Chemistry [Set 1]

Academic Year: 2018-2019 Marks: 70
Date & Time: 27th February 2019, 11:00 am
Duration: 3h

SECTION - A

Question 1: A compound used as pistachio flavour in ice cream is _____ **[1]**

vanillin
acetophenone
muscone
butyraldehyde

Solution: acetophenone

Question 2: Oxidation states of scandium are _____. **[1]**

+1, +2
+1, +3
+2, + 3
+3, +4

Solution: +2, + 3

Question 3: In Van Arkel method for refining zirconium or titanium, the halogen used is _____. **[1]**

fluorine
chlorine
bromine
iodine

Solution: iodine

Question 4: A system absorbs 6 kJ of heat and does 1.5 kJ of work on its surroundings. The change in internal energy is _____. **[1]**

– 7.5 kJ
– 4.5 kJ
+4.5 kJ
+ 7.5 kJ

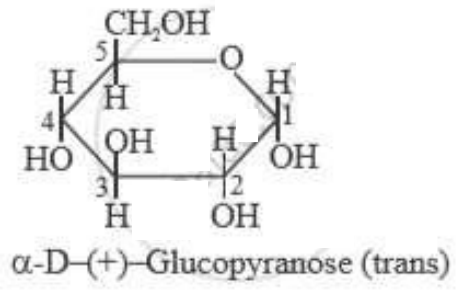
Solution: +4.5 kJ

Question 5: Write the molecular formula of noverstrol. **[1]**

Solution: Molecular formula of novestrol is $C_{20}H_{24}O_2$.

Question 6: Write the number of hydroxyl groups present in α - D (+) -Glucopyranose (trans.) **[1]**

Solution: Five OH groups are present: (Structure is only for reference.)

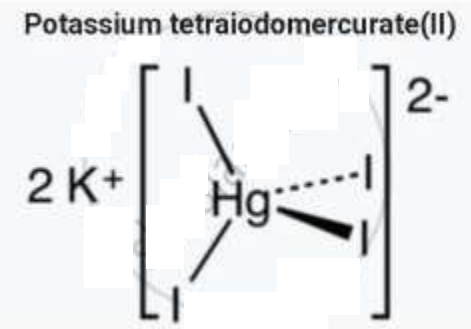


α-D–(+)–Glucopyranose (trans)

Question 7: What is Nessler's reagent ? **[1]**

Solution: Nessler's reagent is a solution of mercury(II) iodide (HgI2) in potassium iodide (KI) and potassium hydroxide (KOH) named after the German chemist **Julius Nessler**

Nessler's reagent is an alkaline solution of $K_2\ HgI_4$



It is used in testing for ammonia, with which it forms a brown coloration or precipitate.

Question 8: What is the ratio of octahedral holes to the number of anions in hexagonal closed packed structure? **[1]**

Solution: 1 : 1

SECTION - B

Question 9: What are ethers? **[2]**

Solution: Ethers are alkoxy derivatives of alkane
Ethers are a class of organic compounds that contain an **ether** group. An **ether** group is

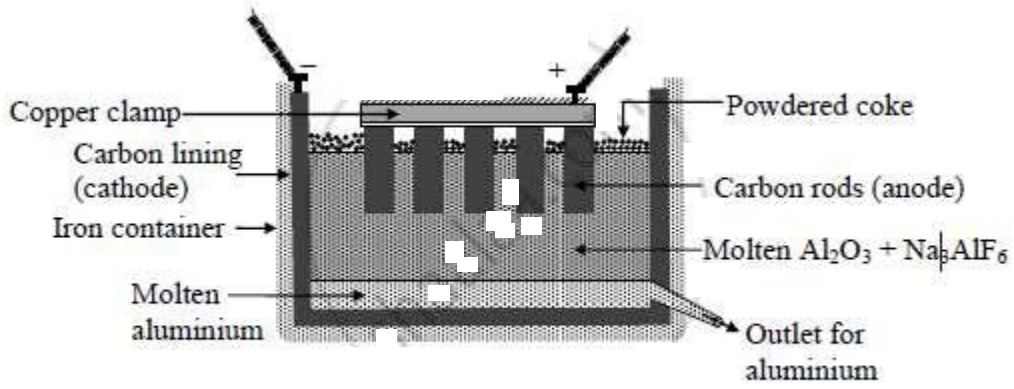
an oxygen atom connected to two alkyl or aryl groups. They follow the general formula R-O-R'.

