2023

CHEMISTRY

(Theory)

Full Marks : 70

Pass Marks : 21

Time : Three hours

All the questions are compulsory.

The figures in the right margin indicate full marks for the questions.

Question Nos. 1 – 10 are Very Short Answer (VSA) types of 1 mark each.

1. Suggest a liquid that could be added to water so that the mixture boils below 100°C at the same pressure. 　　1

2. A solution of $MgSO_4$ is electrolysed to carry out a deposition of 24.3g of magnesium at cathode. How many electrons pass through the solution during the process ? 　　1

3. Cyclopropane undergoes isomerization at 1000°C to propylene following first order kinetics with a rate constant $9.9s^{-1}$. How long would it take for the concentration of cyclopropane to decrease to 50% of its initial value ? 　　1

4. What is pyrometallurgy ? 　　1

5. Why do actinoids show larger number of oxidation states as compared to the lanthanoids ? 　　1

6. How many isomeric monochloro derivatives will be formed when 2-methylpropane is subjected to photochlorination ? 1

7. Direct iodination of benzene requires the presence of an oxidizing agent. What is the role of the oxidizing agent ? 1

8. Why is *o*-chorophenol more acidic than phenol ? 1

9. An amine with molecular formula C_3H_9N reacts with $NaNO_2$ / HCl to form a carcinogenic nitrosamine derivative. Write the structure of the amine. 1

10. A copolymer is prepared using isoprene and propene as monomers. Predict the magnitude of the intermolecular forces present in the polymer. 1

Question Nos. 11 –14 are Objective types carrying 1 mark each. Choose and rewrite the best answer out of the given alternatives.

11. The reaction taking place at cathode of fuel cells is – 1

   (A) $O_2(g) + 4H^+ (aq) + 4e^- \rightarrow 2H_2\,O(g)$

   (B) $2H_2(g) + 4OH^- (aq) \rightarrow 4H_2O(l) + 4e^-$

   (C) $H_2(g) \rightarrow 2H^+ (aq) + 2e^-$

   (D) $2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$

12. Which of the following lanthanoid ions in solution is a good oxidizing agent ? 1

   (A) Eu^{2+} (B) Yb^{2+}

   (C) Sm^{2+} (D) Tb^{4+}

13. Which of the following is a Heteroleptic complex ?   1

    (A) $K_4[Fe(CN)_6]$ (B) $Na_3[Co(NH_3)_6]$

    (C) $[Pt(NH_3)_4Cl_2]Br_2$ (D) $[Cr(H_2O)_6]Cl_3$

14. Williamson's method is a very useful method for the preparation of ethers. However it will not work in the preparation of –   1

    (A) $(CH_3)_2O$ (B) $CH_3OC_2H_5$

    (C) $C_6H_5OCH_2CH_3$ (D) $C_6H_5OC_6H_5$

Question Nos. 15 – 24 are Short Answer (SA-II) types and each carries 2 marks.

15. Give two properties that should be possessed by a solution to be an ideal solution.

                                                              1+1=2

16. Ozone in the stratosphere is decomposed by nitrogen monoxide in an elementary reaction given as –   1+1=2

$$O_3 + NO \longrightarrow O_2 + NO_2$$
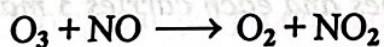
    Write the rate law and predict its overall order.

17. Concentrated aqueous ammonia contains 1.00 mol NH_3 dissolved in 2.44 mol H_2O. Calculate the molal concentration of the ammonia solution ?   2

18. Mention a factor   1+1=2

    (i) which affects the rate of reaction as well as magnitude of the rate constant.

    (ii) which affects the rate of reaction but not the magnitude of the rate constant.

19. Explain with a suitable example the process of vapour phase refining.   2

20. Why are interhalogen compounds more reactive than the halogens (except fluorine) ? Write the products formed when ClF undergoes hydrolysis.   1+1=2

21. Show how would you convert benzenediazonium chloride to benzylamine.   2

22. What is peptide bond ? How many peptide bonds are present in a tripeptide ?
                                                                                    1+1=2

23. Give the differences between cellulose and glycogen in terms of monosaccharide unit and linkage between the units.   1+1=2

24. Represent the polymers formed by the monomers –   1+1=2

    (i) Lactic acid, $\quad$ OH
    $$\quad\quad\quad\quad\quad\quad\quad |$$
    $$\quad\quad\quad CH_3 - CH - COOH$$

    (ii) Propylene, $CH_2 = CH - CH_3$

Question Nos. 25 – 31 are Short Answer (SA-I) types and each carries 3 marks.

