2023	12	18	TS-C1	SEAT NUMBER				

IIT INSPIRE
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XI & XII Science (CBSE/state)
IIT- JEE (Mains + Advance)
NEET, MH-CET , NDA
Mo. No. 9595445177/9021445177

Branches : Chhatrapati Sq., Mangalmurti Sq.

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(4 Pages)

is not allowed.
5. All symbols having their usual meanings unless otherwise stated.
6. For each MCQ, correct answer must be written along with its alphabet.
7. Evaluation of each MCQ would be done for the first attempt only.

Physical Constants:
(1) $\pi=3.142$ (2) $g=10\,m/s^2$ (3) $h=6.63\times10^{-34}\,J.s$ (4) $c=3\times10^{8}\,m/s$
(5) $e=1.6\times10^{-19}C$ (6) $\varepsilon_0=8.85\times10^{-12}C^2/N.m^2$ (7) $\mu_0=4\pi\times10^{7}\,T.m/A$,
(8) $\sigma=5.7\times10^{-8}W/m^2K^4$

SECTION-A

Q.1 Select and write the correct answers to the following questions: **[10]**

1) **Wool is _____ fibre. __**
Ans:
d) Animal **(1)**

2) **Carbohydrates that do not undergo hydrolysis further are called as_____.**
Ans:
c) Monosaccharides **(1)**

3) **Carbylamine test is given by only_____.**
Ans:
a) Primary amines **(1)**

4) **Diethyl ketone is an example of_____.**
Ans:
b) Symmetrical ketone **(1)**

5) **The pH of 0.0001 M of monobasic acid is_____.**
Ans:
d) 4 **(1)**

6) _____ **noble gas does note occur in atmosphere.**
Ans:
b) Radon **(1)**

7) **Heat of combustion of methane is -890 kJ/mol. On combustion of 12 gm of methane in excess of oxygen _____ heat is evolved.**

Ans:

b) - 667.71 kJ **(1)**

8) **Anisole on heating with concentrated HI gives_____.**

Ans:

c) Phenol + CH_3I **(1)**

9) **Which of the following expression represents molar conductivity of** AI_2¿¿

Ans:

b) $2\lambda^0_{Al^{3+}¿}+3\lambda^0_{SO_{4^{2-}}¿}$¿ **(1)**

10) _____ **member of lanthanoids is radioactive.**

Ans:

c) Promethium **(1)**

Q.2 Answer the following questions in one sentence: **[8]**

(1) Define the terms with examples: Isomerism **(1)**

Ans:

1. Two or more substances having the same crystal structure are said to be isomorphous.

Examples:

a. NaF and MgO b. $NaNO_3$ and $CaCO_3$

(2) Explain van't Hoff factor? **(1)**

Ans:

Van't Hoff factor (i) is defined as the ratio of colligative property of a solution of electrolyte divided by the colligative property of nonelectrolyte solution of the same concentration.

Thus,

$$i=\frac{colligative\ property\ of\ electrolyte\ solution}{colligative\ property\ of\ nonelectrolyte\ solution\ of\ the\ same\ concentration}$$

¿ $\frac{(\Delta T_f)}{(\Delta T_f)_0}=\frac{(\Delta T_b)}{(\Delta T_b)_0}=\frac{(\Delta P)}{(\Delta P)_0}=\frac{(\pi)}{(\pi)_0}$

Where quantities without subscript refer to electrolytes and those with subscript to nonelectrolytes.

(3) What is Kohlrausch law of independent migration of ions? How is it useful in obtaining molar conductivity at zero concentration of a weak electrolyte? Explain with an example.

(1)

Ans:

1. Kohlrausch law states that, "at infinite dilution each ion migrates independent of co-ion and contributes to total molar conductivity of an electrolyte irrespective of the nature of other ion to which it is associated."
2. Both cation and anion contribute to molar conductivity of the electrolyte at zero concentration and thus $\wedge_0$ is sum of molar conductivity of cation and that of the anion at zero concentration.

