General Instructions :

Read the following instructions carefully and follow them :

(i) This question paper contains **33** questions. **All** questions are **compulsory.**

(ii) Question paper is divided into **FIVE** sections – Section **A, B, C, D** and **E**.

(iii) **Section A** – question number **1** to **16** are multiple choice type questions. Each question carries **1 mark**.

(iv) **Section B** – question number **17** to **21** are very short answer type questions. Each question carries **2 marks**.

(v) **Section C** – question number **22** to **28** are short answer type questions. Each question carries **3 marks**.

(vi) **Section D** – question number **29** and **30** are case-based questions. Each question carries **4 marks**.

(vii) **Section E** – question number **31** to **33** are long answer type questions. Each question carries **5 marks**.

(viii) There is no overall choice given in the question paper. However, an internal choice has been provided in few questions in all the Sections except Section –**A**.

(ix) Kindly note that there is a separate question paper for Visually Impaired candidates.
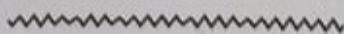
(x) Use of calculator is NOT allowed.

SECTION – A
$$16 \times 1 = 16$$

Question No. **1** to **16** are Multiple Choice type questions carrying **1 mark** each.

1. The molar ionic conductivities of Ca^{2+} and Cl^- are 119.0 and 76.3 S cm^2 mol^{-1} respectively. The value of limiting molar conductivity of $CaCl_2$ will be :
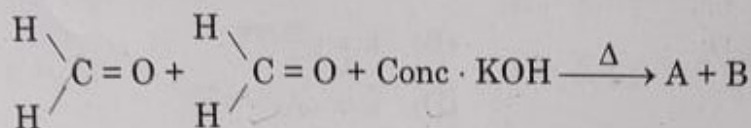
(A) 195.3 S cm^2 mol^{-1}

(B) 43.3 S cm^2 mol^{-1}

(C) 314.3 S cm^2 mol^{-1}

(D) 271.6 S cm^2 mol^{-1}

2. Consider the following reaction :

$$\begin{matrix} H \\ \diagdown \\ \diagup \\ H \end{matrix} C = O + \begin{matrix} H \\ \diagdown \\ \diagup \\ H \end{matrix} C = O + Conc \cdot KOH \xrightarrow{\Delta} A + B$$

Identify A and B from the given options :

(A) A – Methanol, B – Potassium formate

(B) A – Ethanol, B – Potassium formate

(C) A – Methanal, B – Ethanol

(D) A – Methanol, B – Potassium acetate

3. Which of the following acids represents Vitamin C ?

(A) Saccharic acid   (B) Gluconic acid

(C) Ascorbic acid   (D) Benzoic acid

4. Rosenmund reduction is used for the preparation of Aldehydes. The catalyst used in this reaction is

(A) $Pd - BaSO_4$ (B) Anhydrous $AlCl_3$

(C) Iron (III) oxide   (D) $HgSO_4$

5. Which alkyl halide from the given options will undergo S_N1 reaction faster ?

(A) $(CH_3)_3C-Br$ (B) $(CH_3)_2CH-Br$

(C) CH_3-CH_2-Br (D) $(CH_3)_3C-CH_2-Br$

6. From the elements of 3d series given below, which element shows the maximum number of oxidation states ?

(A) Scandium   (B) Manganese

(C) Chromium   (D) Titanium

7. The correct Mathematical expression of Arrhenius equation is

(A) $k = -Ae^{Ea/RT}$

(B) $k = e^{Ea/RT}$

(C) $k = Ae^{-Ea/RT}$

(D) $k = -Ae^{-Ea/RT}$

8. Identify the tertiary amine from the following :

(A) $CH_3 - \underset{\underset{CH_3}{|}}{N} - CH_3$

(B) $CH_3 - \underset{\underset{NH_2}{|}}{CH} - CH_3$

(C) $CH_3 - NH - CH_2 - CH_3$

(D) $(C_2H_5)_2CHNH_2$

9. Nucleophilic addition of Grignard reagent to ketones followed by hydrolysis with dilute acids forms :

(A) Alkene

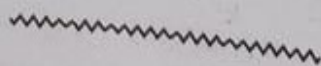(B) Primary alcohol.