Question 10: What are antacids? **[2]**

Solution: Antacids are medicines that neutralize stomach acid to cut down on heartburn, sour stomach, acid indigestion, and stomach upset. Some antacids also contain simethicone, an ingredient that helps your body get rid of gas. Others have ingredients that can lead to diarrhea or constipation.

Question 11: Draw a neat, well labelled diagram of electrolytic cell for extraction of aluminium **[2]**

Solution: Electrolytic cell for the extraction of aluminium:



Electrolytic cell for the extraction of aluminium

Question 12.A: How many faradays of electricity are required to produce 6 g of Mg from $MgCl_2$? **[2]**

Solution: $Mg^{2+} + 2e^- \rightarrow Mg_{(s)}$

1 mole Mg^{2+} equals 2 mole e^- for electrosis

1 mole Mg required 2 Faraday electricity

24g Mg rquired 2 faraday electricity

6g Mg will require = $\frac{2 \times 6}{24}$

= 0.5 F

OR

Question 12.B: The molar conductivity of 0.05 M $BaCl_2$ solution at 25° C is $223\Omega^{-1}$ cm^2 mol^{-1}. What is its conductivity? **[2]**

Solution:

C = 0.05 M

$\lambda_m = 223\Omega^{-1}\ cm^2\ mol^{-1}$

$$\lambda_m = \frac{1000k}{C}$$

$$\therefore\ k = \frac{\lambda_m \times C}{1000}$$

$$= \frac{223 \times 0.05}{1000}$$

$= 0.01115\ S\ cm^{-1}$

Question 13: Derive van't Hoff general solution equation. **[2]**

Solution: Combining van't Hoff Boyle's and Charle's laws, van't Hoff deducted the following equation.

$$\pi\ \alpha\ \frac{T}{V} = \text{constant}$$

πV = kT (k is constant of proportionality)
k is called general solution constant. The equation is called van't Hoff general solution. It is similar to the general gas equation (PV = RT). van't Hoff further proved that the value of k is the same as R, the gas constant hence,

πV = RT

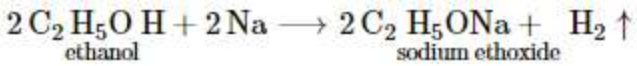
Where, π - osmotic pressure
V – a volume of solution containing 1 mole of solute
R – gas constant equal to 8.314 J mol^{-1} K^{-1} or 0.082 atm mol^{-1} K–1
T – absolute temperature

Question 14: Write the conditions for maximum work done by the system. **[2]**

Solution: Conditions for maximum work:
Maximum work is obtainable from a system when
1) any change taking place in it is thermodynamically reversible.
2) the change in the system takes place in an infinite number of steps.
3) the driving force of the change is infinitesimally greater than the opposing force.
4) the system is in mechanical equilibrium with its surroundings.

Question 15: Write balanced chemical equation for the following : [2]
Action of sodium metal on ethanol.

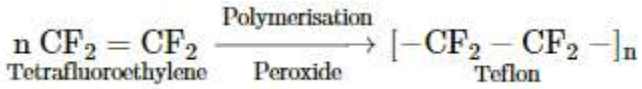
Solution:



SECTION - C

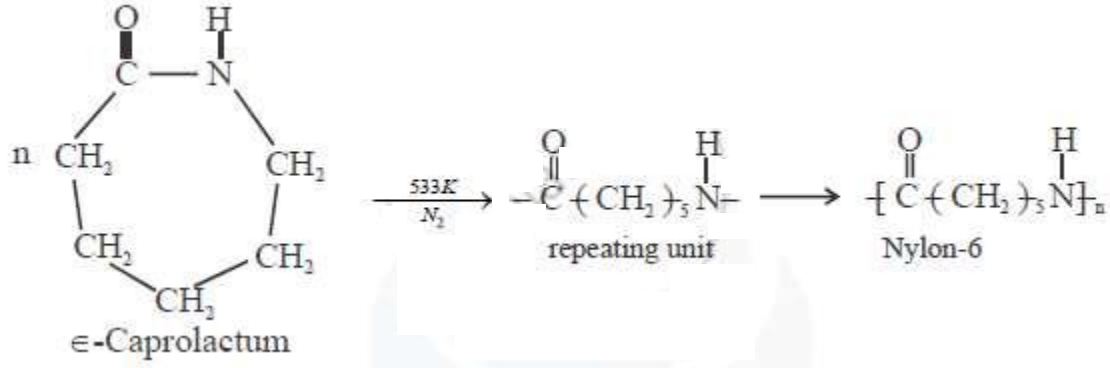
Question 16.1: Write chemical reaction to prepare the following polymer: **Teflon** [3]

