



**FEDERAL PUBLIC SERVICE COMMISSION
COMPETITIVE EXAMINATION-2016
FOR RECRUITMENT TO POSTS IN BS-17
UNDER THE FEDERAL GOVERNMENT**

Roll Number

CHEMISTRY PAPER-I

TIME ALLOWED: THREE HOURS	PART-I (MCQS)	MAXIMUM MARKS = 20
PART-I(MCQS): MAXIMUM 30 MINUTES	PART-II	MAXIMUM MARKS = 80
NOTE: (i) Part-II is to be attempted on the separate Answer Book. (ii) Attempt ONLY FOUR questions from PART-II. ALL questions carry EQUAL marks. (iii) All the parts (if any) of each Question must be attempted at one place instead of at different places. (iv) Candidate must write Q. No. in the Answer Book in accordance with Q. No. in the Q.Paper. (v) No Page/Space be left blank between the answers. All the blank pages of Answer Book must be crossed. (vi) Extra attempt of any question or any part of the attempted question will not be considered. (vii) Use of Calculator is allowed.		

PART-II

- Q. No. 2.** (a) What is Schrodinger wave equation? Discuss its importance in quantum chemistry. (6)
(b) Solve the Schrodinger wave equation for a particle in three-dimensional box and find the expression for the energy and wave function. (8)
(c) What is a well-behaved function? What are the requirements of a physically acceptable wave function? (6)
- Q. No. 3.** (a) What is Gibbs free energy? Discuss its significance in chemistry. (6)
(b) Give a brief account of transition state theory indicating its advantages over collision theory. (8)
(c) Explain 3rd law of thermodynamics. How this law is useful to determine the absolute value of entropy? (6)
- Q. No. 4.** (a) Define and explain Langmuir adsorption isotherm. What are its limitations? (8)
(b) What is acid-base catalysis? Discuss its significance in chemistry. (6)
(c) What is Phase rule? Discuss its application in one component system. (6)
- Q. No. 5.** (a) What are solubility product and common ion effect? Discuss their significance in chemical analysis (8)
(b) Valence shell electron pair repulsion theory can be used to predict the shapes of molecules. Using this theory explain the shapes acquired by BF₃ and IF₅. (7)
(c) Explain why HSH bond angle in H₂S is slightly less than the tetrahedral angle 109.5 (5)
- Q. No. 6.** (a) Describe main features of crystal field theory, How this theory explains colour of coordination complexes? (10)
(b) Write the electronic configuration for each of the following: (4)
Ni²⁺, Cu, Mn²⁺, Cr³⁺
(c) What is John-Teller theorem? Explain its significance in coordination chemistry. (6)
- Q. No. 7.** (a) What are lanthanides? How are these extracted from their ores? (10)
(b) What is decay law? How half-life and decay constant are related with each (5)



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CHEMISTRY PAPER-II

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PART-I(MCQS): MAXIMUM 30 MINUTES

PART-I (MCQS)
PART-II

MAXIMUM MARKS = 20
MAXIMUM MARKS = 80

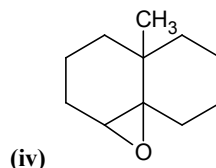
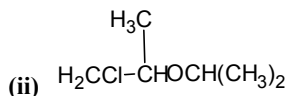
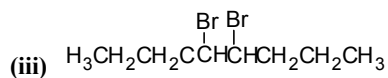
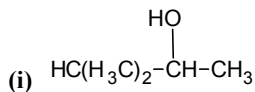
- NOTE:** (i) **Part-II** is to be attempted on the separate **Answer Book**.
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(vii) **Use of Calculator is allowed.**

PART-II

Q. No. 2. Write briefly on the following terms: (2 each) (20)

- | | |
|--------------------------|------------------------------|
| (i) Hyper-conjugation | (ii) Aromaticity |
| (iii) Grignard's reagent | (iv) S_N1 reaction |
| (v) Molecular chirality | (vi) Monosaccharides |
| (vii) Chemical shift | (viii) Glycolysis |
| (ix) Detergents | (x) Friedel Craft alkylation |

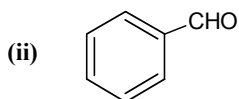
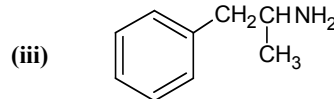
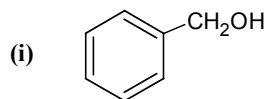
Q. No. 3. (a) How would you synthesize each of the following molecule from an alkene of appropriate structure (structure of your choice). (8)



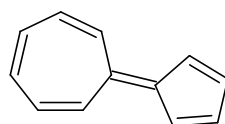
(b) Write the expected major product of the reaction of propyne with each of the following reagents. (6)

- | | |
|---|---|
| (i) Cu_2Cl_2 , O_2 , pyridine | (iv) H_2O , HgSO_4 , H_2SO_4 |
| (ii) Na , ND_3 | (v) Di-isoamylborane, then NaOH , H_2O_2 |
| (iii) $[(\text{CH}_3)_2\text{CHCH}_2\text{CH}_2]_2\text{BD}$
then $\text{CH}_3\text{CO}_2\text{H}$ | (vi) Di-isoamylborane, then $\text{CH}_3\text{CO}_2\text{D}$ |

(c) Starting with benzene, design reasonable syntheses of each of the following compounds. (6)

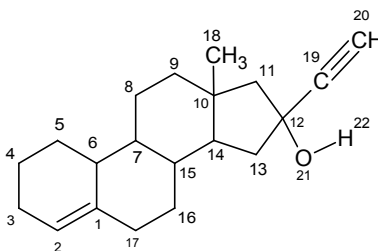


- (b) Draw the structures of the following molecules: (10)
- | | |
|--|--|
| (i) 5-(2,2-Dimethylpropyl)nonane | (vi) 4-(2-Ethylbutyl)decane |
| (ii) 2,3-Dimethylhept-3-ene | (vii) 5-Ethyl-4,6-dimethylhept-4-en-2-yne |
| (iii) 1-Chloro-1-methoxy-2-methylbut-1-ene | (viii) 5,5-Dichloro-3-methylhepta-3,6-dien-1-yne |
| (iv) 6-Chloro-2-nitrooct-1-en-3-yne | (ix) 6-bromo-5-chloro-9-nitropentadecane |
| (v) 8-Chloro-7-methoxy-5-methyl-4-nitroundec-5-ene | (x) 6-chloroocta-1,3-diyne |
- (c) (i) The structure(I) given below has significant dipole moment. Which end of the molecule would you expect to owe positive charge, and which tend to be negative. (2)



(I)

- (ii) The structure(II) given below is a component of certain oral contraceptives: (3)

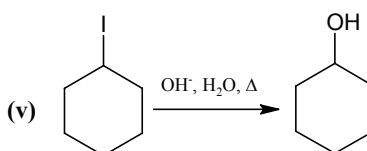
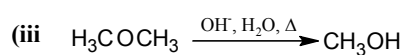
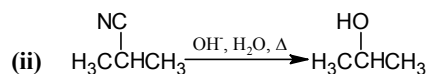
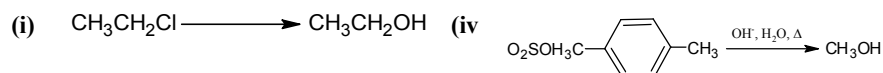


(II)

Locate in this structure an example of each of the following bonds or atoms

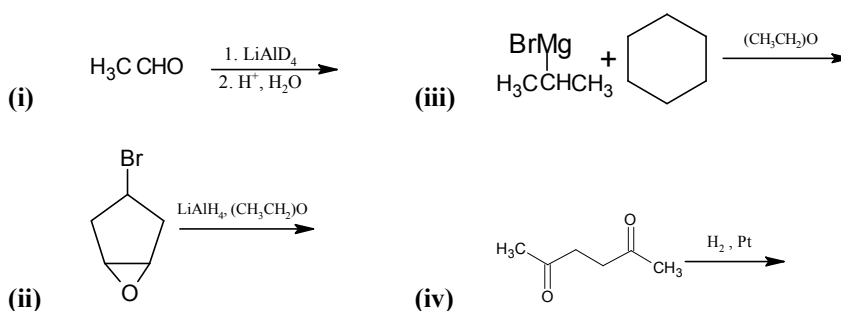
- A highly polarized covalent bond
- Sp-hybrid carbon atoms
- A nearly unpolarized covalent bond

- Q. No. 5. (a) Consider the reaction of bromocyclohexane with each of the four reagents below, and answer the questions below. Also write down the reaction mechanism in each case. (7)
- | | | | |
|----------------------|---------------|--------------------------|---------------------------|
| H_2O | OH^- | CH_3COOH | CH_3COO^- |
| (i) | (ii) | (iii) | (vi) |
- (i) What is the most important type of reaction mechanism in each case?
- (ii) Which reagent gives the most elimination product?
- (iii) Which reagent is most useful in synthesizing the alcohol?
- (b) Evaluate each of the possible alcohol syntheses below as being good (the desired alcohol is major or only product), not so good (the desired alcohol is a minor product, or worthless). (5)

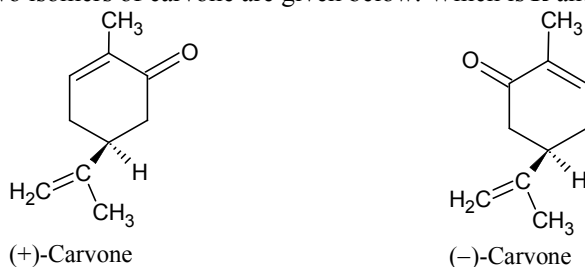


CHEMISTRY PAPER-II

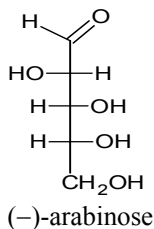
- (c) Write the major product(s) of each of the following reactions. It is implied that aqueous work-up has taken place in all those cases that require it to obtain the organic product. (8)



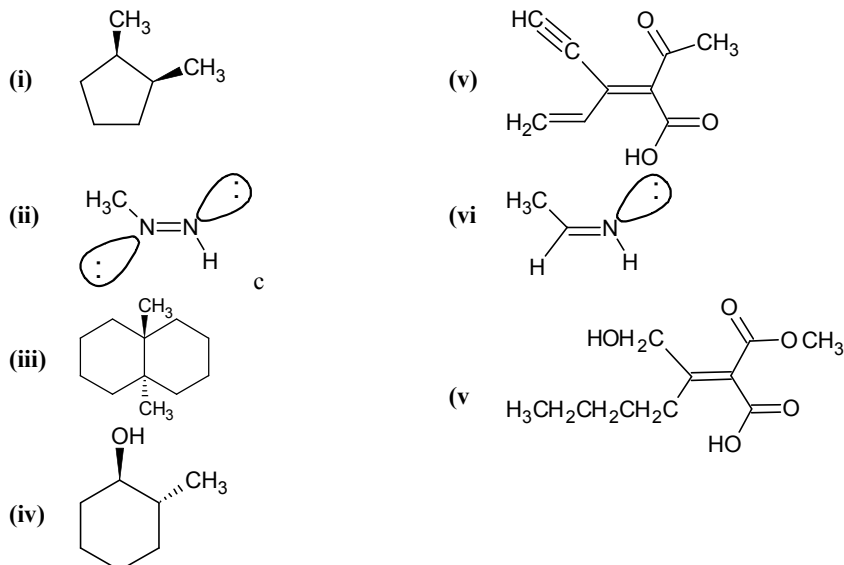
- Q. No. 6. (a) The two isomers of carvone are given below. Which is *R* and which is *S*? (2)



- (b) The structure of compound given below is a sugar called (-)-arabinose. Its specific rotation is -105° . (3)



- (i) Draw enantiomer(s) of (-)-arabinose
 (ii) Draw diastereomer(s) of (-)-arabinose
 (iii) Does (-)-arabinose have any optically inactive diastereomers? If it does, draw one.
- (c) Assign E,Z designation to the following structures. (7)



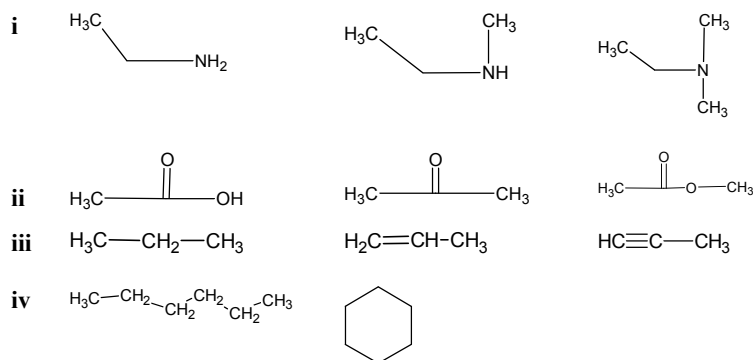
CHEMISTRY PAPER-II

- (d) Draw the structures of the product(s) described for each reaction. Specify all aspects of the stereochemistry. (8)
- (i) Stereospecific anti addition of bromine to cis- and trans-cinnamic acid.
- (ii) Methanolysis of S-3-bromooctane with 6% racemization.
- (iii) Stereospecific syn thermal elimination of acetic acid from 1R,2S-diphenylpropyl acetate
- (iv) Stereoselective epoxidation of bicyclo[2.2.1]hept-2-ene proceeding 94% from the exo face.

Q. No. 7. Write a brief account on the following: (5 each) (20)

- (a) Biological importance of starch (c) Primary structure of Proteins
- (b) Classification of Amino acids (d) Glycogenesis

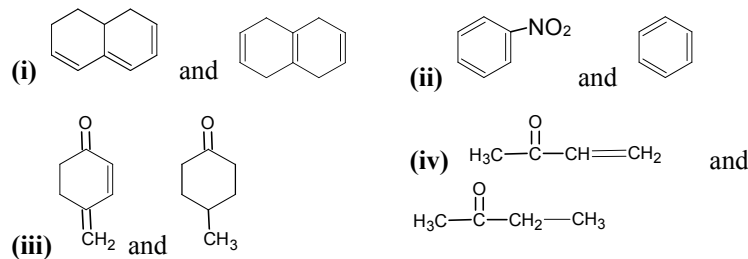
Q. No. 8. (a). Differentiate following using IR Spectroscopy? (4)



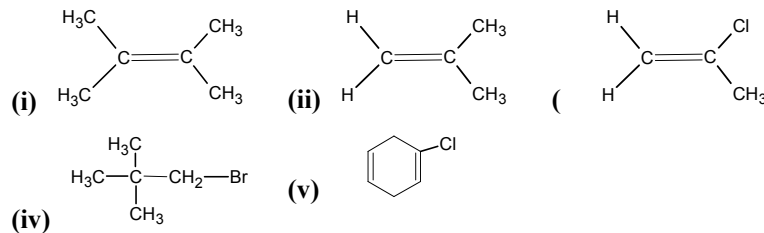
(b). What type of electronic transition are possible in the following compounds? (2)

- (i) Butadiene (iii) Acetaldehyde
- (ii) Diethyl ether (iv) Trimethylamine

(c). How will you distinguish the following compounds using UV/Visible spectrophotometer? (4)



(d). Give the chemical shift of the following compounds for each proton (5)



(e). The mass spectrum of compound shows following peaks: (5)

m/e = 120, relative intensity = 20% (M^+ peak), m/e = 105, relative intensity = 80%,
m/e = 77, relative intensity = 96%, m/e = 43, relative intensity = 35%.
Assign the structure which would be expected.



