic compound but NCl_3 is endothermic compound.

(*iii*) CIF_3 molecule has a T-shaped structure and not a trigonal planar one.

Or, (*a*) **Write the formula and describe the structure of a noble gas species which is iso-structural with:**

(*i*) IBr_2^- and (*ii*) BrO_3^-.

(*b*) **Assign reasons for the following:**

(*i*) SF_6 is kinetically inert.

(*ii*) NF_3 is an exothermic compound whereas NCl_3 is not.

(*iii*) HCl is a stronger acid than HF though flourine is more electronegative than chlorine.

32. (*a*) **Give names of the reagents to bring about the following transformations:**

(*i*) Ethanoic acid to ethanol (*ii*) Propan-1-ol to propanal

(*iii*) Pent-3-en-2-ol to pent-3-en-2-one (*iv*) Sodium benzoate to benzene

(*b*) **Arrange the following in the increasing order of:**

(*i*) Methanal, Propanal, Butanone, Ethanal, Propanone (nucleophilic addition reaction)

(*ii*) Formaldehyde, Acetone, Acetaldehyde (reactivity towards HCN)

(*iii*) Acetophenone, *p*-tolualdehyde, *p*-nitrobenzaldehyde, Benzaldehyde (nucleophilic addition reaction)

(*a*) **Bring out the following conversions:**

(*i*) 4-nitrotoluene to 2-bromobenzoic acid. (*ii*) Ethylcyanide to 1-phenyl propanone.

(*b*) **Give a reason for the following:**

(*i*) Chloroacetic acid is more acidic than acetic acid.

(*ii*) Carboxylic acids have higher boiling point than alcohols.

(*iii*) 4-nitrobenzoic acid is more acidic than 4-methoxy benzoic acid.

33. (*a*) When a bright silver object is placed in the solution of gold chloride, it acquires a golden tinge but nothing happens when it is placed in a solution of copper chloride. Explain this behaviour of silver.

[**Given:** $E^\circ_{Cu^{2+}/Cu} = +0.34$ V, $E^\circ_{Ag^+/Ag} = +0.80$ V, $E^\circ_{Au^{3+}/Au} = +1.40$ V]

(*b*) **Consider the figure given and answer the following questions:**

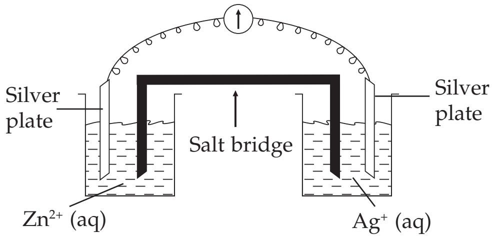
(*i*) What is the direction of flow of electrons?

(*ii*) Which is anode and which is cathode?

(*iii*) What will happen if the salt bridge is removed?

(*iv*) How will concentration of Zn^{2+} and Ag^+ ions be affected when the cell functions?

(*v*) How will concentration of these ions be affected when the cell becomes dead?



Or, (*a*) Define conductivity and molar conductivity for the solution of an electrolyte. Discuss their variation with concentration.

(*b*) **Calculate the standard cell potential of the galvanic cell in which the following reactions takes place:**

$$Fe^{2+}(aq) + Ag^+(aq) \longrightarrow Fe^{3+}(aq) + Ag(s)$$

Calculate the Δ_rG° and equilibrium constant of the reaction also.

($E^\circ_{Ag^+/Ag} = 0.80$ V; $E^\circ_{Fe^{3+}/Fe^{2+}} = 0.77$ V)

Answer Sheet

SAMPLE PAPER

Code No. 043

Roll No.

CHEMISTRY

SECTION A

1. (*i*) (*b*) lower temperature

(*ii*) (*d*) increases with increase of pressure. *Or* (*b*) decrease in pressure

(*iii*) (*b*) ΔH is of the order of 400 kJ

(*iv*) (*c*) Chemisorption depends on the nature of gas.

2. (*i*) (*a*) Assertion and reason both are correct statements and reason is correct explanation for assertion.

(*ii*) (*b*) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

(*iii*) (*d*) Assertion is wrong statement but reason is correct statement.

(*iv*) (*a*) Assertion and reason both are correct statements and reason is correct explanation for assertion.

