Solution

Class 12 - Chemistry

2020-21 paper 5

Section A

1. i. (b) Fe^{3+}
   ii. (b) Zn, Cd, Hg
   iii. (c) Nearly same atomic size
   iv. (d) Variable oxidation state
   v. (d) Fe^{2+}
2. i. (b) Assertion and reason both are correct statements but reason is not correct explanation for assertion
   ii. (d) Assertion is wrong statement but reason is correct statement
   iii. (d) Assertion is wrong statement but Reason is correct statement
   iv. (b) Assertion and reason both are correct statements but reason is not correct explanation for assertion
   v. (c) Assertion is correct statement but reason is wrong statement
3. **(c)** p – nitroaniline < aniline < p – toluidine < p – methoxyaniline
   Explanation: -OMe group at a para position will increase the basicity of more than-CH_3 group at the para position. While the presence of $–NO_2$ at a para position will decrease the basicity.
4. **(d)** phosphodiester linkage
   Explanation: Nucleotides are together by phosphodiester linkage between 5' and 3' carbon atoms of the pentose sugar.

   OR

   (a) Amino acids
   Explanation: Only α-amino acids are obtained on hydrolysis of proteins.
5. **(b)** Benzene and Toluene
   Explanation: The intermolecular attractive forces between benzene-benzene and toluene-toluene are nearly equal to those between benzene-toluene, this leads to the formation of ideal solution.
6. **(c)** Butane < 1-Chlorobutane < 1-Bromobutane < 1-Iodobutane
   Explanation: Due to the polar nature of alkyl halides and the increase in molecular weight compared to their parent alkanes, the boiling points of alkyl halides are higher than that of their parent alkanes. The boiling points of alkyl halides depend on the molecular mass and the size of the halogen atom (decrease from I to F). With the increase in size, mass, and the number of electrons in halogen atoms, the magnitude of Van Der Waals forces increase and the boiling point also increases. The boiling point of alkyl halides reduces in the order RI > RBr > RCl > RF.
   Therefore, the order of increasing order of boiling points should be Butane < 1-Chlorobutane < 1-Bromobutane < 1-Iodobutane.

   OR

   (d) Cyclopentane
   Explanation: Alkanes undergo free radical halogenation in the presence of sunlight to give a mixture of isomeric mono- and polyhaloalkanes. So cyclopentane must be the compound with formula C_5H_{10} which must have reacted with Chlorine in presence of sunlight (but not in dark) to form C_5H_9Cl.
7. **(c)** Hoffmann bromamide reaction
   Explanation: In Hoffmann bromamide degradation reaction, the amine formed has one carbon less than the amide.
   $RCONH_2 + Br_2 + 4NaOH \rightarrow RNH_2 + Na_2CO_3 + 2NaBr + 2H_2O$

   OR

   (c) $NH_2^- > OH^- > NH_3 > H_2O$
   Explanation: $NH_2^- > OH > NH_3 > H_2O$. Due to higher electronegativity of O than N atom, the O-H bond is

more polar than the N-H bond. Hence, O-H is more acidic in nature than the N-H bond. Now, NH_2 and OH have a negative charge due to which they are more basic than NH_3 and H_2O.

8. **(b)** H_2

   Explanation: The critical temperature is the maximum temperature at which a gas can be liquefied by applying high pressure. Higher the critical temperature of a gas, more easily it can be liquefied and adsorbed.
   Here, H_2 gas has the least value of the critical temperature. So it shows the least adsorption.

   OR

   (c) associated colloid

   Explanation: At low concentration, the soap solution behaves like a normal strong electrolyte. But at high concentration, soap molecules aggregate to form micelles. These are known as associated colloids.

9. **(d)** Ammonia is more easily liquefiable
   Explanation: Ammonia is easily liquefiable because of H- bonding interactions.

10. **(b)** (a), (b), (c)
    Explanation: Asymmetric/chiral carbon atom is that in which all of its four valencies with four different groups or atoms (can not be superimpose). In molecules (i), (ii), and (ii), all have asymmetric carbon as each carbon has satisfied all four valencies with four different groups of atoms.

11. **(c)** 74.65
    Explanation: $M = \frac{dN_A a^3}{Z}$
    $= \frac{1.984 \times 6.02 \times 10^{23} \times 25.0 \times 10^{-23}}{4}$
    = 74.65 g mol^{-1}

12. **(c)** Assertion is CORRECT but, reason is INCORRECT.
    Explanation: Assertion is CORRECT but, reason is INCORRECT.

13. **(c)** The assertion is the correct statement and reason is the wrong statement.
    Explanation: 'D' corresponds to the position of -OH group on the right side on the farthest asymmetric C-atom.

