

2022

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. A compound formed by elements A and B has the A atoms forming a ccp lattice and the B atoms occupy half of the tetrahedral voids. What is the co-ordination number of B atoms in the crystal ? 1
2. Identify the product formed at the cathode during electrolysis of aqueous solution of MgSO_4 ? 1
3. A key reaction in the upper atmosphere is $\text{O}_3(\text{g}) + \text{O}(\text{g}) \rightarrow 2\text{O}_2(\text{g})$. The E_a for the forward reaction is 19 kJ, and the ΔH_{rxn} is -392 kJ. What will be the E_a for the reverse reaction ? 1
4. In metallurgy what is meant by concentration ? 1
5. Why does scandium show preferably (+3) oxidation state ? 1

P.T.O.

6. Identify the product formed when phenyl magnesium bromide undergoes hydrolysis. 1
7. Why is the boiling point of ethanol higher than its isomer methoxymethane ? 1
8. Methanal forms cyanohydrin with HCN in the presence of a base much faster than acetone. Why ? 1
9. Benzamide, $C_6H_5CONH_2$ on reduction with $LiAlH_4$ followed by hydrolysis gives an amine. It also undergoes Hofmann's bromamide reaction (with Br_2/KOH) and forms amine. What will be the difference between the two amines ? 1
10. Identify the monomer of the polymer represented as $\left[CH_2 - CHCl\right]_n$. 1

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

11. Which one of the following statements is incorrect for a voltaic cell ? 1
- (A) It converts chemical energy to electrical energy.
- (B) It uses electrical energy to carry out chemical changes.
- (C) It is based on a redox reaction.
- (D) It has $-\Delta G$.

12. Trivalent ion of which of the following lanthanide metals is colourless ? 1

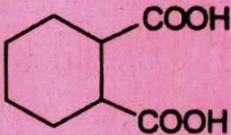
(A) La (B) Ce

(C) Pr (D) Nd

13. In metal carbonyls the ligand is _____ . 1

(A) carbon dioxide (B) carbon monoxide

(C) carbonate (D) aldehydes and ketones

14. The IUPAC name of the compound,  is 1

(A) Phthalic acid (B) Benzene-1,2-dioic acid

(C) Cyclohexane-1,2-dicarboxylic acid (D) Cyclohexane-1,2-dioic acid

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

15. Classify solids into different types on the basis of the arrangement of constituent particles. 2

16. The rate of decomposition of N_2O_5 to NO_2 and O_2 is expressed as 2

$$k = \frac{2.303}{t} \log \frac{x_0}{x_t},$$

Where x_0 and x_t are the initial concentration and concentration at time t of N_2O_5 . Show that the half-life period of the reaction is independent of x_0 .

17. Platinum crystallizes in a face-centered cubic lattice with all atoms at the lattice points. Calculate the mass of a unit-cell of the metallic crystal (Atomic mass of platinum = 195 amu). 2
18. When hydrogen gas is used as fuel the combustion reaction is represented as $2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\text{g})$. When $[\text{O}_2]$ is decreasing at $0.23 \text{ mol L}^{-1} \text{ s}^{-1}$, at what rate is $[\text{H}_2\text{O}]$ increasing? 2
19. Illustrate how leaching technique is used for extraction of gold. 2
20. Sulphur dioxide has reducing as well as oxidizing property. Write two reactions to illustrate the character. 2
21. Describe how Sandmeyer reaction can be used as a method for converting aniline to chlorobenzene. 2
22. Compare the two disaccharides, Sucrose and Maltose regarding their reducing/non reducing character. 2
23. Based on the polymerization reaction mode, identify what type of polymers will be formed by the following monomers? 2
- (i) 1,3-butadiene
- (ii) 5-aminopentanoic acid
24. How many bases are present in nucleic acids? Which one of them is not present in DNA? 2