25. Two sols of hydrated ferric oxide are prepared by adding ferric chloride solution to hot water and sodium hydroxide solutions respectively. 10 ml each of the two sols are taken and mixed together. Explain what would happen.   3

26. Zinc metal and chlorine gas are utilized in a voltaic cell represented as

    $$Zn\ (s)\ |\ Zn^{2+}\ (aq)\ ||\ Cl^-(aq)\ |\ Cl_2\ (g)\ |\ Pt\ (s)$$
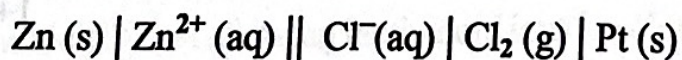
    Write the half-cell reactions and calculate the standard potential of this cell at 25°C (given that $\Delta^\circ = -410$ kJ).   1+1+1=3

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27. Give accounts for the following :   1+1+1=3

    (i) Cr^{2+} is strongly reducing in aqueous solution.

    (ii) Zn^{2+} salts are colourless.
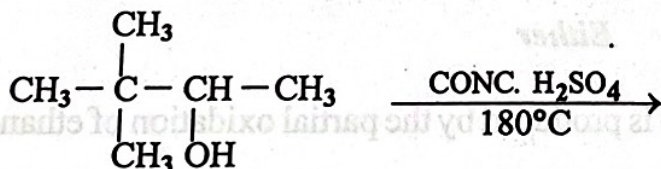
    (iii) MnO_4^{2-} is paramagnetic.

28. Chromium (III) forms an octahedral complex with water molecules and chloride ions as ligands. Conductance measurement shows the complex to be non-ionic in nature. Write the IUPAC name of the complex and draw the possible geometrical isomers.   1+1+1=3

29. In the given reaction, identify the product A, write the IUPAC name and comment on its molecular chirality.   1+1+1=3

$$\langle\ \rangle - CH = CH - CH_3 \quad \xrightarrow[\text{(ii) Aq.KOH}]{\text{(i) HCl}} \quad A$$

OR
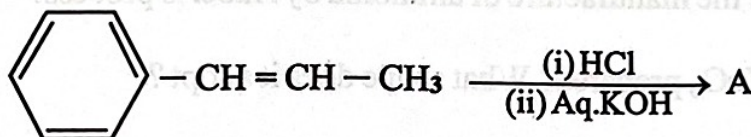
30. What are analgesics ? Classify them.   1+2=3

31. Give the major product and write plausible mechanism of the following reaction: 1+2=3

$$CH_3 - \overset{\overset{\displaystyle CH_3}{|}}{\underset{\underset{\displaystyle CH_3}{|}}{C}} - \overset{\overset{}{}}{\underset{\underset{\displaystyle OH}{|}}{CH}} - CH_3 \quad \xrightarrow[180°C]{\text{CONC. } H_2SO_4}$$

Question nos. 32 – 34 are Essay (E) types and each carries 5 marks.

32.   *Either*

    (a) An element having atomic mass 80 g mol^{-1} adopts face centre cubic structure. Calculate the number of unit cells present in 8 g of the element.

(b) NaCl crystal becomes yellowish when heated with sodium vapour. Explain what effect would be observed on the density of the crystal ? 3+2=5

OR

(c) An alloy of three metals A, B and C has the A atoms forming ccp lattice while B atoms occupy the edge centres and C atoms occupy the body centres. Establish the formula of the alloy.

(d) Germanium is an intrinsic semiconductor. How can you increase its conductivity ? 3+2=5

33. *Either*

(a) Describe the manufacture of ammonia by Haber's process.

(b) How is XeO_3 prepared? What shape does it adopt ? 3+2=5

OR

(c) Describe the manufacture of sulphuric acid by Contact process.

(d) How is PCl_3 prepared ? What shape does it adopt ? 3+2=5

34. *Either*

(a) Compound, A (C_2H_4O) is produced by the partial oxidation of ethanol with PCC. It reacts with HCN to produce compound B which on hydrolysis forms an optically active compound, C. Identify A, B, C and write the reactions.

(b) Illustrate Hell-Volhard - Zelinsky reaction of 2-methylpropanoic acid. 3+2=5

OR

(c) An organic compound with molecular formula $C_5H_{10}O$ exists in different isomeric structures. Identify the isomer which –

(i) undergoes Cannizaro reaction.

(ii) undergoes haloform reaction and gives butanoic acid.

(iii) is obtained by ozonolysis of 3,4-diethylhex-3-ene.   3+2=5

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