   Thus, $\bigwedge_0=n_{+¿}\lambda_{+¿^0+n_{-¿}\lambda_{-¿^0}¿}$¿

   Where, $\lambda_{+¿¿}$ and $\lambda_{-¿¿}$ are molar conductivities of cation and anion, respectively, and $n_{+¿¿}$ and $n_{-¿¿}$ are the number of moles of cation and anion specified in the chemical formula of the electrolyte.

3. Determination of molar conductivity of weak electrolyte at zero concentration:
The theory is particularly useful in calculating Λ_0 values of weak electrolytes from those of strong electrolytes.
For example, Λ_0 of acetic acid can be calculated by knowing those of HCl, NaCl and CH_3COONa as described below:
$\Lambda_0(HCl)+\Lambda_0(CH_3COONa)-\Lambda_0(NaCl)$
¿ $\lambda_{H^{¿}+\lambda_{Cl^{-}}+\lambda_{CH_3COO^{-}}+\lambda_{Na^{+}}-\lambda_{Na^{+}}-\lambda_{Cl^{-}}}$ ¿
¿ $\lambda_{H^{¿}+\lambda_{CH_3COO^{-}}=\Lambda_0(CH_3COOH)}$ ¿
Thus, $\Lambda_0(CH_3COOH)=\Lambda_0(HCl)+\Lambda_0(CH_3COONa)-\Lambda_0(NaCl)$
Because Λ_0 values of strong electrolytes, HCl, CH_3COONa and NaCl, can be determined by extrapolation method, the Λ_0 of acetic acid can be obtained.

(4) Explain: Rate of reaction **(1)**

Ans:

1. The rate of reaction describes how rapidly the reactants are consumed or the products are formed.
2. The rate of reaction represent a decrease in concentration of the reactant per unit time or increase in concentration of product per unit time.

The SI unit of rate of reaction is $mol\,dm^{-3}\,sec^{-1}$.

(5) What is entropy? Give its units. **(1)**

Ans:

1. Entropy is a measure of molecular disorder or randomness.
2. An entropy change of a system is equal to the amount of heat transferred (Q_{rev}) to it in a reversible manner divided by the temperature (T) in kelvin at which the

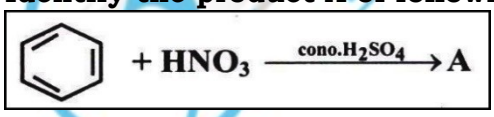
(6) What is the coordination number and oxidation state of metal ion in the complex $[Pt(NH_3)Cl_5]^{-¿¿}$?

(1)

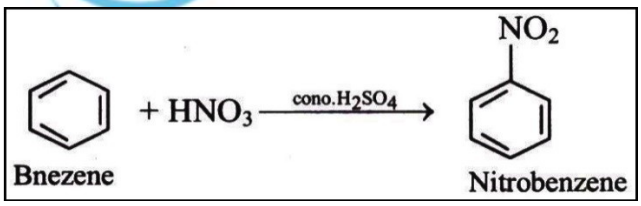
Ans:

In complex $[Pt(NH_3)Cl_5]^{-¿¿}$, the coordination number of metal ion is 6 and oxidation state of metal ion is +4.

(7) Identify the product A of following reaction. **(1)**



Ans:



(8) Which flower is an example of Self – cleaning? **(1)**

Ans:

Lotus is an example of self-cleaning.

SECTION-B

Attempt any eight of the following questions: [16]

Q.3 A compound made of elements C and D crystallizes in fcc structure. Atoms of C are present at the corners of the cube. Atoms of D are at the centres of faces of the cube. What is the formula of the compound (2)

Ans:

The formula of the given compound is CD_3.

Q.4 What are the characteristics of ideal and nonideal solutions? (2)

Ans:

1. Ideal solutions obey Raoult's law over entire range of concentrations.
2. No heat is evolved or absorbed when two components forming an ideal solution are mixed. Thus, the enthalpy of mixing is zero. $\Delta_{mix} H = 0$
3. There is no volume change when two components forming an ideal solution are mixed. Thus, volume of an ideal solution is equal to the sum of volumes of two components taken for mixing. $\Delta_{mix} V = 0$
   In an ideal solution solvent-solute, solute-solute and solvent-solvent molecular

Q.5 Find the values of ΔU under following conditions: (2)

1) 30 kJ of heat is supplied to the system.