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PART-II

- Q. No. 2.** (a) Derive Schrodinger wave equation for motion of a particle in one dimensional box. (10)
(b) Solve Schrodinger wave equation to find the expression for wave function energy of a particle in one dimensional box. (6)
(c) What is Eigen function and Eigen value? Give examples. (4)
- Q. No. 3.** (a) Define heat capacities and molar heat capacities. Prove that $C_p - C_v = R$ for ideal gases. (10)
(b) What is Gibbs energy? Derive a relation between standard Gibbs energy change and equilibrium constant. (6)
(c) Differentiate spontaneous and non spontaneous process. (4)
- Q. No. 4.** (a) State and explain Kohlrausch's law. Give its applications. (10)
(b) What is meant by standard deviation? Give its significance in analytical chemistry. (6)
(c) Briefly describe conductometric titrations. (4)
- Q. No. 5.** (a) Discuss the effect of temperature on rate of chemical reaction on the basis of Arrhenius equation. How can you determine activation energy and pre-exponential factor for a chemical reaction using Arrhenius equation? (10)
(b) Derive kinetic equation for 1st order reaction. (6)
(c) Prove that half life period for 1st order reaction is independent of initial concentration of reactant. (4)
- Q. No. 6.** (a) What is adsorption isotherm? Derive Langmuir adsorption isotherm for adsorption of a gas on solid surface. (10)
(b) What is enzyme catalysis? Discuss its kinetics. (6)
(c) What are surfactants? Give their properties. (4)
- Q. No. 7.** (a) What is electrophoresis? Give its principle and discuss its applications in biochemistry. (10)
(b) Give six chemical properties of nitrogen. (6)
(c) What is Common ions effect? Give its applications. (4)
- Q. No. 8.** (a) State John-Teller theorem. Explain it using suitable examples from coordination complexes. (10)
(b) Give postulates of Werner's theory of coordination complexes. (6)
(c) Briefly describe nuclear decay rate law for disintegration of radioactive elements. (4)



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CHEMISTRY PAPER-II

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PART-I (MCQS)

PART-II

MAXIMUM MARKS = 20

MAXIMUM MARKS = 80

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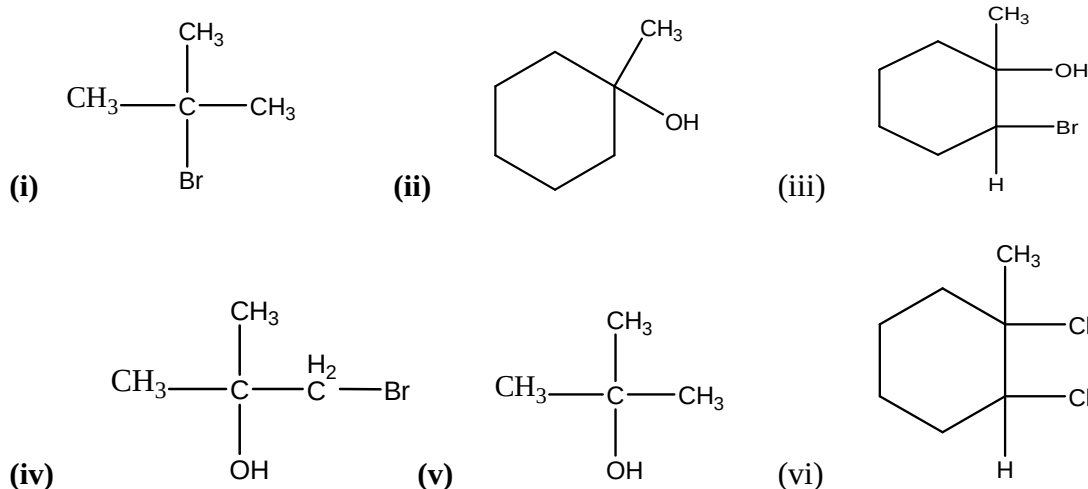
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PART-II

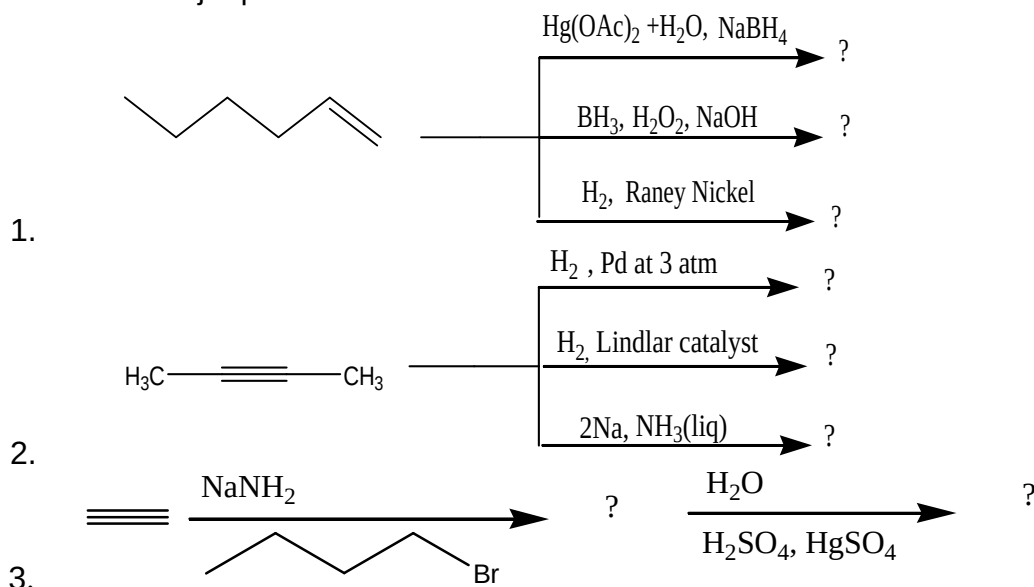
Q. No. 2. Write brief notes on the following (2 each) (20)

- | | | |
|----------------------------|-----------------------|------------------------|
| (i) Covalent Bond | (ii) Hybridization | (iii) Isomerism |
| (iv) Monosaccharides | (v) Triglycerides | (vi) Electronegativity |
| (vii) The Inductive Effect | (viii) Chemical Shift | (ix) Stereoselectivity |
| (x) Fertilizers | | |

Q. No. 3. (a) Give the method of synthesis of the following compounds from an appropriate alkene of your choice with reagents. (12)

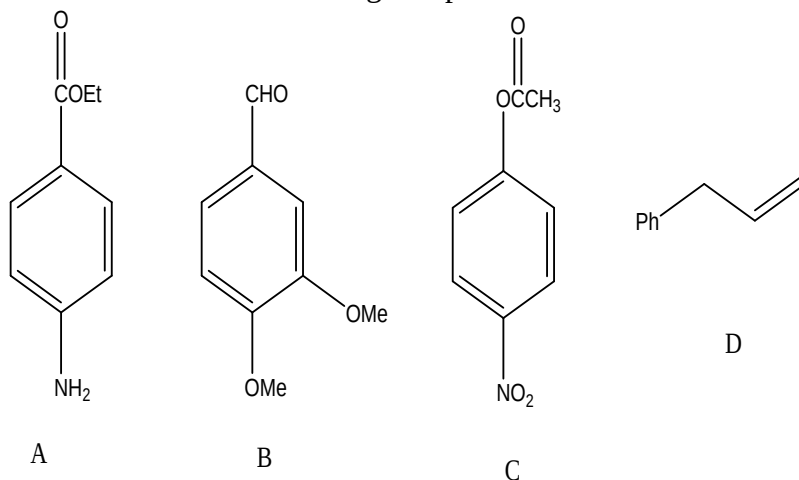


(b) Write the Major product for these Reactions. (8)



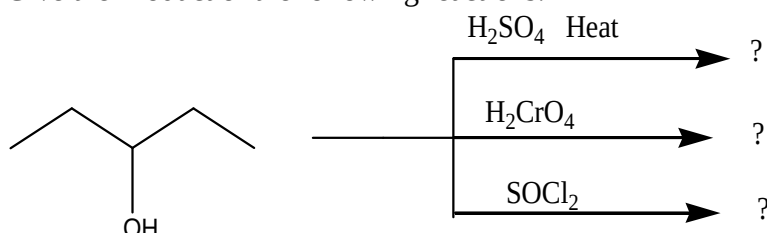
CHEMISTRY PAPER-II

- Q. No. 4.** (a) What is aromaticity? Explain the Hückel criteria for aromaticity. (6)
 (b) Write names of the following compounds. (4)

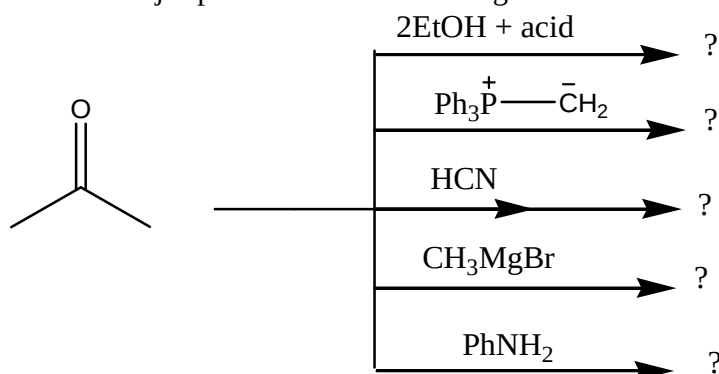


- (c) Write the reaction and mechanism of Friedel Craft alkylation and acylation reaction. (10)

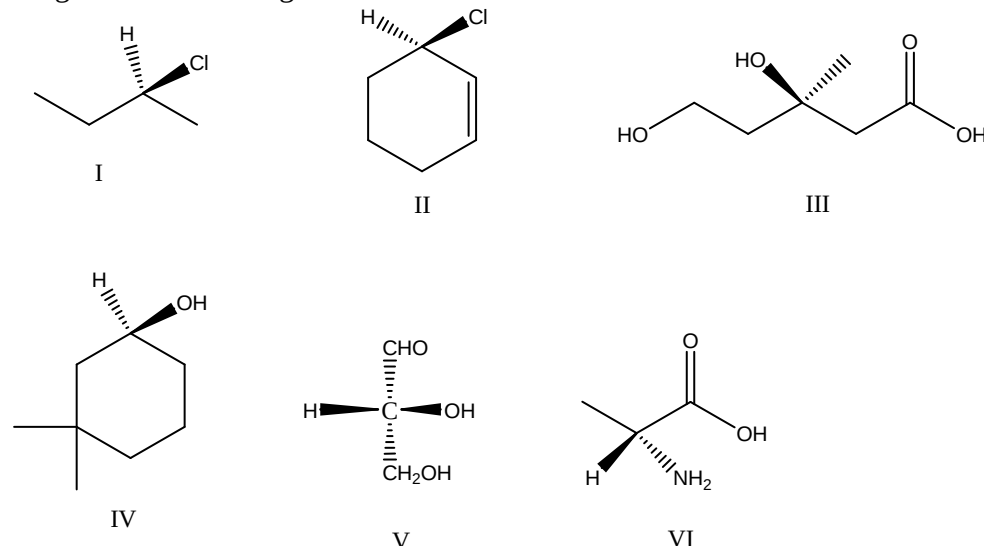
- Q. No. 5.** (a) What is Grignard reagent? What are its applications? How would you prepare Grignard reagent starting from an alkyl halide of your choice. (8)
 (b) Give the Product of the following reactions: (3)



- (c) Give the IUPAC nomenclature of Aldehydes and Ketones. (4)
 (d) Give the major products of the following reactions. (5)

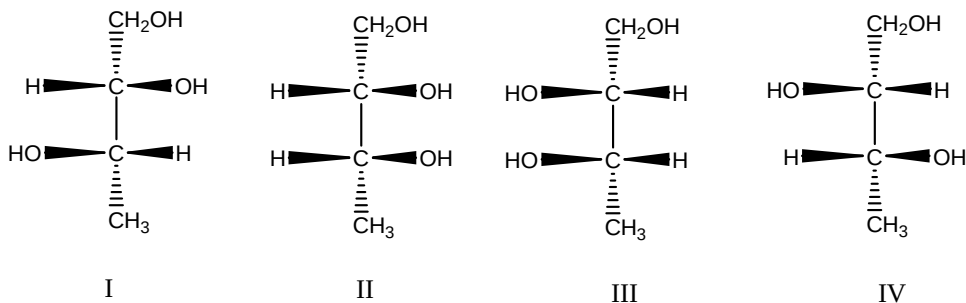


- Q. No. 6.** (a) What is stereoisomerism? Give an account of different types of stereoisomerism. (5)
 (b) Assign an R or S configuration to the chiral center in each molecule. (9)

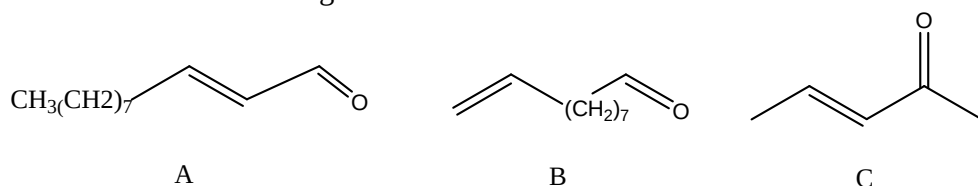


CHEMISTRY PAPER-II

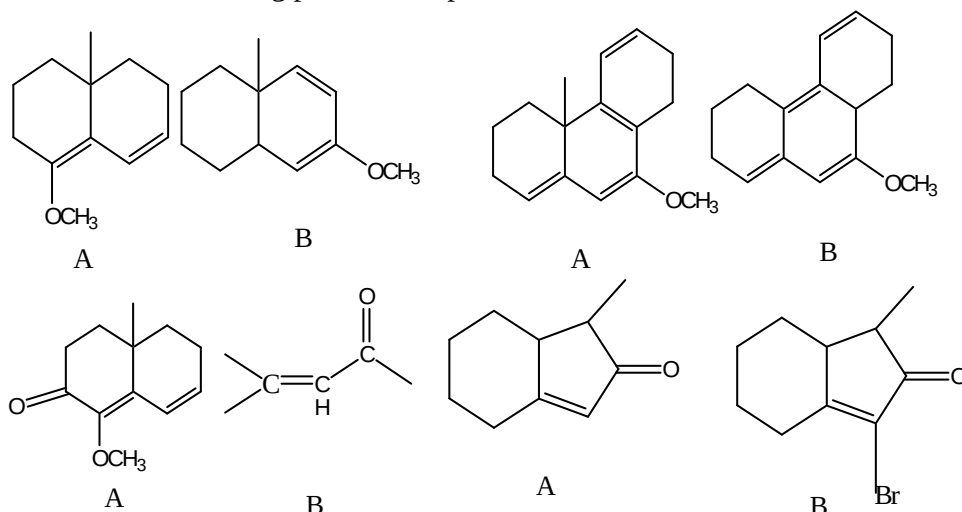
- (c) In the following molecules identify that which are diastereomers and which are enantiomers? (6)



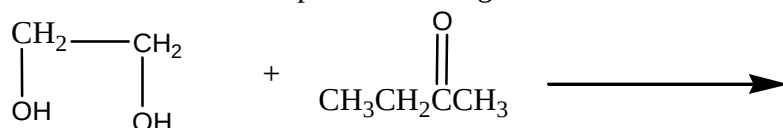
- Q. No. 7. (a) What is the difference between Dispersive IR Spectrometer and Fourier Transform (FT)-IR Spectrometer. (5)
- (b) Differentiate the following on the basis of IR. (3)



- (c) Differentiate the following pairs of compounds on the basis of UV. (8)



- (d) Deduce the structure of the product of the given reaction from the following data. (4)



The product has

IR: Four strong bands that appear in the range of 1200 to 1020 cm^{-1}

NMR: 3 Proton triplet at 0.8ppm, 3 Proton singlet at 1.3ppm, 2 proton quartet at 1.8ppm and 4 proton multiplet at 4.0ppm

- Q. No. 8. Write notes on any **FOUR** of the following: (5 each) (20)
- Reactions of Monosaccharides
 - Biosynthesis of Cholesterol
 - Primary structure of Polypeptides and Protein.
 - Prostaglandins
 - Synthesis of Peptides



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PART-II

- Q. No. 2.** (a). Explain de Broglie's hypothesis and derive its equation. How Davisson and Germer proved the dual nature of electron? (10)
- (b). Explain transport number. How it can be determined by Hittorf's method for Ag^+ ions in AgNO_3 solution? (10)
- Q. No. 3.** (a). Explain the working of quinhydrone electrode. (5)
- (b). Calculate the standard heat of formation of propane (C_3H_8) if its heat of combustion is $-2220.2 \text{ kJ mol}^{-1}$. The heats of formation of $\text{CO}_2(\text{g})$ and $\text{H}_2\text{O}(\text{l})$ are -393.5 and $-285.8 \text{ kJ mol}^{-1}$ respectively. (5)
- (c). Describe the criteria of spontaneity of a chemical process. Explain in terms of change in entropy, enthalpy and free energy with derivation of necessary equations. (10)
- Q. No. 4.** (a). Discuss the factors which can affect the rate of a chemical reaction. (5)
- (b). Explain Arrhenius equation. Discuss Arrhenius concept of activation energy and explain it by graphical representation. (8)
- (c). Explain enzyme catalysis with examples. Also give some characteristics of this catalysis. (7)
- Q. No. 5.** (a). What are colloids? How are they classified? Describe how colloidal solution of sulphur can be prepared? (8)
- (b). What is meant by confidence limits? Seven replicate analysis for mercury in natural gas condensate gave following results in ng/mL :
21.9 21.5 19.9 21.3 21.7 23.8 24.7
Calculate the 95% and 99% confidence limits for these measurements. (7)
- (c). Explain R_f value. Suppose that components of a mixture are separated by paper chromatography using a non-polar solvent like hexane. Describe and explain how the polarity of a compound in the mixture will affect its R_f value? (5)
- Q. No. 6.** (a). What is electrophoresis? Explain its working principle and describe its different applications as a separation and characterization technique. (7)
- (b). Explain the paramagnetic behavior of O_2 molecule on the basis of molecular orbital theory. Explain why the existence of He_2 molecule is not possible on the basis of MOT? (6)
- (c). Explain the molecular shape of $[\text{Ni}(\text{CN})_4]^{2-}$ with the help of valence bond theory. Also discuss its magnetic behaviour. (7)