Or

(*b*) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

3. (*a*) $\Lambda^\circ_m (HCl) + \Lambda^\circ_m (NaOH) - \Lambda^\circ_m (NaCl)$

4. (*c*) Hydrogen bonds

Or

(*b*) Nucleotides

5. (*a*) K kg mol^{-1} or K $(molality)^{-1}$

6. (*a*) Cu (II) is more stable

Or

(*b*) +3

7. (*d*) N-methylprop-2-ene-1-amine

Or

(*d*) $LiAlH_4$/ether

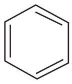
8. (*a*) diamminedichloridoplatinum (II)

Or

(*a*) $[Cr(H_2O)_4 Cl_2]^+$

9. (*b*) 3.87 BM

10. (*a*)



11. (*b*) Quartz glass (SiO_2)

12. (*b*) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

13. (*b*) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

14. (*c*) Assertion is correct statement but reason is wrong statement.

Or

(*b*) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

15. (*a*) Assertion and reason both are correct statements and reason is correct explanation for assertion.

16. (*a*) Assertion and reason both are correct statements and reason is correct explanation for assertion.

SECTION B

17. (*i*) It is due to the symmetry of para-isomers that its molecules fit in the crystal lattice better as compared to ortho and meta-isomers. Hence it requires more heat to break the bonds. Therefore the melting point of para isomer like p-dichloro-benzene is much higher.

(*ii*) In haloarenes, the benzene ring undergoes resonance due to which C—X bond acquires partial double bond character and hence is difficult to break C—X bond. Secondly, sp^2 hybridised C-atom of haloarenes has more s character than sp^3 hybridised C-atom of haloalkanes. So C—X bond becomes shorter and stronger in haloarenes.

Or

(*a*) The alkoxide (RO^-) ion in alcoholic KOH is a strong nucleophile as well as strong base which is able to abstract β-hydrogen of alkyl chloride and can form alkene, while aqueous KOH cannot do so due to its high solvation energy and weak basic nature.

(*b*) ***By carbylamine reaction:***

$$\underset{\text{Methyl bromide}}{CH_3Br} + CHCl_3 + \underset{\text{(alc.)}}{3\,KOH} \xrightarrow{\Delta} \underset{\text{Methyl isocyanide}}{CH_3N \equiv C} + 3KBr + 3H_2O$$

18. Molar mass of KCl = 39 + 35.5 = 74.5 g mol^{-1}

As KCl dissociates completely, number of ions produced = 2

∴ Van't Hoff factor, $i = 2$

Mass of KCl solution = 1000 × 1.04 = 1040 g

Mass of solvent = 1040 – 74.5 = 965.5 g = 0.9655 kg

Molality of the solution:

$$\frac{\text{No. of moles of solute}}{\text{Mass of solvent in kg}} = \frac{1\text{ mol}}{0.9655\text{ kg}} = 1.0357\text{ m}$$

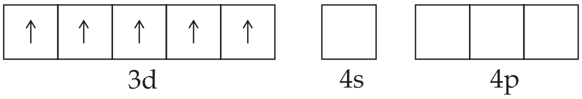
$$\Delta T_b = i \times K_b \times m$$

$$= 2 \times 0.52 \times 1.0357 = 1.078^\circ\text{ C}$$

∴ Boiling point of solution = 100 + 1.078 = **101.078° C**

19. In both the cases, Fe is in oxidation state +3.

Outer electronic configuration of Fe+3 is :



In the presence of CN^-, the 3d electrons pair up leaving only one unpaired electron. The hybridisation involved is d^2sp^3 forming inner orbital complex which is weakly paramagnetic. In the presence of H_2O (a weak ligand), 3d electrons do not pair up. The hybridisation involved is sp^3d^2 forming an outer orbital complex. As it contains five unpaired electrons so it is strongly paramagnetic.

Or

(*i*) $[Cr(NH_3)_2Cl_2(en)]Cl$

IUPAC name : *Diammine dichlorido ethylenediamine chromium (III) chloride.*

(*ii*) $[Co(NH_3)_5(ONO)]^{2+}$

20. $2NH_3(g) \xrightarrow{Pt} N_2(g) + 3H_2(g)$

(*i*) It is a zero order reaction and its molecularity is two.

