रोल नं.
Roll No. ☐☐☐☐☐☐☐☐☐☐

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.

नोट

(I) कृपया जाँच कर लें कि इस प्रश्न-पत्र में मुद्रित पृष्ठ 23 हैं ।

(II) कृपया जाँच कर लें कि इस प्रश्न-पत्र में 33 प्रश्न हैं ।

(III) प्रश्न-पत्र में दाहिने हाथ की ओर दिए गए प्रश्न-पत्र कोड को परीक्षार्थी उत्तर-पुस्तिका के मुख-पृष्ठ पर लिखें ।

(IV) **कृपया प्रश्न का उत्तर लिखना शुरू करने से पहले, उत्तर-पुस्तिका में प्रश्न का क्रमांक अवश्य लिखें ।**

(V) 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 ।

NOTE

(I) Please check that this question paper contains **23** printed pages.

(II) Please check that this question paper contains **33** questions.

(III) 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.

(IV) **Please write down the serial number of the question in the answer-book before attempting it.**

(V) 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.

रसायन विज्ञान (सैद्धान्तिक)
CHEMISTRY (Theory)

निर्धारित समय : 3 घण्टे
Time allowed : 3 hours

अधिकतम अंक : 70
Maximum Marks : 70

General Instructions :

Read the following instructions carefully and follow them :

(i)   *This question paper contains **33** questions. **All** questions are **compulsory**.*

(ii)   *This question paper is divided into **five** sections – **Section A, B, C, D** and **E**.*

(iii)   *Section A – questions number **1** to **16** are multiple choice type questions. Each question carries **1** mark.*

(iv)   *Section B – questions number **17** to **21** are very short answer type questions. Each question carries **2** marks.*

(v)   *Section C – questions number **22** to **28** are short answer type questions. Each question carries **3** marks.*

(vi)   *Section D – questions number **29** and **30** are case-based questions. Each question carries **4** marks.*

(vii)   *Section E – questions number **31** to **33** are long answer type questions. Each question carries **5** marks.*

(viii) *There is no overall choice given in the question paper. However, an internal choice has been provided in few questions in all the sections except Section A.*

(ix)   *Kindly note that there is a separate question paper for Visually Impaired candidates.*

(x)   *Use of calculators is **not** allowed.*

SECTION A

*Questions no. **1** to **16** are Multiple Choice type Questions, carrying **1** mark each.   16×1=16*

1. The standard electrode potential for Sn^{4+}/Sn^{2+} couple is + 0.15 V and for Cr^{3+}/Cr couple is – 0.73 V. These two couples are connected to make an electrochemical cell. The redox reaction is spontaneous. The cell potential will be :

(A)   + 0.88 V

(B)   + 0.58 V

(C)   – 0.88 V

(D)   – 0.58 V

2. The most stable complex among the following is :

(A) $[Pt(NH_3)_2Cl_2]$

(B) $[Ag(NH_3)_2]Cl$

(C) $[Pt(en)_2Cl_2]^{2+}$

(D) $K_4[Fe(CN)_6]$

3. The geometry of diamagnetic nickel complex $[Ni(CN)_4]^{2-}$ is :

(A)   Tetrahedral

(B)   Octahedral

(C)   Square planar

(D)   Distorted octahedral

4. Out of Fe^{2+}, Co^{2+}, Cr^{3+}, Ni^{2+}, the one which shows highest magnetic moment is :

(A) Fe^{2+}

(B) Co^{2+}

(C) Cr^{3+}

(D) Ni^{2+}

[Atomic number : Cr = 24, Fe = 26, Co = 27, Ni = 28]

