SAMPLE
QUESTION
PAPER

BLUE PRINT

Time Allowed : 3 hours **Maximum Marks :** 70

S. No.	Chapter	Passage based/ MCQs/A & R (1 mark)	SA-I (2 marks)	SA-II (3 marks)	LA (5 marks)	Total
1.	The Solid State	1(1)	–	1(3)	–	**12(23)**
2.	Solutions	1(1)	1(2)	–	1(5)	
3.	Electrochemistry	1(1)	–	1(3)	–	
4.	Chemical Kinetics	2(2)	1(2)	–	–	
5.	Surface Chemistry	1(1)	1(2)	–	–	
6.	The *p*-Block Elements	2(2)	1(2)	–	–	**8(19)**
7.	The *d*- and *f*-Block Elements	1(1)	1(2)	–	1(5)	
8.	Coordination Compounds	1(4)	–	1(3)	–	
9.	Haloalkanes and Haloarenes	1(1)	–	–	1(5)	**13(28)**
10.	Alcohols, Phenols and Ethers	1(4)	1(2)	–	–	
11.	Aldehydes, Ketones and Carboxylic Acids	2(2)	2(4)	–	–	
12.	Amines	1(1)	1(2)	1(3)	–	
13.	Biomolecules	1(1)	–	1(3)	–	
	Total	**16(22)**	**9(18)**	**5(15)**	**3(15)**	**33(70)**

Subject Code : **043**

CHEMISTRY

Time allowed : 3 hours *Maximum marks : 70*

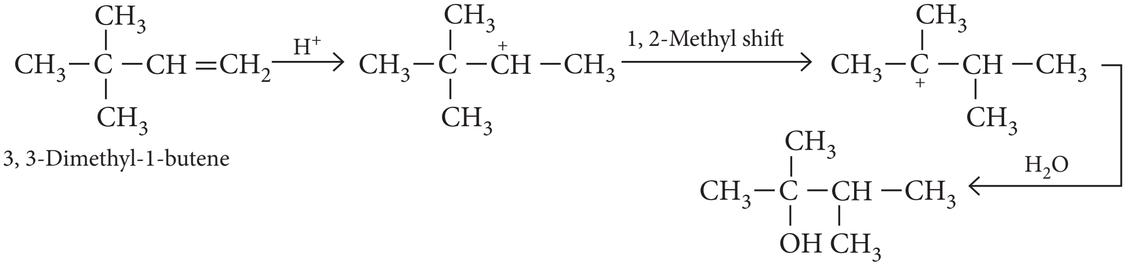
General Instructions : Read the following instructions carefully.

- *(a) There are 33 questions in this question paper. All questions are compulsory.*
- *(b) Section A : Q. No. 1 to 16 are objective type questions. Q. No. 1 and 2 are passage based questions carrying 4 marks each while Q. No. 3 to 16 carry 1 mark each.*
- *(c) Section B : Q. No. 17 to 25 are short answer questions and carry 2 marks each.*
- *(d) Section C : Q. No. 26 to 30 are short answer questions and carry 3 marks each.*
- *(e) Section D : Q. No. 31 to 33 are long answer questions carrying 5 marks each.*
- *(f) There is no overall choice. However, internal choices have been provided.*
- *(g) Use of calculators and log tables is not permitted.*

SECTION - A (OBJECTIVE TYPE)

1. **Read the passage given below and answer the following questions :**

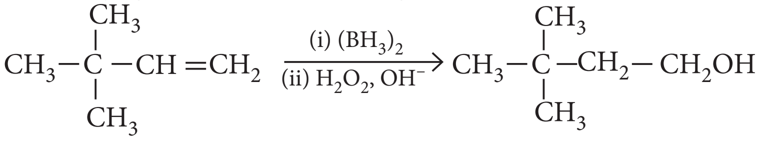
Hydration of alkenes occurs through carbocation intermediate. In case the initially formed carbocations are less stable, they first rearrange to the more stable carbocation (either by, 1,2-hydride shift or by 1, 2-methyl shift) which can give rearranged alcohols.