(*ii*) Unit of k is mol L^{-1} s^{-1}.

Or

(*i*) The reaction whose rate constant has same units as the rate of reaction, will have zero order of reaction.

(*ii*) The reaction $A + H_2O \rightarrow B$ Rate $\propto [A]$

The order of this reaction will be pseudo first order reaction as the rate of reaction depends only on concentration of A only.

21. (*a*) *According to the formula :* $r = k[A]^{1/2}[B]^2$

Order w.r.t. A = $\frac{1}{2}$, Order w.r.t B = 2

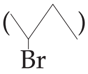
$$\therefore \quad \text{Overall order} = \frac{1}{2} + \frac{2}{1} = \frac{5}{2}$$

(*b*) For first order reaction, $t_{1/2} = \frac{0.693}{k}$

Given: $k = 5.5 \times 10^{-14}\ s^{-1}$

Thus, $t_{1/2} = \frac{0.693}{5.5 \times 10^{-14} s^{-1}}$

Hence $\mathbf{t_{1/2} = 1.26 \times 10^{13} s}$

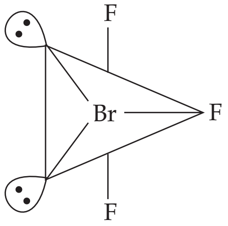
22. (*i*) 2-bromobutane () is a chiral compound

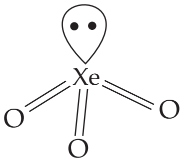
and 1 Bromo Butane undergoes S_N2 reaction faster.

(*ii*) (*a*) Inversion of configuration occurs with S_N2 reaction.

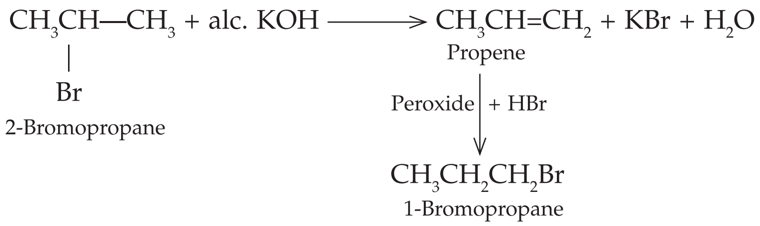
(*b*) Racemisation occurs with S_N1 reaction.

23. (*i*) **BrF_3 *(T-shape)*** (*ii*) **XeO_3 *(Triagonal pyramidal)***





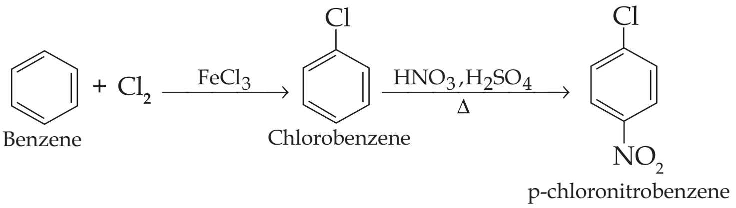
24. (*i*)



$$\underset{\text{2-Bromopropane}}{CH_3\underset{\underset{Br}{|}}{C}H-CH_3} + \text{alc. KOH} \longrightarrow \underset{\text{Propene}}{CH_3CH{=}CH_2} + KBr + H_2O$$

$$CH_3CH{=}CH_2 \xrightarrow[\text{Peroxide}]{+\ HBr} \underset{\text{1-Bromopropane}}{CH_3CH_2CH_2Br}$$

(*ii*) Benzene to p-chloronitrobenzene



25. $z = 4(\text{fcc}) \quad d = 7.2\ \text{g/cm}^3 \quad a = ?$

4.2832×10^{24} atoms have mass = 208 g

6.022×10^{23} atoms have mass

$$= \frac{208}{4.2832 \times 10^{24}} \times 6.022 \times 10^{23} = \mathbf{29.24\ (at.\ mass)}$$

$$a^3 = \frac{Z \times M}{d \times N_A} = \frac{4 \times 29.24}{7.2 \times 6.022 \times 10^{23}}$$

$$a^3 = 0.2696 \times 10^{-24}\ \text{cm}^3$$

$\therefore \quad a = 0.646 \times 10^{-8}\ \text{cm} = \mathbf{0.646\ Å}$

SECTION C

26. (*i*) Due to lanthanoid contraction in second series after lanthanum, the atomic radii of elements of second and third series become almost same and hence show similarities in properties.