14. **(a)** Both assertion and reason are CORRECT and reason is the CORRECT explanation of the assertion.
    Explanation: Both assertion and reason are CORRECT and reason is the CORRECT explanation of the assertion.

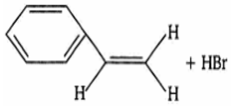
    OR

    (c) Assertion is CORRECT but, reason is INCORRECT.
    Explanation: Assertion is CORRECT but, reason is INCORRECT.

15. **(c)** Assertion is CORRECT but, reason is INCORRECT.
    Explanation: Assertion is CORRECT but, reason is INCORRECT.

16. **(a)** The assertion is wrong but the reason is the correct statement.
    Explanation: Haloalkanes react with AgCN to form alkyl isocyanides as the main product while KCN forms alkyl cyanides as the chief product.

Section B

17. i. 

$\xrightarrow{peroxide}$ $C_6H_5 - CH_2 - CH_2Br$

ii. $CH_3 - CH_2 - CH = CH_2 + HCl \rightarrow CH_3 - CH_2 - CHCl\text{-}CH_3$

OR

Reaction with KCN produces methyl cyanide and with AgCN produces methyl isocyanide preferentially.

$$\underset{\text{Methyl bromide}}{CH_3Br} + KCN \rightarrow \underset{\text{Methyl cyanide}}{CH_3C \equiv N} + KBr$$

$$\underset{\text{Methyl bromide}}{CH_3Br} + AgCN \rightarrow \underset{\text{Methyl isocyanide}}{CH_3N \underset{\rightarrow}{=} C} + AgBr$$

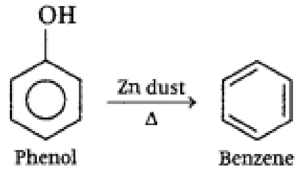
18. The vapour pressure of a liquid depends on the escape of solvent molecules from the surface of the liquid. On addition of a non-volatile solute vapour pressure of solvent gets reduced because the surface contains solute molecule as well as solvent molecules. Consequently, the number of solvent (volatile) molecules escaping from the surface correspondingly reduced, thus the vapour pressure of solvent gets reduced.
19. According to the Hardy-Schulze rule, the coagulation property of an electrolyte depends upon the valency of the coagulation ion. Higher the charge on flocculating ion added, the greater is its power to cause precipitation. Phosphate ion has -3 charge while chloride ion carries only -1 charge. So the coagulating power of phosphate is higher than chloride.

OR

   a. Brownian movement: The continuous zig-zag movement of particles in a colloidal solution when observed under microscope is called Brownian movement.
   b. Electrophoresis: The movement of colloidal particles under an applied electric potential is called electrophoresis.
20. Zero order reaction means that the rate of reaction is proportional to zero power of concentration of reactants. For example: the decomposition of gaseous ammonia on a hot platinum surface is a zero order reaction at high pressure.

$$2NH_3(g) \xrightarrow[\text{Pt catalyst}]{1130} N_2(g) + H_2(g)$$

Unit of zero order reaction is $mol\, L^{-1} S^{-1}$
21. The four factors that effect the rate of reaction are:
   i. Nature of reactants
   ii. Temperature
   iii. Catalyst
   iv. Physical state of reactant
22. i. Zn dust and heat



   ii. 85% H_3PO_4/440 K

$$\underset{\text{Propan-2-ol}}{CH_3 - \overset{\overset{OH}{|}}{C}H - CH_3} \xrightarrow[440\ K]{85\%/H_3PO_4} \underset{\text{Propene}}{CH_3 - CH = CH_2} + H_2O$$

23. Fe^{3+} has electronic configuration [Ar] $3d^5 4s^0$

It has 5 unpaired electron, so n=5

$\mu = \sqrt{n(n+2)}$

$= \sqrt{5(5+2)} = \sqrt{35}$

= 5.9 BM
24. Iodoform test: This test is used to identify methyl ketones. In this the given ketone is reacted with I_2 and NaOH. If a yellow coloured substance (iodoform) is produced it shows the presence of a methyl ketone.

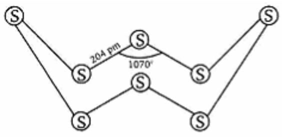
$$\underset{\text{Acetone}}{CH_3 - \overset{\overset{O}{||}}{C} - CH_3} + \underset{\text{Iodine}}{3I_2} + 4NaOH \rightarrow \underset{\text{Iodoform}}{CHI_3} + CH_3COONa + 3NaI + 3H_2O$$

25. Electrical conductivity decreases with rise in temperature because positively charged Kernels begin to vibrate about their mean position and create hindrance in the flow of electrons.