2) A system releases 10 kJ of heat and performs 15 kJ of work on the surroundings.

Ans:

1. $30\,kJ$ of heat supplied to the system. It would be added to internal energy of the system. Hence, $\Delta U = +30\,kJ$
2. Suppose a system release $10\,kJ$ of heat and performs $15\,kJ$ of work on the surroundings. These quantities are removed from internal energy of the system. Hence, $\Delta U = -25\,kJ$

Q.6 Define: Reference electrode. (2)

Ans:

Reference electrode: A reference electrode is defined as an electrode whose potential is arbitrarily taken as zero or is exactly known.

Q.7 What are Interhalogen compounds? Give two examples. (2)

Ans:

An Interhalogen compound is a compound formed by combination of atoms of different halogens.

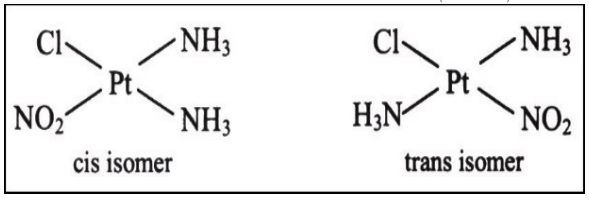
Eg: ClF, BrF_3

Q.8 Draw isomers in each of the following (2)

1) $Pt(NH_3)_2ClNO_2$

Ans:

1) Cis and trans isomers of $Pt(NH_3)_2ClNO_2$



Q.9 Why salts of Sc^{3+}, Ti^{4+}, V^{5+} are colourless? (2)

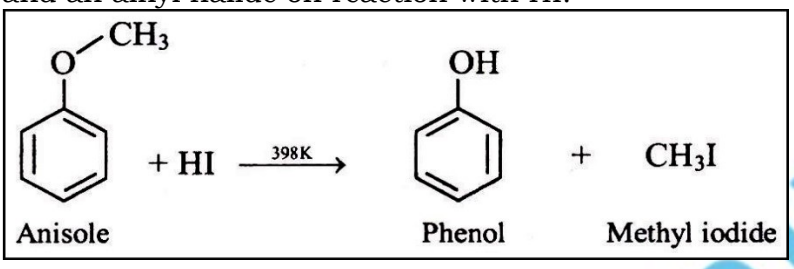
Ans:

1. Condensed electronic configuration of Sc^{3+}, Ti^{4+}, V^{5+} are: $Sc^{3+}: [Ar]3d^0$; $Ti^{4+}: [Ar]3d^0$; $V^{5+}: [Ar]3d^0$
2. The ions Sc^{3+}, Ti^{4+} and V^{5+} have completely empty d-orbitals i.e., no unpaired electrons are present. Thus, their slats are colourless, as d-d transitions are not possible.

Q.10 What happens when aryl alkyl ethers are treated with hot HI? (2)

Ans:

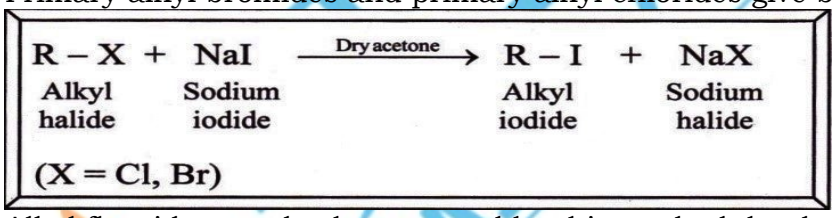
Aryl alkyl ethers have stronger and shorter bond between oxygen and the aromatic ring. Hence an aryl alkyl ether undergoes cleavage of oxygen - alkyl bond and yields a phenol and an alkyl halide on reaction with HI.