CHEMISTRY, PAPER-I

- Q. No. 7.** (a). Using VSEPR theory, identify the type of hybridization and draw the structure of OF_2 . What are oxidation states of O and F? (5)
- (b). A buffer of pH 9.26 is made by dissolving x moles of ammonium sulphate and 0.1 mole of ammonia into 100 mL solution. If pK_b of ammonia is 4.74, calculate the value of x. (5)
- (c). Explain soft and hard acids and bases (SHAB) concept with examples. How is it able to explain the stability of complexes and reaction rates? (10)
- Q. No. 8.** (a). Explain crystal field theory. How it differs from valence bond theory? Also explain crystal field splitting. How crystal field stabilization energy of a complex is calculated? (10)
- (b). Write systemic names of following compounds. (5)
 $\text{K}_4[\text{NiF}_6]$, $\text{K}_3[\text{Fe}(\text{CN})_6]$, $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]\text{Cl}$, $\text{K}_2[\text{PtCl}_6]$, $\text{K}_2[\text{Cu}(\text{CN})_4]$
- (c). Write the coordination number and oxidation state of the metal ion in each of the above stated complexes. (5)



FEDERAL PUBLIC SERVICE COMMISSION
COMPETITIVE EXAMINATION-2018
FOR RECRUITMENT TO POSTS IN BS-17
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Roll Number

CHEMISTRY, PAPER-II

TIME ALLOWED: THREE HOURS	PART-I (MCQS)	MAXIMUM MARKS = 20
PART-I(MCQS): MAXIMUM 30 MINUTES	PART-II	MAXIMUM MARKS = 80
NOTE: (i) Part-II is to be attempted on the separate Answer Book. (ii) Attempt ONLY FOUR questions from PART-II. ALL questions carry EQUAL marks. (iii) All the parts (if any) of each Question must be attempted at one place instead of at different places. (iv) Candidate must write Q. No. in the Answer Book in accordance with Q. No. in the Q.Paper. (v) No Page/Space be left blank between the answers. All the blank pages of Answer Book must be crossed. (vi) Extra attempt of any question or any part of the attempted question will not be considered.		

PART-II

- Q.No. 2.** (a) Define Resonance and Resonance effect. (10)
(b) Write Short note on followings. (5+5) (20)
(i) Tautomerism (ii) Hyperconjugation.
- Q.No. 3.** (a) Complete the following reactions. (8×2=16)
(i) $\text{CH}_3\text{-CH=CH}_2 + \text{KMnO}_4 \xrightarrow{\text{H}_2\text{O}} ?$
(ii) $\text{CH}_3\text{-CH=CH}_2 + \xrightarrow[\text{Pressure}]{\text{Ni}\Delta}$
(iii) $\text{CH}_3\text{-CH=CH}_2 + \text{dil. H}_2\text{SO}_4 \longrightarrow$
(iv) $\text{CH}_3\text{-CH=CH}_2 + \text{CH}_3\text{-}\overset{\text{O}}{\parallel}\text{C-H} \longrightarrow$
(v) $\text{CH}_3\text{-CH=CH}_2 + \text{Br}_2 \xrightarrow{\text{CCl}_4}$
(vi) $\text{CH}_3\text{-C}\equiv\text{CH}_3 + \text{Na / lig NH}_3 \longrightarrow$
(vii) $\text{CH}\equiv\text{CH} + \text{NaNH}_2 \longrightarrow$
(viii) $\text{CH}\equiv\text{CH} + \text{H}_2\text{O} \xrightarrow{\text{H}_2\text{SO}_4 / \text{HgSO}_4}$
(b) 1-Butyne forms a precipitate with an ammonical solution of silver nitrate where 2-Butyne does not. Why? (4) (20)
- Q.No. 4.** Explain electrophilic substitution reaction mechanism with the help of:
(i) Nitration (ii) Sulphonation. (20)
- Q.No. 5.** (a) Distinguish between: (4×3=12)
(i) Configuration and conformation
(ii) Enantiomer and Diastereomers
(iii) R. Convention and S. Convention
(b) Define specific rotation. How do you measure using polarimeter? (8) (20)
- Q.No. 6.** (a) What do you mean by the setting of cement. (10)
(b) Discuss future of cement industry in Pakistan. (10) (20)
- Q.No. 7.** (a) Explain Aldol condensation reaction with examples. (10)
(b) What are proteins? (5)
(c) Explain Bio synthesis of cholesterol. (5)
- Q.No. 8.** Explain the following: (4 marks each) (20)
(a) Beers Lamberts Law. (b) Wood Wards Fieser Rule
(c) Hooks Law (d) Basic principle of NMR?
(e) Chemical Shift.



FEDERAL PUBLIC SERVICE COMMISSION
COMPETITIVE EXAMINATION-2019
FOR RECRUITMENT TO POSTS IN BS-17
UNDER THE FEDERAL GOVERNMENT

Roll Number

CHEMISTRY, PAPER-I

TIME ALLOWED: THREE HOURS	PART-I (MCQS)	MAXIMUM MARKS = 20
PART-I(MCQS): MAXIMUM 30 MINUTES	PART-II	MAXIMUM MARKS = 80
NOTE: (i) Part-II is to be attempted on the separate Answer Book. (ii) Attempt ONLY FOUR questions from PART-II. ALL questions carry EQUAL marks. (iii) All the parts (if any) of each Question must be attempted at one place instead of at different places. (iv) Write Q. No. in the Answer Book in accordance with Q. No. in the Q.Paper. (v) No Page/Space be left blank between the answers. All the blank pages of Answer Book must be crossed. (vi) Extra attempt of any question or any part of the question will not be considered. (vii) Use of calculator is allowed.		

PART-II

- Q. 2.** (a) Describe the assumption of Bohr's atomic model. Based on Bohr's calculation, establish the energy expression of the rotation of electrons in Hydrogen like atomic species. (8)
- (b) Derive de-Broglie's equation for the dual nature of matter. Apply this equation for microscopic and macroscopic properties of substances. (6)
- (c) What are the postulates of Quantum Mechanics? (6) **(20)**
- Q. 3.** (a) What is Third law of thermodynamics? How it is used to determine the entropies of substance. (7)
- (b) Discuss the isothermal expansion of a gas and derive the equation for the work done due to expansion of a gas. (7)
- (c) Explain the law of corresponding states. (6) **(20)**
- Q. 4.** (a) Deduce the rate expression for 2nd order reaction where both the concentration terms are same. What is the half-life period for the 2nd order reaction? (10)
- (b) What is activation energy? How it can be determined? (5)
- (c) Write a note on Transition state theory of reaction rates. (5) **(20)**
- Q. 5.** (a) Develop a relation among phase, component and degree of Freedom. Draw a complete diagram for water system. (10)
- (b) What is catalysis? Differentiate between positive and negative catalysis. (6)
- (c) What is stoichiometry? Explain it with help of examples. (4) **(20)**
- Q. 6.** (a) State and explain Lowry-Bronsted theory and Lewis theory of acids and bases. In what way Lewis theory differs from Bronsted theory. (8)
- (b) Explain with the help of examples why pH of a buffer solution does not change significantly on small addition of acids and bases. (6)
- (c) What are indicators? How a suitable indicator can be chosen? Discuss. (6) **(20)**
- Q. 7.** (a) Give an account of phenomena of isomerism in co-ordination compound with suitable example. (8)
- (b) Describe the extraction of thorium from mozite sand. (6)
- (c) Compare the properties of lanthanides and actinides? (6) **(20)**
- Q. 8.** (a) Explain Kohlrausch's Law? Give its applications. (7)
- (b) What is meant by transport number of ions? Give different methods for determination of transport number. (7)
- (c) What is specific conductance? How it can be determined by using Wheatstone bridge? (6) **(20)**



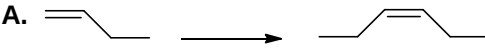
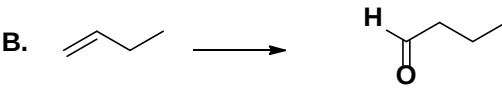
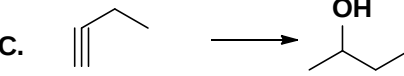
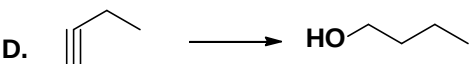
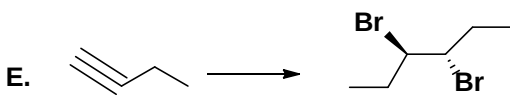
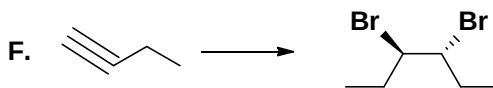
FEDERAL PUBLIC SERVICE COMMISSION
COMPETITIVE EXAMINATION-2019
FOR RECRUITMENT TO POSTS IN BS-17
UNDER THE FEDERAL GOVERNMENT

Roll Number

CHEMISTRY, PAPER-II

TIME ALLOWED: THREE HOURS	PART-I (MCQS)	MAXIMUM MARKS = 20
PART-I(MCQS): MAXIMUM 30 MINUTES	PART-II	MAXIMUM MARKS = 80
NOTE: (i) Part-II is to be attempted on the separate Answer Book. (ii) Attempt ONLY FOUR questions from PART-II. ALL questions carry EQUAL marks. (iii) All the parts (if any) of each Question must be attempted at one place instead of at different places. (iv) Write Q. No. in the Answer Book in accordance with Q. No. in the Q.Paper. (v) No Page/Space be left blank between the answers. All the blank pages of Answer Book must be crossed. (vi) Extra attempt of any question or any part of the question will not be considered. (vii) Use of Calculator is allowed.		

PART – II

- Q. No. 2.** (a) Elaborate the optical isomerism with appropriate examples. (10)
 (b) Express the resolution and its applications. (5)
 (c) Explain the geometric isomerism in cyclic compounds. (5) **(20)**
- Q. No. 3.** (a) Prepare a plausible synthesis for each of the following transformation: (12)
- A.  CCCC=C >> C=CCC
- B.  CCCC=C >> CCCC=O
- C.  CCCC#C >> CCC(O)C
- D.  CCCC#C >> CCCC(O)C
- E.  CCCC#C >> C[C@H](Br)[C@H](Br)C
- F.  CCCC#C >> C[C@H](Br)[C@@H](Br)C
- (b) Explain the type of hybridization in 1,3-Butadiene. (4)
 (c) Mention any three methods for preparation of Alkynes. (4) **(20)**
- Q. No. 4.** (a) Describe the necessary conditions and reagents required to convert benzene into the following. (8)
 Nitrobenzene, Ethyl benzene, cyclohexane, Benz-aldehyde, Benzoic acid, and Chlorobenzene.
- (b) Draw all possible structures of aromatic compounds with the formula C_9H_{12} containing the benzene ring. (6)
- (c) How do you account for the fact that phenol is more easily attacked by electrophiles than nitrobenzene? (6) **(20)**
- Q. No. 5.** (a) Outline stepwise reaction mechanism for the following reactions: (8)
 (i) SN_1 reaction between bromoethane and NaOH.
 (ii) SN_2 reaction between 2-chloro-2-methyl propane and NaCN.
- (b) Discuss the various factors, nature of substrate, solvent, catalyst, and the leaving group in SN_2 reaction. (8)
- (c) How does methyl iodide react with the following reagents? (4) **(20)**
 Acetic acid, Mg, Alcoholic KOH and Na.

CHEMISTRY, PAPER-B

- Q. No. 6.** (a) Describe two methods for preparation of salicylic acid? How would you convert it into (a) Phenol, (b) Salol, (c) Benzoic acid and (d) Aspirin? Give its at least two medicinal uses. (10)
- (b) How will you obtain the following from suitable mono carboxylic acid? (6)
(a) Iso-butane (b) Butanone (c) Benzamide (d) Propionaldehyde.
- (c) Describe the mechanism of esterification of an acid. (4) **(20)**
- Q. No. 7.** (a) An unknown substance shows a molecular ion peak at $m/z=170$ with a relative intensity of 100. The $M+1$ peak has relative intensity of 13.2 and the $M+2$ peak has an intensity of 1.00. What is the molecular formula for this substance? (10)
- (b) Mention the various tools to interpret the mass spectra. (5)
- (c) What is the nitrogen rule? Explain it with suitable examples. (5) **(20)**
- Q. No. 8.** (a) Elucidate the various steps involved in Glycolysis. (12)
- (b) Express the role of ATP in Glycolysis. (4)
- (c) Describe the pathway that leads to the formation of Lactic acid. (4) **(20)**



FEDERAL PUBLIC SERVICE COMMISSION
COMPETITIVE EXAMINATION-2020
FOR RECRUITMENT TO POSTS IN BS-17
UNDER THE FEDERAL GOVERNMENT

Roll Number

CHEMISTRY, PAPER-I

TIME ALLOWED: THREE HOURS PART-I(MCQS): MAXIMUM 30 MINUTES	PART-I (MCQS) PART-II	MAXIMUM MARKS = 20 MAXIMUM MARKS = 80
NOTE: (i) Part-II is to be attempted on the separate Answer Book. (ii) Attempt ONLY FOUR questions from PART-II. ALL questions carry EQUAL marks. (iii) All the parts (if any) of each Question must be attempted at one place instead of at different places. (iv) Write Q. No. in the Answer Book in accordance with Q. No. in the Q.Paper. (v) No Page/Space be left blank between the answers. All the blank pages of Answer Book must be crossed. (vi) Extra attempt of any question or any part of the question will not be considered. (vii) Use of calculator is allowed.		

PART-II

- Q. 2.** (a) Write two equations of state for real gases and compare them highlighting their important features. (10)
- (b) (i) Explain Heisenberg's uncertainty principle. (05)
(ii) Discuss Born's interpretation of wave function. (05) (10) **(20)**
- Q. 3.** (a) Explain the Kohlrausch law. Why do the real solution should deviate from the law? (10)
- (b) Compare Langmuir's and Freundlich's adsorption isotherms. (10) **(20)**
- Q. 4.** (a) Explain the Arrhenius equation. Also highlight its applications and limitations. (10)
- (b) Explain various acid-base theories. What are hard and soft acids and bases? (10) **(20)**
- Q. 5.** (a) Make a comparison of column chromatography and thin layer chromatography (TLC) by highlighting merits and demerits of the both. (10)
- (b) Explain Werner's theory of coordination complexes. Give examples from d-block transition metals. (10) **(20)**
- Q. 6.** (a) Give a comprehensive classification of various chromatographic techniques. Also mention potential application of each. (10)
- (b) (i) What is Hydrogen bonding. Explain. (05)
(ii) Describe Hybridization in p-block elements. (05) (10) **(20)**
- Q. 7.** (a) Explain crystal Field Theory (CFT) for d-block elements. (10)
- (b) Write an extensive essay on types of chemical bonding giving examples. (10) **(20)**
- Q. 8.** Write short notes on the following: (5 each) **(20)**
- (i) Liquid junction potential
(ii) Potentiometry
(iii) Collision theory of Chemical reactions.
(iv) Transition state theory.



FEDERAL PUBLIC SERVICE COMMISSION
COMPETITIVE EXAMINATION-2020
FOR RECRUITMENT TO POSTS IN BS-17
UNDER THE FEDERAL GOVERNMENT
CHEMISTRY, PAPER-II

Roll Number

TIME ALLOWED: THREE HOURS	PART-I (MCQS)	MAXIMUM MARKS = 20
PART-I(MCQS): MAXIMUM 30 MINUTES	PART-II	MAXIMUM MARKS = 80
NOTE: (i) Part-II is to be attempted on the separate Answer Book. (ii) Attempt ONLY FOUR questions from PART-II. ALL questions carry EQUAL marks. (iii) All the parts (if any) of each Question must be attempted at one place instead of at different places. (iv) Candidate must write Q. No. in the Answer Book in accordance with Q. No. in the Q.Paper. (v) No Page/Space be left blank between the answers. All the blank pages of Answer Book must be crossed. (vi) Extra attempt of any question or any part of the attempted question will not be considered.		

