

**Series HFG1E/3**



**SET-2**

प्रश्न-पत्र कोड  
Q.P. Code

**56/3/2**

रोल नं.

Roll No.

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परीक्षार्थी प्रश्न-पत्र कोड को उत्तर-पुस्तिका के मुख-पृष्ठ पर अवश्य लिखें ।

Candidates must write the Q.P. Code on the title page of the answer-book.

## रसायन विज्ञान (सैद्धान्तिक)

### CHEMISTRY (Theory)

निर्धारित समय : 3 घण्टे

अधिकतम अंक : 70

Time allowed : 3 hours

Maximum Marks : 70

- कृपया जाँच कर लें कि इस प्रश्न-पत्र में मुद्रित पृष्ठ **23** हैं ।
- प्रश्न-पत्र में दाहिने हाथ की ओर दिए गए प्रश्न-पत्र कोड को परीक्षार्थी उत्तर-पुस्तिका के मुख-पृष्ठ पर लिखें ।
- कृपया जाँच कर लें कि इस प्रश्न-पत्र में **35** प्रश्न हैं ।
- कृपया प्रश्न का उत्तर लिखना शुरू करने से पहले, उत्तर-पुस्तिका में प्रश्न का क्रमांक अवश्य लिखें ।
- इस प्रश्न-पत्र को पढ़ने के लिए 15 मिनट का समय दिया गया है । प्रश्न-पत्र का वितरण पूर्वाह्न में 10.15 बजे किया जाएगा । 10.15 बजे से 10.30 बजे तक छात्र केवल प्रश्न-पत्र को पढ़ेंगे और इस अवधि के दौरान वे उत्तर-पुस्तिका पर कोई उत्तर नहीं लिखेंगे ।
- Please check that this question paper contains **23** printed pages.
- Q.P. Code given on the right hand side of the question paper should be written on the title page of the answer-book by the candidate.
- Please check that this question paper contains **35** questions.
- **Please write down the serial number of the question in the answer-book before attempting it.**
- 15 minute time has been allotted to read this question paper. The question paper will be distributed at 10.15 a.m. From 10.15 a.m. to 10.30 a.m., the students will read the question paper only and will not write any answer on the answer-book during this period.



### General Instructions :

Read the following instructions carefully and strictly follow them :

- (i) This question paper contains **35** questions. **All** questions are **compulsory**.
- (ii) This question paper is divided into **five** Sections – **A, B, C, D** and **E**.
- (iii) In **Section A** – Questions no. **1** to **18** are multiple choice (MCQ) type questions, carrying **1** mark each.
- (iv) In **Section B** – Questions no. **19** to **25** very short answer (VSA) type questions, carrying **2** marks each.
- (v) In **Section C** – Questions no. **26** to **30** are short answer (SA) type questions, carrying **3** marks each.
- (vi) In **Section D** – Questions no. **31** and **32** are case-based questions carrying **4** marks each.
- (vii) In **Section E** – Questions no. **33** to **35** are long answer (LA) type questions carrying **5** marks each.
- (viii) There is no overall choice. However, an internal choice has been provided in 2 questions in Section B, 2 questions in Section C, 2 questions in Section D and 2 questions in Section E.
- (ix) Use of calculators is **not** allowed.

### SECTION A

Questions no. **1** to **18** are Multiple Choice (MCQ) type Questions, carrying **1** mark each.  $18 \times 1 = 18$

1. Which of the following has the highest melting point ?
  - (a) o-Dichlorobenzene
  - (b) m-Dichlorobenzene
  - (c) p-Dichlorobenzene
  - (d) All have the same melting point
2. Sodium phenoxide when heated with  $\text{CO}_2$  under pressure, followed by acidification, yields :
  - (a) Sodium benzoate
  - (b) Salicylic acid
  - (c) Salicylaldehyde
  - (d) Benzoic acid