(*ii*) The electronic configuration of Mn^{2+} ion is more symmetrical as compared to that of Cr^{2+} ion. So 3rd ionisation potential of Mn^{2+} is much higher. As a result $E°$ value of Mn^{3+}/Mn^{2+} couple is much more positive than for Cr^{3+}/Cr^{2+} couple.

(*iii*) The highest oxidation state of a metal is exhibited in its oxide or fluoride due to its high electronegativity.

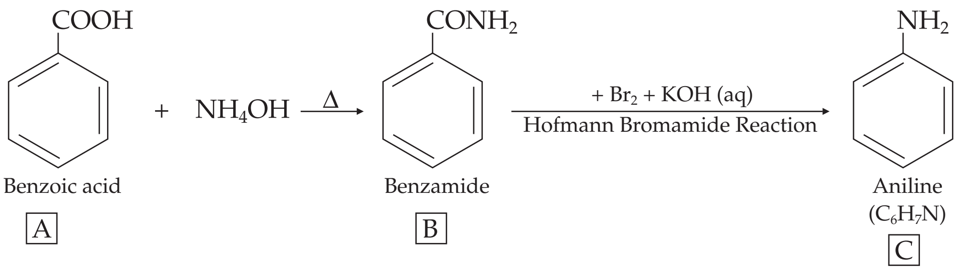
Or

(*a*) This is due to lanthanoid contraction.

(*b*) Sc (21) is regarded as a transition element due to the presence of incomplete d- subshell ($3d^1 4s^2$) but Ca (20) does not have any d-subshell.

(*c*) Fe^{+2} [Ar] $3d^6$ can be easily oxidised to Fe^{+3} [Ar] $3d^5$, which is half filled and is more stable but Mn^{+2} is d^5 in configuration which is again half filled configuration and Mn^{+3} is d^4 in configuration.

27. The data shows that C_6H_7N may be $C_6H_5NH_2$ *i.e.* Aniline. Since it is obtained by heating with Br_2 and KOH (Hoffmann bromamide reaction), then the compound 'B' is Benzamide $C_6H_5CONH_2$ which is in turn obtained by reaction with aqueous ammonia then the compound 'A' can be Benzoic acid *i.e.* C_6H_5COOH

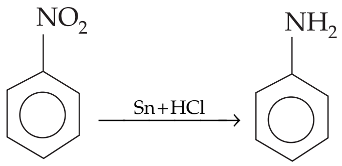


Thus,

A → **Benzoic acid,** B → **Benzamide,** C → **Aniline**

Or

(*i*) **Nitrobenzene into aniline**



Nitrobenzene Aniline

(*ii*) **Ethanoic acid into methanamine**

$$\begin{tikzcd}[column sep=large] CH_3COOH \arrow[r, "NH_3"] & \underset{\text{Ammonium acetate}}{CH_3COONH_4} \arrow[r, "\Delta", "-H_2O"'] & CH_3CONH_2 \arrow[d, "Br_2\ +\ KOH"] \\ & & \underset{\text{Methanamine}}{CH_3NH_2} \end{tikzcd}$$

(*iii*) **Aniline into N-phenylethanamide**

$$C_6H_5NH_2 \xrightarrow[\text{Pyridine}]{(CH_3CO)_2O} C_6H_5NHCOCH_3$$

(Acetylation) N-Phenylethanamide

28. **Given :** $a = 400\ \text{pm} = 400 \times 10^{-10}$ cm

$z = 2$ (for bcc), M = ?, d = ?