PART-II

- Q.No. 2.** Explain the difference between: **(5 each) (20)**
- Inductive and Field effects
 - Inductive and Resonance effects
 - Localized and Delocalized bonding
 - Conjugation and Hyperconjugation
- Q.No. 3. (a)** “The resonance effect has an appreciable influence on physical characteristics and the chemical reactivity of organic molecules”. Elaborate the statement with the help of examples. **(10)**
- (b)** Outline the EAS mechanism (Electrophilic Aromatic Substitution) through which aromatic compounds react with electrophiles. **(5)**
- (c)** Discuss factors which favour an elimination reaction occurring over a substitution reaction. **(5) (20)**
- Q.No. 4.** How would you carry out the following conversions? Account for your answer with mechanism in each case. **(4 each) (20)**
- $(\text{CH}_3)_3\text{CCH}=\text{CH}_2 \rightarrow (\text{CH}_3)_2\text{C}(\text{OH})\text{CH}(\text{CH}_3)_2$
 - $(\text{CH}_3)_3\text{CCH}=\text{CH}_2 \rightarrow (\text{CH}_3)_3\text{CCH}(\text{OH})\text{CH}_3$
 - $(\text{CH}_3)_3\text{CCH}=\text{CH}_2 \rightarrow (\text{CH}_3)_3\text{CCH}_2\text{CH}_2\text{OH}$
 - $(\text{CH}_3)_3\text{CC}\equiv\text{CH} \rightarrow (\text{CH}_3)_3\text{CCOCH}_3$
 - $(\text{CH}_3)_3\text{CC}\equiv\text{CH} \rightarrow (\text{CH}_3)_3\text{CCH}_2\text{CHO}$
- Q.No. 5.** The following reactions can be used for the preparation of alkanes or cycloalkanes. Elaborate them with the help of reaction mechanisms. **(5 each) (20)**
- Corey House reaction
 - Wurtz reaction
 - Kolbe reaction
 - Simmons - Smith Reaction
- Q.No. 6.** How would you convert cyclohexanone into the following compounds? Write down the mechanisms of the reactions. **(4 each) (20)**
- Caprolactone
 - Caprolactam
 - Cycloheptanone
 - Cyclohexa-1,2-dione
 - Cyclohexane
- Q.No. 7. (a)** How can a racemic mixture be separated into its components? Describe different methods. **(16)**
- (b)** (-)-Lactic acid has a specific rotation of -3.8° . What will be the specific rotation of a solution containing 7.5g of (-)-lactic acid and 2.5 g of (+)-lactic acid? **(4) (20)**
- Q.No. 8. (a)** Starch, glycogen and cellulose are polymers of glucose. How will you differentiate among these three both structurally and functionally. **(12)**
- (b)** Explain precisely the following terms. **(8) (20)**
- Glycolysis
 - Glycogenolysis
 - Glycogenesis
 - gluconeogenesis



FEDERAL PUBLIC SERVICE COMMISSION

COMPETITIVE EXAMINATION-2021 FOR RECRUITMENT TO POSTS IN BS-17 UNDER THE FEDERAL GOVERNMENT

Roll Number

CHEMISTRY, PAPER-I

TIME ALLOWED: THREE HOURS PART-I(MCQS): MAXIMUM 30 MINUTES	PART-I (MCQS) PART-II	MAXIMUM MARKS = 20 MAXIMUM MARKS = 80
NOTE: (i) Part-II is to be attempted on the separate Answer Book . (ii) Attempt ONLY FOUR questions from PART-II . ALL questions carry EQUAL marks. (iii) All the parts (if any) of each Question must be attempted at one place instead of at different places. (iv) Write Q. No. in the Answer Book in accordance with Q. No. in the Q. Paper. (v) No Page/Space be left blank between the answers. All the blank pages of Answer Book must be crossed. (vi) Extra attempt of any question or any part of the question will not be considered. (vii) Use of calculator is allowed.		

PART-II

- Q. 2.** (a) Explain applications of Schrodinger wave equation to hydrogen and hydrogen like Atom. (10)
- (b) (i) Give Molecular interpretation of entropy. (05) (10) (20)
(ii) Explain factors affecting the rate of a chemical reactions. (05)
- Q. 3.** (a) What are the uses of chelates. (07)
- (b) State and explain Nomenclature of coordination complexes. (07)
- (c) Explain VBT (Valence Bond Theory) of coordination complexes in detail. (06) (20)
- Q. 4.** (a) Explain photoelectric effect and probability density. (10)
- (b) (i) Explain Eigen function & Eigen value. (05) (10) (20)
(ii) Derive Schrödinger wave equation for a particle in one dimensional box. (05)
- Q. 5.** (a) Predict molecular shapes using Valence Shell Electron Pair Repulsion (VESPER) model. (10)
- (b) (i) Explain the experimental techniques for determination of order of reaction. (05) (10) (20)
(ii) Write a note on thermochemistry and calorimetry. (05)
- Q. 6.** (a) Derive a relation for dependence of Gibbs free energy on temperature or Gibbs Helmholtz equation. (07)
- (b) What is isothermal process? Explain work done in isothermal reversible expansion of an ideal gas. (07)
- (c) Explain fugacity and activity. (06) (20)
- Q. 7.** (a) Discuss common ion effect and its industrial applications in detail. (08)
- (b) Describe significance of pK_a , pK_b , pH. (06)
- (c) Write a note on basic concepts of chemical equilibrium. (06) (20)
- Q. 8.** Write notes on the following:-
- (i) Debye-Huckel theory. (07)
- (ii) Nernst's equation. (07)
- (iii) Electrochemical series. (06) (20)



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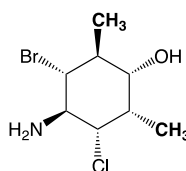
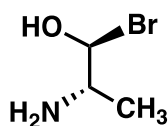
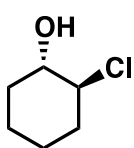
Roll Number

CHEMISTRY, PAPER-II

TIME ALLOWED: THREE HOURS	PART-I (MCQS)	MAXIMUM MARKS = 20
PART-I(MCQS): MAXIMUM 30 MINUTES	PART-II	MAXIMUM MARKS = 80
NOTE: (i) Part-II is to be attempted on the separate Answer Book. (ii) Attempt ONLY FOUR questions from PART-II. ALL questions carry EQUAL marks. (iii) All the parts (if any) of each Question must be attempted at one place instead of at different places. (iv) Candidate must write Q. No. in the Answer Book in accordance with Q. No. in the Q.Paper. (v) No Page/Space be left blank between the answers. All the blank pages of Answer Book must be crossed. (vi) Extra attempt of any question or any part of the attempted question will not be considered.		

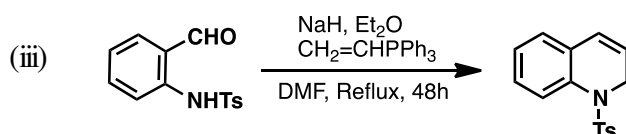
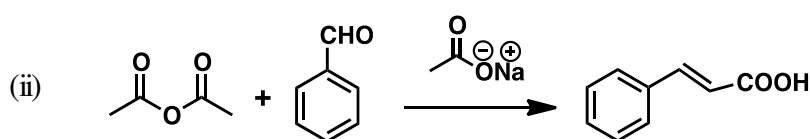
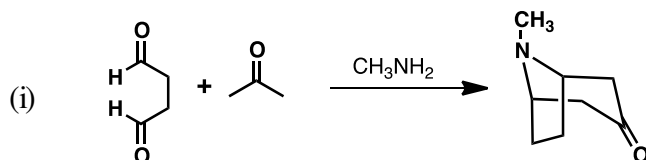
PART-II

- Q. 2. (a)** Describe factors that influence keto-enol tautomerization. Elaborate the statement with the help of examples. (10)
- (b)** Assign "R" or "S" configuration on each of the chiral centers of the given compounds. (10) (20)

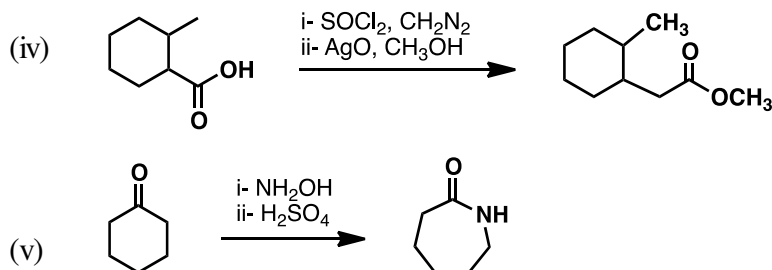


- Q. 3. (a)** Give the products expected (if any) when ethylbenzene reacts under following conditions: (02 marks each) (10)
- Br_2 in CCl_4 (dark)
 - $\text{HNO}_3, \text{H}_2\text{SO}_4$
 - Conc. H_2SO_4
 - $\text{C}_2\text{H}_5\text{COCl}, \text{AlCl}_3$ (1.1 equiv.), then H_2O
 - Alkaline KMnO_4
- (b)** Account for the following: (05 marks each) (10) (20)
- Intramolecular H-bonding is stronger than intermolecular H-bonding
 - Control of nucleophilic substitution reaction over elimination reactions
- Q. 4. (a)** Write down reagents, reaction conditions and important steps for the following conversions: (10)
- Chlorobenzene to 2,4-dinitrophenyl hydrazine
 - Pyridine to 2-amino pyridine
- (b)** Write a note that substituents on aromatic rings dictate reactivity and orientation of the incoming electrophile in electrophilic aromatic substitution reactions. (10) (20)

- Q. 5.** Draw detailed mechanisms for: (04 marks each) (20)

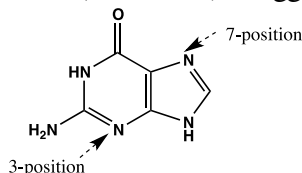


CHEMISTRY, PAPER-II

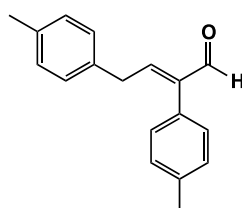


Q. 6. Account for the following: **(05 marks each)** **(20)**

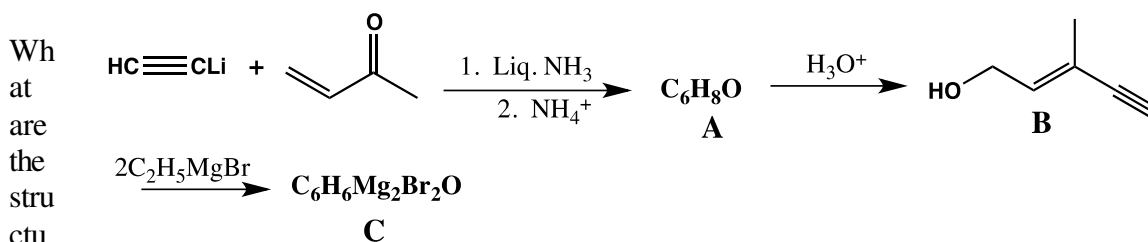
- (i) In DNA, a guanine residue reacts with electrophiles predominantly at the 7 and 3 positions of the ring system (see below). Suggest an explanation for this.



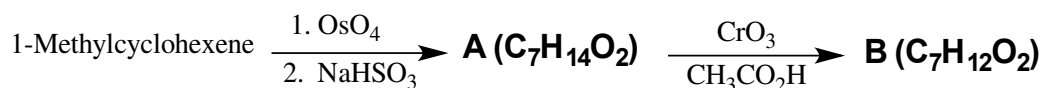
- (ii) Outline the synthesis of following compound:



- (iii) A Grignard reagent that is a key intermediate in an industrial synthesis of vitamin A can be synthesized in the following way:



- (iv) What are compounds **A** and **B** in the reaction given below? Compound **B** has a strong IR absorption band in the 1650–1730 cm⁻¹ region and a broad strong band in the 3200–3550 cm⁻¹ region.



Q. 7. Explain the following: **(04 marks each)** **(20)**

- (i) How can IR be used to help interpret NMR spectra?
- (ii) What are diastereotopic protons? Explain with examples.
- (iii) Determine the structure for a compound with formula C₆H₄N₂O₄ with following ¹H-NMR data:
δ 8.76 t (1H), 8.38 dd (2H), 7.97 t (1H)
- (iv) Assign chemical shifts of each proton in the above structure.
- (v) Why ¹³C-NMR is less sensitive than ¹H-NMR?

Q. 8. Answer following questions: **(04 marks each)** **(20)**

- (i) Comment if glycogenesis is anabolic or catabolic. Write down all steps involved in glycogenesis.
- (ii) Describe endergonic and exergonic reactions.
- (iii) Write a note on anionic and cationic surfactants.
- (iv) Comment if waste glass can be used for cement production.
- (v) What is the chemical composition of nucleic acids and their biological significance?



FEDERAL PUBLIC SERVICE COMMISSION
COMPETITIVE EXAMINATION-2022
FOR RECRUITMENT TO POSTS IN BS-17
UNDER THE FEDERAL GOVERNMENT
CHEMISTRY, PAPER-I

Roll Number

TIME ALLOWED: THREE HOURS PART-I(MCQS): MAXIMUM 30 MINUTES	PART-I (MCQS) PART-II	MAXIMUM MARKS = 20 MAXIMUM MARKS = 80
NOTE: (i) Part-II is to be attempted on the separate Answer Book. (ii) Attempt ONLY FOUR questions from PART-II. ALL questions carry EQUAL marks. (iii) All the parts (if any) of each Question must be attempted at one place instead of at different places. (iv) Write Q. No. in the Answer Book in accordance with Q. No. in the Q.Paper. (v) No Page/Space be left blank between the answers. All the blank pages of Answer Book must be crossed. (vi) Extra attempt of any question or any part of the question will not be considered. (vii) Use of calculator is allowed.		

PART-II

- Q. 2.** (a) Derive Schrodinger wave equation for particle in one dimensional box. (10)
(b) Discuss Heisenberg's Uncertainty principle. (05)
(c) What is corrosion? How it can be prevented? (05) **(20)**
- Q. 3.** (a) What is Stereoisomerism? Discuss it with reference to coordination complexes. (08)
(b) Define and explain Jahn-Teller theorem. (06)
(c) Write a short note on column chromatography. (06) **(20)**
- Q. 4.** (a) What is Valence Bond theory? How does this theory explains the structure of inorganic molecules? (08)
(b) Define and explain the phenomenon of resonance in inorganic compounds. (06)
(c) Write some general characteristics of actinides. (06) **(20)**
- Q. 5.** (a) What is photoelectric effect? How quantum mechanics explains this effect? (08)
(b) What is wave-function? Discuss its interpretation given by Born. (06)
(c) What are fuel cells? Discuss their working with suitable examples. (06) **(20)**
- Q. 6.** (a) What are electron-deficient compounds? Discuss bond in such compounds. (07)
(b) Define and explain the VSEPR model to explain the geometry of inorganic substances. (07)
(c) Discuss variation in oxidation states of lanthanides. (06) **(20)**
- Q. 7.** (a) What is Nernst equation? Explain it. (08)
(b) Define and explain Kohlrausch's law. (07)
(c) Write a short note on Arrhenius equation. (05) **(20)**
- Q. 8.** (a) What is crystal field theory? How does this theory explain the geometry of complexes? (08)
(b) Explain Lewis theory of acids and bases. (06)
(c) Write a short note on thin layer chromatography. (06) **(20)**



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UNDER THE FEDERAL GOVERNMENT
CHEMISTRY, PAPER-II

Roll Number

TIME ALLOWED: THREE HOURS PART-I(MCQS): MAXIMUM 30 MINUTES	PART-I (MCQS) MAXIMUM MARKS = 20 PART-II MAXIMUM MARKS = 80
NOTE: (i) Part-II is to be attempted on the separate Answer Book. (ii) Attempt ONLY FOUR questions from PART-II. ALL questions carry EQUAL marks. (iii) All the parts (if any) of each Question must be attempted at one place instead of at different places. (iv) Candidate must write Q. No. in the Answer Book in accordance with Q. No. in the Q.Paper. (v) No Page/Space be left blank between the answers. All the blank pages of Answer Book must be crossed. (vi) Extra attempt of any question or any part of the attempted question will not be considered.	