Solution:



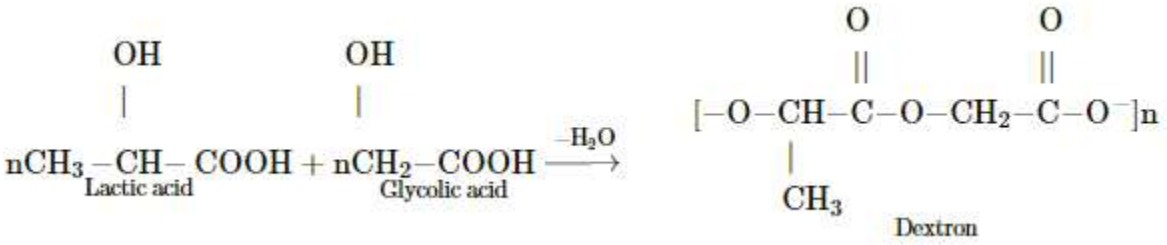
Question 16.2: Write chemical reaction to prepare the following polymer : [3]
Nylon – 6

Solution:



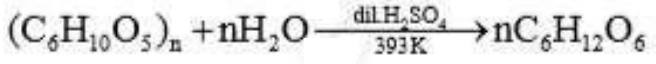
Question 16.3: Write chemical reaction to prepare the Dextron polymer: [3]
Dextron

Solution:

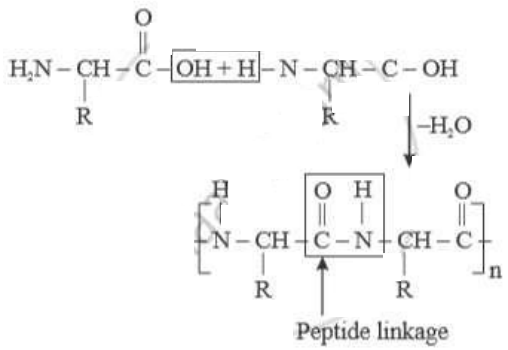


Question 17: How is glucose prepared by commercial method? How is peptide linkage formed? [3]

Solution: Commercially glucose is prepared using starch. Starch is boiled with dil. H2SO4 at 393 k. It undergoes hydrolysis to give glucose.

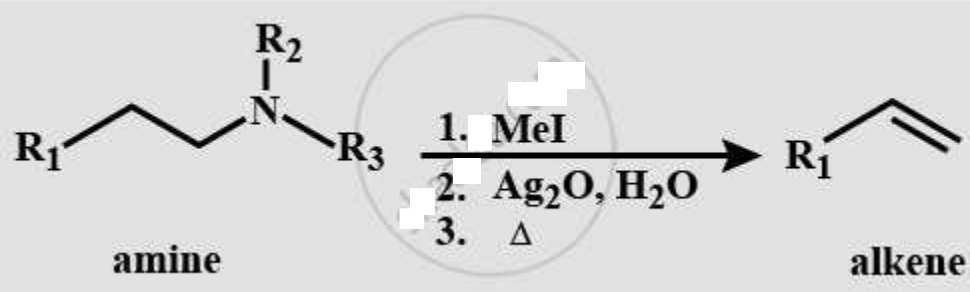


Peptide linkage is formed when two amino acids undergo condensation with loss of water molecule



Question 18: Write a short note on Hoffmann elimination [3]

Solution: The Hoffmann elimination is an organic reaction used to convert an amine with a B-hydrogen to an alkene using methyl iodide, silver oxide and water under thermal conditions The mechanism begins with an attack of the amine on methyl iodide to form an ammonium iodide salt. The iodide reacts with silver oxide to form silver iodide which is insoluble it deprotonates water to form hydroxide ion floating the mixture facilitates an elimination to a given alkene.



Question 19: What is the action of the following on ethyl bromide [3]
alcoholic solution of potassium hydroxide.