3, 3-Dimethyl-1-butene

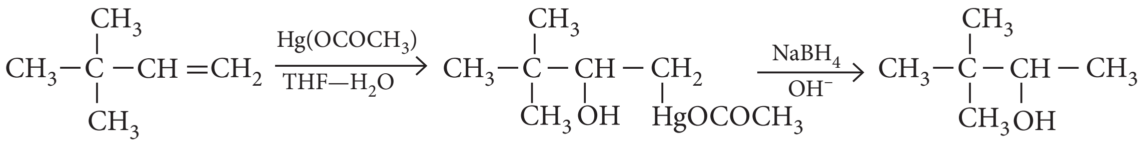
2, 3-Dimethyl-2-butanol

On the other hand, hydroboration-oxidation and oxymercuration reduction do not involve carbocation intermediates and hence always give expected(unarranged) alcohols.



3, 3-Dimethyl-1-butene

3, 3-Dimethyl-1-butanol



3, 3-Dimethyl-1-butene

3, 3-Dimethyl-2-butanol

The following questions are multiple choice questions. Choose the most appropriate answer:

(i) Reaction of propene with diborane followed by alkaline hydrolysis in the presence of hydrogen peroxide gives

(a) 1-propanol (b) 2-propanol (c) 1, 2-dihydroxypropane (d) *n*-propane.

(ii) The best method to prepare 3-methylbutan-2-ol from 3-methylbut-1-ene is

(a) addition of water in the presence of dil. H_2SO_4

(b) addition of HCl followed by reaction with dil. $NaOH_{(aq)}$

(c) hydroboration-oxidation reaction

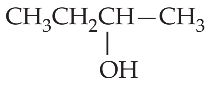
(d) oxymercuration-demercuration reaction.

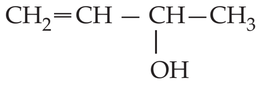
OR

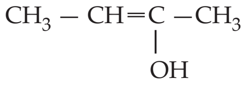
$$\text{But-1-ene} \xrightarrow[H_3O^+]{(CH_3COO)_2Hg} ?$$

The product in the above reaction is

(a) $CH_3CH_2CH_2CH_2OH$

(b) 
$CH_3CH_2\underset{OH}{\underset{|}{CH}}-CH_3$

(c) 
$CH_2{=}CH-\underset{OH}{\underset{|}{CH}}-CH_3$

(d) 
$CH_3-CH{=}\underset{OH}{\underset{|}{C}}-CH_3$

(iii) Oxymercuration-demercuration reaction of 1-methylcyclohexene gives

(a) *cis*-2-methylcyclohexanol

(b) *trans*-2-methylcyclohexanol

(c) 1-methylcyclohexanol

(d) mixture of *cis*- and *trans*-2-methylcyclohexanol.

(iv) Acid catalysed hydration of alkenes except ethene leads to the formation of

(a) primary alcohol (b) secondary or tertiary alcohol

(c) mixture of primary and secondary alcohols (d) mixture of primary and tertiary alcohols.

2. Read the passage given below and answer the following questions :

Co(II) forms numerous complexes, which may be tetrahedral, octahedral or occasionally square planar. The monodentate ligands Cl^-, Br^-, I^-, OH^- and SCN^- commonly form tetrahedral complexes. The complex $[CoHg(CNS)_4]$ is unusual in that Co^{2+} is tetrahedrally coordinated by S-atoms giving a polymeric solid. This compound is often used to calibrate a magnetic balance when measuring magnetic moments. Square planar complexes are formed with several bidentate ligands such as dimethylglyoxime. Even though Co^{2+} is much more stable than Co^{3+}, many Co(II) complexes are readily oxidised to Co(III) complexes.

$$[Co(NH_3)_6]^{2+} \xrightarrow{\text{bubble in air}} [Co(NH_3)_6]^{3+}$$

In these question (Q. No. i-iv), a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

(a) Assertion and reason both are correct statements and reason is correct explanation for assertion.

