

Question Paper

Conducted by the Central Board of Secondary Education (CBSE)



Time Allowed: 3 Hours

Maximum Marks: 70

General Instructions

- (i) This question paper contains **33 questions**. All questions are compulsory.
- (ii) Section A: Questions 1 to 16 are multiple choice questions, carrying 1 mark each.
- (iii) Section B: Questions 17 to 21 are very short answer questions, carrying 2 marks each.
- (iv) Section C: Questions 22 to 28 are short answer questions, carrying 3 marks each.
- (v) Section D: Questions 29 to 30 are case-based questions, carrying 4 marks each.
- (vi) Section E: Questions 31 to 33 are long answer questions, carrying 5 marks each.
- (vii) Attempt one alternative where an internal choice is provided. Follow the instructions within each question.
- (viii) Use of calculators is not allowed.

Section A

1. Which one of the following first row transition elements is expected to have the highest third ionization enthalpy?

- (A) Iron (Z = 26) (B) Manganese (Z = 25)
(C) Chromium (Z = 24) (D) Vanadium (Z = 23)

2. Which of the following compounds will give a ketone on oxidation with chromic anhydride (CrO₃)?

- (A) (CH₃)₂CH-CH₂OH (B) CH₃CH₂CH₂OH
(C) (CH₃)₃C-OH (D) CH₃-CH₂-CH(OH)-CH₃

3. Two among the three components of DNA are β-D-2-deoxyribose and a heterocyclic base. The third component is:

- (A) Adenine (B) Phosphoric acid
(C) Sulphuric acid (D) Uracil

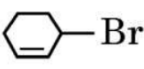
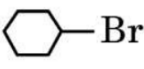
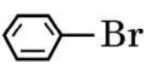
4. For an electrolyte undergoing association in a solvent, the van't Hoff factor:

- (A) is always greater than one (B) has negative value
(C) has zero value (D) is always less than one

5. For the reaction $X + 2Y \rightarrow P$ the differential form equation of the rate law is:

- (A) $\frac{2d[P]}{dt} = \frac{-d[X]}{dt}$ (B) $\frac{-d[P]}{dt} = \frac{-d[X]}{dt}$
(C) $\frac{d[Y]}{dt} = \frac{-d[P]}{dt}$ (D) $\frac{-2d[Y]}{dt} = \frac{+d[P]}{dt}$

6. The compound which undergoes S_N1 reaction most rapidly is:

- (A) 
(B) 
(C) 
(D) 

- (A) Structure (A) (B) Structure (B)
(C) Structure (C) (D) Structure (D)

7. Acetic acid reacts with PCl₅ to give:

- (A) Cl-CH₂-COCl (B) Cl-CH₂-COOH
(C) CH₃-COCl (D) CCl₃-COOH

8. The formation of cyanohydrin from an aldehyde is an example of:

- (A) nucleophilic addition (B) electrophilic addition
(C) nucleophilic substitution (D) electrophilic substitution

9. In the Arrhenius equation, when log k is plotted against 1/T, a straight line is obtained whose:

- (A) slope is $\frac{-E_a}{R}$ and intercept is E_a (B) slope is A and intercept is $\frac{-E_a}{R}$
(C) slope is $\frac{-E_a}{R}$ and intercept is log A (D) slope is $\frac{-E_a}{2.303 R}$ and intercept is log A

10. The reaction of an alkyl halide with sodium alkoxide forming ether is known as:

- | | |
|--------------------------|-----------------------------|
| (A) Wurtz reaction | (B) Reimer-Tiemann reaction |
| (C) Williamson synthesis | (D) Kolbe reaction |