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3. A compound (A) with molecular formula  $C_5H_{10}O$ , forms a phenyl hydrazone and gives negative Tollens' and iodoform tests. The compound on reduction gives n-pentane. The compound (A) is :
- (a) Pentan-3-one (b) Pentanal  
(c) Pentanol (d) Pentan-2-one
4. Benzene diazonium chloride on hydrolysis gives :
- (a) Phenol (b) Chlorobenzene  
(c) Benzene (d) Aniline
5. Helical structure of proteins is stabilized by :
- (a) ionic bond (b) covalent bond  
(c) hydrogen bond (d) Van der Waals forces
6. A vitamin which plays a vital role in the clotting of blood is :
- (a) Vitamin A (b) Vitamin K  
(c) Vitamin D (d) Vitamin B
7. The rate of reaction  $A + B \longrightarrow \text{Products}$ , is given by the equation  $r = k[A][B]$ . If B is taken in large excess, the order of reaction would be :
- (a) 2 (b) 0  
(c) 1 (d) Cannot be predicted
8. An azeotropic mixture of two liquids has a boiling point higher than either of the two liquids when it :
- (a) shows large negative deviation from Raoult's law.  
(b) shows no deviation from Raoult's law.  
(c) shows large positive deviation from Raoult's law.  
(d) obeys Raoult's law.



9. Kohlrausch gave the following relation for strong electrolyte :

$$\Lambda = \Lambda_o - A\sqrt{C}$$

Which of the following equality holds true ?

- (a)  $\Lambda = \Lambda_o$  as  $C \longrightarrow \sqrt{A}$   
(b)  $\Lambda = \Lambda_o$  as  $C \longrightarrow 0$   
(c)  $\Lambda = \Lambda_o$  as  $C \longrightarrow \infty$   
(d)  $\Lambda = \Lambda_o$  as  $C \longrightarrow 1$
10. Isotonic solutions have :  
(a) same osmotic pressure (b) same boiling point  
(c) same melting point (d) same vapour pressure
11.  $\text{KMnO}_4$  acts as an oxidising agent in alkaline medium. When alkaline  $\text{KMnO}_4$  is treated with KI, iodide ion is oxidised to :  
(a)  $\text{I}_2$  (b)  $\text{IO}^-$   
(c)  $\text{IO}_3^-$  (d)  $\text{IO}_4^-$
12. Which of the following transition metals does **not** show variable oxidation state ?  
(a) Ti (b) Cr  
(c) Cu (d) Sc
13. Which of the following complexes is a 'chelate' complex ?  
(a)  $[\text{Co}(\text{NH}_3)_6]^{3+}$  (b)  $[\text{Co}(\text{en})_3]^{3+}$   
(c)  $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]^+$  (d)  $[\text{CoF}_6]^{3-}$
14. Optical isomerism is **not** shown by the complex :  
(a)  $[\text{Co}(\text{en})_2\text{Cl}_2]^+$  (trans form)  
(b)  $[\text{Co}(\text{en})_2\text{Cl}_2]^+$  (cis form)  
(c)  $[\text{Cr}(\text{ox})_3]^{3-}$   
(d)  $[\text{Cr}(\text{en})_3]^{3+}$



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***For Questions number 15 to 18, two statements are given — one labelled as Assertion (A) and the other labelled as Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.***

- (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):* Zinc is not regarded as a transition element.

*Reason (R):* In zinc, 3d orbitals are completely filled in its ground state as well as in its oxidised state.

**16.** *Assertion (A):* Nucleophilic substitution of iodoethane is easier than chloroethane.

*Reason (R):* Bond energy of C – Cl bond is less than C – I bond.

**17.** *Assertion (A):* Electrolysis of aqueous solution of NaCl gives chlorine gas at anode instead of oxygen gas.

*Reason (R):* Formation of oxygen gas at anode requires overpotential.

**18.** *Assertion (A):* Order and molecularity of a reaction are always same.

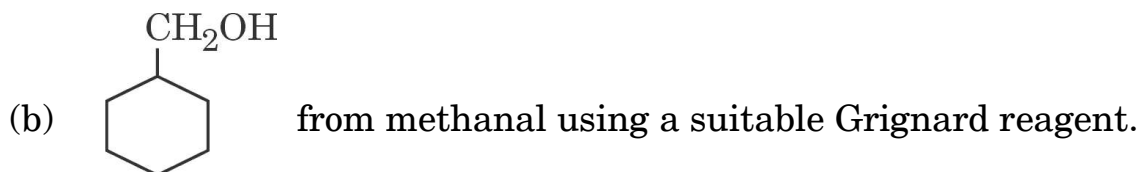
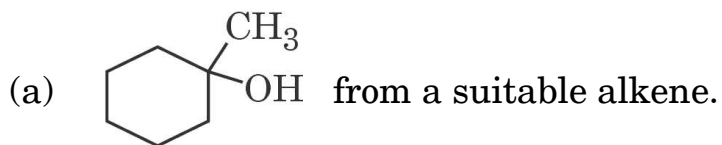
*Reason (R):* Complex reactions involve a sequence of elementary reactions and the slowest step is rate determining.