Using formula, $d = \dfrac{Z \times M}{a^3 \times N_A}$

$\because$ 2.5×10^{24} atoms of an element have mass = 250 g

$\therefore$ 6.022×10^{23} atoms of an element have mass $= \dfrac{250 \times 6.022 \times 10^{23}}{2.5 \times 10^{24}}$

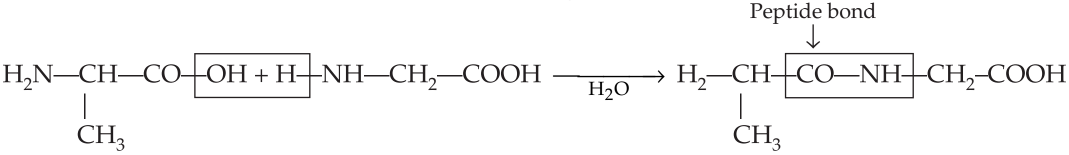
$\therefore$ M = 60.22 g

Substituting all values in formula :

$$d = \frac{2 \times 60.22}{(400 \times 10^{-10})^3 \times 6.022 \times 10^{23}} = \frac{120.44}{38.5408}$$

$\therefore$ **d = 3.125 g cm^{-3}**

29. (*i*) **Peptide linkage :** A peptide linkage is an amide linkage formed between –COOH group of one α-amino acid and NH_2 group of the other α-amino acid by loss of a molecule of water. The–CO–NH–bond formed is called petide linkage.



$$H_2N—\underset{\substack{|\\ CH_3}}{CH}—CO\boxed{OH + H}NH—CH_2—COOH \xrightarrow[H_2O]{} H_2—\underset{\substack{|\\ CH_3}}{CH}\boxed{\overset{\text{Peptide bond}}{\overset{\downarrow}{CO—NH}}}CH_2–COOH$$

(*ii*) **Primary structure :** Proteins may have one or more polypeptide chains. Each polypeptide in a protein has amino acids linked with each other in a specific sequence and it is this sequence of amino acids that is called the primary structure of that protein.

(*iii*) **Denaturation :** Due to coagulation of globular protein under the influence of change in temperature, change in pH etc., the native shape of the protein is destroyed and biological activity is lost and the protein so formed is called denaturated proteins and the phenomenon is denaturation.

30. (*i*) Bi(V) is a stronger oxidizing agent than Sb(V) due to inert pair effect as the stability of lower oxidation state (+3) increases down the group.

(*ii*) Due to smaller size of Nitrogen, their lone pairs repel the bond pair of N – N bond while P – P due to bigger size does not show more repulsion.

(*iii*) Due to presence of weak Van der waal forces of attraction, noble gases have very low boiling point.

SECTION D

31. (*a*) (*i*) $6NaOH + 3Cl_2 \longrightarrow 5NaCl + 1NaClO_3 + 3H_2O$

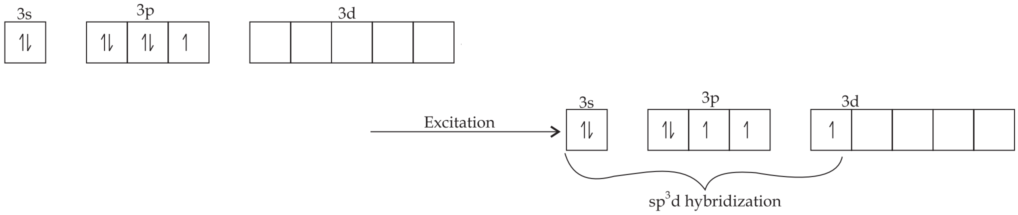
(*ii*) $XeF_6\,(s) + 3H_2O\,(l) \longrightarrow XeO_3\,(s) + 6HF\,(aq)$

(*b*) (*i*) Because of enthalpy of dissociation of S–S bond is higher than O–O bond and the hydration energy of S^{2-} is less than that of O^{2-} ion.

(*ii*) Due to smaller size of F as compared to Cl, the N–F bond is much stronger than N–Cl bond while bond dissociation energy of F_2 is much lower than that of Cl_2. Therefore, energy released during the formation of NF_3 molecule is more than the energy needed to break N_2 and F_2 molecules into individual atoms. In other words, formation of NF_3 is an exothermic reaction.

The energy released during the formation of NCl_3 molecule is less than the energy needed to break N_2 and Cl_2 molecule into individual atoms. Thus formation of NCl_3 is an endothermic reaction.

(*iii*) The electronic configuration of Cl is $1s^2\,2s^2\,2p^6\,3s^2 3P_x^2 3P_y^2 3P_z^1$. It has only one half filled orbital. But to form three Cl–F bonds, we need three half filled orbitals. To achieve this, one of the $3P_y^2$ electrons gets excited to 3d orbital. The resulting five orbitals of the third shell of Cl in the first excited state undergoes SP^3d hybridization to give T-shaped structure to ClF_3 molecule. Since Cl does not undergo sp^2 hybridization, therefore ClF_3 does not have trigonal planar structure.