PART-II

- Q. 2.** Define the following terms and give suitable examples **(4 each) (20)**
- (i)** Aromaticity **(ii)** Conjugation **(iii)** Inductive effect
(iv) Imine-enamine Tautomerism **(v)** Intra molecular Hydrogen Bonding
- Q. 3.** Write down Preparations of Alkanes and Aldehydes. Also give specific example of addition reactions of alkenes with special reference to Markonikav and anti Markonikav rule. **(20)**
- Q. 4. (a)** Starting from acetylene how you can prepare 1-Octyne. **(10)**
- (b)** Write down the condition for the conversion of 2-Octyne to cis 2-Octene. **(10) (20)**
- Q. 5.** Write the structural formula of your choice for all the structural isomers with the molecular formula C_4H_6 . Also explain cis, trans, E,Z and syn, anti geometrical isomerism. **(20)**
- Q. 6.** Phenol is more acidic than methylalcohol. Explain in detail. Also draw resonating structures of phenoxide ion. **(20)**
- Q. 7. (a)** Describe the instrumentation of IR spectrophotometer in detail. **(15)**
- (b)** What are the basic Principals of IR Spectroscopy? **(05) (20)**
- Q. 8. (a)** What is chemical shift? What are the factors effecting chemical shift? **(10)**
- (b)** Describe the instrumentation of NMR spectroscopy.? **(10) (20)**



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CHEMISTRY, PAPER-I

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PART-II

- Q.2. (a)** The following reaction occurs via two steps, where the first step is rate-determining step. (12)
Step I $\text{NO}_2(\text{g}) + \text{NO}_2(\text{g}) \rightarrow \text{NO}(\text{g}) + \text{NO}_3(\text{g})$
Step II $\text{NO}_3(\text{g}) + \text{CO}(\text{g}) \rightarrow \text{NO}_2(\text{g}) + \text{CO}_2(\text{g})$
i. Write down the rate equation for the above reaction.
ii. Which molecule acts as a catalyst in this reaction? Give a reason.
iii. Which molecule is an intermediate in this reaction and justify it.
- (b)** Describe Arrhenius's equation. (8) (20)
- Q.3. (a)** An explosion is usually considered adiabatic, indicating negligible heat transfer, even though it's rapidly expanding gaseous products are not at the same temperature as the surroundings, and the boundary permits heat transfer. Explain the phenomenon. (10)
- (b)** Draw a working diagram for a reversible heat engine that operates with two isothermal steps and two constant-pressure steps. How many heat reservoirs are needed to operate this engine? (10) (20)
- Q.4. (a)** Describe Schrodinger Wave Equation for a particle in a three-dimensional box. (10)
- (b)** Explain photoelectric effect. (8)
- (c)** What is a wave function? Give Born's interpretation of wave function. (2) (20)
- Q.5. (b)** Describe Nernst's equation. (10)
- (b)** Describe the significance of pH, pK_a , and pK_b . (6)
- (c)** What is the relationship between conductance and Kohlrausch's law? (4) (20)
- Q.6. (a)** Describe three methods of mechanical phase separation. (10)
- (b)** Briefly discuss "The Hard-Soft Acid-Base Principle." (10) (20)
- Q.7. (a)** Compare Valence Bond Theory with Molecular Orbital Theory. (10)
- (b)** What is the oxidation state? Differentiate between the oxidation state and valency/covalency of an element with suitable examples. (6)
- (c)** Write the molecular orbital configuration of the followings: (4) (20)
 O_2^+ , O_2 , O_2^- and O_2^{-2}
- Q.8.** Discuss the following in detail. (5 each) (20)
i. Crystal Field Theory
ii. Hess's Law
iii. Electrophoresis Technique
iv. Freundlich Adsorption Isotherm



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CHEMISTRY, PAPER-II

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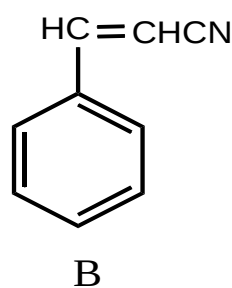
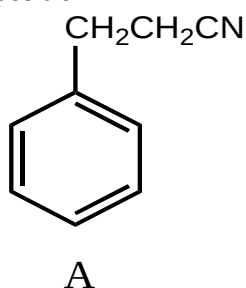
PART-II

- Q. 2. (a)** Arrange the following alkenes in order of their relative stability. How will you proceed to determine the order practically? **(5)**

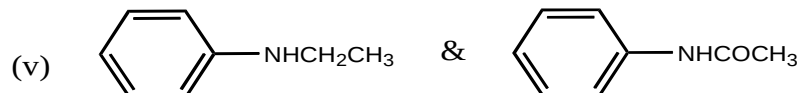
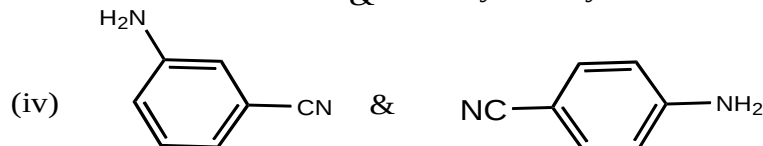
- i. 1-hexene
- ii. cis-3-hexene
- iii. trans-3-hexene
- (iv) 2-methyl-2-pentene
- (v) 2,3-dimethyl-2-butene

- (b)** Explain why? **(5)**

- (i) Poly substitution is a complicating factor in aromatic alkylation but not in aromatic nitration or halogenation.
- (ii) A undergoes nitration predominantly at the ortho/ para positions but B mainly at meta position



- (c)** Compare the basicity of: **(5)**



- (d)** Explain why? **(2.5 each) (5) (20)**

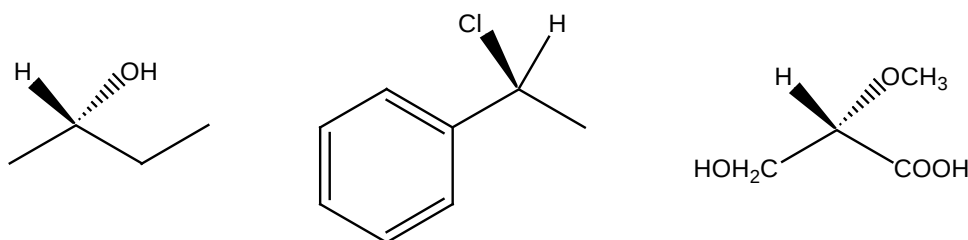
- (i) Tertiary carbocation is more stable than primary.
- (ii) Ethanol has higher boiling point than diethyl ether.

- Q. 3. (a)** Write the structural formula for more stable conformation of each of the following compounds. **(8)**

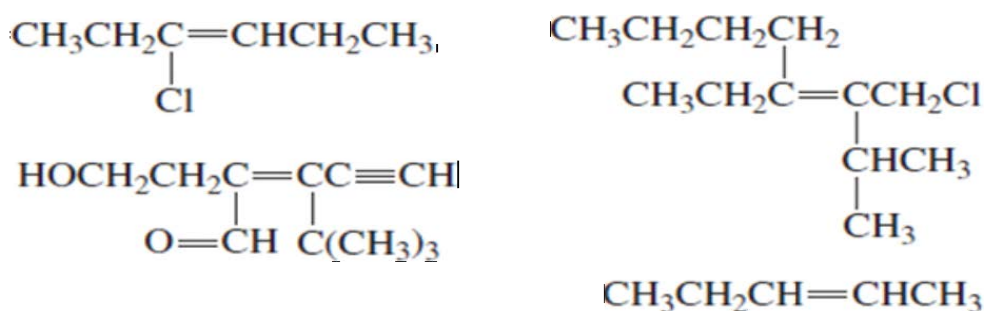
- a) *trans*-1-Fluoro-3-methylcyclohexane,
- b) *cis*-1-Iodo-4-methylcyclohexane
- c) *cis*-1-*tert*-Butyl-4-methylcyclohexane,
- d) *cis*-1,3,5-Trimethylcyclohexane

CHEMISTRY, PAPER-II

- (b) Mention R & S configuration of the following compounds. (5)



- (c) Draw and label the *E* and *Z* isomers for each of the following compounds. (5)



- (d) Draw the structure of (Z)-3-isopropyl-2-heptene. (2) (20)

- Q. 4. (a) In benzaldehyde, two of the ring protons have resonance at 7.87 ppm, and the other three have resonance in the range from 7.5 to 7.6 ppm. Explain. (4each) (20)
- (b) Arrange the following protons in the decreasing order of their δ values in $^1\text{H-NMR}$ and account for your order: Methyl, ethylenic, acetylenic, aryl and aldehydic.
- (c) List the solvents most commonly used in IR spectroscopy. Why water and ethanol are not suitable solvents?
- (d) The UV spectrum of acetone shows absorption maxima at 166, 189, and 279 nm. What type of transition is responsible for each of these bands?
- (e) What types of electronic transitions are possible for each of the following compounds?
- Cyclopentene,
 - Acetaldehyde,
 - Dimethyl ether,
 - Methyl vinyl ether.

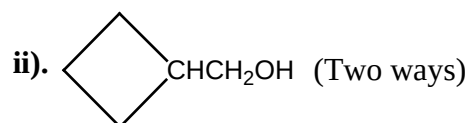
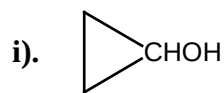
- Q. 5. (a) Write down the reagents, conditions and mechanisms of the following reactions. (10 each) (20)
- Kolbe reaction.
 - Williamson synthesis
 - Dow Process
 - Reimer-Tiemann reaction
 - Bromination of phenol
- (b) Outline all steps involved in the synthesis of the following compounds from benzene or toluene, assuming that the ortho / para mixtures are separable.
- n-Butylbenzene
 - m-Nitrotoluene
 - p- Bromonitrobenzene
 - p- Bromobenzoic acid.
 - 1,2-Dibromo-4-nitrobenzene

- Q. 6. (a) Describe with equations all possible methods that can be used for the preparation of n-hexane. (10)
- (b) Why Corey-House Method is more suitable as compared to Wurtz reaction for the synthesis of alkane. Explain with examples. (5)

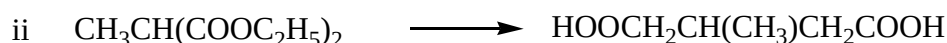
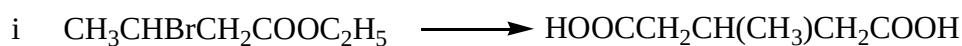
CHEMISTRY, PAPER-II

- (c) Draw the structures of following compounds and label them with IUPAC systematic rules. (5) (20)
- 3-cyclopentylhexane
 - 2-cyclobutyl-3-methylpentane
 - Isopropylcyclodecane
 - 2-methylbicyclo [3.2.0] heptanes
 - 8-methylbicyclo [3.2.1] octane

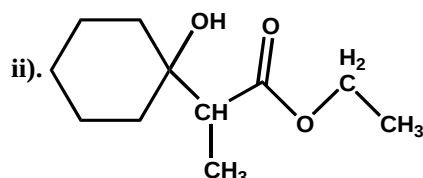
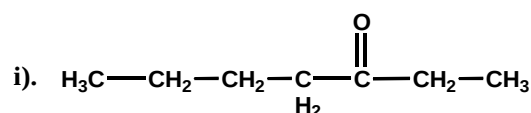
- Q. 7. (a) How can you prepare each of the following substances by a reaction involving Grignard reagent? (5)



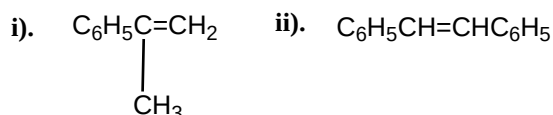
- (b) How will you bring about the following conversions? (5)



- (c) How would you synthesize each of the following compounds by the Reformatsky reaction? (5)



- (d) How would you synthesize each of the following compounds by the Wittig reaction? (2.5)



- (e) How will you synthesize each of the following substances by an acetoacetic ester synthesis? (2.5) (20)

- 3,4-dimethyl-2,5-hexanedione
- 3-acetyl-5-hexanoic acid.

- Q. 8. (a) Discuss the following topics. (6 each) (12)

- Prostaglandins
- Terpenes

- (b) Name the epimers of d -glucose. (4)

- (c) Clearly represent the most stable conformation of the -pyranose form of each of the following sugars. (4) (20)

- D-Galactose
- D-Mannose
- L-Mannose
- L-Ribose



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Roll Number

CHEMISTRY, PAPER-I

TIME ALLOWED: THREE HOURS	(PART-I MCQs)	MAXIMUM MARKS: 20
PART-I (MCQs) : MAXIMUM 30 MINUTES	(PART-II)	MAXIMUM MARKS: 80
NOTE: (i) First attempt PART-I (MCQs) on separate OMR Answer Sheet which shall be taken back after 30 minutes.		
(ii) Overwriting/cutting of the options/answers will not be given credit.		
(iii) There is no negative marking. All MCQs must be attempted.		

PART-I (MCQs)(COMPULSORY)

Q.1. (i) Select the best option/answer and fill in the appropriate Box ☐ on the OMR Answer Sheet.(20x1=20)
(ii) Answers given anywhere else, other than OMR Answer Sheet, will not be considered.

- When we consider a proton (p^+) instead of an electron (e^-) in a one dimensional (1D) box of 0.1 nm, then the energy levels:**
(A) Become less widely spaced (B) Become more widely spaced (C) Cannot be recognized (D) None of these
- Which of the following statements concerning the quantum numbers (l , m , and s) is false?**
(A) If the value of azimuthal quantum number (l) is zero, the electronic distribution has spherical symmetry
(B) The spin quantum number (s) indicates the orientation of the spin of the nucleus with respect to a magnetic field
(C) The magnetic quantum number (m) indicates the possible orientations of orbital in a magnetic field
(D) None of these
- A characteristic of an oxidizing agent is that it is always:**
(A) A non-metal (B) Oxidized in a redox reaction (C) Gaining electrons (D) None of these
- During electrolysis, the oxidation takes place at the:**
(A) Anode (B) Cathode (C) Both (A) & (B) (D) None of these
- The process of chemical adsorption which is a surface phenomena:**
(A) Is exothermic (B) Takes place at high temperature (C) Is reversible (D) None of these
- The most commonly used adsorbent for chromatographic separations of organic compounds is:**
(A) Activated charcoal (B) Aluminium (C) Silica gel (D) None of these
- If x/m is the amount of adsorbate per unit mass of the adsorbent and P is the pressure, then according to the Langmuir adsorption isotherm, which one of the followings is correct?**
(A) $x/m > P$ (B) $x/m = 1/P$ (C) $x/m \propto P$ (D) None of these
- Inversion of the cane sugar in the presence of a mineral acid is the best example of:**
(A) Heterogeneous catalyst (B) Homogeneous catalysis (C) Extremely fast reaction (D) None of these
- At standard conditions of temperature and pressure the order of mean square velocity of molecules N_2 , H_2 , O_2 and HCl is:** (A) $H_2 > N_2 > O_2 > HCl$ (B) $N_2 > O_2 > H_2 > HCl$ (C) $HCl > O_2 > N_2 > H_2$ (D) None of these
- The density of an ideal gas under the given conditions:**
(A) Is proportional to its molecular mass (B) Increases with increasing pressure, keeping temperature constant
(C) Decreases with increasing temperature, keeping pressure constant (D) None of these
- According to the third law of thermodynamics, the entropy of a pure and perfect crystalline substance is:**
(A) Zero at $0^\circ C$ (B) Zero at $0 K$ (C) Zero at $0^\circ F$ (D) None of these
- Which one of the followings is a factor which does not influence the rate of a chemical reaction?**
(A) Molecularity of the reaction (B) Order of the reaction (C) Temperature of the reaction (D) None of these
- According to transition state theory, the rate constant of a chemical reaction**
(A) Depends upon inverse of temperature (B) Is directly proportional to temperature
(C) Is inversely proportional to negative free energy change (ΔG) (D) None of these
- During steady state of a unimolecular gaseous phase reaction:**
(A) The concentration of activated molecules goes on decreasing
(B) The concentration of activated molecules goes on increasing
(C) The concentration of activated molecules remains constant (D) None of these
- Viscosity of a liquid at a given temperature is:**
(A) Frictional resistance between adjacent layers (B) Exportability to flow on the walls of tube
(C) Independent of the sizes of molecules and their shape (D) None of these
- The critical angle of refraction of a liquid as compared to air is:**
(A) Greater than 90° (B) Less than 180° but greater than 120° (C) Always less than 90° (D) None of these
- Which of the followings has the highest oxidation state of the central atom?**
(A) $K_3[Fe(CN)_6]$ (B) $Na[Co(CO)_4]$ (C) $Fe(CO)_5$ (D) None of these
- A compound has the empirical formula $CoCl_3 \cdot 4NH_3$. One mole of it gives one mole of $AgCl$ on treatment with $AgNO_3$ solution. NH_3 is not removed with conc. H_2SO_4 . It has structure:**
(A) $Co(NH_3)_4 Cl_3$ (B) $[Co(NH_3)_4 Cl_2]Cl$ (C) $[Co(NH_3)_3 Cl_3]NH_3$ (D) None of these
- There are two scales of energy to measure the crystal field splitting. Which is true from the following?**
(A) $\Delta_{Oh} = 10D_q$ (B) $0.4 \Delta_{Oh} = 6D_q$ (C) $0.6 \Delta_{Oh} = 4D_q$ (D) None of these
- The value of one Bohr Magneton is:**
(A) $9.27 \times 10^{-21} \text{ erg} \cdot G^{-1}$ (B) $92.7 \times 10^{-21} \text{ erg} \cdot G^{-1}$ (C) $5.28 \times 10^{-20} \text{ erg} \cdot G^{-1}$ (D) None of these