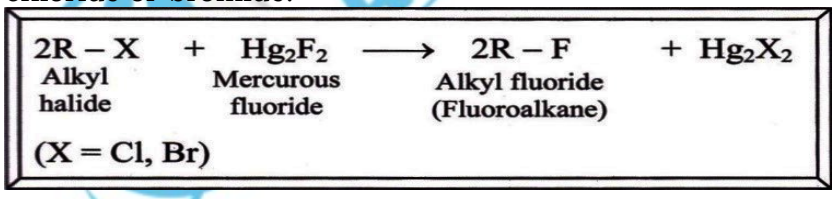
Q.11 Write a note on: Halogen exchange reactions (Finkelstein reaction) (2)

Ans:

1. This method is used for the preparation of alkyl iodides. Alkyl chlorides or bromides are heated with solution of sodium iodide in dry acetone to give corresponding alkyl iodide. The reaction is known as "Finkelstein reaction".
2. Sodium bromide and sodium chloride are less solution in dry acetone and thus they get precipitated.
3. These precipitates are removed by filtration and thus backward reaction is also prevented.
4. Primary alkyl bromides and primary alkyl chlorides give best results by this reaction.



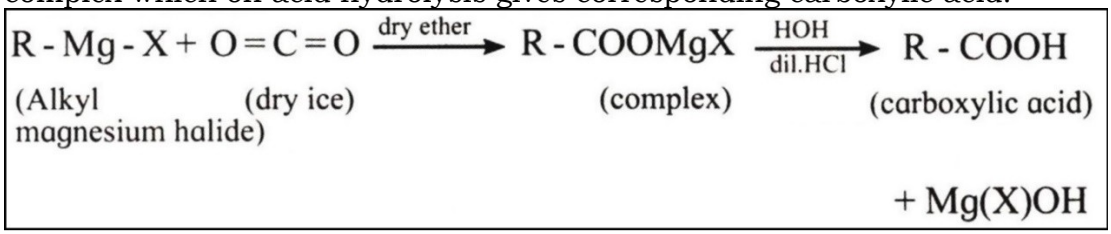
5. Alkyl fluoride can also be prepared by this method, by the action of mercurous fluoride (Hg_2F_2), silver fluoride (AgF), cobalt fluoride (CoF_3) or antimony trifluoride SbF_3 on alkyl chloride or bromide.



Q.12 Explain the preparation of carboxylic acids from Grignard reagent. (2)

Ans:

Grignard reagent in dry ether solvent is added to solid carbon dioxide (dry ice) to give a complex which on acid hydrolysis gives corresponding carboxylic acid.



Q.13 Write a note on Stephen reaction. **(2)**

Ans:

Nitriles are reduced to imine hydrochloride by stannous chloride in presence of hydrochloric acid which on acid hydrolysis give corresponding aldehydes. This reaction is called Stephen reaction.

$$\underset{\text{Alkane nitrile}}{R-C\equiv N} + 2[H] \xrightarrow{SnCl_2, HCl} \underset{\text{Imine hydrochloride}}{R-HC=NH.HCl} \xrightarrow{H_3O^+} \underset{\text{Aldehyde}}{R-CHO} + NH_4Cl$$

$$\text{e.g. } \underset{\text{Ethanenitrile}}{H_3C-C\equiv N} + 2[H] \xrightarrow[\text{(reduction)}]{SnCl_2, HCl} \underset{\text{Ethanimine hydrochloride}}{CH_3-HC=NH.HCl} \xrightarrow{H_3O^+} \underset{\text{Ethanal}}{CH_3-CHO} + NH_4Cl$$

Q.14 Distinguish between thermosetting and thermoplastic resins. Write example of both the classes. **(2)**

Ans:

No.	Thermosetting resin	Thermoplastic resin
1	They do not soften on heating.	They soften on heating and harden on cooling.
2	They cannot be remoulded or reshaped.	These can be remoulded or reshaped.
3	They possess extensive cross-linking formed by covalent bonds.	They possess moderately strong intermolecular forces that are intermediate between elastomers and fibres.
4	They are rigid polymers.	They are not rigid polymers.
Eg:	Bakelite, urea-formaldehyde resins, etc.	PVC, polythene, polystyrene, etc.

SECTION-C

Attempt any eight of the following questions: **[24]**

Q.15 The following pictures show population of bands for materials having different electrical properties. Classify them as insulator, semiconductor or a metal. **(3)**

Ans:

The picture in the left represents a metal, the picture in the middle represents an insulator and the picture in the right represents a semiconductor.