(b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

(c) Assertion is correct statement but reason is wrong statement.

(d) Assertion is wrong statement but reason is correct statement.

(i) **Assertion :** $[Co(NH_3)_6]^{2+}$ is oxidised to $[Co(NH_3)_6]^{3+}$ by the oxygen in air.

Reason : Crystal field stablisation energy of Co(III) with a d^6 configuration is higher than for Co(II) with a d^7 arrangement.

(ii) **Assertion :** On dehydration pink coloured octahedral $[Co(H_2O)_6]^{2+}$ ions turn into blue coloured tetrahedral $[Co(H_2O)_4]^{2+}$ ions

Reason : Most Co(II) compounds are soluble in water.

(iii) **Assertion :** The IUPAC name of $Hg[Co(CNS)_4]$ is mercury tetrathiocyanato–N– Cobaltate (II).
Reason : SCN^- is a unidentate negative ligand.

OR

Assertion : The complex $[Co(NH_3)_3Cl_3]$ does not give precipitate with $AgNO_3$.
Reason : The complex does not contain counter ions.

(iv) **Assertion :** $[CoF_6]^{3-}$ is paramagnetic while $[Co(C_2O_4)_3]^{3-}$ is diamagnetic.
Reason : $[Co(C_2O_4)^3]^{3-}$ form an outer orbital complex.

Following questions (No. 3-11) are multiple choice questions carrying 1 mark each.

3. Which of the following sequence is used to prepare α-Hydroxypropanoic acid from ethanal?
(a) Treat with HCN followed by acidic hydrolysis.
(b) Treat with $NaHSO_3$ followed by reaction with Na_2CO_3.
(c) Treat with H_2SO_4 followed by hydrolysis.
(d) Treat with $K_2Cr_2O_7$ in presence of sulphuric acid.

4. Which of the following give both Frenkel and Schottky defect?
(a) AgCl
(b) CsCl
(c) KCl
(d) AgBr

OR

The ionic radii of A^+ and B^- ions are 0.98×10^{-10} m and 1.81×10^{-10} m. The coordination number of each ion in *AB* is
(a) 8
(b) 2
(c) 6
(d) 4

5. Which pair of electrolytes could not be distinguished by the products of electrolysis using inert electrodes?
(a) 1 M $CuSO_4$ solution, 1 M $CuCl_2$ solution
(b) 1 M KCl solution, 1M KI solution
(c) 1M $AgNO_3$ solution,1M $Cu(NO_3)_2$ solution
(d) 1M KCl solution, 1M NaCl solution

6. In a transition series, with the increase in atomic number, the paramagnetism
(a) increases gradually
(b) decreases gradually
(c) first increases to a maximum and then decreases
(d) first decreases to a minimum and then increases.

OR

Which of the following transition metals of 3*d* series has the lowest melting point?
(a) Ti (Z = 22)
(b) V (Z = 23)
(c) Cr (Z = 24)
(d) Mn (Z = 25)

7. How many primary amines are possible with the formula of $C_4H_{11}N$?
(a) 1
(b) 2
(c) 3
(d) 4

OR

2-Butanamine was added to the solution of sodium nitrite in hydrochloric acid. Gas liberated in this reaction is
(a) N_2
(b) NH_3
(c) O_2
(d) H_2

8. The combination of two layers of opposite charges around the colloidal particle is called Helmholtz electrical double layer. The potential difference between the fixed layer and the diffused layer of opposite charge is called
(a) electrode potential
(b) zeta potential
(c) adsorption potential
(d) diffused potential.