PART-II

- NOTE: (i)** Part-II is to be attempted on the separate **Answer Book**.
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- (vii)** **Use of Calculator is allowed.**

- Q. 2.** (a) What is the de Broglie hypothesis and how was this proved experimentally? (10)
Explain in detail.
- (b) How do you compare the Gibb's and Helmholtz free energies? (05)
- (c) Explain occurrence and oxidation states of Lanthanides. (05) (20)
- Q. 3.** (a) Explain in detail the Nernst equation. (10)
- (b) Justify that half life period of third order reaction is inversely proportional to square of the initial concentration of reactants. (05)
- (c) What are Eigen function and Eigen values? Explain with examples. (05) (20)
- Q. 4.** (a) Discuss in detail the Hess's law with the help of suitable examples. (10)
- (b) Discuss the Hamiltonian operator in detail. (05)
- (c) Explain the phase diagram by applying the Gibb's phase rule for a two component system with the help of a suitable example. (05) (20)
- Q. 5.** (a) Derive the equation for rate constant of a third order reaction with same initial concentrations. Give its half life and examples as well. (10)
- (b) What is solvent extraction? Discuss its theory and uses for the extraction of metals. (05)
- (c) What is theory of buffer solutions? Explain. (05) (20)
- Q. 6.** (a) Explain the kinetics of the enzymes catalysis (10)
- (b) Give postulates of Werner's theory of co-ordination compounds. How does it justify the formulae of $\text{CoCl}_3 \cdot 6\text{NH}_3$, $\text{CoCl}_3 \cdot 5\text{NH}_3$, $\text{CoCl}_3 \cdot 4\text{NH}_3$, and $\text{CoCl}_3 \cdot 3\text{NH}_3$? (05)
- (c) How the electrochemical series will help us, that whether a particular metal will react with an acid or not? (05) (20)
- Q. 7.** (a) Discuss in detail the soft and hard acid and base (SHAB) concept with suitable examples. (10)
- (b) Derive relationship between equilibrium constant and Gibb's free energy. (05)
- (c) What are different statistical tests in chemical analysis? Explain. (05) (20)
- Q. 8.** (a) Discuss the nomenclature and structure of coordination complexes with coordination number 2-10. (10)
- (b) How do you calculate the degree of dissociation (α) of a weak electrolyte by Kohlrausch law? (05)
- (c) The hydrolysis of $\text{CH}_3\text{COOH}_2\text{H}_5$ with NaOH is a second order reaction. How do you follow the progress of this reaction in the laboratory? (05) (20)



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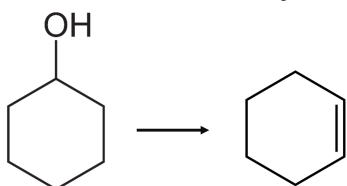
CHEMISTRY, PAPER-II

TIME ALLOWED: THREE HOURS	(PART-I MCQs) MAXIMUM MARKS: 20
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PART-I (MCQs)(COMPULSORY)

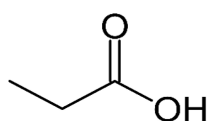
Q.1. (i) Select the best option/answer and fill in the appropriate Box ☐ on the OMR Answer Sheet.(20x1=20)
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1. Cyclohexanol can be converted into cyclohexene by heating with:

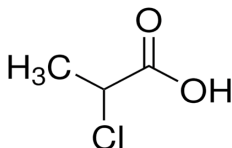


- (A) Zn(Hg)/HCl (B) Concentrated H₂SO₄ (C) SOCl₂ (D) None of these

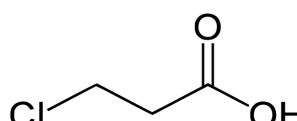
2. Identify the optically active compound from the following:



A



B



C

- (A) Compound A (B) Compound B (C) Compound C (D) None of these

3. _____ is a characteristic chemical property of alkanes?

- (A) Addition reactions (B) Substitution reactions (C) Elimination reactions (D) Oxidation reactions

4. Which of the following reactions is a characteristic chemical property of alkynes?

- (A) Addition reactions (C) Elimination reactions
(B) Substitution reactions (D) Oxidation reactions

5. In Ultraviolet-Visible (UV-Vis) Spectroscopy, what is the origin of the absorption bands observed for conjugated systems?

- (A) $\pi \rightarrow \pi^*$ transitions (B) $n \rightarrow \pi^*$ transitions (C) $\sigma \rightarrow \sigma^*$ transitions (D) None of these

6. The reagent that can be used to convert an alkene into an alkyl halide is:

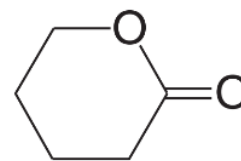
- (A) HBr (B) HNO₃ (C) KMnO₄ (D) None of these

7. The order of stability of carbanions is:

- (A) primary > secondary > tertiary (C) tertiary > secondary > primary
(B) secondary > tertiary > primary (D) None of these

8. Cyclic compounds of the general type shown here are called lactones. What functional group does a lactone contain?

- (A) Ether (C) Carboxylic
(B) Ester (D) None of these



9. Homolytic fission of C-C bond leads to formation of:

- (A) Free radicals (B) Carbanions (C) Carbocation (D) None of these

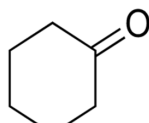
10. Which of the following is not heterocyclic compound?



A



B



C

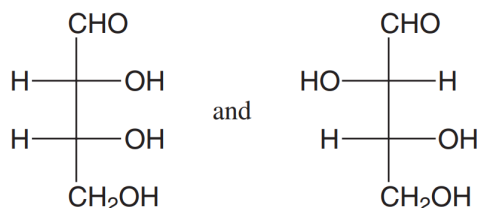
- (A) Compound A (B) Compound B (C) Compound C (D) None of these

11. The most stable conformation of cyclohexane is the:

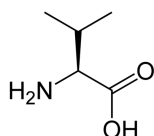
- (A) Haworth form (B) Boat form (C) Newman form (D) Chair form

CHEMISTRY, PAPER-II

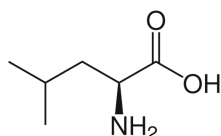
12. All carbon atoms in naphthalene are:
(A) sp hybridized (B) sp^2 hybridized (C) sp^3 hybridized (D) None of these
13. Which of the following is a correct name according to the IUPAC rules?
(A) 2-Methylcyclohexane (C) 2-Ethyl-2-methylpentane
(B) 3,4-Dimethylpentane (D) 3-Ethyl-2-methylpentane
14. Identify the relation between the following pair of structure.



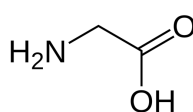
- (A) Enantiomers (B) Diastereomers (C) Constitutional isomers (D) None of these
15. What is the function of adenosine triphosphate (ATP) in the cell?
(A) Energy storage (B) Structural support (C) Genetic information storage (D) None of these
16. Which of the following is a non-essential amino acid?



Valine



Leucine



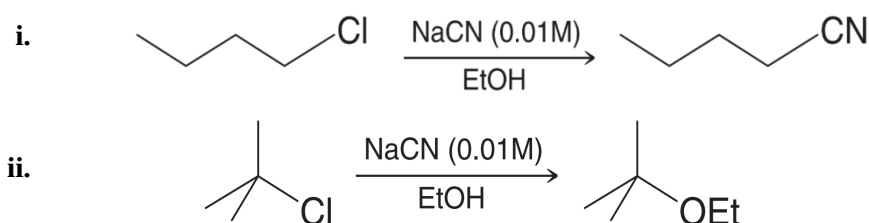
Glycine

- (A) Valine (B) Leucine (C) Glycine (D) None of these
17. In gluconeogenesis, what is the primary source of carbon for the synthesis of glucose?
(A) Pyruvate (B) Acetyl-CoA (C) Glycerol (D) None of these
18. Which of the following is an example of a saturated fatty acid?
(A) Oleic acid (B) Linoleic acid (C) Stearic acid (D) None of these
19. Which chemical process is used to convert fatty acids or triglycerides into biodiesel?
(A) Saponification (B) Transesterification (C) Dehydration (D) None of these
20. Which additive is commonly used to enhance the brightness of paper?
(A) Kaolin (B) Rosin (C) Titanium dioxide (D) None of these

PART-II

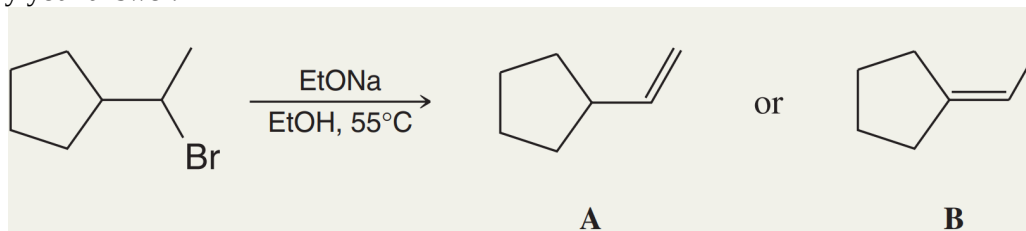
- NOTE:** (i) Part-II is to be attempted on the separate Answer Book.
(ii) Attempt **ONLY FOUR** questions from PART-II. ALL questions carry **EQUAL** marks.
(iii) All the parts (if any) of each Question must be attempted at one place instead of at different places.
(iv) Write Q. No. in the Answer Book in accordance with Q. No. in the Q.Paper.
(v) No Page/Space be left blank between the answers. All the blank pages of Answer Book must be crossed.
(vi) Extra attempt of any question or any part of the question will not be considered.
(vii) Use of Calculator is allowed.

- Q.2.** Explain the following:
- (a) Hybridization in organic chemistry involves s and p orbitals only. Why? Also discuss the concept of sp^3 hybridization in the context of organic compounds, providing example and explaining how it influences molecular shapes and bond angles. (8)
- (b) The process of converting *tert*-butyl alcohol into *tert*-butyl chloride, providing details on the reagents and reaction conditions involved. (6)
- (c) In contrast to S_N2 reactions, S_N1 reactions show relatively little nucleophile selectivity. That is, when more than one nucleophile is present in the reaction medium, S_N1 reactions show only a slight tendency to discriminate between weak nucleophiles and strong nucleophiles, whereas S_N2 reactions show a marked tendency to discriminate. (6)
- (a) Provide an explanation for this behavior.
(b) Show how your answer accounts for the following:



CHEMISTRY, PAPER-II

- Q.3. (a)** Using Zaitsev's rule, predict which would be the major product of the following reaction. Also justify your answer. (4)



- (b)** Give the equation for the following reactions along with reaction conditions: (8)

- i. Reduction of propyl bromide
- ii. Synthesis of acetone from propene
- iii. Synthesis of cyclohexane from phenol
- iv. Oxidation of ethylene in hot and cold KMnO_4

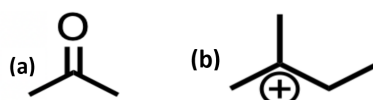
- (c)** A compound with molecular formula $\text{C}_4\text{H}_8\text{O}$ has a strong IR absorption at 1730 cm^{-1} . Its mass spectrum is tabulated below, and includes key peaks at m/z 44 (the base peak) and m/z 29. Propose a structure for the compound and write fragmentation equations showing how peaks having these m/z values arise. (8)

Table: Mass spectrum of an unknown compound

m/z	Intensity (as percent of base peak)	m/z	Intensity (as percent of M^{++})
27	59.0	72	M^{++} 100.0
28	15.0	73	$\text{M}^{++} + 1$ 4.5
29	54.0	74	$\text{M}^{++} + 2$ 0.3
39	23.0		
41	60.0		
42	12.0		
43	79.0		
44	100.0 (base)		
72	73.0 M^{++}		
73	3.3		
74	0.2		

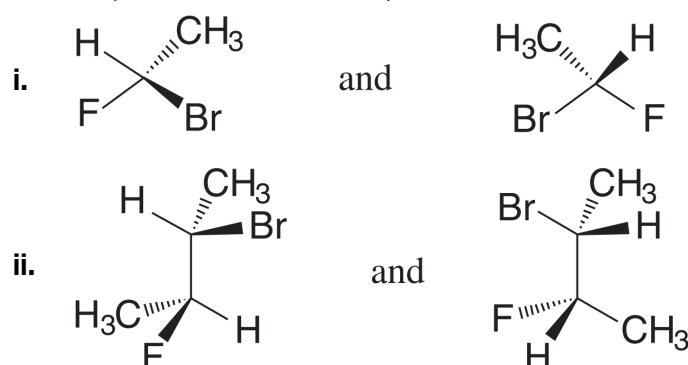
- Q.4. (a)** Answer the following: (2 marks each) (10)

- i. Write resonance structures for the azide ion, N_3^- . Explain how these resonance structures account for the fact that both bonds of the azide ion have the same length.
- ii. Explain why *cis*-1,2-dichloroethene has a large dipole moment i.e 1.90 whereas *trans*-1,2-dichloroethene has a dipole moment equal to zero.
- iii. Identify the nucleophilic center of each molecule.



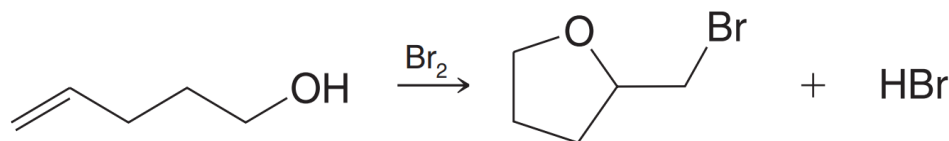
- iv. Write the structures of two chair conformations of 1-tert-butyl-1-methylcyclohexane. Which conformation is more stable? Explain your answer.
- v. Why alkenes are more reactive than alkanes in chemical reactions.

