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CHEMISTRY

(Theory)

Full Marks : 70

Time : 3 hours

The figures in the margin indicate full marks for the questions

General Instructions :

(i) Attempt all parts of a question together in one place.

(ii) All questions are compulsory.

(iii) Section—A : Question Nos. **1** to **5** are of multiple choice type, each carrying *1* mark.

(iv) Section—B : Question Nos. **6** to **12** are of short answer-type questions and carry *2* marks each.

(v) Section—C : Question Nos. **13** to **24** are also short answer-type questions and carry *3* marks each.

(vi) Section—D : Question Nos. **25** to **27** are long answer-type questions and carry *5* marks each.

[P.T.O.

(**2**)

(vii) There is no overall choice. However, an internal choice has been provided in four questions of *2* marks, four questions of *3* marks, and all three questions of *5* marks weightage. Students have to attempt only one of the choices in such questions.

(viii) Use of non-programmable ordinary scientific calculators and log tables are allowed.

(ix) Mobile phones and pagers are not allowed inside the Examination Hall.

SECTION—A

(*Marks* : 5)

Choose and write the correct answers for the following in the answer script :

1. When benzoic acid is dissolved in benzene, the van't Hoff factor will be

   (a) 1

   (b) 0·5

   (c) 2

   (d) 1·5   1

2. A device that converts energy of combustion of fuels like hydrogen and methane directly into electrical energy is known as

   (a) fuel cell

   (b) electrolytic cell

   (c) dynamo

   (d) Nickel-Cadmium cell   1

3. The number of d-electrons in $[Cr(H_2O)_6]^{3+}$ ion (atomic number of Cr = 24) is

(a) 2

(b) 3

(c) 4

(d) 5   1

4. The existence of two different coloured complexes with composition of $[Co(NH_3)_4Cl_2]^+$ is due to

(a) linkage isomerism

(b) geometrical isomerism

(c) coordination isomerism

(d) ionization isomerism   1

5. The strongest acid among the following aromatic compounds is

(a) o-nitrophenol

(b) p-chlorophenol

(c) p-nitrophenol

(d) m-nitrophenol   1

(4)

SECTION—B

(*Marks* : 14)

6. *Either*

(a) Show that the half-life period of a first-order reaction is independent of the initial concentration of the reactant.   2

Or

(b) A first-order reaction has a rate constant of 10^{-3} sec^{-1}. How much time will it take for 10 g of the reactant to reduce to 2·5 g?

7. (a) When does average rate become equal to instantaneous rate?   1

(b) Write any one condition under which a bimolecular reaction may kinetically become first order.   1

8. *Either*

(a) Why are Mn^{2+} compounds more stable than Fe^{2+} compounds towards oxidation to their +3 state?   2

Or

(b) Write any two consequences of lanthanoid contraction.   2

9. *Either*

(a) Give one example of a complex showing linkage isomerism.   1

(b) Write the IUPAC name of the complex $[Cr(NH_3)_3(H_2O)_3]Cl_3$.   1

Or

(c) Explain, on the basis of valence bond theory, why $[NiCl_4]^{2-}$ is paramagnetic while $[Ni(CO)_4]$ is diamagnetic though both are tetrahedral.   2

10.   *Either*

(a) Name the reagent(s) used in the following conversions :   1+1=2

   (i) Ethanoic acid to ethanol

   (ii) Bromination of phenol to 2,4,6-trinitrophenol

Or

(b) How would you convert methyl magnesium bromide to 2-methyl propan-2-ol?   2

11. *(a)* Name two components of starch.   1

(b) Which vitamin deficiency causes poor coagulation of blood?   1

12. *(a)* What do you mean by glycosidic linkage?   1

(b) Write the structure of product formed when D-glucose is treated with NH_2OH.   1

(**6**)

SECTION—C

(*Marks* : 36)

13. *Either*

(a) Give one example of a solution showing positive deviation from Raoult's law. 1

(b) The vapour pressure of pure benzene at certain temperature is 0·850 bar. A non-volatile non-electrolyte solute weighing 0·5 g is added to 39 g of benzene. The vapour pressure of the solution is 0·845 bar. What is the molar mass of the solute added? (Given, molar mass of benzene = 78 g mol^{-1}) 2

Or

(c) What are azeotropic mixtures? 1

(d) Calculate the mole fraction of ethylene glycol ($C_2H_6O_2$) in an aqueous solution containing 20% of ethylene glycol by mass. 2

14. (a) What are isotonic solutions? 1

(b) A solution is prepared by dissolving 60 g of glucose ($C_6H_{12}O_6$) in 250 g of water. Calculate the freezing point of the solution. (K_f for $H_2O = 1\cdot86$ K kg mol^{-1}) 2