5. If amines are arranged in increasing order of their basic strength in gaseous phase, then the correct order will be :

(A) $NH_3 < CH_3NH_2 < (CH_3)_3N < (CH_3)_2NH$

(B) $NH_3 < (CH_3)_2NH < (CH_3)_3N < CH_3NH_2$

(C) $(CH_3)_3N < (CH_3)_2NH < CH_3NH_2 < NH_3$

(D) $NH_3 < CH_3NH_2 < (CH_3)_2NH < (CH_3)_3N$

6. Which of the following does *not* undergo Aldol condensation ?

(A) CH_3CHO

(B) CH_3COCH_3

(C) CH_3CH_2CHO

(D) C_6H_5CHO

7. The correct IUPAC name of $(CH_3)_3\,C - CH_2Br$ is :

(A)   2,2-Dimethyl-2-bromopropane

(B)   1-Bromo-2,2,2-trimethylethane

(C)   2-Bromo-1,1,1-trimethylethane

(D)   1-Bromo-2,2-dimethylpropane

8. Considering the strength of the ligand, the highest excitation energy will be observed in :

(A) $[Co(H_2O)_6]^{3+}$

(B) $[Co(NH_3)_6]^{3+}$

(C) $[Co(CN)_6]^{3-}$

(D) $[CoCl_6]^{3-}$

9. For a chemical reaction, $A \longrightarrow B$, it was observed that the rate of reaction doubles when the concentration of A is increased four times. The order of the reaction is :

(A)   2

(B)   1

(C)   1/2

(D)   Zero

10. The IUPAC name of the complex $[Co(NH_3)_5(NO_2)]Cl_2$ is :

(A)   Pentaamminenitrito-O-cobalt(III) chloride

(B)   Pentaamminenitrito-N-cobalt(III) chloride

(C)   Pentaamminenitro-cobalt(III) chloride

(D)   Pentaaminenitrito-cobalt(II) chloride

11. Williamson's synthesis of preparing dimethyl ether is a/an :

(A) electrophilic substitution

(B) S_N1 reaction

(C) electrophilic addition

(D) S_N2 reaction

12. The chemical test which can be used to distinguish between ethanamine and aniline is :

(A) Haloform test

(B) Tollens' test

(C) Azo dye test

(D) Hinsberg test

For Questions number 13 to 16, 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.

13. *Assertion (A) :* Maltose is a reducing sugar.

Reason (R) : Maltose is composed of two glucose units in which C-1 of one glucose unit is linked to C-4 of another glucose unit.
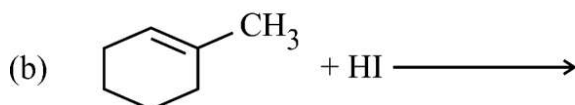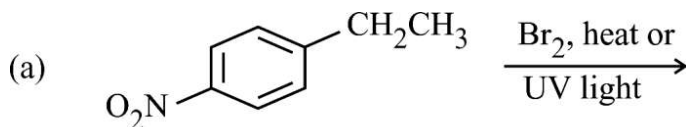
NHCOCH₃

14. *Assertion (A) :* Acetanilide $\left(\underset{}{\bigcirc} \right)$ is less basic than aniline.

Reason (R) : Acetylation of aniline results in decrease of electron density on nitrogen.

15. *Assertion (A) :* Rate constant increases with increase in temperature.

Reason (R) : Increasing the temperature of the substance increases the fraction of molecules, which collide with energies greater than activation energy.

16. *Assertion (A) :* Cu^{2+} iodide is not known.

Reason (R) : Cu^{2+} has strong tendency to oxidise I^- to iodine.

SECTION B

17. Write the reaction involved in the following :   *1+1=2*

    (a)   Reimer-Tiemann reaction

    (b)   Kolbe's reaction

18. Draw the structures of major monohalo products in each of the following reactions :   *1+1=2*

    (a) O_2N—(benzene ring)—CH_2CH_3 $\xrightarrow[\text{UV light}]{\text{Br}_2, \text{ heat or}}$

    (b)   (cyclohexene ring)—CH_3 $+ HI \longrightarrow$

19. The thermal decomposition of an acid is a first order reaction with a rate constant of 2.3×10^{-3} s^{-1} at a certain temperature. Calculate how long it will take for three-fourths of the initial quantity of acid to decompose.
($\log 4 = 0.6021$, $\log 2 = 0.301$)   *2*

20. (a)   Account for the following :   *1+1=2*

        (i) CH_3CHO is more reactive than CH_3COCH_3 towards reaction with HCN.

        (ii)   Carboxylic acids are higher boiling liquids than aldehydes and ketones.