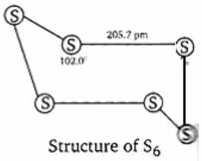
Section C

26. **Allotropy of sulphur:**

  i. The stable form of sulphur at room temperature is orthorhombic sulphur, which transforms to monoclinic sulphur when heated above 369 K.
  ii. Both orthorhombic and monoclinic sulphur are molecular solids. The S_8 ring in both, the form is puckered and has a crown shape.



Structure of S_8



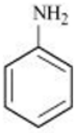
Structure of S_6

OR

$3Cl_2 + 6NaOH \rightarrow 5NaCl + NaClO_3 + 3H_2O$

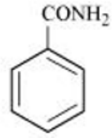
This reaction is a disproportionation reaction as chlorine from zero oxidation state is changed to -1 and + 5 oxidation state.

27. It is given that compound 'C' having the molecular formula, C_6H_7N, and formed by the reaction of compound 'B' with Br_2 and KOH. This is a Hoffmann bromamide degradation reaction. Therefore, compound 'B' is an amide, and compound 'C' is an amine. The only amine having the molecular formula C_6H_7N is aniline, ($C_6H_5NH_2$).



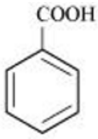
Aniline

Compound 'B' (from which 'C' is formed) must be benzamide, ($C_6H_5CONH_2$).



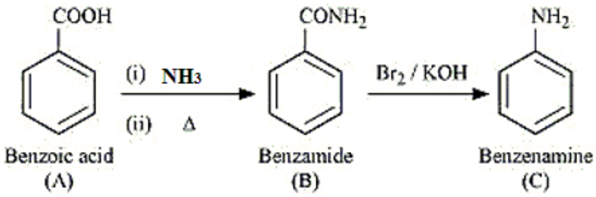
Benzamide

Further, benzamide is formed by heating compound 'A' with aqueous ammonia. Therefore, compound 'A' must be benzoic acid.



Benzoic acid

The given reactions can be explained with the help of the following equations:



OR

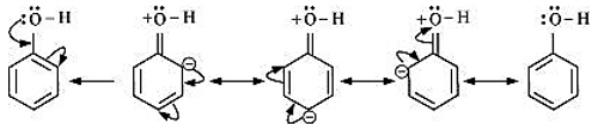
  i. Aniline being a Lewis base reacts with Lewis acid ($AlCl_3$) to form a salt.

$$\mathrm{C_6H_5NH_2 + AlCl_3} \longrightarrow C_6H_5\overset{+}{N}H_2AlCl_3^-$$

As a result, N acquires a positive charge so, it acts as a strong deactivating group for electrophilic substitution reaction. Thus, aniline does not undergo Friedel-Crafts reaction.
  ii. Primary aromatic amines cannot be prepared by Gabriel phthalimide synthesis because aryl halides do not undergo nucleophilic substitution with the anion formed by phthalimide. Gabriel phthalimide synthesis is used for the preparation of primary amines.
  iii. Aliphatic amines are stronger bases than the ammonia because the alkyl group in aliphatic amines has +I effect. So the alkyl group tends to increase the electron density on the nitrogen atom whereas the electron releasing tendency of amines becomes more than that of ammonia.

28. **Given ,** In bcc no. of atoms per unit cell ,Z = 2
M = Atomic mass of Iron = 55.845 u
Density (d) = 7.874 g/cm^3 , a (edge length) = 286.65 pm = 286.65 × 10^{-10} cm
By applying density formula, we get
$d = \frac{ZM}{a^3 N_A}$
$7.874 = \frac{2\times 55.845}{(286.65\times 10^{-10})\times N_A}$
$N_A = \frac{2\times 55.845}{7.874\times(296.65\times 10^{-10})^3}$
$= 6.167 \times 10^{23}$

29. a. **Isoelectric point.** It is the pH at which +ve and -ve charges on zwitter ion are equal, e.g. amino acid exists as zwitterions at pH = 5.5 to 6.3
    b. **Mutarotation.** It is a spontaneous change in optical rotation when an optically active substance is dissolved in water, e.g. α-glucose, when dissolved in water, its optical rotation changes from 111° to 52.5°.
    c. **Enzymes.** Enzymes are biocatalysts which speed up the reactions in biosystems. They are very specific and selective in their action. Chemically all enzymes are proteins.

30. The -OH group is an electron-donating group. Thus, it increases the electron density in the benzene ring as shown in the given resonance structure of phenol.

As a result, the benzene ring is activated towards electrophilic substitution.