15. *Either*

(a) What is the difference between electrochemical cell and electrolytic cell? 1

(b) Why does a dry cell become dead after a long time even if it has been not in use? 1
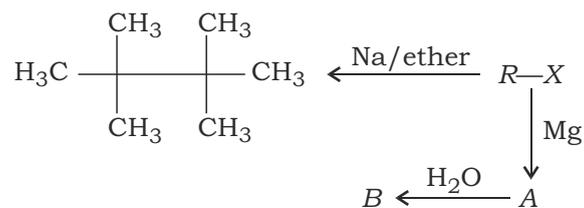
(c) What is cathodic protection? 1

Or

(d) When a current of 0·75 A is passed through $CuSO_4$ solution for 25 minutes, 0·369 g of copper is deposited at the cathode. Calculate the atomic mass of copper. $(F = 96500 \text{ C mol}^{-1})$ 2

(e) Write the products of electrolysis of NaCl (aq) solution.   1

16. (a) What is the order of a reaction whose rate constant has same unit as the rate of reaction?   1

(b) The rate constants of a reaction at 500 K and 700 K are 0·02 s^{-1} and 0·07 s^{-1} respectively. Calculate the activation energy of the reaction. $(R = 8·314 \text{ J K}^{-1} \text{ mol}^{-1})$ 2

17. (a) What is crystal field splitting energy?   1

(b) Write the coordination number and oxidation state of Pt in the complex $[Pt(en)_2Cl_2]$.   1

(c) Name the type of hybridization of central metal atom in the complex $[Fe(H_2O)_6]^{2+}$. (Given atomic number of Fe = 26)   1

18.   *Either*

(a) Arrange the following compounds in order of their increasing boiling points :   1

     Bromomethane, Bromoform, Chloromethane, Dibromomethane

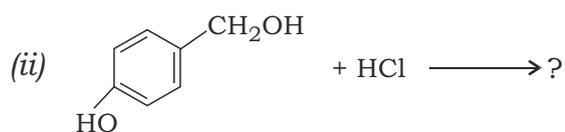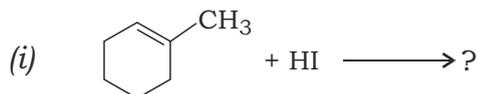(b) Identify *A*, *B* and *R* in the given sequence of reactions : 2

$$H_3C - \underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}} - \underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}} - CH_3 \xleftarrow{\text{Na/ether}} R\text{—}X$$

$$R\text{—}X \downarrow Mg$$

$$B \xleftarrow{H_2O} A$$

Or

(c) Arrange the following compounds in order of their reactivity towards S_N2 reaction : 1

2-bromo-2-methylbutane, 1-bromobutane, 2-bromobutane

(d) How would you convert 1-bromopropane to butanoic acid? 2

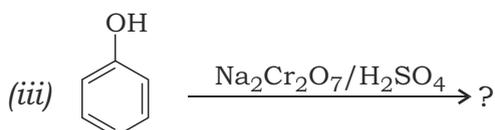**19.** Complete the following reactions : 1×3=3

(i) [cyclohexene with CH$_3$] + HI $\longrightarrow$?

(ii) [4-hydroxybenzyl alcohol, CH$_2$OH and HO] + HCl $\longrightarrow$?

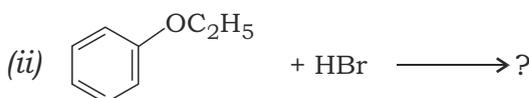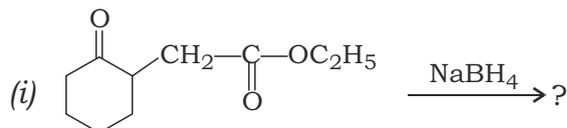(iii) CH_3CH_2Br + AgCN $\xrightarrow{\text{Ethanol}}$?

20. *Either*

(a) Write the chemical equation for Kolbe's reaction. 1

(b) Give the mechanism of acid catalyzed hydration of ethene. 2

Or

(c) Complete the following reactions :   1×3=3

(i)   [cyclohexanone with side chain] $CH_2-\overset{O}{\underset{}{C}}-OC_2H_5$ $\xrightarrow{\text{NaBH}_4}$?

(ii)   [benzene ring] OC_2H_5 + HBr $\longrightarrow$?

(iii)   [benzene ring] OH $\xrightarrow{\text{Na}_2\text{Cr}_2\text{O}_7/\text{H}_2\text{SO}_4}$?