11. The correct order of the ease of dehydration of the following alcohols by the action of conc. H_2SO_4 is:

- | | |
|---|---|
| (A) $(\text{CH}_3)_3\text{C}-\text{OH} > (\text{CH}_3)_2\text{CH}-\text{OH} > \text{CH}_3\text{CH}_2-\text{OH}$ | (B) $(\text{CH}_3)_2\text{CH}-\text{OH} > \text{CH}_3\text{CH}_2-\text{OH} > (\text{CH}_3)_3\text{C}-\text{OH}$ |
| (C) $\text{CH}_3\text{CH}_2-\text{OH} > (\text{CH}_3)_2\text{CH}-\text{OH} > (\text{CH}_3)_3\text{C}-\text{OH}$ | (D) $(\text{CH}_3)_2\text{CH}-\text{OH} > (\text{CH}_3)_3\text{C}-\text{OH} > \text{CH}_3\text{CH}_2-\text{OH}$ |

12. Which functional groups of glucose interact to form cyclic hemiacetal leading to pyranose structure?

- | | |
|--|--|
| (A) Aldehyde group and hydroxyl group at C-4 | (B) Aldehyde group and hydroxyl group at C-5 |
| (C) Ketone group and hydroxyl group at C-4 | (D) Ketone group and hydroxyl group at C-5 |

13. Assertion (A): When NaCl is added to water a depression in freezing point is observed.

Reason (R): NaCl undergoes dissociation in water.

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|--|---|
| (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. |

14. Assertion (A): Separation of Zr and Hf is difficult.

Reason (R): Zr and Hf have similar radii due to lanthanoid contraction.

- | | |
|--|---|
| (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. |

15. Assertion (A): The pK_a of ethanoic acid is lower than that of $\text{Cl}-\text{CH}_2-\text{COOH}$.

Reason (R): Chlorine shows electron withdrawing (-I) effect which increases the acidic character of $\text{Cl}-\text{CH}_2-\text{COOH}$.

- | | |
|--|---|
| (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. |

16. Assertion (A): Aniline is a stronger base than ammonia.

Reason (R): The unshared electron pair on nitrogen atom in aniline becomes less available for protonation due to resonance.

- | | |
|--|---|
| (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. |

Section B

17. Calculate the potential of Iron electrode in which the concentration of Fe^{2+} ion is 0.01 M.

($E^\circ_{\text{Fe}^{2+}/\text{Fe}} = -0.45 \text{ V}$ at 298 K)

[Given: $\log 10 = 1$]

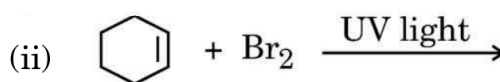
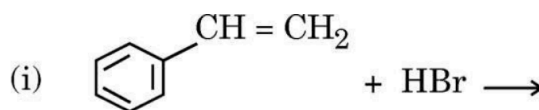
18. Define molecularity of the reaction. State any one condition in which a bimolecular reaction may be kinetically of first order.

19. What happens when D-glucose is treated with the following reagents?

(a) HI

(b) Conc. HNO_3

20. (a) Draw the structures of major monohalo products in each of the following reactions:



OR

(b) Give reasons for the following:

(i) Grignard reagent should be prepared under anhydrous conditions.

(ii) Alkyl halides give alcohol with aqueous KOH whereas in the presence of alcoholic KOH, alkenes are formed.

21. Write the chemical equation when:

(a) Butan-2-one is treated with Zn(Hg) and conc. HCl .

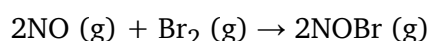
(b) Two molecules of benzaldehyde are treated with conc. NaOH .

Section C

22. When a certain conductivity cell was filled with 0.05 M KCl solution, it has a resistance of 100 ohm at 25°C. When the same cell was filled with 0.02 M AgNO₃ solution, the resistance was 90 ohm. Calculate the conductivity and molar conductivity of AgNO₃ solution.

(Given: Conductivity of 0.05 M KCl solution = $1.35 \times 10^{-2} \text{ ohm}^{-1} \text{ cm}^{-1}$)

23. The following initial rate data were obtained for the reaction:



Expt. No.	[NO]/mol L ⁻¹	[Br ₂]/mol L ⁻¹	Initial Rate (mol L ⁻¹ s ⁻¹)
1	0.05	0.05	1.0×10^{-3}
2	0.05	0.15	3.0×10^{-3}
3	0.15	0.05	9.0×10^{-3}

(a) What is the order with respect to NO and Br₂ in the reaction?