OR

In the plot of $\log \frac{x}{m}$ *vs* $\log p$ for an adsorption, a straight line inclined at an angle of $\theta = 14.04°$ to the *x* axis was obtained. The '*n*' value for this adsorption process is ($\tan 14.04° = 0.25$)
(a) 5
(b) 8
(c) 4
(d) 2

9. A 5% solution of cane sugar (M.wt. = 342) is isotonic with 1% solution of substance *X*. The molecular weight of *X* is

(a) 171.2 (b) 68.4 (c) 34.2 (d) 136.2

10. The property of halogens which is not correctly matched is

(a) F > Cl > Br > I (Ionisation energy)
(b) F > Cl > Br > I (Electronegativity)
(c) I > Br > Cl > F (Density)
(d) F > Cl > Br > I (Electron affinity)

11. The rate of a certain reaction is given by, rate = $k[H^+]^n$. The rate increases 100 times when the pH changes from 3 to 1. The order (n) of the reaction is

(a) 2 (b) 0 (c) 1 (d) 1.5

In the following questions (Q. No. 12 - 16) a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

(a) Assertion and reason both are correct statements and reason is correct explanation for assertion.
(b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.
(c) Assertion is correct statement but reason is wrong statement.
(d) Assertion is wrong statement but reason is correct statement.

12. **Assertion :** In vapour state sulphur is paramagnetic in nature.

Reason : In vapour state sulphur exists as S_2 molecule.

13. **Assertion :** On free radical monochlorination of $(CH_3)_2CHCH_2CH_3$ four monochloro structural isomers are possible.

Reason : In $(CH_3)_2CHCH_2CH_3$ there are four different types of hydrogen atoms.

14. **Assertion :** Picric acid is a strong acid inspite of absence of carboxylic group.

Reason : Three —NO_2 groups in picric acid activate the phenolate ion.

OR

Assertion : Aromatic aldehydes and formaldehyde undergo Cannizzaro reaction.

Reason : Those aldehydes which have α-H atom undergo Cannizzaro reaction.

15. **Assertion :** In rate law, unlike in the expression for equilibrium constants, the exponents for concentrations do not necessarily match the stoichiometric coefficients.

Reason : It is the mechanism and not the balanced chemical equation for the overall change that governs the reaction rate.

16. **Assertion :** Glucose and fructose give the same osazone.

Reason : During osazone formation stereochemistry at C_1 and C_2 is destroyed.

SECTION - B

The following questions, Q. No. 17-25 are short answer type and carry 2 marks each.

17. A reaction is first order in *A* and second order in *B*.

(i) How is the rate affected on increasing the concentration of *B* three times?
(ii) How is the rate affected when the concentrations of both *A* and *B* are doubled?

OR

With the help of an example explain what is meant by pseudo first order reaction.

18. Compare the basicity of the following compound :

(i) $H_2C{=}CHCH_2NH_2$

(ii) $CH_3CH_2CH_2NH_2$

(iii) $HC{\equiv}CCH_2NH_2$

19. Describe the chemical reaction of chlorine with

(i) dry calcium hydroxide (slaked lime).

(ii) aqueous solution of hot calcium hydroxide (milk of lime).

OR

Draw the structures and state hybridisation for the following :

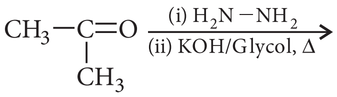
(a) SF_4 (b) IF_5

20. Arrange the following in decreasing order of their acidic strength and give reason for your answer.

CH_3CH_2OH, CH_3COOH, $ClCH_2COOH$, FCH_2COOH, $C_6H_5CH_2COOH$

OR

Predict the products of the following reactions :

(i) 

$$\underset{\displaystyle CH_3}{CH_3-\underset{|}{C}{=}O} \xrightarrow[\text{(ii) KOH/Glycol, }\Delta]{\text{(i) } H_2N-NH_2}$$

(ii) $C_6H_5-CO-CH_3 \xrightarrow{NaOH/I_2}$

21. The air is a mixture of a number of gases. The major components are oxygen and nitrogen with approximate proportion of 20% and 79% by volume at 298 K. The water is in equilibrium with air at a pressure of 10 atm. At 298 K, if the Henry's law constants for oxygen and nitrogen are 3.30×10^7 mm Hg and 6.51×10^7 mm Hg respectively, calculate the composition of these gases in water.