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## SECTION B

19. Show how you will synthesise : 2×1=2



20. Write the chemical equation involved in the following reactions : 2

(a) Carbylamine reaction

(b) Gabriel phthalimide synthesis

21. (a) (i) How are carbohydrates stored in animal body ? Mention any one organ where they are present.  
(ii) What is the basic structural difference between starch and cellulose ? 2

**OR**

(b) Differentiate between : 2  
(i) Peptide linkage and Glycosidic linkage  
(ii) Nucleoside and Nucleotide

22. (a) Define fuel cell and write its two advantages. 2

**OR**

(b) Using  $E^\circ$  values of X and Y given below, predict which is better for coating the surface of Iron to prevent corrosion and why ? 2

Given :  $E^\circ_{X^{2+}/X} = -2.36 \text{ V}$

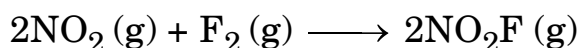
$$E^\circ_{Y^{2+}/Y} = -0.14 \text{ V}$$

$$E^\circ_{Fe^{2+}/Fe} = -0.44 \text{ V}$$



23. On mixing liquid X and liquid Y, volume of the resulting solution decreases. What type of deviation from Raoult's law is shown by the resulting solution ? What change in temperature would you observe after mixing liquids X and Y ? 2

24. The following data were obtained for the reaction :



| Experiment No. | $[\text{NO}_2]/\text{M}$ | $[\text{F}_2]/\text{M}$ | Initial rate $\text{M min}^{-1}$ |
|----------------|--------------------------|-------------------------|----------------------------------|
| 1              | 0.2                      | 0.05                    | $6 \times 10^{-3}$               |
| 2              | 0.4                      | 0.05                    | $1.2 \times 10^{-2}$             |
| 3              | 0.8                      | 0.10                    | $4.8 \times 10^{-2}$             |

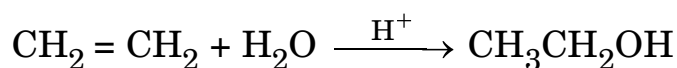
Determine the overall order of reaction. 2

25. Give reasons for the following : 2

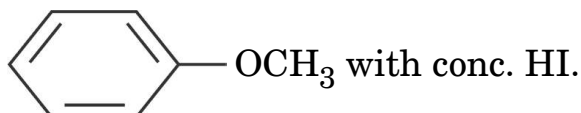
- Carboxylic carbon is less electrophilic than Carbonyl carbon of aldehydes and ketones.
- Propanal is more reactive than Propanone towards addition of HCN.