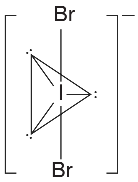
Or

(*a*) (*i*) **IBr_2^- :** It has 2 bond pairs and 3 lone pairs. Therefore according to *VSEPR theory* it should have Linear structure.

IBr_2^- has (7 + 2 × 7 + 1) *i.e.* 22 valence electrons.

No noble gas has 22 electrons

∴ The isoelectronic species for IBr_2^- is XeF_2

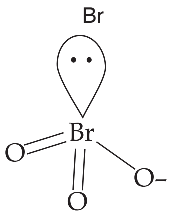


(*ii*) **BrO_3^- :** It has 3 bond pairs and 1 lone pair of electrons. Therefore according to *VSEPR theory* it has pyramidal structure.

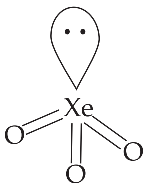
It has 26 valence electrons *i.e.* (7 + 3 × 6 + 1 = 26).

A noble gas having 26 valence electrons is XeO_3 (8 + 3 × 6 = 26).

Thus XeO_3 also has pyramidal structure.



Pyramidal shape



(*b*) (*i*) Because SF_6 is showing steric hindrance due to 6 (six) fluorine atoms which make it unable to react further with any other atom.

(*ii*) Due to smaller size of F as compared to Cl, the N–F bond is much stronger than N–Cl bond while bond dissociation energy of F_2 is much lower than that of Cl_2. Therefore, energy released during the formation of NF_3 molecule is more than the energy needed to break N_2 and F_2 molecules into individual atoms. In other words, formation of NF_3 is an exothermic reaction.

The energy released during the formation of NCl_3 molecule is less than the energy needed to break N_2 and Cl_2 molecule into individual atoms. Thus formation of NCl_3 is an endothermic reaction.

(*iii*) Because HCl has large size and less bond strength than HF which makes easier liberation of H^+.

32. **(*a*)**

	Reagent	*Name*
(*i*)	Ethanoic acid to ethanol	: $LiAlH_4/H_3O^+$
(*ii*)	Propan-1-ol to propanal	: PCC (Pyridinium chloro chromate)
(*iii*)	Pent-3-en-2-ol to pent-3-en-2-one	: PCC
(*iv*)	Sodium benzoate to benzene	: Sodalime

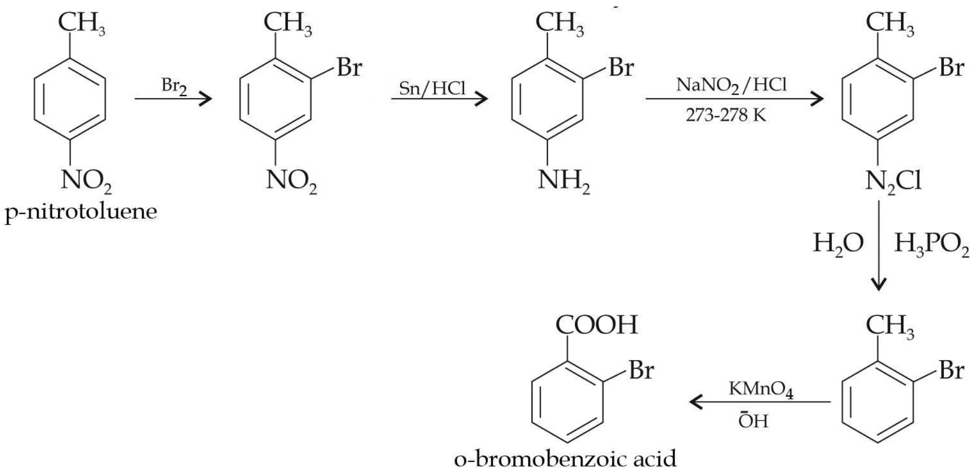
(*b*) **(*i*)** Butanone < Propanone < Propanal < Ethanal < Methanal