22. Use the data to answer the following and also justify giving reasons :

	Cr	**Mn**	**Fe**	**Co**
$E^\circ_{M^{2+}/M}$	−0.91	−1.18	−0.44	−0.28
$E^\circ_{M^{3+}/M^{2+}}$	−0.41	+1.57	+0.77	+1.97

(a) Which is a stronger reducing agent in aqueous medium, Cr^{2+} or Fe^{2+} and why?

(b) Which is the most stable ion in +2 oxidation state and why?

23. (i) In chemisorption why, $\frac{x}{m}$ initially increases and then decreases with rise in temperature?

(ii) The enthalpy in case of chemisorpion is usually higher than that of physisorption. Why?

24. Preparation of ethers by acid dehydration of secondary or tertiary alcohols is not a suitable method. Give reason.

25. A compound (*A*) $C_5H_8O_2$ liberates CO_2 on reaction with sodium bicarbonate. It exists in two forms neither of which is optically active. It yields (*B*) $C_5H_{10}O_2$ on hydrogenation. Compound (*B*) can be separated into two enantiomers. Write structural formulae for (*A*) and (*B*) with reason.

SECTION - C

Q. No. 26-30 are short answer type II carrying 3 marks each.

26. (i) The equivalent conductivity of 0.05 N solution of a monobasic acid is 15.8 mho $cm^2\ eq^{-1}$. If equivalent conductivity of the acid at infinite dilution is 350 mho $cm^2\ eq^{-1}$, calculate the (a) degree of dissociation of acid (b) dissociation constant of acid.

(ii) State Kohlrausch's law.

OR

Four metals are labelled as *A*,*B*,*C* and *D*. They react with each other and with acids in the following way:

(i) *B* displaces only *C* from solution

(ii) Only *A* and *D* displace hydrogen from 1 M HCl

(iii) None of the metals displace *D* from its solution.

Arrange the metals along with hydrogen in the decreasing order of their reduction potential values.

27. (a) Arrange the following complexes in the increasing order of conductivity of their solutions : $[Co(NH_3)_3Cl_3]$, $[Co(NH_3)_4Cl_2]Cl$, $[Co(NH_3)_6]Cl_3$, $[Co(NH_3)_5Cl]Cl_2$.

(b) $CoSO_4Cl{\cdot}5NH_3$ exists in two isomeric forms '*A*' and '*B*'. Isomer '*A*' reacts with $AgNO_3$ to give white precipitate, but does not react with $BaCl_2$. Isomer '*B*' gives white precipitate with $BaCl_2$ but does not react with $AgNO_3$.

Answer the following questions :

(i) Identify '*A*' and '*B*' and write their structural formulae.

(ii) Give the IUPAC name of '*A*' and '*B*'.

28. Suggest chemical reactions for the following conversions :

(i) Cyclohexanol → Cyclohexylamine

(ii) 1-Hexanenitrile → 1-Aminopentane

29. (i) Calculate the value of Avogadro constant from the following data :

Density of NaCl = 2.165 g cm^{-3}

Distance between Na^+ and Cl^- in NaCl = 281 pm

Molar mass of NaCl = 58.5 g mol^{-1}

(ii) In the compound *AX*, the radius of A^+ ion is 95 pm and that of X^- is 181 pm. Predict the crystal structure of *AX* and write the coordination number of each of the ions.

30. (i) What are the different types of RNA found in cells of organisms? State the functions of each type.

(ii) Amylase present in the saliva becomes inactive in the stomach. Explain.

OR

(a) α-Helix is a secondary structure of proteins formed by twisting of polypeptide chain into right handed screw like structures. Which type of interactions are responsible for making the α-helix structure stable?

(b) Under what conditions glucose is converted to gluconic and saccharic acid?