Solution:

$$\underset{\text{ethylbromide}}{C_2H_5Br} + \text{alc KOH} \longrightarrow \underset{\text{ethene}}{CH_2 = CH_2} + KBr + H_2O$$

Question 19: What is the action of the following on ethyl bromide:
moist silver oxide

Solution:

$$2\,C_2H_5Br + Ag_2O \longrightarrow C_2H_5 - O - C_2H_5 + 2\,AgBr$$

$$Ag_2O + H_2O \longrightarrow 2\,AgOH$$

$$AgOH + C_2H_5Br \longrightarrow \underset{\text{Ethanol}}{C_2H_5OH} + AgBr$$

Question 19: What is the action of the following on ethyl bromide:
silver acetate

Solution:

$$\underset{\text{ethyl bromide}}{C_2H_5Br} + \underset{\text{silver acetate}}{CH_3COOAg} \longrightarrow CH_3COOC_2H_5 + AgBr$$

Question 20: What is effective atomic number? Calculate effective atomic number of copper (Z = 29) in $(Cu(NH_3)_4)^{2+}$ **[3]**

Solution: Effective atomic number (EAN) in a complex is defined as the total number of electrons present around the central metal ion.

EAN = Atomic number (Z) – Oxidation number + 2 × Coardination number

Let us consider a chemical complex $[Cu(NH_3)_4]^{2+}$

The atomic number of the central metal atom (Cu) Z = 29

Oxidation number = +2

Coordination number = 4

EAN = 29 – 2 + (2 × 4)

EAN = 29 – 2 + 8

EAN = 35

Question 21: Write chemical reactions for different steps in the manufacture of sulphuric acid by lead chamber process. Draw the structure of phosphorous pentachloride **[3]**

Solution: $2SO_2 + O_2 + 2H_2O \xrightarrow{No} 2H_2SO_4$

The above net reaction can be written as the sum of following reactions taking place in different steps.

1) $2H_2O + NO \rightarrow HNO_3 + 3H^+$

2) $S + O_2 \rightarrow SO_2$ (Oxidation of sulpher)

3) $2HNO_3 + 2SO_2 \rightarrow H_2O + NO + NO_2 + 2SO_3$

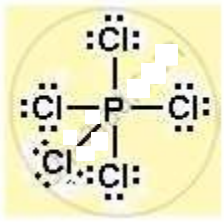
Nitric acid or NO_2 is used to oxidize SO_2 to SO_3.

Or $SO_2 + NO_2 \rightarrow SO_3 + NO$

4) $SO_3 + H_2O \rightarrow H_2SO_4$

Sulphur trioxide reacts with water to from $H_2\ SO_4$.

Structure of phosphorous pentachloride :



Phosphorus has 5 valence electrons. Each electron is shared with a chlorine atom.

Question 22: Write Arrhenius equation. Derive an expression for temperature variations [3]

Solution:

Arrhenius equation, $K = A.e^{-Ea/RT}$ for temperature variation

$$\log_{10}k = \log_{10}A - \frac{E_a}{2.303RT}$$

at two different temperatures T_1 and T_2 is written as

$$\log_{10}k_1 = \log_{10}A - \frac{E_a}{2.303RT_1} \quad ...(1)$$

and $$\log k_2 = \log_{10}A - \frac{E_a}{2.303RT_2} \quad ..(2)$$

where k1 is the rate constant at T1 and k2 at T2. The subtraction of equation (1) from equation (2)

`"log"_10"k"_2 - "log"_10"k"_1 = - "E"_"a"/(2.303"RT"_2) +

"E"_"a"/(2.303"RT"_1)

$$\text{Or } \log_{10}\frac{k_2}{k_1} = \frac{E_a}{2.303R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$$

$$= \frac{E_a}{2.303R}\left[\frac{T_2 - T_1}{T_1T_2}\right]$$

Question 23: Define electrochemical series. Write its applications [3]

Solution: EMF series is defined as the arrangement of the electrode with the electrode half-reaction in order of decreasing standard potentials.

Applications of Electrochemical series :

Oxidizing and Reducing Strengths: The electrochemical series helps to identify the substances that are good oxidizing agents and reducing agents.

All the substances appearing on the top of the series behave as good reducing agents.

All the substances appearing at the bottom of the table are good oxidizing agents.

Displacement reactions: A metal higher in the series will displace the metal from its solution which is lower in the series. A metal higher in the series has a greater tendency to provide electrons to the cations of the metal to be precipitated.

The metal having low standard reduction potential will displace the metal from its salt's solution which has a higher value of standard reduction potential.

Predicting the Liberation of Hydrogen Gas from Acids by Metals: All metals having negative electrode potentials (- E°) show a greater tendency of losing electrons as compared to hydrogen. So, when such a metal is placed in an acid solution, the metal gets oxidized, and H^+ ions get reduced to form hydrogen gas. Thus, the metals having - E° values liberate hydrogen from acids.