(C) Tertiary alcohol

(D) Secondary alcohol

10. In a given graph of zero order reaction, the slope and intercept are :
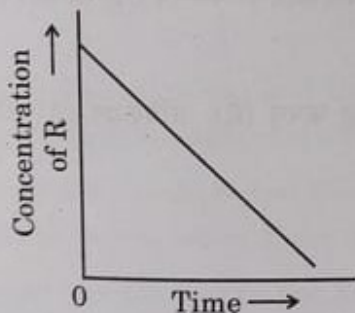
(A) Slope $= k$, Intercept $= [R]_0$

*(B) Slope $= -k$, Intercept $= [R]_0$

(C) Slope $= k/2.303$, Intercept $= \ln[R]_0$

(D) Slope $= -k/2.303$, Intercept $= \ln A \times$

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P.T.O.

11. Match the reagents required for the given reactions :

I. Oxidation of primary alcohols to aldehydes (p) $NaBH_4$

II. Butan-2-one to Butan-2-ol (q) 85% phosphoric acid at 440 K

III. Bromination of Phenol to 2, 4, 6-Tribromophenol (r) PCC

IV. Dehydration of propan-2-ol to propene (s) Bromine water

(A) I – (r), II – (p), III – (s), IV – (q) (B) I – (q), II – (r), III – (p), IV – (s)

(C) I – (s), II – (q), III – (p), IV – (r) (D) I – (p), II – (s), III – (r), IV – (q)

12. The general electronic configuration of d-block elements is :

(A) $(n - 1) d^{1-10} ns^{1-2}$

(B) $(n - 1) d^{10} ns^{1-2}$

(C) $(n - 1) d^{10} ns^{2-3}$

(D) $(n - 1) d^{0} ns^{1-2}$

For questions number 13 to 16, two statements are given – one labelled as Assertion (A) and the other labelled as Reason (R). Select the correct answer to these questions from the codes (A), (B), (C) and (D) as given below :

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Assertion (A) is false, but Reason (R) is true.

13. Assertion (A) : p-nitrophenol is less acidic than phenol.

Reason (R) : Nitro group is electron withdrawing and helps in the stabilisation of p-nitrophenoxide ion.

14. **Assertion (A)** : Benzoic acid does not undergo Friedel – Crafts reaction.

Reason (R) : Carboxyl group is deactivating and the catalyst aluminium chloride gets bonded to the carboxyl group.

15. **Assertion (A)** : Fructose is a reducing sugar.

Reason (R) : Fructose does not reduce Fehling solution and Tollen's reagent.

16. **Assertion (A)** : For a Daniell cell, $Zn/Zn^{2+}(1M) \parallel Cu^{2+} (1M)/Cu$ with $E°cell = 1.1$ V, if the external opposing potential is more than 1.1 V, the electrons flow from Cu to Zn.

Reason (R) : Cell acts like a galvanic cell.

SECTION – B

17. Define the following terms :

    (a)   Order of a reaction

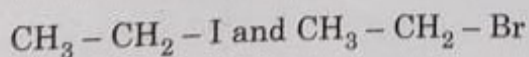   (b)   Activation energy 1×2

18. 18 g of a non-volatile solute is dissolved in 200 g of H_2O freezes at 272.07 K. Calculate the molecular mass of solute (K_f for water = 1.86 K kg mol⁻¹)   2

                                                   = 60

19. (a)   Which compound in the given pair would undergo S_N2 reaction at a faster rate and why ?

        $CH_3 - CH_2 - I$ and $CH_3 - CH_2 - Br$

    (b)   Arrange the following compounds in the increasing order of their boiling points :

        Butane, 1–Bromobutane, 1–Iodobutane, 1–Chlorobutane 1×2
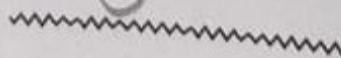
20. (a) Write the stepwise mechanism of nucleophilic addition reactions in the carbonyl compounds. ②

<div align="center">OR</div>

(b) How will you convert the following :

(i) Toluene to benzoic acid.

(ii) Ethanol to 3-Hydroxybutanal 1 × 2

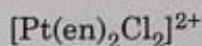**21.** (a) What happens when glucose reacts with bromine water ? Write chemical equation.