- (b)** Consider the following pairs of structures. Designate each chirality center as (R) or (S) and identify the relationship between them by describing them as representing enantiomers, diastereomers, constitutional isomers, or two molecules of the same compound. (5)

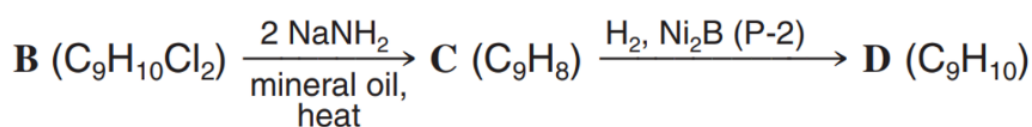
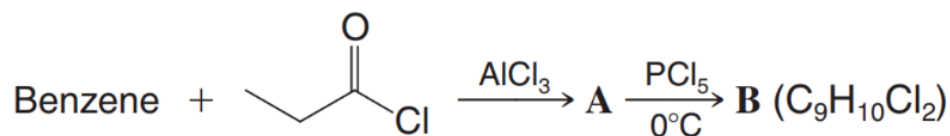


CHEMISTRY, PAPER-II

- (c) Write a mechanism for the following reaction. Include formal charges and curved arrows to show the movement of electrons in all steps. (5)

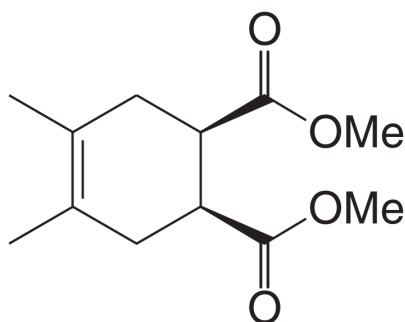


- Q.5. (a) Give structures (including stereochemistry where appropriate) for compounds A–D. (5)

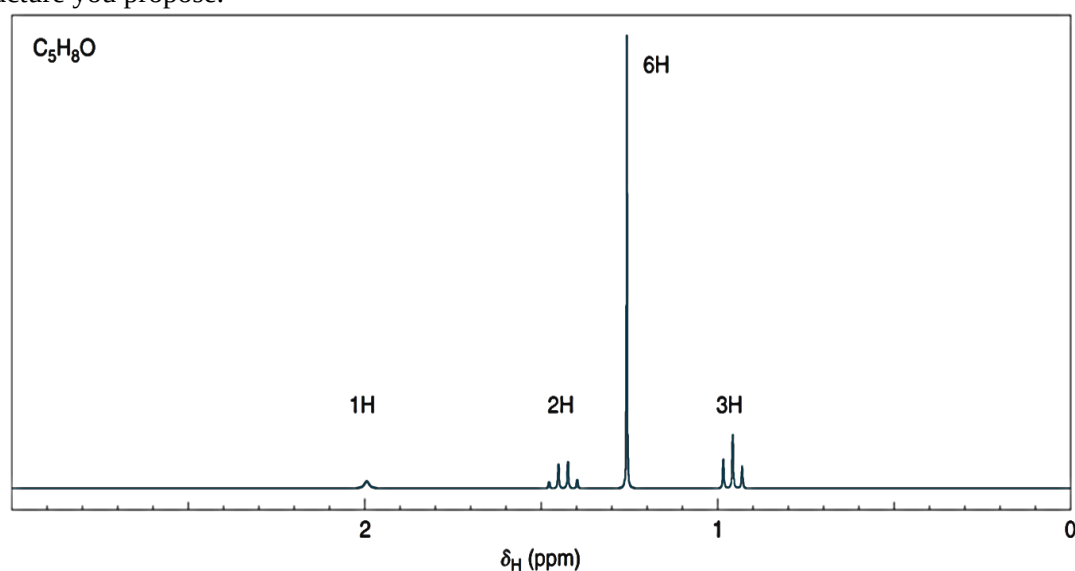


[Hint: The ^1H NMR spectrum of compound C consists of a multiplet at δ 7.20 (5H) and a singlet at δ 2.0 (3H).]

- (b) Which diene and dienophile would you employ in the synthesis of following? Give mechanism also. (5)



- (c) Propose a structure for an alcohol with molecular formula $\text{C}_5\text{H}_{12}\text{O}$ that has the ^1H NMR spectrum given in Figure below. Assign the chemical shifts and splitting patterns to specific aspects of the structure you propose. (5)



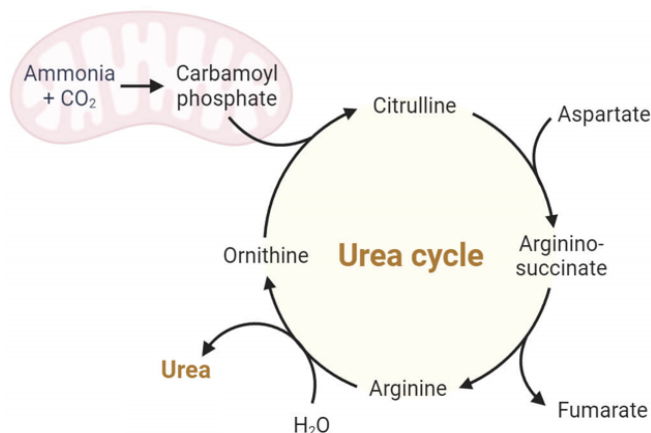
- (d) What are the common by-products generated during sugar manufacturing process. Discuss the applicability of each by-product in perspective of Pakistan. (5)

CHEMISTRY, PAPER-II

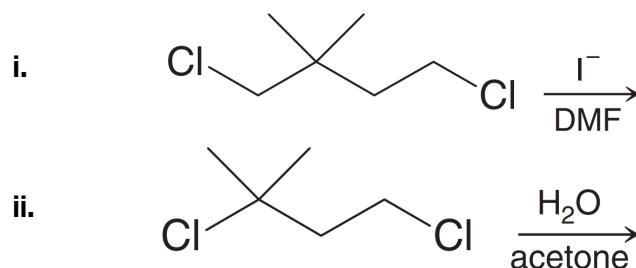
- Q.6. (a) Starting with styrene, outline a synthesis of 1-bromo-2-phenylethane. (5)



- (b) Urea cycle is illustrated in figure below. Explain the significance of the urea cycle in the context of nitrogen metabolism. How does the urea cycle prevent the toxic accumulation of ammonia in the body? (5)



- (c) Illustrate the mechanism for dehydrating an alcohol to produce an alkene, using ethanol as a specific example. (5)
- (d) What is the role of grinding and milling processes in cement manufacturing. How do they impact the fineness of the final product? (5)
- Q.7. (a) Compare and contrast the Lucas test and the dichromate test for alcohols. Provide a detailed explanation of the procedures, reactions involved, and the specific observations or results expected in each test. Highlight the distinguishing features that allow these tests to differentiate between primary, secondary, and tertiary alcohols. (5)
- (b) Compare the structure of saturated and unsaturated fatty acids and explain their impact on human health. (5)
- (c) Describe the process of glycolysis. Include the key intermediates, enzymes involved, and the fate of pyruvate under aerobic and anaerobic conditions. (5)
- (d) Explain the role of limestone in cement production and its impact on the chemical composition of the final product. (5)
- Q.8. (a) Competition experiments are those in which two reactants at the same concentration (or one reactant with two reactive sites) compete for a reagent. Predict the major product resulting from each of the following competition experiments: (8)



- (b) Define phospholipids and discuss their structural components. Explain how the structure of phospholipids contributes to their unique properties in biological membranes. Describe the process of phospholipid synthesis. (6)
- (c) Explain the role of enzymes in biomolecular reactions, providing examples of specific enzymatic reactions. (6)



**FEDERAL PUBLIC SERVICE COMMISSION
COMPETITIVE EXAMINATION-2025 FOR RECRUITMENT
TO POSTS IN BS-17 UNDER THE FEDERAL GOVERNMENT**

Roll Number

CHEMISTRY, PAPER-I

TIME ALLOWED: THREE HOURS	(PART-I MCQs)	MAXIMUM MARKS: 20
PART-I (MCQs) : MAXIMUM 30 MINUTES	(PART-II)	MAXIMUM MARKS: 80
NOTE: (i) First attempt PART-I (MCQs) on separate OMR Answer Sheet which shall be taken back after 30 minutes.		
(ii) Overwriting/cutting of the options/answers will not be given credit.		
(iii) There is no negative marking. All MCQs must be attempted.		

PART-I (MCQs)(COMPULSORY)

Q.1. (i) Select the best option/answer and fill in the appropriate Box ☐ on the OMR Answer Sheet.(20x1=20)
(ii) Answers given anywhere else, other than OMR Answer Sheet, will not be considered.

- Which of the following does not have the ground-state configuration $1s^2 2s^2 2p^6$?**
(A) Ne (B) Na^+ (C) Cl^- (D) None of these
- A reaction is exothermic if:**
(A) $\Delta H > 0$ (B) $\Delta H < 0$ (C) $\Delta G > 0$ (D) $\Delta G < 0$
- In chemometrics, multivariate calibration involves:**
(A) Using multiple independent variables to predict dependent variables
(B) Using regression only on X-data (C) Performing correlation without regression (D) None of these
- Langmuir isotherm assumes:**
(A) Multilayer adsorption (B) Uniform surface without interactions between adsorbed molecules
(C) Gas behaves as ideal (D) None of these
- A zero-order reaction rate does not depend on:**
(A) Temperature (B) Pressure (C) Reactant concentration (D) None of these
- Enzymes act as catalysts by:**
(A) Increasing activation energy (B) Lowering activation energy
(C) Changing equilibrium position (D) None of these
- In an electrolytic cell:**
(A) Electrons move from cathode to anode (B) The anode is negative
(C) Energy is consumed to drive the reaction (D) None of these
- Silicones are primarily:**
(A) Organic polymers (B) Inorganic polymers (C) Hybrid organic-inorganic polymers (D) None of these
- The Nernst equation relates electrode potential to:**
(A) Pressure (B) Temperature and concentration (C) Surface area (D) None of these
- In solvent extraction, distribution coefficient is:**
(A) Ratio of solute concentration in two phases (B) Ratio of solvents used
(C) Ratio of extractant to sample volume (D) None of these
- In gas chromatography, the mobile phase is:**
(A) Liquid (B) Gas (C) Solid (D) None of these
- Solubility of a salt is decreased in presence of:**
(A) Common ion (B) High temperature (C) High Ph (D) None of these
- The solubility of a gas in a liquid is directly proportional to the partial pressure of the gas above the liquid. This statement is based upon:**
(A) Raoult's law (B) Henry's law (C) Kohlrausch's law (D) None of these
- The heat capacity of a calorimeter is determined using:**
(A) A bomb calorimeter (B) A known standard material (C) Adiabatic temperature rise (D) None of these
- Fugacity is used to measure:**
(A) Real gas behavior (B) Ideal gas compressibility (C) Equilibrium constant (D) None of these
- Lattice enthalpy is always:**
(A) Positive and represents energy absorption (B) Positive and represents energy release
(C) Negative and represents energy absorption (D) Negative and represents energy release
- According to Hess's law:**
(A) Enthalpy change depends on reaction pathway (B) Enthalpy change is path independent
(C) Enthalpy depends on final state only (D) Enthalpy change includes entropy changes
- Debye-Hückel theory is used to calculate:**
(A) Solubility of salts (B) Ionic strength of solutions (C) Gibbs free energy of ions (D) None of these
- Potentiometric titration involves measurement of:**
(A) Current in the reaction (B) Volume at equivalence
(C) Electrode potential as a function of titrant added (D) None of these
- According to molecular orbital theory the bond order of O_2^- is:**
(A) 1.0 (B) 1.5 (C) 2.5 (D) None of these

PART-II

- NOTE:** (i) **Part-II** is to be attempted on the separate **Answer Book**.
 (ii) Attempt **ONLY FOUR** questions from **PART-II** by selecting **TWO** questions from **EACH SECTION**. **ALL** questions carry **EQUAL** marks.
 (iii) All the parts (if any) of each Question must be attempted at one place instead of at different places.
 (iv) Write Q. No. in the Answer Book in accordance with Q. No. in the Q.Paper.
 (v) No Page/Space be left blank between the answers. All the blank pages of Answer Book must be crossed.
 (vi) Extra attempt of any question or any part of the question will not be considered.
 (vii) **Use of Calculator is allowed.**

- Q. 2.** (a) Define adsorption and explain its types. Derive an expression for the Langmuir adsorption isotherm and discuss factors influencing adsorption on solids. (08)
 (b) Why are transition metal complexes often colored? Explain using crystal field theory with an example. (07)
 (c) Compare and contrast the Lewis concept and the Bronsted-Lowry theory of acids and bases. Include relevant examples and limitations. (05) (20)
- Q. 3.** (a) What is lanthanide contraction? Analyze its impact on the atomic radii and chemical properties of lanthanides and post-lanthanides. (08)
 (b) Analyze the quantum numbers associated with atomic orbitals and describe their importance in explaining electron configurations. (07)
 (c) Describe the catalytic activity of transition metals with reference to their variable oxidation states. Support your explanation with one example. (05) (20)
- Q. 4.** (a) Derive the Gibbs free energy equation from the first and second laws of thermodynamics and discuss its importance in predicting the spontaneity of chemical reactions. (10)
 (b) Explain the principle of fractional distillation. Compare it with simple distillation using a diagram and examples of their applications. (05)
 (c) Adsorption isotherms fail at high pressure. Why? Explain with reference to the limitations of the Freundlich isotherm. (05) (20)
- Q. 5.** (a) Why are Lewis's acids and bases more versatile in their applications than Bronsted-Lowry acids and bases? Provide two examples to support your answer. (10)
 (b) Derive the integrated rate law for a first-order reaction and explain why the half-life of such a reaction is independent of its initial concentration. (05)
 (c) State and explain the Heisenberg Uncertainty Principle. How does it limit our ability to precisely determine the position and momentum of particles? (05) (20)
- Q. 6.** (a) Discuss the Freundlich adsorption isotherm. Derive the equation and highlight its limitations. (07)
 (b) Using a diagram, explain the principle and working of a galvanic cell. Discuss its components with the example of a Zn-Cu system. (07)
 (c) Why does an exothermic reaction sometimes become non-spontaneous at high temperatures? (06) (20)
- Q. 7.** (a) Explain the relationship between entropy, enthalpy, and Gibbs free energy. Derive an expression for equilibrium using these thermodynamic quantities. (08)
 (b) Derive the first law of thermodynamics and explain its connection with internal energy and enthalpy. (07)
 (c) Define the concept of activation energy and illustrate its significance in reaction kinetics using the Arrhenius equation. (05) (20)
- Q. 8. Define the following:** (5 each) (20)
 (a) Difference between Homogenous and Heterogenous Catalysis
 (b) Define Molecular Orbital Theory (MOT)
 (c) Difference between ANOVA and Gaussian Distribution
 (d) Define Chromatography and write key differences between Paper Chromatography and Gas Chromatography



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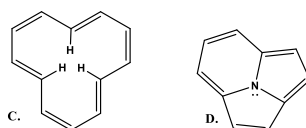
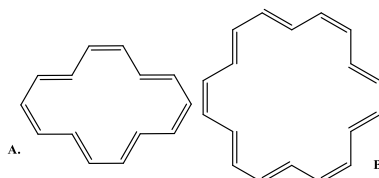
CHEMISTRY, PAPER-II

TIME ALLOWED: THREE HOURS	(PART-I MCQs) MAXIMUM MARKS: 20
PART-I (MCQs) : MAXIMUM 30 MINUTES	(PART-II) MAXIMUM MARKS: 80
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PART-I (MCQs)(COMPULSORY)

Q.1. (i) Select the best option/answer and fill in the appropriate Box ☐ on the OMR Answer Sheet.(20x1=20)
(ii) Answers given anywhere else, other than OMR Answer Sheet, will not be considered.

- Which of the following is the primary site for the digestion of carbohydrates?
(A) Stomach (B) Mouth (C) Small intestine (D) None of these
- In glycolysis, the enzyme hexokinase catalyzes the conversion of:
(A) Glucose to glucose-6-phosphate (B) Pyruvate to lactate
(C) Fructose-6-phosphate to fructose-1,6-bisphosphate (D) None of these
- Which of the following is a common byproduct of the cement manufacturing process?
(A) Sulfur dioxide (SO₂) (B) Nitrogen oxides (NO_x) (C) Both (A) and (B) (D) None of these
- The raw materials for glass manufacturing typically include:
(A) Limestone and sand (B) Sand, soda ash, and lime (C) Clay and sodium hydroxide (D) None of these
- Starch is composed of:
(A) Amylose and amylopectin (B) Glycogen and amylopectin
(C) Amylopectin and cellulose (D) None of these
- An allosteric enzyme:
(A) Follows Michaelis-Menten kinetics (B) Is regulated by molecules that bind to a site other than the active site
(C) Is always inhibited by competitive inhibitors (D) None of these
- What type of fragmentation occurs in mass spectrometry?
(A) Homolytic cleavage (B) Heterolytic cleavage (C) Both (A) and (B) (D) None of these
- In IR spectroscopy, the fingerprint region is found in the range:
(A) 4000–2500 cm⁻¹ (B) 2500–1500 cm⁻¹ 1500–600 cm⁻¹ (D) None of these
- Which of the following is stereospecific?
(A) Free radical substitution (B) SN₂ reaction
(C) E₂ reaction with anti-periplanar elimination (D) None of these
- A molecule is chiral if:
(A) It has at least one plane of symmetry. (B) It has a chiral center and is non-superimposable on its mirror image.
(C) It rotates polarized light to the left. (D) None of these
- Which reaction is most likely to occur with a bulky base like *tert*-butoxide?
(A) SN₁ (B) SN₂ (C) E₂ (D) None of these
- What is the major product when ethyl acetate is hydrolyzed under acidic conditions?
(A) Acetic acid and ethanol (B) Acetaldehyde and ethanol
(C) Acetone and ethanol (D) None of these
- Which reaction involves the conversion of aldehydes into alcohols?
(A) Oxidation (B) Reduction (C) Hydrolysis (D) None of these
- Which compound will give a silver mirror test with Tollens' reagent?
(A) Propanone (B) Ethanal (C) Benzophenone (D) None of these
- The resonance energy of benzene is approximately:
(A) 150 kJ/mol (B) 200 kJ/mol (C) 250 kJ/mol (D) None of these
- Which of the following compounds are aromatic?