### SECTION C

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



- (b) Write the structures of the products obtained by heating

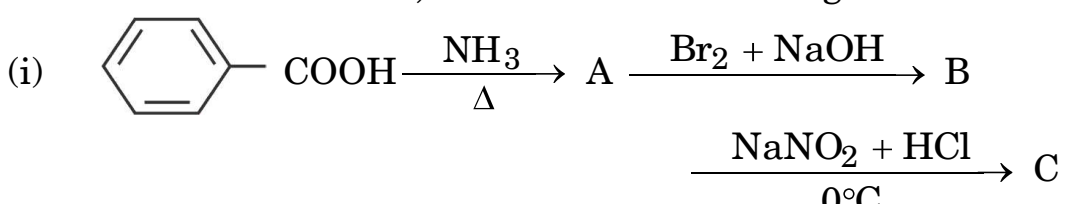


2+1=3

27. Write the structure of product when D-Glucose reacts with the following :  
(any **three**) 3×1=3

- HI
- Conc.  $\text{HNO}_3$
- $\text{Br}_2$  water
- HCN



28. The rate of a reaction doubles when temperature changes from 27°C to 37°C. Calculate energy of activation for the reaction.  
( $R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$ ) 3  
(Given :  $\log 2 = 0.3010$ ,  $\log 3 = 0.4771$ ,  $\log 4 = 0.6021$ )
29. 0.3 g of acetic acid ( $M = 60 \text{ g mol}^{-1}$ ) dissolved in 30 g of benzene shows a depression in freezing point equal to 0.45°C. Calculate the percentage association of acid if it forms a dimer in the solution. 3  
(Given :  $K_f$  for benzene =  $5.12 \text{ K kg mol}^{-1}$ )
30. (a) Write the structures of A, B and C in the following reactions :  $2 \times 1 \frac{1}{2} = 3$
- (i) 
- (ii)  $\text{CH}_3\text{CH}_2\text{Br} \xrightarrow{\text{KCN}} \text{A} \xrightarrow{\text{LiAlH}_4} \text{B} \xrightarrow[0^\circ\text{C}]{\text{HNO}_2} \text{C}$
- OR**
- (b) How will you convert the following :  $3 \times 1 = 3$
- Aniline to p-bromoaniline
  - Ethanoic acid to methanamine
  - Butanenitrile to 1-aminobutane

### SECTION D

*The following questions are case-based questions. Read the case carefully and answer the questions that follow.*

31. Coordination compounds are widely present in the minerals, plant and animal worlds and are known to play many important functions in the area of analytical chemistry, metallurgy, biological systems and medicine. Alfred Werner's theory postulated the use of two types of linkages (primary and secondary), by a metal atom/ion in a coordination compound. He predicted the geometrical shapes of a large number of coordination entities using the property of isomerism. The Valence Bond Theory (VBT) explains the formation, magnetic behaviour and geometrical shapes of coordination compounds. It, however, fails to describe the optical properties of these compounds. The Crystal Field Theory (CFT) explains the effect of different crystal fields (provided by the ligands taken as point charges) on the degeneracy of d-orbital energies of the central metal atom/ion.



Answer the following questions :

- (i) When a coordination compound  $\text{NiCl}_2 \cdot 6\text{H}_2\text{O}$  is mixed with  $\text{AgNO}_3$  solution, 2 moles of  $\text{AgCl}$  are precipitated per mole of the compound. Write the structural formula of the complex and secondary valency for Nickel ion. 1
- (ii) Write the IUPAC name of the ionisation isomer of  $[\text{Co}(\text{NH}_3)_5(\text{SO}_4)]\text{Cl}$ . 1
- (iii) Using Valence Bond Theory, predict the geometry and magnetic nature of :
- (1)  $[\text{Ni}(\text{CO})_4]$
- (2)  $[\text{Fe}(\text{CN})_6]^{3-}$
- [Atomic number : Ni = 28, Fe = 26]  $2 \times 1 = 2$

**OR**

- (iii) Give reasons :  $2 \times 1 = 2$
- (1) Low spin tetrahedral complexes are not formed.
- (2)  $[\text{Co}(\text{NH}_3)_6]^{3+}$  is an inner orbital complex whereas  $[\text{Ni}(\text{NH}_3)_6]^{2+}$  is an outer orbital complex.
- [Atomic number : Co = 27, Ni = 28]

**32.** The polarity of C – X bond of alkyl halides is responsible for their nucleophilic substitution, elimination and their reaction with metal atoms to form organometallic compounds. Alkyl halides are prepared by the free radical halogenation of alkanes, addition of halogen acids to alkenes, replacement of – OH group of alcohols with halogens using phosphorus halides, thionyl chloride or halogen acids. Aryl halides are prepared by electrophilic substitution of arenes. Nucleophilic substitution reactions are categorised into  $\text{S}_\text{N}^1$  and  $\text{S}_\text{N}^2$  on the basis of their kinetic properties. Chirality has a profound role in understanding the  $\text{S}_\text{N}^1$  and  $\text{S}_\text{N}^2$  mechanism.