        OR

(b) Give chemical tests to distinguish between the following pair of compounds : *1+1=2*

    (i) Propanal and Propanone

    (ii) Benzaldehyde and Benzoic acid

21. Write the reaction of glucose with : *1+1=2*

    (a) HI

    (b) Br_2 water

SECTION C

22. (a) Draw the geometrical isomers of the complex $[Pt(NH_3)_2Cl_2]$.

    (b) Give the electronic configuration of d^4 ion when $\Delta_o > P$.

    (c) Solution of $[Ni(H_2O)_6]^{2+}$ is green in colour whereas $[Ni(CN)_4]^{2-}$ is colourless. Give reason. [Atomic number : Ni = 28] *1+1+1=3*

23. The electrical resistance of a column of 0.05 M NaOH solution of cell constant 50 cm^{-1} is 4.5×10^3 ohm. Calculate its resistivity, conductivity and molar conductivity. *3*

24. Calculate elevation of the boiling point of the solution when 4 g of $MgSO_4$ (molar mass = 120 g/mol) was dissolved in 100 g of water, assuming $MgSO_4$ undergoes complete ionisation. (K_b for water = 0.52 K kg mol^{-1}) *3*
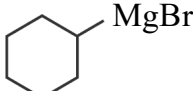
25. Account for the following : *1+1+1=3*

(a) The dipole moment of chlorobenzene is lower than that of cyclohexylchloride.

(b) Alkyl halides are immiscible in water.

(c) t-butyl bromide has lower boiling point than n-butyl bromide.

26. What happens when : (any ***three***) *3×1=3*

(a) is treated with CH_3CHO followed by hydrolysis.

(b) Phenol is treated with conc. $(HNO_3 + H_2SO_4)$.

(c) Anisole is treated with CH_3COCl in the presence of anhydrous $AlCl_3$.

(d) Propan-2-ol is heated with Cu at 573 K.

27. Give plausible explanation for the following : *1+1+1=3*

(a) Diazonium salts of aromatic amines are stable.

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

(c) Aniline on nitration gives a substantial amount of meta product.

28. Hydrolysis of sucrose takes place by the chemical reaction :

$$C_{12}H_{22}O_{11} + H_2O \text{ (excess)} \xrightarrow{H^+} C_6H_{12}O_6 + C_6H_{12}O_6$$
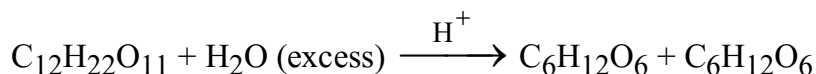
Based on the above reaction, write : *1+1+1=3*
(a) Rate law equation
(b) Molecularity and order of reaction
(c) What do you call such reactions ?

SECTION D

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

29. The particles in the nucleus of the cell, responsible for heredity, are called chromosomes which are made up of proteins and another type of biomolecules called nucleic acids. These are mainly of two types, DNA and RNA. Nucleic acids on hydrolysis yield a pentose sugar, phosphoric acid and nitrogen containing heterocyclic compound. Nucleic acids have a very diverse set of functions, such as cell creation, the storage and processing of genetic information, protein synthesis and the generation of energy cells. Although their functions may differ, the structure of DNA and RNA are very similar, with only a few fundamental differences in their molecular make-up.

Based on the above information, answer the following questions :

(a)	Write two functions of DNA.	*1*
(b)	What products will be formed when a nucleotide from DNA containing Adenine is hydrolyzed ?	*1*
(c)	(i) What are nucleic acids ? What is the difference between nucleotide and nucleoside ?	*2*

<div align="center">OR</div>

(c)	(ii) Give one similarity and one difference between DNA and RNA.	*2*

30. The cause for deviation from Raoult's law in the colligative properties of non-ideal solutions lie in the nature of interactions at the molecular level. These properties show deviations from Raoult's law due to difference in interactions between solute – solvent, solute – solute and solvent – solvent. Some liquids on mixing, form azeotropes which are binary mixtures having the same composition in liquid and vapour phase and boil at a constant temperature. In such cases, it is not possible to separate the components by fractional distillation. There are two types of azeotropes called minimum boiling azeotrope and maximum boiling azeotrope.