Section D

31. General trends in group 15 elements:
    i. **Electronic configuration:** All the elements in group 15 have 5 valence electrons. Their general electronic configuration is ns^2 np^3. The s orbitals in these elements are completely filled and the p orbital is half-filled.
    ii. **Oxidation states:** All these elements have 5 valence electrons common oxidation state of these elements are -3, +3 and +5. They usually require three more electrons to complete their octets. However, gaining electrons is very difficult as the nucleus will have to attract three more electrons. This can take place only with nitrogen as it is the smallest in size and the distance between the nucleus and the valence shell is relatively small. The remaining elements of this group show a formal oxidation state of -3 in their covalent compounds in addition to the -3 state, N and P also show -1 and -2 oxidation states, All the elements present in this group show +3 and +5 oxidation states. However, the stability of the +5 oxidation state decreases down a group, whereas the stability of the +3 oxidation state increases, This happens because of the inert pair effect.
    iii. **Ionization energy and electronegativity:** ionization enthalpy decreases on moving down a group. This is because of increasing atomic sizes. As we move down a group, electronegativity decreases, owing to an increase in size.
    iv. **Atomic size:** On moving down a group, the atomic size increases. This increase in the atomic size is attributed to an increase in the number of shells.

OR

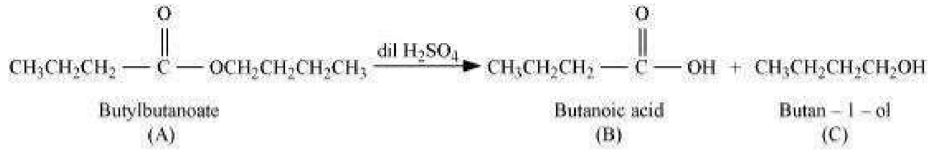
    i. $PbS\ (s)\ +\ 4O_3\,(g) \rightarrow PbSO_4\,(s)\ +\ 4O_2\,(g)$
    ii. $NO(g)\ +\ O_3\,(g)\ \rightarrow NO_2\,(g)\ +\ O_2\,(g)$
    iii. $4FeS_2\,(s) + 11O_2\,(g) \rightarrow 2Fe_2O_3\,(s) + 8SO_2\,(g)$
    iv. $2NaOH\ +\ SO_2 \rightarrow Na_2SO_3 + H_2O$
    v. $2Fe^{3+} + SO_2\ + 2H_2O\ \rightarrow 2Fe^{2+} + SO_4^{2-} + 4H^+$
    vi. $Cu + 2H_2SO_4\,(conc) \rightarrow CuSO_4 + SO_2 + 2H_2O.$

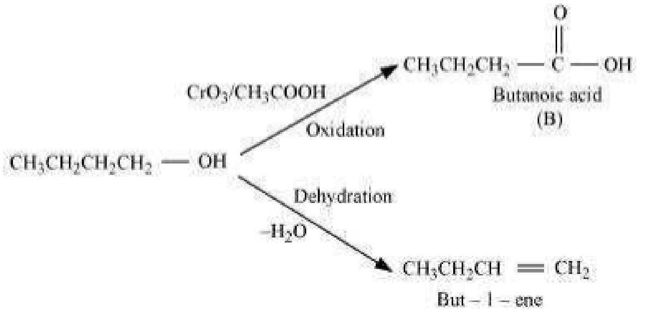
32. An organic compound A with molecular formula $C_8H_{16}O_2$ gives a carboxylic acid (B) and an alcohol (C) on hydrolysis with dilute sulphuric acid. Thus, compound A must be an ester. Further, alcohol C gives acid B on oxidation with chromic acid. Thus, B and C must contain equal number of carbon atoms. Since compound A contains a total of 8 carbon atoms, each of B and C contain 4 carbon atoms. Again, on dehydration, alcohol C gives but-1-ene. Therefore, C is of straight chain and hence, it is butan-1-ol. On oxidation, Butan-1-ol gives

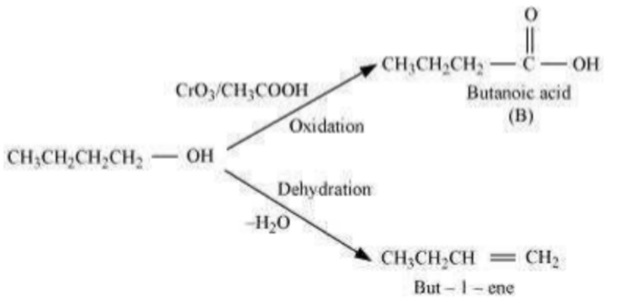
butanoic acid. Hence, acid B is butanoic acid. Hence, the ester with molecular formula $C_8H_{16}O_2$ is butylbutanoate.

$$\underset{Butylbutanoate}{CH_3CH_2CH_2-\overset{\overset{O}{||}}{C}-OCH_2CH_2CH_2CH_3}$$

All the given reactions can be explained by the following equations.