Q.16 Explain the following: **(3)**

1) Conductors, 2) Semiconductors, 3) Insulators

Ans:

1. **Conductors:**

Solids having electrical conductivities in the range 10^4 to $10^7\,Ohm^{-1}\,m^{-1}$ are called conductors.
Metals and electrolytes (ionic solids) are examples of electrical conductors.
Metals conduct electricity by movement of electrons while electrolytes conduct electricity by movement of ions.

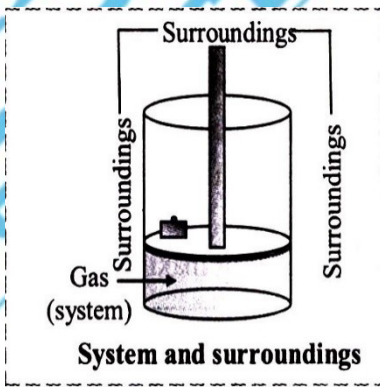
2. **Insulators:**
Solids having low electrical conductivities in the range 10^{-20} to $10^{-10}\,Ohm^{-1}\,m^{-1}$ are called insulators.
Most nonmetals and molecular solids belong to this category.

3. **Semiconductors:**
Solids having electrical conductivities in the range 10^{-6} to $10^4\,Ohm^{-1}\,m^{-1}$ are called semiconductors.
This range is intermediate between conductors and insulators.
Metalloids like silicon, germanium belong to this category.

Q.17 Explain the term system and surrounding with the help of a diagram. (3)

Ans:

1. Consider a gas enclosed in a cylinder equipped with a movable piston as shown in figure.
2. Suppose we undertake study of change in volume of a gas and the amount of energy released or gained by a gas the when the pressure is varied by putting certain mass on piston.
3. In this case, a gas under study is called the system. A part of the universe under thermodynamic investigation is called the system. All other parts of the universe outside the system such as cylinder, room and others, are surroundings.
4. The universe is made of system plus surroundings.



System and surroundings

Q.18 How many moles of electrons are required for reduction of 3 moles of Zn^{2+} to Zn? How many Faradays of electricity will be required? (3)

Ans:

Current strength in amperes required to produce 2.4 g of Cu from $CuSO_4$ is 2.03 A.

Q.19 What are the key features of the order of the reaction? (3)

Ans:

1. The order of chemical reaction is experimentally determined.
2. The order can be integer or fractional. Look at the reaction,
$CH_3CHO_{(g)} \longrightarrow CH_{4(g)} + CO_{(g)}$
The rate law for the reaction was found to be rate $= k\left[CH_3CHO\right]^{\frac{3}{2}}$
Here, the order of the reaction is 3/2.
3. The order of the reaction, can be zero for:
$NO_{2(g)} + CO_{(g)} \longrightarrow NO_{(g)} + CO_{2(g)}$
The rate expression for this is: $rate = k\left[NO_2\right]^2$.
This shows that order of reaction with respect to NO_2 is 2 and with CO is zero or the rate is independent of concentration of CO. The overall of reaction is 2.
4. Only a few reactions of third order are known. Reactions with the order higher than three are scanty.

Q.20 What is an acidic buffer solution? Give Henderson Hasselbalch equation to calculate pH of acidic buffer solution. **(3)**

Ans:

1. *A solution containing a weak acid and its salts with strong base is called an acidic buffer solution.*

   Example: A solution containing weak acid such as CH_3COOH and its salt such as CH_3COONa is an acidic buffer solution.

2. The pH of acidic buffer is given by Henderson Hasselbalch equation.

   $$pH = pK_a + \log_{10}\frac{[salt]}{[acid]}$$

   Where, $pK_a = -\log_{10}K_a$ and K_a is the dissociation constant of the acid.

Q.21 Write the reaction of conc. H_2SO_4 with sugar.