Predicting the Feasibility of a Redox Reaction: Depending on the E° values of the two electrodes feasibility of the given redox reaction can be found out. A redox reaction is feasible only if the species which has higher potential is reduced i.e., accepts the electrons and the species which has lower reduction potential is oxidized i.e., loses electrons.

Calculation of the EMF of the Cell: If the EMF of the cell is positive, the reaction is feasible in the given direction and the cell is correctly represented. If it is negative, the cell reaction is not feasible in the given direction and the cell is wrongly represented.

Comparison of Reactivities of Metals: The relative ease with which the various species of metals and ions may be oxidized or reduced is indicated by the reduction of potential values. The metals with lower reduction potential are not reduced easily but are easily oxidized to their ions losing electrons.

Question 24.A: Calculate the work done in the following reaction at 50°C. State whether work is done on the system or by the system. **[3]**

$$SO_2(g) + \frac{1}{2}O_{2(g)} \rightarrow SO_{3(g)}$$

Solution:

$$SO_2(g) + \frac{1}{2}O_{2(g)} \rightarrow SO_{3(g)}$$

Δn = (moles of gaseous product) - (moles of gaseous reactant)

$= 1-(1+\frac{1}{2})$

$=-\frac{1}{2}$

$w = -\Delta nRT$

$-(-\frac{1}{2} \times 8.314 \times 323)$

$=1342.7J$

As work done is positive. Therefore work is done by surrounding on system.

(OR)

The standard enthalpy of combustion of formaldehyde $\Delta\ {}_0H^0$ = -571 kJ How much heat will be evolved in the formation of 22 g of CO_2 ?

$$\underset{\underset{\|}{O}}{H-C-H} + O_2 \rightarrow CO_2 + H_2O \quad \Delta_c H = -571\,kJ$$

for 44g of CO_2, $\Delta H = -571\,kJ$

$\therefore$ 22 g of CO_2, $\Delta H = \frac{22 \times -571}{44} = -285.5\,kJ$

OR

Question 24.B: The standard enthalpy of combustion of formaldehyde $\Delta_0 H^0$ = -571 kJ. How much heat will be evolved in the formation of 22 g of CO_2? [3]

Solution:

$$\underset{\underset{\|}{O}}{H-C-H} + O_2 \longrightarrow CO_2 + H_2O$$

$\Delta_C H$ = -571 kJ

for 44g of CO_2, ΔH = -571 kJ

$\therefore$ 22g of CO_2, $\Delta H = \frac{22 \times -571}{44}$ = -285.5 kJ

Question 25: Define the following term: [3]
isotonic solution

Solution: Isosotonic solution - two or more solutions exerting same osmotic pressure are called isotonic solution.

Question 25: Define the following term:
hypertonic solution

Solution: Hypertonic solution - The solution having higher osmotic pressure than other is called Hypertonic to other.

Question 25: Define the following term:
hypotonic solution

Solution: Hypotonic solution - The solution having lower osmotic pressure than other is called Hypotonic to other solution.

Question 26: Distinguish between crystalline solids and amorsphous solids. [3]

Solution:

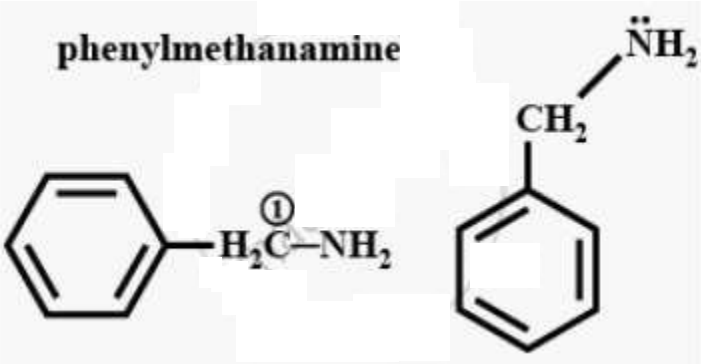
Points	Crystalline solids	Amorphous solids
Arrangement	The constituents particles are arranged in regular order.	The constituents particles show disordered arrangement.
Order	Exhibit both long-range and short-range order.	Exhibit only short-range order.
Melting point	They have a sharp melting point.	They melt over a range of temperatures.
Heat of fusion	Show definite heat of fusion.	Do not have definite heat of fusion.
Clearage property	They undergo a clean clearage.	They cut irregularly.
Physical property	Show anisotropy in physical property measurements.	They are isotropic.
Nature	They are true solids.	They are pseudo solid or supercooled liquid.