Based on the above passage, answer the following questions :

(a) Pure ethanol cannot be prepared by fractional distillation of ethanol – water mixture. Comment. *1*

(b) Why does a mixture of chloroform and acetone show deviation from ideal behaviour ? *1*

(c) (i) The vapour pressure of pure benzene at a certain temperature is 1.25 atm. When 1.2 g of non-volatile, non-electrolyte solute is added to 60 g of benzene (M = 78 g mol^{-1}), the vapour pressure of the solution becomes 1.237 atm. Calculate the molar mass of the non-volatile solute. *2*

OR

(c) (ii) The boiling point of benzene is 353.23 K. When 1.80 g of a non-volatile solute was dissolved in 90 g of benzene, the boiling point is raised to 354.11 K. Calculate the molar mass of the solute. K_b for benzene is 2.53 K kg mol^{-1}. *2*

SECTION E

31. Attempt any *five* of the following : *5×1=5*

(a) Cu^+ is not stable in aqueous solution. Comment.

(b) Out of Cr^{2+} and Fe^{2+}, which one is a stronger reducing agent and why ?

(c) Actinoid contraction is greater from element to element than lanthanoid contraction. Why ?

(d) $KMnO_4$ acts as an oxidising agent in acidic medium. Write the ionic equation to support this.

(e) Name the metal in the first transition series which exhibits +1 oxidation state most frequently.

(f) Transition metals and their compounds are good catalysts. Justify.

(g) Scandium forms no coloured ions, yet it is regarded as a transition element. Why ?

32. (a) (i) What type of battery is the lead storage battery ? Write the anode and the cathode reactions and the overall reaction occurring in a lead storage battery when current is drawn from it. *3*

(ii) Calculate the time to deposit 1.5 g of silver at cathode when a current of 1.5 A was passed through the solution of $AgNO_3$.

[Molar mass of Ag = 108 g mol^{-1}, 1 F = 96500 C mol^{-1}] *2*

OR

(b) (i) State Kohlrausch's law of independent migration of ions. Molar conductivity at infinite dilution for NH_4Cl, NaOH and NaCl solution at 298 K are 110, 100 and 105 S cm^2 mol^{-1} respectively. Calculate the molar conductivity of NH_4OH solution. *3*

(ii) Calulate $\Delta G°$ of the following cell at 25°C : *2*

$Zn (s) | Zn^{2+}(aq) \| Cu^{2+} (aq) | Cu (s)$

Given : $E°_{Zn^{2+}/Zn} = -0.76$ V

$E°_{Cu^{2+}/Cu} = +0.34$ V

1 F = 96500 C mol^{-1}

33. (a) (i) Explain with the help of chemical reaction when : *3*

(I) Acetone is treated with semicarbazide.

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

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

(ii) Arrange the following in the increasing order of their acidic strength : *2*

(I) $CH_3CH_2CH_2COOH$, $BrCH_2CH_2CH_2COOH$,

$CH_3CHBrCH_2COOH$, $CH_3CH_2CHBrCOOH$

(II) Benzoic acid, 4-Methoxybenzoic acid, 4-Nitrobenzoic acid, 3,4-Dinitrobenzoic acid

OR

(b) (i) Identify the products A, B, C and D in the following sequence of reactions : *2*

$$CH_3CHO \xrightarrow{[O]} A \xrightarrow{PCl_5} B$$

$$B \xrightarrow{(CH_3)_2Cd} C$$

$$D \xleftarrow[\text{Conc. HCl}]{Zn - Hg} C$$
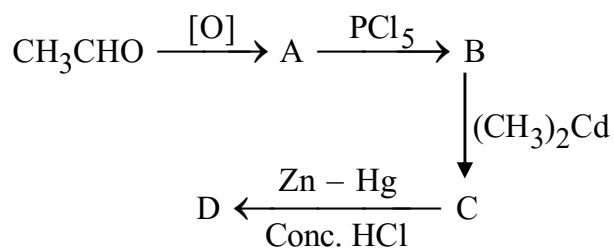
(ii) How will you bring about the following conversions ? *3×1=3*

(I) Propanone to Propene

(II) Benzoic acid to Benzaldehyde

(III) Ethanal to But-2-enal