Series CHE/SP/1E   **Code No. SP/1-E**

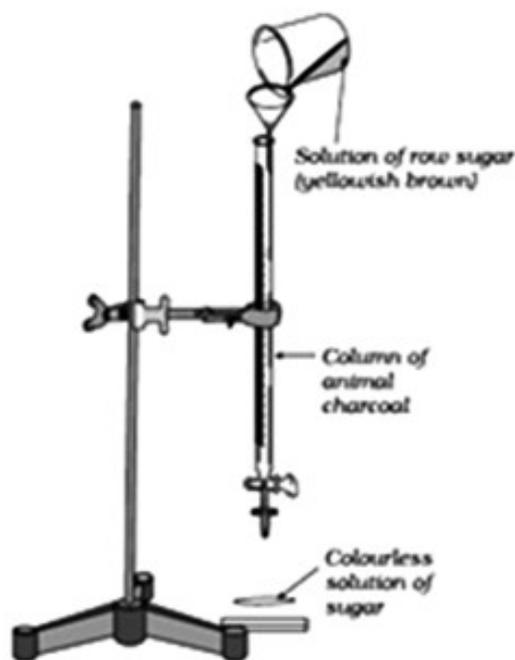## CHEMISTRY

Time Allowed: 3 hours   *Maximum Marks: 70*

General Instructions:

(i)   **All** questions are compulsory.

(ii)   Questions No. **1** to **5** are very short answer type questions and carry **1** mark each.

(iii) Questions No. **6** to **10** are short-answer questions and carry **2** marks each.

(iv)   Questions No. **11** to **22** are also short-answer questions and carry **3** marks each.

(v)   Questions No. **23** is a value based question and carry 4 marks.

(vi)   Questions No. **24** to **26** are long-answer questions and carry **5** marks each.

(vii) Use Log Tables, if necessary. Use of calculators is **not** allowed.

1.   What is the percentage of empty space present in a body centred cubic lattice?   1

2.   We have three aqueous solutions of NaCl labelled as 'A', 'B' and 'C' with concentrations 0.1M, 0.01M and 0.001M, respectively. The value of van't Hoff factor for these solutions will be in which order?   1

3.   Which phenomenon is applicable to the process given below?

Solution of raw sugar
(yellowish brown)

Column of
animal
charcoal

Colourless
solution of
sugar

1

4. How can zinc sulphide and lead sulphide be separated in the Froth Floatation process?

1

5. In the preparation of HNO_3, we get NO gas by catalytic oxidation of ammonia. How many moles of NO will be produced by the oxidation of two moles of NH_3?

1

6. Explain why on addition of 1 mol of NaCl to 1 litre of water, the boiling point of water increases, while addition of 1 mol of methyl alcohol to one litre of water decreases its boiling point.

2

7. Why can't molecularity of any reaction be equal to zero?

2

8. Which method is used for refining Zr and Ti? Explain with equation.

2

9. Write steps to carry out the conversion of phenol to aspirin.   2

OR

Dipole moment of phenol is smaller than that of methanol. Why?   2

10. α-Helix is a secondary structure of proteins formed by twisting of polypeptide chain into right handed screw like structures. Which types of interactions are responsible for making the α-helix structure stable?   2

11. Explain why $MeNH_2$ is stronger base than MeOH?   3

12. Explain the following phenomena with the help of Henry's law:
   a. Painful condition known as bends
   b. Feeling of weakness and discomfort in breathing at high altitude   3

13. What happens when benzene diazonium chloride is heated with water?   3

14. What is the role of pyridine in the acylation reaction of amines?   3

15. During curdling of milk, what happens to sugar present in it?   3

**16.** Give reasons:
   a. ZnO (s) becomes yellow upon heating
   b. Electrical conductivity of semiconductors increases with rise in

temperature. 3

17. Oxygen is present in plenty in air yet fuels do not burn by
   themselves at room temperature. Explain. 3

18. Why is desorption important for a substance to act as good
   catalyst? 3

OR

What is the role of diffusion in heterogenous catalysis? 3

19. Nitric acid forms an oxide of nitrogen on reaction with P_4O_{10}.
   Write the reaction involved. Also write the resonating structures
   of the oxide of nitrogen formed. 3

20. PCl_5 reacts with finely divided silver on heating and a white silver
   salt is obtained, which dissolves on adding excess aqueous NH_3
   solution. Write the reactions involved to explain what happens. 3

21. Give the electronic configuration of the following complexes on the
   basis of Crystal Field Splitting theory.
   $[CoF_6]^{3-}$, $[Fe(CN)_6]^{4-}$ and $[Cu(NH_3)_6]^{2+}$ 3

22. Draw other resonance structures related to the following
   structure and find out whether the functional group present in the
   molecule is ortho, para directing or meta directing.
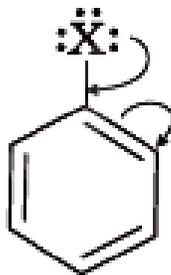
3

23. Nitrogen combines with hydrogen to form ammonia.

$N_2 + 3H_2 \rightarrow 2NH_3$.
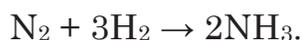
Ammonia is the basic raw material for preparing fertilizers. Always associated with a refinery/ petrochemical industry we have a fertilizer industry.

a. Why?

b. What is the value you derive from this.