(3)

Ans:

The reaction is,

$$\underset{Cane\ sugar}{C_{12}H_{22}O_{11}} \xrightarrow{H_2SO_4} \underset{Carbon}{12C} + ¿. \underset{Water}{11H_2O}$$

Q.22 What are the difference between cast iron, wrought iron and steel? **(3)**

Ans:

No.	Cast Iron	Wrought Iron	Steel
1	Hard and brittle	Very soft	Neither too hard nor too soft
2	Contains 4% carbon	Contains less than 0.2% carbon	Contains 0.2 to 2% carbon
3	Used for making popes, manufacturing automotive parts, pans, utensils, etc.	Used for making pipes, bars for stay bolts, engine bolts and rivets, etc.	Used in buildings infrastructure, tools, ships, automobiles, weapons, etc.

Q.23 Explain linkage isomers giving one example. **(3)**

Ans:

1. Linkage isomers are formed when the ligand has two different donor atoms.
2. It coordinates to the metal via different donor atoms.

Eg:

The nitrite ion ¿ having two donor atoms shows isomers as:

$\left[Co\left(NH_3\right)_5\left(NO_2\right)\right]^{2+¿¿}$ and $\left[Co\left(NH_3\right)_5\left(ONO\right)\right]^{2+¿¿}$

The nitro complex has Co-N bond and the nitrito complex is linked through Co-O bond. These are linkage isomers.

Q.24 How are alcohols classified **(3)**

Ans:

On the basis of number of hydroxyl groups (-OH) present in their molecule, alcohols are classified as follows:

1.Monohydric Alcohols: They contain one hydroxyl group.

Eg: CH_3CH_2OH

2.Dihydric Alcohols: They contain two hydroxyl groups.

e.g. CH_2-OH
CH_2-OH

3.Trihydric Alcohols: They contain three hydroxyl groups.

e.g. CH_2-OH
$CH-OH$
CH_2-OH

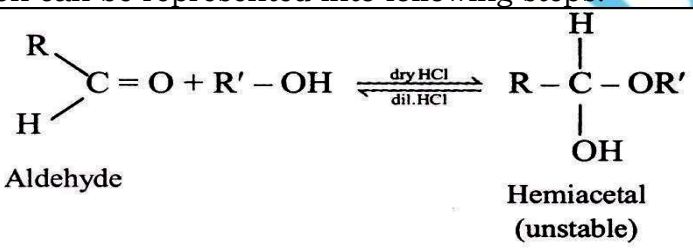
4.Polyhydric alcohols: They contain more than three hydroxyl groups.

Q.25 What is reh action of alcohols on aldehydes? (3)

Ans:

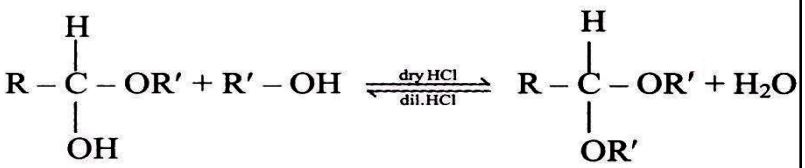
1. Aldehyde reacts with one molecule of anhydrous monohydric alcohol in presence of dry hydrogen chloride to give alkoxyalcohol known as hemiacetal.
2. This further reacts with one more molecule of anhydrous monohydric alcohol to give a germinal dialkoxy compound known as acetal
3. Acetal can be hydrolysed with aqueous mineral acids to give corresponding aldehydes.
4. The reaction can be represented into following steps:

Step 1:



Aldehyde — Hemiacetal (unstable)

Step 2:



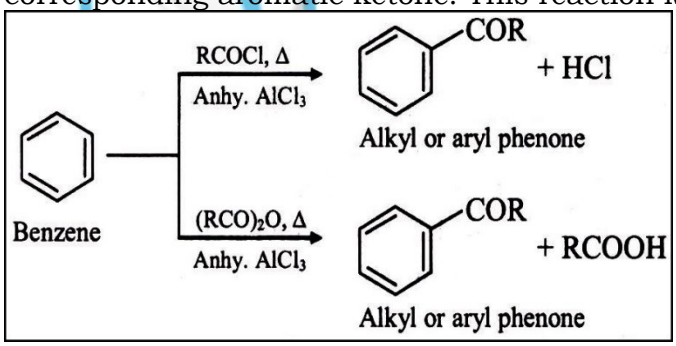
Hemiacetal — Acetal (stable)

Q.26 How are ketones prepared by Friedel-Craft's acylation of arene? (3)

Ans:

Friedel-Craft's Acylation of Arene:

Treatment of benzene or substituted benzene (arenes) with acyl chloride (RCOCl) or acetic anhydride $\left[(CH_3CO)_2O\right]$ in the presence of anhydrous aluminium chloride, yields corresponding aromatic ketone. This reaction is called Friedel-Craft's acylation of arene.