- (b) The freezing point depression constant (K_f) values of water and cyclohexane are $1.86 \text{ K kg mol}^{-1}$ and $20.1 \text{ K kg mol}^{-1}$ respectively. Which one of the two solvents will be used in measuring freezing point depression for determining the molar mass of an unknown soluble solute? Give reason.
- (c) How does common salt added on meat as preservative prevent growth of bacteria? 2+2+1=5

OR

- (d) Ethylene glycol is used as an antifreeze in car radiator water. Calculate the minimum molal concentration of ethylene glycol solution that will protect the car radiator from freezing at -1.90°C ?
- (e) The partial pressure of carbon dioxide gas inside a bottle of a carbonated soft drink is 4 atm at 25°C . How many moles of CO_2 are dissolved in a 355 mL can?
(The Henry's law constant for CO_2 dissolved in water is $3.30 \times 10^{-2} \text{ mol L}^{-1} \text{ atm}^{-1}$ at 25°C).
- (f) The boiling point of 0.1 m aqueous NaCl solution is higher than that of 0.1 m aqueous glucose solution. Give reason. 2+2+1=5

33.

Either

- (a) How is nitric acid manufactured by Ostwald's process?
- (b) How is XeF_2 prepared? What happens when it is hydrolyzed completely?
- (c) Why do the halogens show an oxidation state of -1 ? 2+2+1=5

OR

- (d) How is phosphine prepared in the laboratory?

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

25. 1M HNO₃ does not dissolve gold metal to form a 1M Au³⁺ solution. Explain this using the following two half reactions : 3
- (i) $\text{NO}_3^- + 4\text{H}^+ + 3\text{e}^- \rightarrow \text{NO} + 2\text{H}_2\text{O}$, $E^\circ = 0.96\text{V}$
- (ii) $\text{Au}^{3+} + 3\text{e}^- \rightarrow \text{Au}$, $E^\circ = 1.5\text{V}$
26. What are dispersed phase and dispersion medium in a colloid ? Which substance is present as dispersion medium in aquasols. 3
27. Give reason for 3
- (a) The first ionization enthalpy of chromium is very low but the second ionization enthalpy is very high.
- (b) Titrimetric analysis with potassium permanganate is carried out in the presence of acid. However hydrochloric acid is not used in such titrations.
28. For the complex compound [Co(en)₂Cl₂]Cl, give : 3
- (a) the coordination number of the metal ion
- (b) the oxidation number of the central metal ion
- (c) the IUPAC name
29. Starting from phenol how can you prepare methoxybenzene ? Give the name of the method. 3
30. Write two methods to carry out the conversion of CH₃CHO to CH₃COCH₃. 3
31. What are antihistamines? Give an example. 3

Questions from 32–34 are Essay (E) types and each carries 5 marks.

32.

Either

- (a) A sample of rubbing alcohol contains 122 g of isopropyl alcohol (C₃H₇OH) and 55g of water. What are the mole fractions of alcohol and water ?

- (e) Ferric ion is more stable than ferrous ion. However when finely powdered iron reacts with hydrochloric acid, ferrous chloride is produced. Give reason.
- (f) Why does oxygen rarely show positive oxidation state while the other group 16 elements show more positive oxidation state ? 2+2+1=5

34.

Either

- (a) Compound A (mol. formula, C_4H_8) is an unsymmetrical alkene. On treatment with HBr, A forms a tertiary bromide, B. Identify A, B and write the mechanism of the hydrolysis reaction of B with aqueous KOH.
- (b) Methylbromide, CH_3Br can be prepared by treating methanol with HBr but not with NaBr. Explain why. 3+2=5

OR

- (c) An aromatic hydrocarbon (C_6H_6) undergoes electrophilic monosubstitution with Br_2 / Fe to give compound A. On treatment with concentrated nitric acid in the presence of concentrated sulphuric acid compound A is converted to compound B as major product. Identify A, B and write the mechanism of the conversion reaction of A to B.
- (d) Benzyl chloride is more reactive than its isomeric form 1-chloro-4-methylbenzene towards hydrolysis reaction. Give reason. 3+2=5