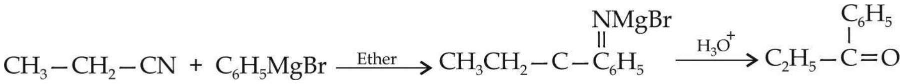
(*ii*) Acetone < Acetaldehyde < Formaldehyde

(*iii*) Acetophenone < *p*-tolualdehyde < Benzaldehyde < *p*-nitrobenzaldehyde

Or

(*a*) **(*i*)**



(*ii*) 

$$CH_3-CH_2-CN + C_6H_5MgBr \xrightarrow{\text{Ether}} CH_3CH_2-\overset{\overset{\text{NMgBr}}{\|}}{C}-C_6H_5 \xrightarrow{H_3O^+} C_2H_5-\overset{\overset{C_6H_5}{|}}{C}=O$$

(*b*) **(*i*)** Because chloroacetate ion is more resonance stabilised than acetate ion due to the presence of electron withdrawing atom (+I effect).

(*ii*) Due to the presence of extensive intermolecular hydrogen bonding in carboxylic acids than in alcohol molecules.

(*iii*) Because of –I effect of nitro group stability of benzoate ion increases in 4-nitro benzoic acid, but methoxy (+I effect) group decreases the stability of benzoate ion.

33. **(*a*)** The standard electrode potential, E° for silver is 0.80 V and that of gold is 1.5 V, hence silver can displace gold from its solution. The replaced gold is deposited on silver object due to which golden tinge is obtained. On the other hand E° for Cu is 0.34 V which is lower than that of silver, thus silver cannot replace copper from its solution.

(*b*) (*i*) Electrons flow from anode (Zinc plate) to cathode (Silver plate).

(*ii*) Zinc plate where oxidation occurs acts as anode and silver plate where reduction occurs acts as cathode.

(*iii*) If the salt bridge is removed then electrons from zinc electrode will flow to the silver electrode where they will neutralize some of Ag^+ ions and the SO_4^{2-} ions will be left and the solution will acquire a negative charge. Secondly the Zn^{2+} ions from zinc plate will enter into $ZnSO_4$ solution producing positive charge. Thus due to accumulation of charges in two solutions, further flow of electrons will stop and hence the current stops flowing and the cell will stop functioning.

(*iv*) As silver from silver sulphate solution is deposited on the silver electrode and sulphate ions migrate to the other side, the concentration of $AgSO_4$ solution decreases and of $ZnSO_4$ solution increases as the cell operates.

(*v*) When the cell becomes dead, the concentration of these ions become equal due to attainment of equilibrium and zero EMF.

Or

(*a*) Conductivity : The conductance of the solution of an electrolyte enclosed in a cell between two electrodes of unit area of cross section separated by 1 cm. It is represented as K with unit $ohm^{-1}\ cm^{-1}$.

Molar conductivity : It is the conductance of the volume V of solution containing one mole of electrolyte kept between two electrodes with area of cross section A and distance of unit length.

Molar conductivity increases with decrease in concentration of solute for both weak and strong electrolytes.

(*b*) Given : $E^\circ_{Ag^+/Ag} = 0.80$, $E^\circ_{Fe^{3+}/Fe^{2+}} = 0.77$ V

$$\Delta_r G^\circ = ? \qquad\qquad K_C = ?$$

Cell Reaction

$$Fe^{2+}\,(aq) + Ag^+\,(aq) \longrightarrow Fe^{3+}\,(aq) + Ag\,(s)$$

$$E^\circ_{cell} = E^\circ_{Cathode} - E^\circ_{Anode} = 0.80\text{ V} - (0.77\text{ V})$$
$$= 0.03\text{ V}$$

$$\Delta_r G^\circ = -nF\,E^\circ_{Cell}$$
$$= -1 \times 96500\text{ C mol}^{-1} \times 0.03\text{ V}$$

$\therefore \quad \Delta_r G^\circ = -2895\text{ J mol}^{-1}$

$$\log K_C = \frac{nE^\circ_{Cell}}{0.0591}, \quad \log K_C = \frac{1 \times 0.03}{0.0591}, \quad \log K_C = 0.5076$$

$\log K_C = 0.508$

$\therefore \quad K_C = \text{antilog } 0.508 \qquad\qquad \therefore\ K_C = \mathbf{3.221}$

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