21. (a) Arrange the following in increasing order of their acidic character :   1

     $HCOOH$, CF_3COOH, $ClCH_2COOH$, CCl_3COOH

(b) How would you obtain the following?   1+1=2

    (i) Benzoic acid from ethyl benzene

    (ii) Butanoic acid from 1-chlorobutane

22. (a) Why do amines act as nucleophiles?   1

(b) How would you convert ethanoic acid into methanamine?   2

23. (a) Name a test to distinguish between aniline and N-methylaniline.   1

(b) Complete the following reactions :   1×2=2

    (i) $C_6H_5N_2Cl$ $\xrightarrow{\text{CuCN}}$?

    (ii) C_6H_5CN $\xrightarrow{\text{LiAlH}_4}$?

24. *(a)* What are nucleotides?   1

(b) What are essential and non-essential amino acids? Give one example of each type.   2

SECTION—D

(*Marks* : 15)

25.   *Either*

(a) Represent the cell in which the following cell reaction takes place :

$$Zn\,(s) + 2Ag^+(aq) \longrightarrow Zn^{2+}(aq) + 2Ag\,(s)$$

Which one of the electrodes is negatively charged?   1+1=2

(b) State Kohlrausch's law.   1

(c) Calculate the molar conductivity of Al^{3+} ions at infinite dilution. Given that the molar conductivity of $Al_2(SO_4)_3$ and ionic conductivity of SO_4^{2-} ion at infinite dilution are $858\ S\ cm^2\ mol^{-1}$ and $160\ S\ cm^2\ mol^{-1}$ respectively.   2

Or

(d) What is electrochemical series?   1

(e) Why is it necessary to use salt bridge in a galvanic cell?   1

(11)

(f) Arrange the following metals in increasing order of their reducing power :

Zn, Ag, Ni, Cu

Given :

$$E^{\circ}_{Zn^{2+}/Zn} = -0 \cdot 76 \text{ V}, \quad E^{\circ}_{Ag^{+}/Ag} = +0 \cdot 80 \text{ V},$$

$$E^{\circ}_{Ni^{2+}/Ni} = -0 \cdot 25 \text{ V}, \quad E^{\circ}_{Cu^{2+}/Cu} = +0 \cdot 34 \text{ V}$$ 1

(g) The cell potential for the cell reaction

$$Zn (s) + Cu^{2+} (1 \cdot 0 \ M) \longrightarrow Zn^{2+} (0 \cdot 1 \ M) + Cu (s)$$

is 1·30 V at 25 °C . Calculate its standard cell potential. 2

26.   *Either*

(a) Why do transition elements show variable oxidation states? 1

(b) Why are Zn^{2+} salts white whereas Cu^{2+} salts are coloured? 1

(c) Draw the structure of a permanganate ion (MnO_4^-). 1

(d) Give the reactions of $KMnO_4$ with KI and $FeSO_4$ in acidic medium. 1+1=2

Or

(e) Write the highest oxidation state shown by an element with atomic number 23. 1

(f) What do you mean by disproportionation reaction? Give one example. 1+1=2

(g) Give reasons for the following :   1+1=2

    (i) Transition metals and their compounds generally exhibit paramagnetic behaviour.

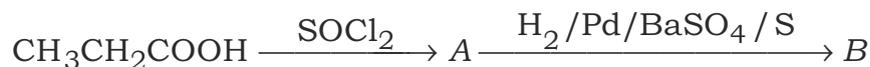   *(ii)* Manganese exhibits the highest oxidation state of +7 among $3d$ series of transition elements.

27.   *Either*

(a) Arrange the following compounds in increasing order of their reactivity in nucleophilic addition reactions :   1

      Ethanal, Propanal, Butanone, Propanone

(b) Identify the compounds A and B in the following sequence of reactions :   2

$$CH_3CH_2COOH \xrightarrow{\;SOCl_2\;} A \xrightarrow{\;H_2/Pd/BaSO_4/S\;} B$$

(c) Give the products of the following reactions :   1×2=2

    (i) $CH_3CH_2CH_2CHO \xrightarrow[\Delta]{NH_2-NH_2} ?$

    (ii) ⬡ $+ C_6H_5COCl \xrightarrow[CS_2]{Anhydrous\ AlCl_3} ?$

                        Or

(d) Name the test to distinguish between propanal and propanone.   1

(e) How would you convert ethanal into but-2-enal in not more than two steps?   2

(f) Write the structures of A and B in the following sequence of reactions :   2

$$CH_3COCH_3 \xrightarrow{\;LiAlH_4\;} A \xrightarrow{\;conc.H_2SO_4/\Delta\;} B$$

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