4

24. a. What is Kohlrausch law of independent migration of ions?

b. Write the cell reaction of a lead storage battery when it is discharged. How does the density of the electrolyte change when the battery is discharged?

5

OR

a. Why on dilution the Λ_m of CH_3COOH increases drastically, while that of CH_3COONa increases gradually?

b. What are the applications of Kohlrausch law?

5

25. A violet compound of manganese (A) decomposes on heating to liberate oxygen, and compounds (B) and (C) of manganese are formed. Compound (C) reacts with KOH in the presence of

potassium nitrate to give compound (B). On heating compound (C) with conc. H_2SO_4 and NaCl, chlorine gas is liberated and a compound (D) of manganese along with other products is formed. Identify compounds A to D and also explain the reactions involved.   5

OR

a. The halides of transition elements become more covalent with increasing oxidation state of the metal. Why?

b. While filling up of electrons in the atomic orbitals, the 4s orbital is filled before the 3d orbital but reverse happens during the ionization of the atom. Explain why?   5

26. a. Write the following name reactions:

    1. Rosenmund's reaction

    2. Stephen's reaction

b. Oxidation of ketones involves carbon-carbon bond cleavage. Name the products formed on oxidation of 2, 5-dimethylhexan-3-one.   5

OR

a. Arrange the following in decreasing order of their acidic strength and give reason for your answer.

CH_3CH_2OH, CH_3COOH, $ClCH_2COOH$, FCH_2COOH, $C_6H_5CH_2COOH$

b. Write the IUPAC names of the following structures:

1. CHO



    CHO

2. Br

    CHO
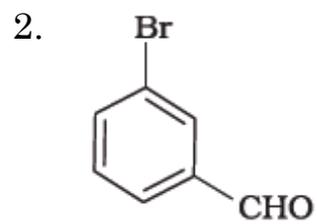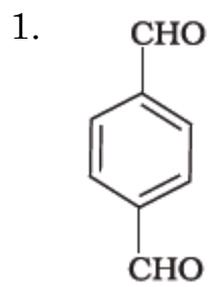
5

ANSWERS

1. 32%

2. $i_A = i_B = i_C$

3. Adsorption

4. By adjusting the proportion of oil to water and by using depressant.

5. 2

6. NaCl is a non volatile solute, therefore, addition of NaCl to water lowers the vapour pressure of water. As a result boiling point of water increases. Methyl alcohol on the other hand is more volatile than water, therefore its addition increases, the total vapour pressure over the solution and a decrease in boiling point of water results.

7. Molecularity is the number of molecules taking part in an elementary step. For this we require at least a single molecule leading to the value of minimum molecularity of one.

8. Van Arkel method is used for refining Zr and Ti. In this method crude metal is heated with iodine.

$$Zr + 2I_2 \rightarrow ZrI_4$$

$$ZrI_4 \xrightarrow{1800K} Zr + 2I_2$$

9.
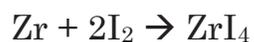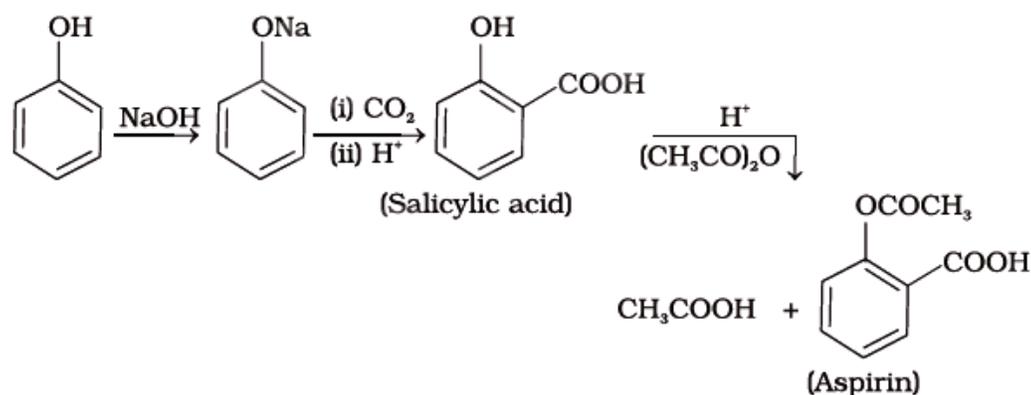
10. In α-helix, a polypeptide chain is stabilised by the formation of hydrogen bonds between —NH— group of amino acids in one turn with the $>C== O$ groups of amino acids belonging to adjacent turn.