(b) Calculate the rate constant (k).

(c) Determine the rate of reaction when concentration of NO and Br₂ are 0.4 M and 0.2 M, respectively.

24. (a) Write the formula for the following coordination compound:

Potassium tetrahydroxidozincate (II)

(b) Arrange the following complexes in the increasing order of conductivity of their solution:

[Cr(NH₃)₅Cl]Cl₂, [Cr(NH₃)₃Cl₃], [Cr(NH₃)₆]Cl₃

(c) Identify the type of isomerism exhibited by the following complexes:

(i) [Co(NH₃)₅NO₂]²⁺

(ii) [Co(en)₃]Cl₃

25. (a) Which of the following is an allylic halide?

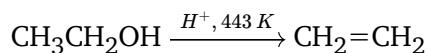
(i) CH₃-CH=CH-Br

(ii) CH₂=CH-CH(Br)-CH₃

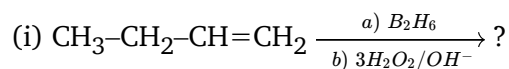
(b) Out of chlorobenzene and 2,4,6-trinitrochlorobenzene, which is more reactive towards nucleophilic substitution and why?

(c) Which isomer of C₄H₉Cl has the lowest boiling point?

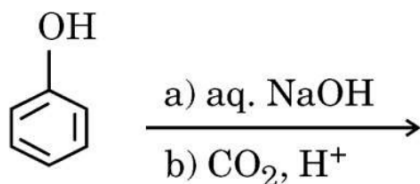
26. (a) Write the mechanism of the following reaction:



(b) Write the main product in each of the following reactions:



(ii)



27. Answer the following: (any three)

(a) What is peptide linkage?

(b) What type of bonds hold a DNA double helix together?

(c) Which one of the following is a polysaccharide?

Sucrose, Glucose, Starch, Fructose

(d) Give one example each for water-soluble vitamins and fat-soluble vitamins.

28. Compound (A) ($\text{C}_6\text{H}_{12}\text{O}_2$) on reduction with LiAlH_4 gives two compounds (B) and (C). The compound (B) on oxidation with PCC gives compound (D) which upon treatment with dilute NaOH and subsequent heating gives compound (E). Compound (E) on catalytic hydrogenation gives compound (C). The compound (D) is oxidized further to give compound (F) which is found to be a monobasic acid (Molecular weight = 60). Identify the compounds (A), (B), (C), (D), (E) and (F).

29. Batteries and fuel cells are very useful forms of galvanic cell. Any battery or cell that we use as a source of electrical energy is basically a galvanic cell. However, for a battery to be of practical use it should be reasonably light, compact and its voltage should not vary appreciably during its use. There are mainly two types of batteries – primary batteries and secondary batteries.

In the primary batteries, the reaction occurs only once and after use over a period of time the battery becomes dead and cannot be reused again, whereas the secondary batteries are rechargeable.

Production of electricity by thermal plants is not a very efficient method and is a major source of pollution. To solve this problem, galvanic cells are designed in such a way that energy of combustion of fuels is directly converted into electrical energy, and these are known as fuel cells. One such fuel cell was used in the Apollo space programme.

Answer the following questions:

29(a). How do primary batteries differ from secondary batteries?

29(b). The cell potential of Mercury cell is 1.35 V, and remains constant during its life. Give reason.

29(c). Write the reactions involved in the recharging of the lead storage battery.

OR

Write two advantages of fuel cells over other galvanic cells.