Where, R may be alkyl or aryl group.

SECTION-D

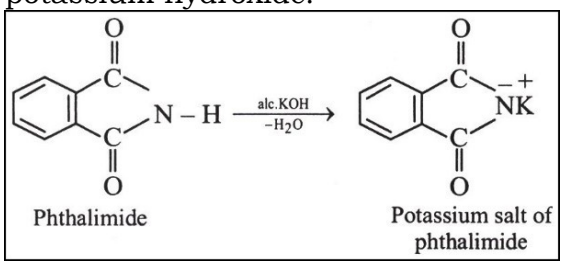
Attempt any three of the following question: [12]

Q.27 Explain Gabriel phthalimide synthesis. **(4)**

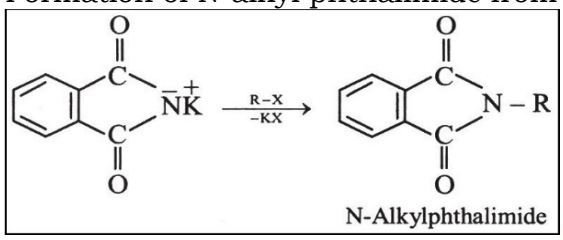
Ans:

This method is used for the synthesis of primary amine. It involves the following three stages.

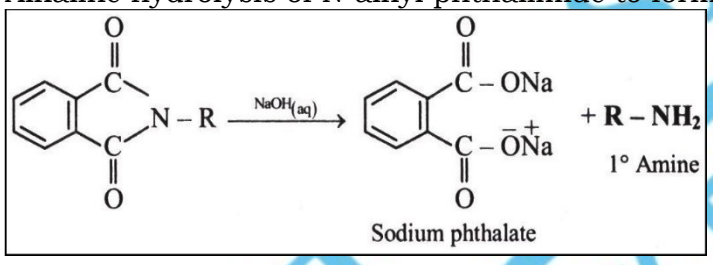
1. Formation of potassium salt of phthalimide from phthalimide on reaction with alcoholic potassium hydroxide.



2. Formation of N-alkyl phthalimide from the potassium salt by reaction with alkyl halide.



3. Alkaline hydrolysis of N-alkyl phthalimide to form the corresponding primary amine.



Q.28 a) Explain the amphoteric nature of water. **(4)**

b) A weak monobasic acid is 0.05% dissociated in 0.02 M solution. Calculate dissociation constant of the acid.

Ans:

(a) Water has the ability to act as an acid as well as a base. Such behaviour is known as amphoteric nature of water.

Example:

1. $H_2O_{(l)} + NH_{3(aq)} \rightleftharpoons OH^-_{(aq)} + NH^+_{4(aq)}$
   $(Acid)$
2. $H_2O_{(l)} + HCl_{(aq)} \rightleftharpoons H_3O^+_{(aq)} + Cl^-_{(aq)}$
   (Base)

   H_2O acts as an acid towards NH_3 and as a base towards HCl. Therefore, H_2O is amphoteric.

(b) Dissociation constant of acid (K_a) is 5×10^{-9}.

Q.29 a) A reaction takes place in tow steps: **(4)**

a) $NO_{(g)} + Cl_{2(g)} \longrightarrow NOCl_{2(g)}$

b) $NOCl_{2(g)} + NO_{(g)} \longrightarrow 2\,NOCl_{(g)}$

1) Write the overall reaction.

2) Identify reaction intermediates.

3) What is the molecularity of each step?

b) Write the names and structural formulae of Oxoacids of chlorine.