11. Nitrogen is less electronegative than oxygen therefore lone pair of electrons on nitrogen is readily available for donation. Hence, $MeNH_2$ is more basic than MeOH.

12. a. When the divers come towards surface, the pressure gradually decreases. This releases the dissolved gases and leads to the formation of bubbles of nitrogen in the blood. This blocks capillaries and creates a medical condition known as bends.

  b. At high altitudes the partial pressure of oxygen is less than that at the ground level. This leads to low concentrations of oxygen in the blood and tissues of people living at high altitudes or climbers. Low blood oxygen causes climbers to become weak and unable to think clearly, symptoms of a condition known as anoxia.
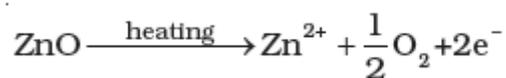
13.

Benzenediazonium chloride
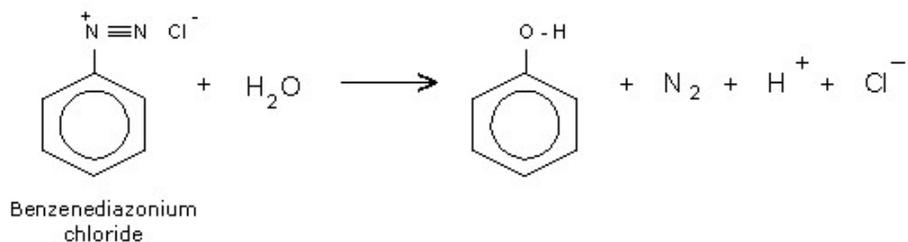
14. Pyridine and other bases are used to remove the side product i.e. HCl from the reaction mixture.

15. Lactic Acid

16. Give reasons:

a. On heating ZnO loses oxygen according to the following reaction.

$$ZnO \xrightarrow{\text{heating}} Zn^{2+} + \frac{1}{2}O_2 + 2e^-$$

Zn^{2+} ions and electrons move to interstitial sites and F-centres are created which impart yellow colour to ZnO(s).

b. The gap between conduction band and valence band is small in semiconductors, therefore, electrons from the valence band can jump to the conduction band on increasing temperature. Thus they become more conducting as the temperature increases.
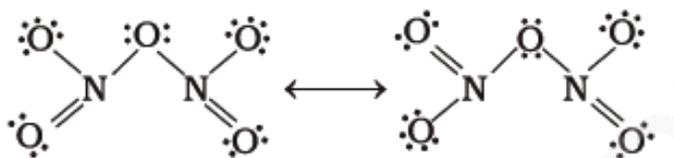
Conduction band

Small energy gap

Valence band
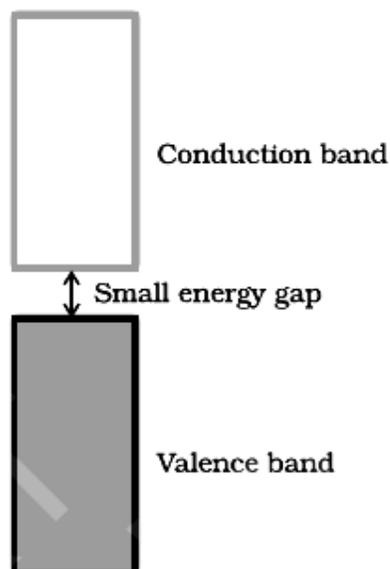
17. The activation energy for combustion reactions of fuels is very high at room temperature therefore they do not burn by themselves.

18. After the reaction is over between adsorbed reactants, the process of desorption is important to remove products and further create space for the other reactant molecules to approach the surface and react.
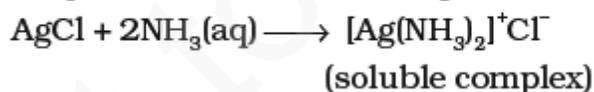
OR

The gaseous molecules diffuse on to the surface of the solid catalyst and get adsorbed. After the required chemical changes the products diffuse away from the surface of the catalyst leaving the surface free for more reactant molecules to get adsorbed and undergo reaction.

