

## 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. The molar ionic conductivities of  $\text{Mg}^{2+}$  and  $\text{SO}_4^{2-}$  are  $106.0 \text{ S cm}^2 \text{ mol}^{-1}$  and  $160.0 \text{ S cm}^2 \text{ mol}^{-1}$  respectively. The value of limiting molar conductivity of  $\text{MgSO}_4$  will be :

- (A)  $266 \text{ S cm}^2 \text{ mol}^{-1}$  (B)  $622 \text{ S cm}^2 \text{ mol}^{-1}$   
(C)  $288 \text{ S cm}^2 \text{ mol}^{-1}$  (D)  $822 \text{ S cm}^2 \text{ mol}^{-1}$

2. 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

3. Which alkyl halide from the given options will undergo  $\text{S}_{\text{N}}1$  reaction faster ?

- (A)  $(\text{CH}_3)_3\text{C}-\text{Br}$  (B)  $(\text{CH}_3)_2\text{CH}-\text{Br}$   
(C)  $\text{CH}_3-\text{CH}_2-\text{Br}$  (D)  $(\text{CH}_3)_3\text{C}-\text{CH}_2-\text{Br}$

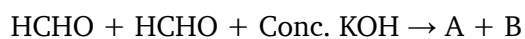
4. Which of the following acids represents Vitamin C ?

- (A) Saccharic acid (B) Gluconic acid  
(C) Ascorbic acid (D) Benzoic acid

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

- (A)  $\text{Pd}-\text{BaSO}_4$  (B) Anhydrous  $\text{AlCl}_3$   
(C) Iron (III) oxide (D)  $\text{HgSO}_4$

6. Consider the following reaction :



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

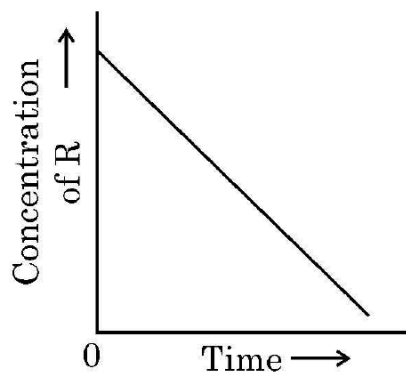
7. In effective collisions the colliding molecules must have :

- (A) Proper orientation only (B) A certain minimum amount of activation energy  
(C) Threshold energy only (D) Threshold energy and proper orientation both

8. Identify the secondary amine from the given options :

- (A)  $(\text{CH}_3)_2\text{CHNH}_2$  (B)  $\text{CH}_3\text{NHCH}(\text{CH}_3)_2$   
(C)  $(\text{CH}_3)_3\text{CNH}_2$  (D)  $\text{CH}_3(\text{CH}_2)_2\text{NH}_2$

9. In a given graph of zero order reaction (Concentration of R on Y-axis vs Time on X-axis), the slope and intercept are :



- (A) Slope =  $k$ , Intercept =  $[\text{R}]_0$  (B) Slope =  $-k$ , Intercept =  $[\text{R}]_0$   
(C) Slope =  $k/2.303$ , Intercept =  $\ln[\text{R}]_0$  (D) Slope =  $-k/2.303$ , Intercept =  $\ln A$

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

- (A)  $(n-1)d^{1-10}ns^{1-2}$  (B)  $(n-1)d^1ns^{1-2}$   
(C)  $(n-1)d^1ns^{2-3}$  (D)  $(n-1)d^0ns^{1-2}$

11. 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 |

12. Match the reagents required for the given reactions :

I. Oxidation of primary alcohols to aldehydes  
(p)  $\text{NaBH}_4$

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),<br>IV-(q) | (B) I-(p), II-(r), III-(s),<br>IV-(q) |
| (C) I-(s), II-(p), III-(r),<br>IV-(q) | (D) I-(q), II-(p), III-(s),<br>IV-(r) |

13. Two statements are given - one labelled Assertion (A) and the other labelled Reason (R).

**Assertion (A) :** Bromination of Phenol can be carried out even in the absence of Lewis acid.

**Reason (R) :**  $-\text{OH}$  group of Phenol has the high activation effect.

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

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

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

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

15. **Assertion (A) :** For a Daniell cell,  $\text{Zn}/\text{Zn}^{2+}$  (1M) ||  $\text{Cu}^{2+}$  (1M)/Cu with  $E^\circ_{\text{cell}} = 1.1 \text{ V}$ , 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.

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

16. **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.

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

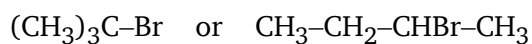
## Section B

17. Define the following terms :

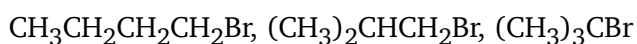
- (a) Molecularity of reaction
- (b) Complex reaction

18. Calculate the molar mass of a compound when 6.3 g of it is dissolved in 27 g of chloroform to form a solution that has a boiling point of 68.04 °C. The boiling point of pure chloroform is 61.04 °C and  $K_b$  for chloroform is 3.63 °C kg mol<sup>-1</sup>.

19. (a) Which of the following compounds will react more rapidly by S<sub>N</sub>2 reaction and why ?



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



20. (a) Write the stepwise mechanism of nucleophilic addition reactions in the carbonyl compounds.

OR

(b) How will you convert the following :

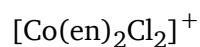
- (i) Toluene to benzoic acid.
- (ii) Ethanol to 3-Hydroxybutanal

21. (a) What happens when Glucose reacts with HI ? Write chemical equation.