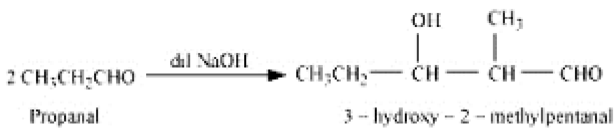




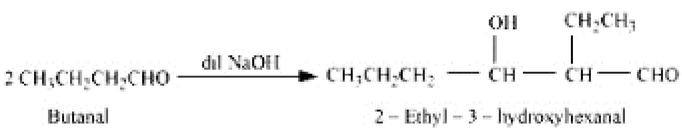


OR

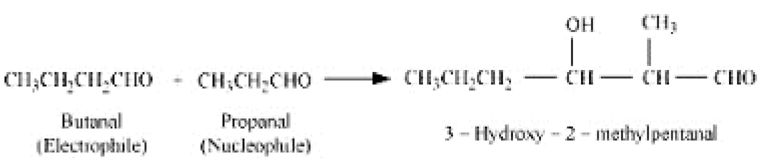
i. Taking two molecules of propanal CH_3CH_2CHO, one which acts as a nucleophile and the other as an electrophile.



ii. Taking two molecules of butanal $CH_3CH_2CH_2CHO$, one which acts as a nucleophile and the other as an electrophile.



iii. Taking one molecule each of propanal CH_3CH_2CHO and butanal$CH_3CH_2CH_2CHO$ in which propanal acts as a nucleophile and butanal acts as an electrophile.



iv. Taking one molecule each of propanal CH_3CH_2CHO and butanal $CH_3CH_2CH_2CHO$ in which propanal acts as an electrophile and butanal act as a nucleophile.

33. The water layer present on the surface of iron (especially in the rainy season) dissolves acidic oxides of air like CO_2 ,SO_2 etc. to from acids which dissociate to give H^+ ions:

$H_2O + CO_2 \rightarrow H_2CO_3 \rightleftharpoons 2H^+ + CO_3^{2-}$

In the presence of H^+ ions iron starts losing electrons at some spot to form ferrous ions, i.e. its oxidation takes place. Hence, this spot acts as the anode:

$Fe(s) \rightarrow Fe^{2+}(aq) + 2e^-$

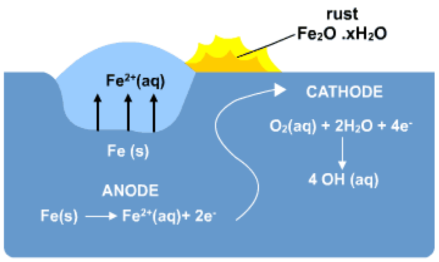
The electrons this released through the metal to reach another spot where H^+ ions and the dissolved oxygen takes up these electrons and reduction reaction takes place. Hence, this spot acts as the cathode:

$O_2(g) + 4H^+(aq) + 4e^- \rightarrow 2H_2O(l)$

The overall reaction is :

$2Fe(s) + O_2(g) + AH^+(aq) \rightarrow 2Fe^{2+}(aq) + 2H_2O(l)$

Ferrous ions are further oxidized by the atmospheric oxygen to ferric ions which combine with water molecules to form hydrated ferric oxide, $Fe_2O_3.xH_2O$ which is rust.



OR

For electrolyte X

Molarity = 0.05 M

Resistance = 100Ω

Conductivity = $1.0 \times 10^{-4} S\, cm^{-1}$

For electrolyte Y

Molarity = 0.01 M

Resistance = 50Ω

Conductivity = ?

i. Cell constant = Conductivity (K) $\times$ Resistance (R)

$G^* = 1.0 \times 10^{-4} \times 100$

$= 10^{-2} cm^{-1}$

ii. Conductivity of solution Y is

$K = \frac{G^*}{R} = \frac{10^{-2}}{50}$

$= 0.02 \times 10^{-2}$

$= 2 \times 10^{-4} S\, cm^{-1}$

iii. Concentration C = 0.01 M

$= 0.01\, mol\, L^{-1}$

$= 0.01 \times 1000\, mol\, ml^{-3}$

$= 10 mol\, cm^{-3}$

$\therefore$ Molar concentration

$\lambda_m = \frac{K}{C} = \frac{2 \times 10^{-4}}{10}$

$= 0.2 \times 10^{-4} S\, cm^2 mol^{-1}$