19.

$$4HNO_3 + P_4O_{10} \longrightarrow 4HPO_3 + 2N_2O_5$$

20.

$$PCl_5 + 2Ag \longrightarrow 2AgCl + PCl_3$$
$$AgCl + 2NH_3(aq) \longrightarrow [Ag(NH_3)_2]^+Cl^-$$

(soluble complex)

21. $[CoF_6]^{3-}$, $Co^{3+}(d\ 6)\ t_{2g}^{\ 4}\ e_g^{\ 2}$,

$[Fe(CN)_6]^{4-}$, $Fe^{2+}(d^6)\ t_{2g}^{\ 6}\ e_g^{\ 0}$,

$[Cu(NH_3)_6]^{2+}$, $Cu^{2+}\ (d^9)\ t_{2g}^{\ 6}\ e_g^3$

22. Ortho-para directing due to increase in the electron density at ortho and para positions.

23. a. In the refinery / petrochemical industry hydrogen gas is evolved as a biproduct. Hence to recycle this hydrogen a fertiliser unit is established nearby.

b. Recycling of industrial waste keeps the environment clean.

24. a. Kohlrausch's law of independent migration of ions states that limiting molar conductivity of an electrolyte can be represented as the sum of the individual contributions of the anion and cation of the electrolyte.

b. Pb + PbO$_2$ + 2H$_2$SO$_4$ → 2PbSO$_4$ + 2H$_2$O

Density of electrolyte decreases as water is formed and sulphuric acid is consumed as the product during discharge of the battery.

OR

a. In the case of CH3COOH, which is a weak electrolyte, the number of ions increase on dilution due to an increase in degree of dissociation.
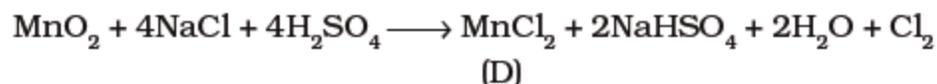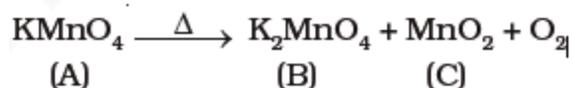
CH$_3$COOH + H$_2$O → CH$_3$COO$^-$ + H$_3$O$^+$

In the case of strong electrolyte the number of ions remains the same but the interionic attraction decreases.

b. Applications of Kohlrausch law:

Using Kohlrausch law of independent migration of ions, it is possible to calculate Ë^o$_m$ for any electrolyte from the λ^o of individual ions. Moreover, for weak electrolytes like acetic acid it is possible to determine the value of its dissociation constant once we know the Ë$_m$° and Λ$_m$ at a given concentration c.

25.

A = KMnO$_4$ B = K$_2$MnO$_4$ C = MnO$_2$ D = MnCl$_2$

KMnO$_4$ $\xrightarrow{\Delta}$ K$_2$MnO$_4$ + MnO$_2$ + O$_2$↑
  (A)   (B)   (C)

MnO$_2$ + KOH + O$_2$ ⟶ 2K$_2$MnO$_4$ + 2H$_2$O

MnO$_2$ + 4NaCl + 4H$_2$SO$_4$ ⟶ MnCl$_2$ + 2NaHSO$_4$ + 2H$_2$O + Cl$_2$
                                        (D)

OR

a. As the oxidation state increases, size of the ion of transition element decreases. As per Fajan's rule, as the size of metal ion decreases, covalent character of the bond formed increases.

b. n + 1 rule:

   $3d = n + l = 5$

   $4s = n + l = 4$

   So electron will enter in 4s orbital. Ionisation enthalpy is responsible for the ionisation of atom. 4s electrons are loosely held by the nucleus. So electrons are removed from 4s orbital prior to 3d.

26. a.

1. Rosenmund's reaction

$$CH_3-\overset{O}{\underset{\|}{C}}-Cl + H_2 \xrightarrow{Pd-C/BaSO_4} CH_3-\overset{O}{\underset{\|}{C}}-H$$

2. Stephen's reaction

$$CH_3-CN \xrightarrow[\text{(ii) } H_2O/H^+]{\text{(i) } SnCl_2/HCl} CH_3CHO$$

b.

OR

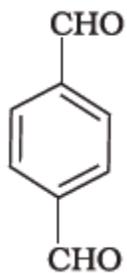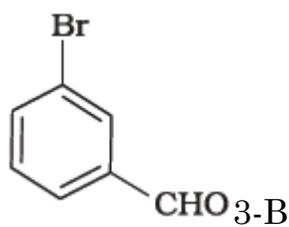a. $FCH_2COOH > ClCH_2COOH > C_6H_5CH_2COOH > CH_3COOH >$

CH₃CH₂OH

b. IUPAC names of the following structures:

1. Benzene-1, 4-dicarbaldehyde

2. romobenzaldehyde