SECTION - D

Question 27 | Attempt any one [5]

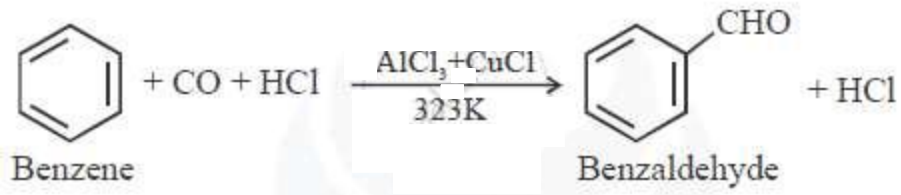
Question 27.A: Write the structure of Phenylmethanamine. **[1]**

Solution:



Question 27.B.i: Write chemical equation for the following : [1]
Gatterman - Koch formylation

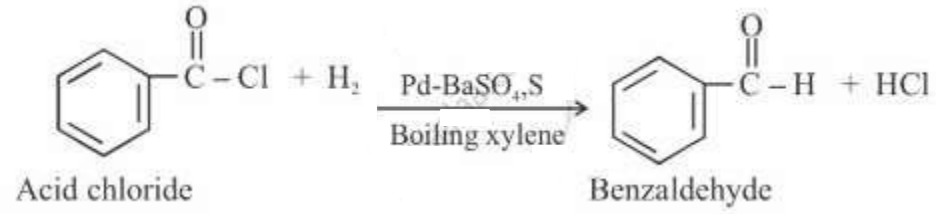
Solution: Gattermann koch formylation



Question 27.B.ii: Write chemical equation for the following: [1]

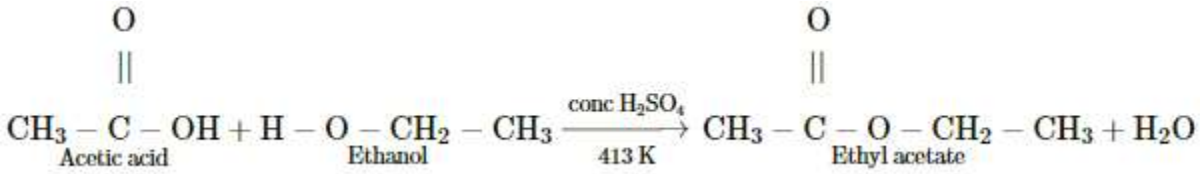
Rosenmund reduction

Solution:



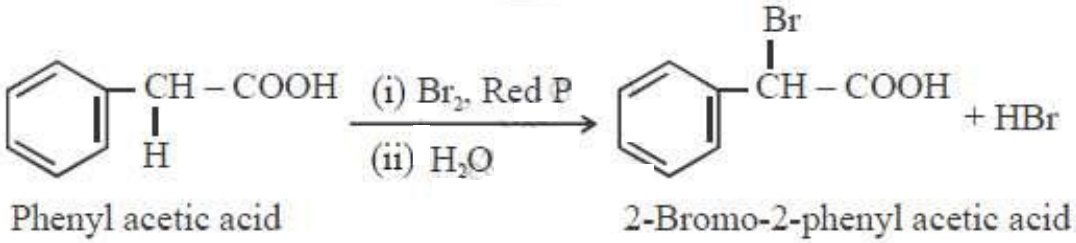
Question 27.B.iii: Write chemical equation for the following : [1]
Fischer esterificatione

Solution: Fischer esterificatione



Question 27.B.iv: Write chemical equation for the following : [1]
Hell - Vohlard - Zelinsky reaction

Solution: Hell - Vohlard - Zelinsky reaction



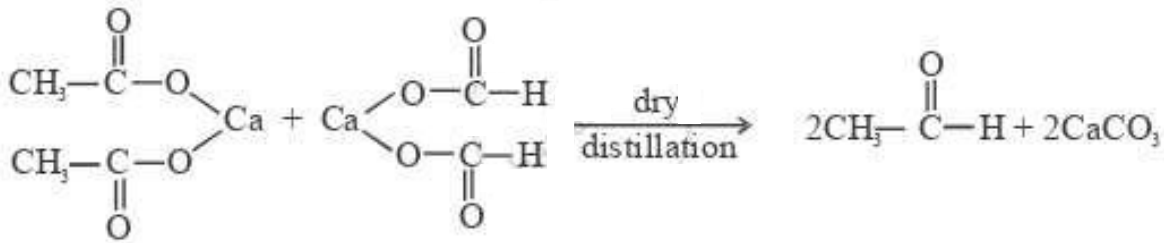
OR

Question 27.C: What are amines? [1]

Solution: Amines are the organic derivatives of ammonia in which one, two or all the three hydrogens atoms attached to nitrogen are replaced by equivalent number of same or diferent alkyl or aryl group.