(b) Two bases are mentioned below, identify which is present in DNA and which one is present in RNA :

(i) Thymine, (ii) Uracil. ① × 2

<div align="center">SECTION – C</div>

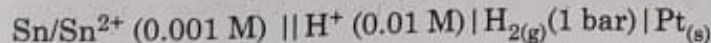**22.** (a) Draw the geometrical isomers of the given complex :

$$[Pt(en)_2Cl_2]^{2+}$$

(b) Write the electronic configuration for d^4 ion if $\Delta_0 < P$ on the basis of crystal field theory.

(c) What is meant by a unidentate ligand ? Give an example. ① × 3

23. Calculate emf of the following cell at 25 °C :

$$Sn/Sn^{2+} (0.001 \text{ M}) \,||\, H^+ (0.01 \text{ M}) \,|\, H_{2(g)}(1 \text{ bar}) \,|\, Pt_{(s)}$$

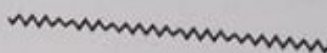Given : $E°(Sn^{2+}/Sn) = -0.14$ V, $E° \, H^+/H_2 = 0.00$ V (log 10 = 1) 3

0.1696v)

24. Write chemical equations for the following reactions : (Do any **three**)

(a) Hydroboration – oxidation reaction

(b) Williamson Synthesis

(c) Friedel-Crafts Alkylation of Anisole

(d) Reimer-Tiemann Reaction 1 × 3

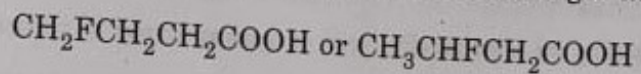56/4/1/21   13   **P.T.O.**

25. (a) Give chemical tests to distinguish between the following pairs of compounds :

(i) Phenol and Benzoic acid

(ii) Propanal and Propanone

(b) Which one of the given compounds is a stronger acid and why ?

$CH_2FCH_2CH_2COOH$ or CH_3CHFCH_2COOH 2 + 1
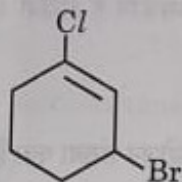
26. Explain the following terms :

(a) Essential amino acids

(b) Peptide bond

(c) Denaturation   1 × 3

27. (a) Write the IUPAC name of the given compound :

(b) The presence of $-NO_2$ group at ortho or para position increases the reactivity of haloarenes towards nucleophilic substitution reactions. Give reason to explain the above statement.

(c) What happens when ethyl chloride is treated with alcoholic potassium hydroxide ?   1 × 3

28. Show that the time required for 99.9% completion in a first order reaction is 10 times of half-life ($t_{1/2}$) of the reaction [log 2 = 0.3010, log 10 = 1].   3

56/4/1/21   15   P.T.O.

SECTION – D

The following questions are case-based questions. Read the case carefully and answer the questions that follow.

29. The nature of bonding, structure of the coordination compound can be explained to some extent by valence bond theory. The central metal atom/ion makes available a number of vacant orbitals equal to its coordination number. The appropriate atomic orbitals (s, p and d) of the metal hybridise to give a set of equivalent orbitals of definite geometry such as square planar, tetrahedral, octahedral and so on. A strong covalent bond is formed only when the orbitals overlap to the maximum extent. The d-orbitals involved in the hybridisation may be either inner d-orbitals i.e. (n–1) d or outer d-orbitals i.e. nd. The complexes formed are called inner orbital complex (low spin complex) and outer orbital complex (high spin complex) respectively. Further, the complexes can be paramagnetic or diamagnetic in nature. The drawbacks of this theory are that this involves number of assumptions and also does not explain the colour of the complex.

Answer the following questions :

(a) Predict whether $[CoF_6]^{3-}$ is diamagnetic or paramagnetic and why ?
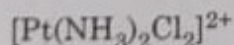[Atomic number : Co = 27]

1

(b) What is the coordination number of Co in $[Co(en)_2 Cl_2]^+$?

1

(c) (i) Write the IUPAC name of the given complex :

$[Pt(NH_3)_2Cl_2]^{2+}$
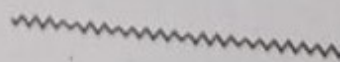
(ii) Explain $[Co(NH_3)_6]^{3+}$ is an inner orbital or outer orbital complex.