SECTION - D

Q. No. 31-33 are long answer type carrying 5 marks each.

31. (i) Calculate molarity and molality of a 13% solution (by weight) of sulphuric acid. Its density is 1.020 g cm^{-3} (Atomic mass of H = 1, O = 16, S = 32 amu).

(ii) Vapour pressure of pure water at 35°C is 31.82 mm Hg. When 27 g of solute is dissolved in 100 g of water (at the same temperature) vapour pressure of the solution thus formed is 30.95 mm Hg. Calculate the molecular mass of the solute.

OR

(i) Based on solute-solvent interactions arrange the following in order of increasing solubility in *n*-octane and explain :

Cyclohexane, KCl, CH_3OH, CH_3CN

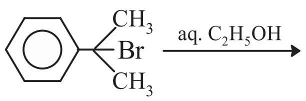
(ii) Two elements *A* and *B* form compounds having molecular formula AB_2 and AB_4. When dissolved in 20 g of benzene (C_6H_6), 1 g of AB_2 lowers the freezing point by 2.3 K whereas 1 g of AB_4 lowers it by 1.3 K. The molal depression constant for benzene is 5.1 K kg mol^{-1}. Calculate atomic masses of *A* and *B*.

(iii) Some ethylene glycol, $HOCH_2CH_2OH$, is added to your car's cooling system along with 5 kg of water. If the freezing point of water-glycol solution is –15.0°C, what is the boiling point of the solution? ($K_b = 0.52$ K kg mol^{-1} and $K_f = 1.86$ K kg mol^{-1} for water)

32. When bromobenzene is monochlorinated, two isomeric compounds (*A*) and (*B*) are obtained. Monobromination of (*A*) gives several isomeric products of formula $C_6H_3ClBr_2$ while monobromination of (*B*) yields only two isomers (*C*) and (*D*). Compound (*C*) is identical with one of the compounds obtained from the bromination of (*A*), however (*D*) is totally different from any of the isomeric compounds obtained from bromination of (*A*). Give structures of (*A*), (*B*), (*C*) and (*D*) and also suggest structures of four isomeric monobrominated products of (*A*).

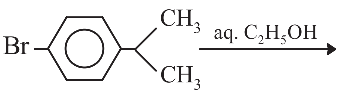
OR

(i)



Acidic solution

(ii)



Neutral solution

(iii) *R*Cl is treated with Li in ether to form *R*—Li. *R*—Li reacts with water to form *iso*-pentane. *R*—Cl also reacts with sodium to form 2, 7-dimethyloctane. What is the structure of *R*—Cl?

(iv) Give reasons :

(a) Racemic mixture is optically inactive.

(b) The presence of nitro group (—NO_2) at *o*/*p* positions increases the reactivity of haloarenes towards nucleophilic substitution reactions.

33. (a) For some of the first row transition elements the *E*° values are :

	V	Cr	Mn	Fe	Co	Ni	Cu
$E^\circ_{(M^{2+}/M)}$(V)	–1.81	–0.91	–1.18	–0.44	–0.28	–0.25	+0.34

Give suitable explanation for the irregular trend in these values.

(b) Give reasons for the following features of transition metal chemistry:

(i) Most of the transition metal ions are coloured in solution.

(ii) Transition metals are well known to form complex compounds.

(iii) The second and third members in each group of the transition elements have similar atomic radii.

OR

(a) How would you account for the following observations :

(i) Ce(IV) is a good analytical reagent.

(ii) Of the lanthanoid, only cerium (Ce = 58) is known to exhibit quite stable +4 state in solutions.

(b) Assign a reason for each of the following observations :

(i) The transition metals (with the exception of Zn, Cd and Hg) are hard and have high melting and boiling points.

(ii) The ionisation enthalpies (first and second) in the first series of the transition elements are found to vary irregularly.

(c) Zn^{2+} salts are white while Cu^{2+} salts are coloured. Why?