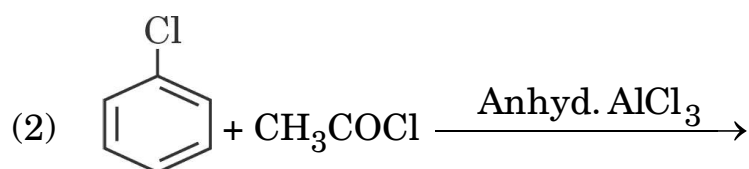
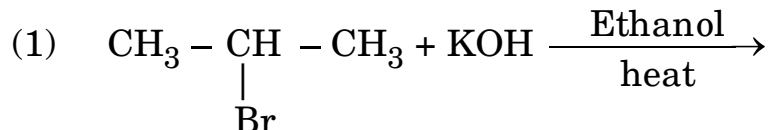


Answer the following questions :

- (i) What happens when bromobenzene is treated with Mg in the presence of dry ether ? 1
- (ii) Which compound in each of the following pairs will react faster in  $S_N^1$  reaction with  $OH^-$  ? 1
- (1)  $CH_2 = CH - CH_2 - Cl$  or  $CH_3 - CH_2 - CH_2 - Cl$
- (2)  $(CH_3)_3C - Cl$  or  $CH_3Cl$
- (iii) Write the equations for the preparation of 1-iodobutane from
- (1) 1-chlorobutane
- (2) but-1-ene. 2 × 1 = 2

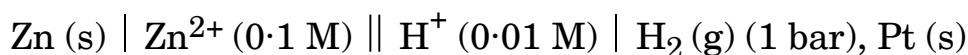
**OR**

- (iii) Write the structure of the major products in each of the following reactions : 2 × 1 = 2



### SECTION E

- 33.** (a) Calculate the emf of the following cell at  $25^\circ C$  :



$$[\text{Given : } E^\circ_{Zn^{2+}/Zn} = -0.76 \text{ V, } E^\circ_{H^+/H_2} = 0.00 \text{ V, } \log 10 = 1]$$

- (b) State Kohlrausch law of independent migration of ions. Why does the conductivity of a solution decrease with dilution ? 3+2=5



34. (a) (i) Account for the following :
- (1) Transition metals form complex compounds.
  - (2) The  $E^\circ_{\text{Mn}^{2+}/\text{Mn}}$  value for manganese is highly negative whereas  $E^\circ_{\text{Mn}^{3+}/\text{Mn}^{2+}}$  is highly positive.
  - (3)  $\text{Cu}^+$  ion is unstable in aqueous solution.
- (ii) Write the equations involved in the preparation of  $\text{KMnO}_4$  from Pyrolusite ore ( $\text{MnO}_2$ ). 3+2=5

**OR**

- (b) (i) Identify the following :
- (1) Transition metal of 3d series that exhibits only one oxidation state.
  - (2) Transition metal of 3d series that acts as a strong reducing agent in +2 oxidation state in aqueous solution.
- (ii) Complete and balance the following equations :
- (1)  $\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 6\text{Fe}^{2+} \longrightarrow$
  - (2)  $\text{KMnO}_4 \xrightarrow{\text{heat}}$
- (iii) What is Misch metal ? Write its one use. 2+2+1=5

35. (a) (i) An organic compound (X) having molecular formula  $\text{C}_5\text{H}_{10}\text{O}$  can show various properties depending on its structures. Draw each of the structures if it
- (1) gives positive iodoform test.
  - (2) shows Cannizzaro's reaction.
  - (3) reduces Tollens' reagent and has a chiral carbon.
- (ii) Write the reaction involved in the following :
- (1) Wolff-Kishner reduction
  - (2) Hell-Volhard-Zelinsky reaction 3+2=5

**OR**



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(b) (i) How can you convert each of the following compounds to Benzoic acid ?

(1) Acetophenone

(2) Ethylbenzene

(3) Bromobenzene

(ii) Arrange the following compounds in increasing order of their property as indicated :

(1)  $\text{O}_2\text{N} - \text{CH}_2 - \text{COOH}$ ,  $\text{F} - \text{CH}_2 - \text{COOH}$ ,  $\text{CN} - \text{CH}_2\text{COOH}$   
(Acidic character)

(2) Ethanal, Propanal, Butanone, Propanone  
(Reactivity in nucleophilic addition reactions) 3+2=5