(b) Which type of bond holds a DNA double helix together ?

## Section C

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



(b) Write the electronic configuration of  $d^4$  ion if  $\Delta_0 > P$

(c) What is a didentate ligand ? Give one example.

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

(i) Phenol and Benzoic acid

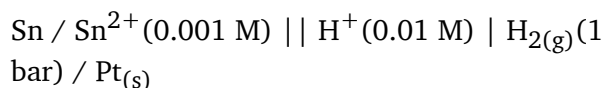
(ii) Propanal and Propanone

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



24. 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. [ $\log 2 = 0.3010$ ,  $\log 10 = 1$ ]

25. Calculate emf of the following cell at  $25^\circ\text{C}$  :



Given :  $E^\circ(\text{Sn}^{2+}/\text{Sn}) = -0.14 \text{ V}$ ,  $E^\circ(\text{H}^+/\text{H}_2) = 0.00 \text{ V}$  ( $\log 10 = 1$ )

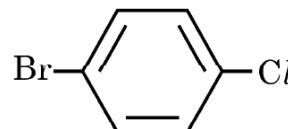
26. Define the following terms :

(a) Non essential amino acids

(b) Monosaccharides

(c) Anomers

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



(b) Why are haloalkanes more reactive towards nucleophilic substitution reactions than haloarenes ?

(c) What happens when ethyl chloride is treated with aqueous KOH ?

28. 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

**29. Case Study :** 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  $\text{ZnSO}_4$  and Cu rod is placed in a solution of  $\text{CuSO}_4$ . 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  $\text{Cu}^{2+}$ . This was first formulated by Faraday in the form of laws of electrolysis.

Answer the following questions :

**29.a.** What is the function of a salt bridge in a galvanic cell ?

**29.b.** When does galvanic cell behave like an electrolytic cell ?

**29.c.** Can copper sulphate solution be stored in a pot made of zinc ? Explain with the help of the value of  $E^\circ_{\text{cell}}$ .

$$(E^\circ \text{Cu}^{2+}/\text{Cu} = 0.34 \text{ V})$$

$$(E^\circ \text{Zn}^{2+}/\text{Zn} = -0.76 \text{ V})$$

OR

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

(i) 1 mol of  $\text{MnO}_4^-$  to  $\text{Mn}^{2+}$

(ii) 1 mol of  $\text{H}_2\text{O}$  to  $\text{O}_2$

**30. Case Study :** 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 :

**30.a.** Predict whether  $[\text{CoF}_6]^{3-}$  is diamagnetic or paramagnetic and why ? [Atomic number : Co = 27]

- |                                                                                                                                                                |                                                                                                 |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|
| (A) Paramagnetic; $\text{F}^-$ is a weak field ligand so $\text{Co}^{3+}$ ( $3d^6$ ) remains high-spin with 4 unpaired electrons ( $sp^3d^2$ , outer orbital). | (B) Diamagnetic; $\text{F}^-$ is a strong field ligand and forces pairing in $\text{Co}^{3+}$ . |
| (C) Paramagnetic; with 2 unpaired electrons because $\text{Co}^{3+}$ uses $d^2sp^3$ hybridisation.                                                             | (D) Diamagnetic; because $\text{Co}^{3+}$ has fully paired 3d electrons in any ligand field.    |

**30.b.** What is the coordination number of Co in  $[\text{Co(en)}_2\text{Cl}_2]^+$  ?

- |       |       |
|-------|-------|
| (A) 4 | (B) 5 |
| (C) 6 | (D) 8 |

**30.c.** (i) Write the IUPAC name of the given complex :  $[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]^{2+}$

(ii) Explain whether  $[\text{Co}(\text{NH}_3)_6]^{3+}$  is an inner orbital or outer orbital complex.

OR

Using valence bond theory, deduce the shape and hybridisation of  $[\text{Ni}(\text{NH}_3)_6]^{2+}$ . [Atomic number of Ni = 28]

31. (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 ( $M = 180 \text{ g mol}^{-1}$ ) 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 ?

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  $\text{CaCl}_2$  (molar mass =  $111 \text{ g mol}^{-1}$ ) to be dissolved in 500 g of water to lower its freezing point by 2 K, assuming that  $\text{CaCl}_2$  undergoes complete dissociation. ( $K_f$  for water =  $1.86 \text{ K kg mol}^{-1}$ )

32. (a) An amide 'A' with molecular formula  $\text{C}_7\text{H}_7\text{ON}$  undergoes Hoffmann Bromamide degradation reaction to give amine 'B'. 'B' on treatment with nitrous acid at 273-278 K forms '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.

OR

(b)

- (i) (1) What is Hinsberg's reagent ?  
 (2) Arrange the following compounds in the increasing order of their basic strength in gaseous phase :  
 $\text{C}_6\text{H}_5\text{NH}_2$ ,  $(\text{C}_2\text{H}_5)_3\text{N}$ ,  $(\text{C}_2\text{H}_5)_2\text{NH}$
- (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.

33. 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.
- (f) Out of  $\text{KMnO}_4$  and  $\text{K}_2\text{MnO}_4$ , which one is paramagnetic and why ?
- (g) Complete the following ionic equation :  
 $\text{Cr}_2\text{O}_7^{2-} + 14 \text{H}^+ + 6 \text{e}^- \rightarrow \text{_____}$

- End of Question Paper -