1 + 1

OR

(c) Using valence bond theory, deduce the shape and hybridisation of $[Ni(NH_3)_6]^{2+}$ [Atomic number of Ni = 28]

2

30. In a galvanic cell, chemical energy of a redox reaction is converted into electrical energy, whereas in an electrolytic cell the redox reaction occurs on passing electricity. The simplest galvanic cell is in which Zn rod is placed in a solution of $ZnSO_4$ and Cu rod is placed in a solution of $CuSO_4$. The two rods are connected by a metallic wire through a voltmeter. The two solutions are joined by a salt bridge. The difference between the two electrode potentials of the two electrodes is known as electromotive force. In the process of electrolysis, the decomposition of a substance takes place by passing an electric current. One mole of electric charge when passed through a cell will discharge half a mole of a divalent metal ion such as Cu^{2+}. This was first formulated by Faraday in the form of laws of electrolysis.

Answer the following questions :

(a) What is the function of a salt bridge in a galvanic cell ?   1

(b) When does galvanic cell behave like an electrolytic cell ?   1

(c) Can copper sulphate solution be stored in a pot made of zinc ? Explain with the help of the value of $E°$ cell.

(E° Cu^{2+} / Cu = 0.34 V)

(E° Zn^{2+} / Zn = – 0.76 V)

    2

OR

(c) How much charge in terms of Faraday is required for the following :

(i)   1 mol of MnO_4^- to Mn^{2+}

(ii)   1 mol of H_2O to O_2

    2

SECTION – E

31. Attempt any **five** of the following :

(a) Why Zinc is not regarded as a transition element ?

(b) What is Lanthanoid contraction ?

(c) Why is first ionization enthalpy of chromium lower than that of Zn ?

(d) Why are transition elements good catalysts ?

(e) Compounds of transition metals are generally coloured. Give reason.

19

(f)   Out of $KMnO_4$ and K_2MnO_4, which one is paramagnetic and why ?

(g)   Complete the following ionic equation :
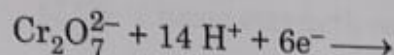
$$Cr_2O_7^{2-} + 14\,H^+ + 6e^- \longrightarrow$$ 1×5

32. (a) (i)   Define reverse osmosis.

(ii) Why are aquatic species more comfortable in cold water in comparison to warm water ?

(iii) A solution containing 2 g of glucose (M = 180 g mol^{-1}) in 100 g of water is prepared at 303 K. If the vapour pressure of pure water at 303 K is 32.8 mm Hg, what would be the vapour pressure of the solution ? $1 + 1 + 3$

OR

(b) (i)   Predict whether Van't Hoff factor will be less or greater than one, when Ethanoic acid is dissolved in benzene.

(ii) Define ideal solution.

(iii) Calculate the mass of $CaCl_2$ (molar mass = 111 g mol^{-1}) to be dissolved in 500 g of water to lower its freezing point by 2K, assuming that $CaCl_2$ undergoes complete dissociation. $1 + 1 + 3$

(K_f for water = 1.86 K kg mol^{-1})

33. (a) An amide 'A' with molecular formula C_7H_7ON undergoes Hoffmann Bromamide degradation reaction to give amine 'B'. B' on treatment with nitrous acid at 273-278 K form 'C' and on treatment with chloroform and ethanolic potassium hydroxide forms 'D'. 'C' on treatment, with ethanol gives 'E'. Identify 'A', 'B', 'C' 'D' and 'E.' and write the sequence of chemical equations.

5

OR

(i) (1) What is Hinsberg's reagent?

(2) Arrange the following compounds in the increasing order of their basic strength in gaseous phase :

$$C_2H_5NH_2, (C_2H_5)_3 N, (C_2H_5)_2 NH$$
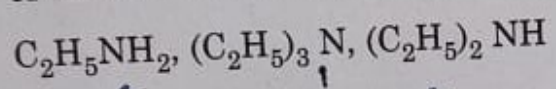
(ii) Give reasons for the following :

(1) Methyl amine is more basic than aniline.

(2) Aniline readily reacts with bromine water to give 2, 4, 6-tribromoaniline.

(3) Primary amines have higher boiling points than tertiary amines.

2 + 3

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