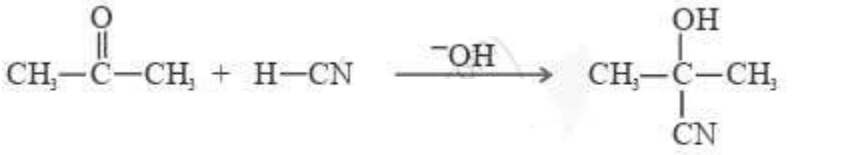
Question 27.D.i: How will you convert calcium acetate to acetaldehyde? **[1]**

Solution:



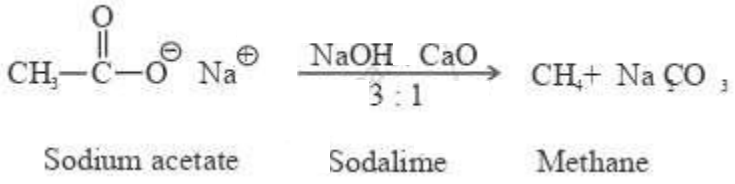
Question 27.D.ii: How will you convert acetone to acetone cyanohydrin? **[1]**

Solution:



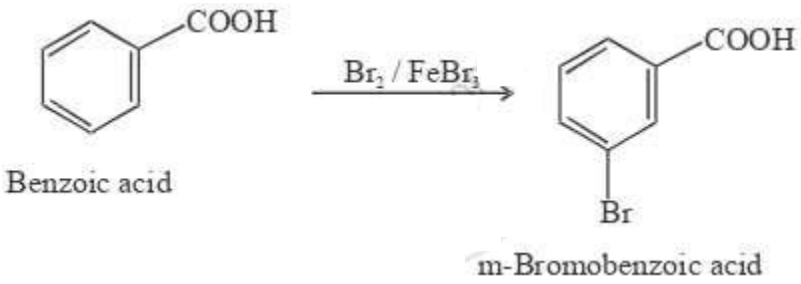
Question 27.D.iii: How will you convert sodium acetate to methane? **[1]**

Solution:



Question 27.D.iv: How will you convert benzoic acid to m-bromobenzoic acid? **[1]**

Solution:



Question 28: Attempt any one. [5]

Question 28.A: Define Enantiomers. [1]

Solution: Stereoisomers which are non-superimposable mirror images of each other and rotate the plane of plane polarised light through the same angle but in opposite directions are known as enantiomers or enatiomorphs.

Question 28.B: How is potassium dichromate prepared from chrome iron ore? [1]

Solution: Potassium dichromate is prepared from chromite ore ($FeCr_2O_4$) in the following steps.

Step (1): Preparation of sodium chromate

$4FeCr_2O_4 + 16NaOH + 7O_2 \rightarrow 8NaCrO_4 + 2Fe_2O_3 + 8H_2O$

Step (2): Conversion of sodium chromate into sodium dichromate

$2Na_2CrO_4 + conc.H_2SO_4 \rightarrow Na_2Cr_2O_7 + Na_2SO_4 + H_2O$

Step(3): Conversion of sodium dichromate to potassium dichromate

$Na_2Cr_2O_7 + 2KCl \rightarrow K_2Cr_2O_7 + 2NaCl$

Potassium dichromate being less soluble than sodium chloride is obtained in the form of orange coloured crystals and can be removed by filtration.

OR

Question 28.C: What is Grignard reagent? [1]

Solution: Grignard's reagent is an organometallic compound in which the divalent magnesium is directly linked to an alkyl group acid and a halogen atom. It is represented by general formula R–Mg–X

Question 28.D: Explain the position of actinoids in the periodic table. [1]
What is the action of sulphur on lanthanoids? Calculate the magnetic moment of divalent ion in aqueous solution it its atomic number is 24.