30. The Valence Bond Theory (VBT) explains the formation, magnetic behaviour and geometrical shapes of coordination compounds whereas 'The Crystal Field Theory' for coordination compounds is based on the effect of different crystal fields (provided by ligands taken as point charges), on the degeneracy of d-orbital energies of the central metal atom/ion. The splitting of the d-orbitals provides different electronic arrangements in strong and weak crystal fields. The crystal field theory attributes the colour of the coordination compounds to d-d transition of the electron. Coordination compounds find extensive applications in metallurgical processes, analytical and medicinal chemistry.

Answer the following questions:

30(a). What is crystal field splitting energy?

30(b). Give reason for the violet colour of the complex $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$ on the basis of crystal field theory.

30(c). $[\text{Cr}(\text{NH}_3)_6]^{3+}$ is paramagnetic while $[\text{Ni}(\text{CN})_4]^{2-}$ is diamagnetic. Explain why. [Atomic No.: Cr = 24, Ni = 28]

OR

Explain why $[\text{Fe}(\text{CN})_6]^{3-}$ is an inner orbital complex, whereas $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$ is an outer orbital complex. [Atomic No.: Fe = 26]

Section E

31. (a) (i) At the same temperature, CO_2 gas is more soluble in water than O_2 gas. Which one of them will have higher value of K_H and why?

(ii) How does the size of blood cells change when placed in an aqueous solution containing more than 0.9% (mass/volume) sodium chloride?

(iii) 1 molal aqueous solution of an electrolyte A_2B_3 is 60% ionized. Calculate the boiling point of the solution.

(Given: K_b for $\text{H}_2\text{O} = 0.52 \text{ K kg mol}^{-1}$)

OR

(b) (i) The vapour pressures of A and B at 25°C are 75 mm Hg and 25 mm Hg, respectively. If A and B are mixed such that the mole fraction of A in the mixture is 0.4, then calculate the mole fraction of B in vapour phase.

(ii) Define colligative property. Which colligative property is preferred for the molar mass determination of macromolecules?

(iii) Why are equimolar solutions of sodium chloride and glucose not isotonic?

32. Answer any five questions of the following:

(a) N,N-diethyl-benzenesulphonamide is insoluble in alkali. Give reason.

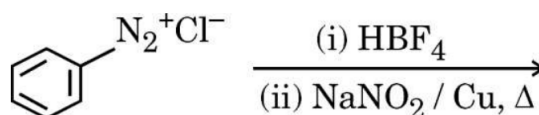
(b) Aniline does not undergo Friedel-Crafts reaction. Why?

(c) Write a simple chemical test to distinguish between methylamine and aniline.

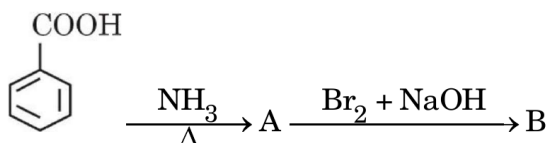
(d) Write the chemical reaction involved in Gabriel phthalimide synthesis.

(e) How will you convert aniline to p-bromoaniline?

(f) Complete the following reaction:



(g) Write the structures of A and B in the following reaction:



33. (a) (i) Account for the following:

(1) The melting and boiling points of Zn, Cd and Hg are low.

(2) Of the d^4 species, Cr^{2+} is strongly reducing while Mn^{3+} is strongly oxidizing.

(3) E° value of Cu^{2+}/Cu is + 0.34 V.

(ii) Complete and balance the following chemical equations:

(1) $KMnO_4 \xrightarrow{\text{heat}} ?$

(2) $Cr_2O_7^{2-} + 6I^- + 14H^+ \rightarrow ?$

OR

(b) (i) Out of Cu_2Cl_2 and $CuCl_2$, which is more stable in aqueous solution and why?

(ii) Write the general electronic configuration of f-block elements.

(iii) Predict which of the following will be coloured in aqueous solution and why?

Sc^{3+} , Fe^{3+} , Zn^{2+}

[Atomic number: Sc = 21, Fe = 26, Zn = 30]

(iv) How can you obtain potassium dichromate from sodium chromate?

(v) Why do transition metals and their compounds show catalytic activities?

- End of Question Paper -