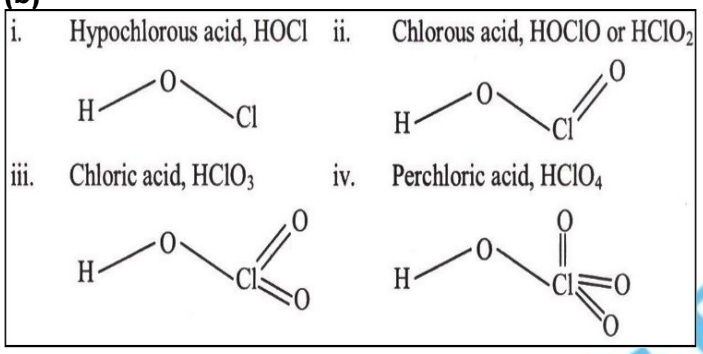
Ans:

(a) 1. The overall reaction: $2\,NO_{(g)} + Cl_{2(g)} \longrightarrow 2\,NOCl_{2(g)}$

2. Since, $NOCl_2$ is formed in the first step and consumed in the second step. Hence, it is the reaction intermediates.

3. The molecularity of each step is 2 because two reactants are involved in each of the steps.

(b)



Q.30 a) What are zero, one and tow dimensional nanoscales system? **(4)**

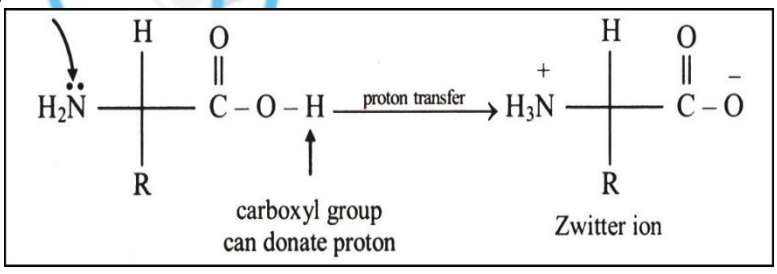
b) Draw a neat diagram for the zwitter ion.

Ans:

(a)

1. **Zero-Dimensional Nanostructures:**
   A zero-dimensional structure is one in which all three dimensions are in the nanoscale. That is, all three dimensions < 100 nm
   Example:
   Nanoparticles, quantum dots, nanoshells, nanorings, microcapsules
2. **One-Dimensional Nanostructures:**
   A one-dimensional nanostructure is one in which two dimensions are in the nanoscale. That is, two dimensions < 100 nm
   Example:
   Nanowires, nanofibres, nanotubes and nanorods
3. **Two-Dimensional Nanostructures:**
   A two-dimensional nanostructure is one in which one dimension is in the nanoscale. That is, one dimension < 100 nm
   Example:
   Thin films, layers and coatings

(b)



Q.31 **a) Difference between lanthanoids and actinoids.** **(4)**

b) What are proteins?

Ans:

(a)

No.	Lanthanoids	Actinoids
1	In lanthanoids, last differentiating electron occupies 4f orbital.	In actinoids, last differentiating electron occupies 5f orbital.
2	They are the elements of first inner transition series.	They are the elements of second inner transition series.
3	They are present in period 6.	They are present in period 7.
4	Lanthanoids show a maximum oxidation state of +4.	Actinoids show oxidation states of +3, +4, +5, +6 and +7.
5	Lanthanoids have less tendency to form complexes.	Actinoids have greater tendency to form complexes with ligands such as thioethers.
6	All lanthanoids are non-radioactive (except promethium).	All actinoids are radioactive.
7	Lanthanoids do not form oxocations.	Actinoids form oxocations such as UO^+, PuO^+, NpO_2^+.
8	Most of the lanthanoids are colourless on nature.	Most of the actinoids are coloured ions.

Ans:

(b)

1. Proteins are the fundamental structural materials of animal bodies. Proteins in the form of enzymes play prime role in all the physiological reactions.
2. The name protein is derived from the Greek word, 'proteios' which means 'primary' or 'of prime importance'.
3. Nutritional sources of proteins are milk, pulses, nuts, fish, meat, etc.
4. Chemically proteins are polyamides which are high molecular weight polymers of the monomer units called ∝-amino acids.

"All the Best"

"When you focus on problems,
you get more problems,
When you focus on possibilities,
you have more opportunities."