Solution: Actinoids have a general electronic configuration $5f^{d\text{-}14}\ 6d^{0\text{-}1}7s^2$.
They are placed at the bottom of periodic table. It follows actinium, Ac = (Z = 89).
i.e., It starts from the seventh period and 3rd group.

$2Ln + 3S \rightarrow Ln_2S_3$ (Ln is any lanthanoids)

$X \rightarrow X^{2+} + 2e^-$

Electronic Configuration :$1s^2\ 2s^2\ 2p^6 3s^2 3p^6 4s^1 3d^5$
in +2 state : $1s^2\ 2s^2\ 2p^6 3s^2 3p^6 4s^0 3d^4$

Number of unpaired electron = 4

Magnetic moment $(\mu) = \sqrt{n(n+2)} = \sqrt{4(4+2)} = \sqrt{24} = 4.89$ B.M

Question 29: Attempt any one **[5]**

Question 29.A: The rate of a first order reaction, A →B is 5.4 ×10^{-6} **[1]** $Ms^{-1}$when [A] is 0.3M. Calculate the rate constant of the reaction.

Solution: Rate =k [A]

5.4 × 10^{-6} = k × 0.3

$$k = \frac{5.4 \times 10^{-6}}{0.3} = 18 \times 10^{-6}\ s^{-1}$$

Question 29.B: Explain the following properties of group 16 elements : **[1]**
1) Electro negativity
2) Melting and boiling points
3) Metallic character
4) Allotropy

Solution: 1) Electronegativity :
The elements of group 16 have higher values of electronegativity than the corresponding elements of group 15. Oxygen is the second most electronegative element, the first being fluorin. The electronegativity decreases on going down the group. The decrease in electronegativity down the group is due to increase in size of the atoms.

2) Melting and boiling points :
The melting and boiling points increases with the increase in atomic number as we go down the group.

3) Metallic character :
The first four elements namely oxygen, sulphur, selenium and tellurium are non-metals. The non-metallic character is stronger in O and S are weaker in Se an Te. On the other hand, last element is markedly metallic. However, it is radioactive and is only short-lived.

4) Allotropy :
All the elements of the group exhibit allotropy. For example, oxygen exists as O_2 and O_3 (ozone.) Sulphur exists in a number of allotropic forms of which yellow ortho-rhombic, α and β -monoclinic forms are most important. All these allotropic forms of sulphur are nonmetallic. Selenium exists in eight allotropic forms of which three are red monoclinic forms containing Se_8 rings.

OR

Question 29.C: The half life period of a first order reaction is 6. 0 h. Calculate the rate constant **[1]**

Solution:

$t_{1/2}$ = 6.0 hrs

$$t_{1/2} = \frac{0.693}{k}$$

$$k = \frac{0.693}{t_{1/2}}$$

$$= \frac{0.693}{6 \times 60 \times 60}$$

$= 0.000032 s^{-1}$

$= 3.2 \times 10^{-5} s^{-1}$

Question 29.D: What are oxides? Write different types of oxides with one example each. **[1]**

Solution: The binary compounds of oxygen with other elements are called oxides. We have studied that oxygen combines with metals and non-metals to form their respective binary oxides. In these oxides, the oxidation state of oxygen is always –2.

Simple oxides

The simple oxides behave as acids or bases according to their dissociation in water. On the basis of acid-base characteristics, the oxides may be classified into the following four types :

1. Acidic oxides: The oxides which combine with water to give acids are called acidic oxides. These are generally the oxides of non-metals such as carbon, sulphur, phosphorus, etc. For example

$SO_2 + H_2O \rightarrow H_2SO_3$

Sulphurous Acid

$CO_2 + H_2O \rightarrow H_2CO_3$

Carbonic acid

2. **Basic oxides :**

The oxides which combine with water to give basic solution are called basic oxides. These are mostly the oxides of metals. For example Na2O +H2O ⟶ NaOH

3)**Amphoteric oxides :** The oxides which show acidic as well as basic character are called amphoteric oxides. For example,

Al2O3(s) + 6HCl(aq) + 9H2O → 2[Al(H2O)6]3+
(Basic)
(aq) +6 Cl-(aq)

$$Al_2O_{3(s)} + 6NaOH_{aq} \rightarrow$$

(Basic)

$$2Na_3[Al(OH)_6]_{aq}$$

4) Neutral Oxides:

Some compounds react with oxygen to form oxides which do not exhibit acidic nor basic characteristics. Such compounds are called as neutral compounds of oxygen.

Example: NO, CO.