(A) A, B and D

(B) A, C and D

(C) A and D

(D) None of these

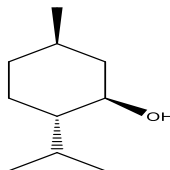
CHEMISTRY, PAPER-II CSS-2025

17. What is the main product when nitrobenzene reacts with chlorine in the presence of AlCl_3 ?
(A) Ortho-chloronitrobenzene (B) Meta-chloronitrobenzene (C) Chlorobenzene (D) None of these
18. Which type of substitution occurs predominantly in benzene?
(A) Nucleophilic substitution (B) Electrophilic substitution (C) Free radical substitution (D) None of these
19. What is the main product when 1-butyne reacts with excess of HBr ?
(A) 1-Bromobutene (B) 1-Bromobutane (C) 2,2-Bromobutene (D) None of these
20. Which of the following has the highest dipole moment?
(A) CO_2 (B) H_2O (C) CCl_4 (D) None of these

PART-II

- NOTE: (i)** Part-II is to be attempted on the separate Answer Book.
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(vii) Use of Calculator is allowed.

- Q.2. (a) Elaborate with examples that how resonance, hyperconjugation and inductive effect, can contribute towards the stability of carbocations. (10)
(a) How 'dipole moment' can be measured? Indicate, among the following molecules which does not have dipole moment and why? (10)
- i. CCl_4 ii. BF_3 iii. CH_4 iv. NH_3
- Q.3. (a) How does the reaction mechanism work for the electrophilic addition of bromine to ethene? Explain the intermediate (s). (10)
(b) Describe the IUPAC rules for naming alkenes and alkynes with appropriate examples. (10)
- Q.4. (a) Categorize benzene substituents, into activating and deactivating groups. Explain their influence on *ortho*, *para* and *meta* orientation of incoming groups in electrophilic substitution reactions. (12)
(b) How did Kekulé propose the benzene structure, and what evidence supported his model? (8)
- Q.5. (a) Compare the reactivity of acid halides, anhydrides, esters, and amides toward nucleophilic substitution. What kind of products do you expect when these react with Grignard reagent (RMgX)? (10)
(b) Explain the reaction mechanism of Williamson synthesis to prepare ethers. (5)
(c) Discuss the acidic nature of phenols. Why picric acid ($\text{C}_6\text{H}_3\text{N}_3\text{O}_7$) is considered strong acid? (5)
- Q.6. (a) Given below is the structure of (1*R*, 2*S*, 5*R*) menthol. Draw the structures of all possible stereoisomers of menthol. (8)



- (b) How does Hofmann's rule differ from Zaitsev's rule? Explain each with suitable example. (6)
(c) Describe the main components of a UV/Visible spectrophotometer and their functions. (6)
- Q.7. (a) Write a comprehensive note on primary, secondary, tertiary, and quaternary structures of proteins. (10)
(b) Write a note on enzyme catalysis and enzyme inhibition. (10)
- Q.8. (a) Outline the steps of the Krebs cycle, and explain its role in cellular respiration. (10)
(b) Describe the environmental impact of the manufacturing industry of sugar, cement, glass, paper and fertilizers. How these industries can address environmental concerns? (10)



**FEDERAL PUBLIC SERVICE COMMISSION
COMPETITIVE EXAMINATION-2026 FOR RECRUITMENT
TO POSTS IN BS-17 UNDER THE FEDERAL GOVERNMENT**

Roll Number

CHEMISTRY, PAPER-I

TIME ALLOWED: THREE HOURS	(PART-I MCQs)	MAXIMUM MARKS: 20
PART-I (MCQs) : MAXIMUM 30 MINUTES	(PART-II)	MAXIMUM MARKS: 80
NOTE: (i) First attempt PART-I (MCQs) on separate OMR Answer Sheet which shall be taken back after 30 minutes.		
(ii) Overwriting/cutting of the options/answers will not be given credit.		
(iii) There is no negative marking. All MCQs must be attempted.		

PART-I (MCQs)(COMPULSORY)

Q.1. (i) Select the best option/answer and fill in the appropriate Box ☐ on the OMR Answer Sheet.(20x1=20)
(ii) Answers given anywhere else, other than OMR Answer Sheet, will not be considered.

- For a particle in a one-dimensional infinite square well of width L, the energy difference between the n=2 and n=1 levels is proportional to:**
(A) 1/L (B) 1/L² (C) L (D) None of these
- Which principle states that it is impossible to simultaneously determine the exact position and momentum of an electron?**
(A) Pauli's Exclusion Principle (B) Bohr's model (C) Heisenberg's Uncertainty Principle (D) None of these
- Kohlrausch's law for limiting molar conductivity states that:**
(A) $\Lambda^\circ = \lambda^\circ_{+} + \lambda^\circ_{-}$ (sum of ionic contributions) (B) Λ° decreases infinitely with dilution
(C) Λ° is independent of ion type (D) None of these
- In a concentration cell without transference, the cell potential is generated by a difference in:**
(A) Temperature (B) Concentration of electrolyte (C) Electrode material (D) None of these
- The Van der Waals equation modifies the ideal gas law to account for:**
(A) The principle of corresponding states (B) Intermolecular forces and finite molecular volume
(C) The critical phenomenon (D) None of these
- The Born-Haber cycle is used to calculate:**
(A) Lattice energy of an ionic solid from measurable quantities (B) Activation energy of a reaction
(C) Standard molar entropy only (D) None of these
- According to collision theory, the rate constant increases because:**
(A) The fraction of collisions with energy $\geq$ activation energy increases with temperature
(B) Molecularity increases with temperature (C) Concentration decreases with temperature (D) None of these
- Which factor typically has the greatest effect on the rate of a chemical reaction?**
(A) Initial pressure (B) Temperature (C) Volume (D) None of these
- In Chemisorption, the forces of attraction between the adsorbate and adsorbent are similar to:**
(A) Van der Waals forces (B) Electrostatic forces (C) Chemical bonds (D) None of these
- A colloidal system stabilized by electrostatic repulsion typically uses:**
(A) Surfactants that provide steric hindrance only (B) Ionic species that develop an electrical double layer
(C) Purely covalent bonding between particles (D) None of these
- ANOVA is primarily used to:**
(A) Compare means across more than two groups to test if at least one differs significantly
(B) Measure central tendency for one group only
(C) Determine molecular weight distributions (D) None of these
- The measure of the spread of a set of data points around their mean is the:**
(A) Arithmetic mean (B) Confidence limit (C) Standard deviation (D) None of these
- Which chromatographic technique is most suitable for preparative separation of large quantities of a substance?**
(A) Paper chromatography (B) Thin layer chromatography (TLC)
(C) Column chromatography (D) None of these
- The process of extracting a solute from a liquid sample by repeatedly mixing it with fresh portions of an immiscible solvent is called:**
(A) Fractional distillation (B) Multiple batch extraction (C) Precipitation (D) None of these
- According to MOT (Molecular Orbital Theory), the bond order of the O₂ molecule is:**
(A) 1 (B) 2 (C) 3 (D) None of these
- According to VSEPR Theory, a molecule with AX₃E (three bonds and one lone pair) has which ideal geometry?**
(A) Tetrahedral electron geometry, trigonal pyramidal molecular shape (B) Trigonal planar geometry
(C) Linear geometry (D) None of these
- According to the SHAB (Soft and Hard Acids and Bases) concept, a hard acid preferentially reacts with a:**
(A) Soft base (B) Neutral base (C) Hard base (D) None of these
- The solubility product K_{sp} decreases when:**
(A) Common ion is added to the solution (B) Temperature always increases
(C) Solid is removed from solution (D) None of these

CHEMISTRY, PAPER-I (2026)

19. Chelate complexes are generally more stable than non-chelate complexes due to the chelate effect, which is primarily a consequence of:
(A) Enthalpy (B) Entropy (C) Energy (D) None of these
20. Werner's Coordination Theory primarily introduced the concept of:
(A) Oxidation states only (B) Primary and secondary valences (coordination number and ligands)
(C) Electron delocalization in metals (D) None of these

PART-II

NOTE: (i) Part-II is to be attempted on the separate Answer Book.
(ii) Attempt **ONLY FOUR** questions from PART-II. ALL questions carry **EQUAL** marks.
(iii) All the parts (if any) of each Question must be attempted at one place instead of at different places.
(iv) Write Q. No. in the Answer Book in accordance with Q. No. in the Q.Paper.
(v) No Page/Space be left blank between the answers. All the blank pages of Answer Book must be crossed.
(vi) Extra attempt of any question or any part of the question will not be considered.
(vii) **Use of Calculator is allowed.**

- Q. 2. (a) Explain the difference between physisorption and chemisorption in terms of energetics and kinetics. Provide typical experimental evidence to distinguish them. (6)
- (b) Define and explain the concepts of internal energy (E) and enthalpy (H). Show the mathematical relationship between them. (7)
- (c) Discuss the physical meaning of eigenfunctions and eigenvalues, and explain why operators must be Hermitian in quantum mechanics. (7) (20)
- Q. 3. (a) Outline selection criteria for stationary and mobile phases in column chromatography for separating polar organic molecules. (6)
- (b) Propose a corrosion prevention strategy for a steel water pipeline system exposed to chloride-rich environments. (7)
- (c) Derive the integrated rate equation for a second-order reaction where two reactants of equal concentration react ($2A \rightarrow \text{Products}$). (7) (20)
- Q. 4. (a) Given small sample data, compute 95% confidence interval for the mean and interpret the result. (6)
- (b) Predict and justify which complex will undergo a stronger Jahn–Teller distortion: $[Cu(H_2O)_6]^{2+}$ or $[Mn(H_2O)_6]^{3+}$ (7)
Support your reasoning with electronic configurations and degeneracy arguments.
- (c) Explain how transport numbers are determined experimentally and derive their relationship with ionic mobilities. (7) (20)
- Q. 5. (a) Explain the photoelectric effect and how it supports the particle nature of light. Discuss the role of work function and threshold frequency. (6)
- (b) Explain the common ion effect and its application in controlling the solubility of sparingly soluble salts. Use an example to illustrate. (7)
- (c) Explain the mechanism of enzyme catalysis, highlighting the role of the active site and the factors that influence enzyme activity. (7) (20)
- Q. 6. (a) Use VSEPR to predict the shape and bond angles of SF_4 and explain the concept of stereochemically active lone pairs. (6)
- (b) Using the Van der Waals equation, explain qualitatively how critical constants (T_c , P_c , V_c) relate to a , b parameters. (7)
- (c) Explain Debye–Hückel theory and derive the limiting law for the mean ionic activity coefficient. Describe its region of validity. (7) (20)
- Q. 7. (a) Discuss isomerism in coordination complexes (geometric, optical, linkage) with three illustrative examples and draw structures. (6)
- (b) A buffer is to be made at pH 5.00 using sodium phosphate salts. Which pair would you choose and how would you prepare it? Show calculations. (7)
- (c) Explain valence bond theory and hybridization for methane (CH_4), and contrast it with an MO description of bonding in the same molecule. (7) (20)

CHEMISTRY, PAPER-I (2026)

- Q. 8.** (a) Discuss the principle of electrophoresis and its application in the separation and characterization of proteins. (6)
- (b) Describe common statistical tests (t-test, chi-square) and their applications in analytical chemistry. Provide decision criteria. (7)
- (c) Using initial rate data (suppose), determine reaction order and rate constant by method of initial rates. (Provide a short worked example). (7) (20)



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CHEMISTRY, PAPER-II

TIME ALLOWED: THREE HOURS	(PART-I MCQs) MAXIMUM MARKS: 20
PART-I (MCQs) : MAXIMUM 30 MINUTES	(PART-II) MAXIMUM MARKS: 80
NOTE: (i) First attempt PART-I (MCQs) on separate OMR Answer Sheet which shall be taken back after 30 minutes. (ii) Overwriting/cutting of the options/answers will not be given credit. (iii) There is no negative marking. All MCQs must be attempted.	

PART-I (MCQs)(COMPULSORY)

Q.1. (i) Select the best option/answer and fill in the appropriate Box ☐ on the OMR Answer Sheet.(20x1=20)
(ii) Answers given anywhere else, other than OMR Answer Sheet, will not be considered.

- Which of the following groups, would have the highest –I effect, relative to hydrogen atom?
(A) – COOH (B) – CN (C) – NO₂ (D) None of these
- Which molecule would have the highest dipole moment among the given series?
(A) Aniline (B) 4-Nitroaniline (C) 3-Nitroaniline (D) None of these
- Cyclobutane is an example of which type of hydrocarbons?
(A) Aromatic (B) Acyclic (C) Alicyclic (D) None of these
- The alpha(α)-elimination in a molecule can be regarded as:
(A) 1,1-Elimination (B) 1,2-Elimination (C) 1,3-Elimination (D) None of these
- Which one, among the given molecules, would require drastic conditions (highest temperature) for nitration?
(A) Phenol (B) Nitrobenzene (C) Toluene (D) None of these
- The greater percentage of *para*-substituted product would be obtained in which of the electrophilic aromatic substitution reactions on chlorobenzene?
(A) Methylation (B) Nitration (C) Sulfonation (D) None of these
- When phenol is subjected to a typical Kolbe's reaction, at 125 °C under a pressure of 5 atm, the main product obtained is:
(A) Salicylic acid (B) Picric acid (C) Carboic acid (D) None of these
- Dow process was introduced by Dow Chemical Company in 1928 to synthesize phenol by hydrolysis of which molecule?
(A) Cumene (B) Chlorobenzene (C) Sodium benzenesulfonate (D) None of these
- Which of the following items does not affect the mechanism of a nucleophilic substitution reaction in a significant fashion?
(A) Intensity of light present (B) Reactivity of the nucleophile
(C) Structure of the alkyl halide (D) None of these
- Which rate law describes the unimolecular nucleophilic substitution reactions?
(A) Rate = k [nucleophile] (B) Rate = k [alkyl halide]²
(C) Rate = k [alkyl halide] (D) None of these
- Which of the following compounds will exhibit the geometrical isomerism?
(A) (CH₃)₂C=CH-CH₃ (B) CH₃-CH=CH-CH₃ (C) CH₃-CH₂-CH=CH₂ (D) None of these
- In which of the following derivative of cyclohexane carboxylic acid, the plane of symmetry is not present?
(A) 4-Methyl derivative (B) 2-Methyl derivative (C) 2-Carboxy derivative (D) None of these
- Which of the following bonds shows the stretching absorption in the 3700-2500 cm⁻¹ region in its IR spectrum?
(A) C-C (B) C-O (C) C-N (D) None of these
- The base peak in the molecule of benzoic acid appears by the loss of –OH radical. At which *m/z* it will appear?
(A) 105 (B) 77 (C) 45 (D) None of these
- In a glyceryl tristearate molecule, the fatty acid involved has a chain length of how many carbon atoms?
(A) 10 (B) 12 (C) 06 (D) None of these
- The diploid number of chromosomes contained in the each human cell is:
(A) 26 (B) 40 (C) 48 (D) None of these
- The coenzyme or metal ion that is covalently bound to the enzyme protein is called a:
(A) Neighboring group (B) Dummy group (C) Prosthetic group (D) None of these
- The mineral present in urease enzyme is:
(A) Nickel (B) Zinc (C) Chromium (D) None of these
- Cement's strength is due to:
(A) Tricalcium aluminate (B) Tricalcium silicate (C) Dicalcium silicate (D) None of these
- The type of glass used in making the lenses and prisms is:
(A) Flint glass (B) Soft glass (C) Pyrex glass (D) None of these

PART-II

- NOTE:** (i) **Part-II** is to be attempted on the separate **Answer Book**.
 (ii) Attempt **ONLY FOUR** questions from **PART-II**. **ALL** questions carry **EQUAL** marks.
 (iii) All the parts (if any) of each Question must be attempted at one place instead of at different places.
 (iv) Write Q. No. in the Answer Book in accordance with Q. No. in the Q.Paper.
 (v) No Page/Space be left blank between the answers. All the blank pages of Answer Book must be crossed.
 (vi) Extra attempt of any question or any part of the question will not be considered.
 (vii) **Use of Calculator is allowed.**

- Q.2.** (a) How the Resonance Effect plays a significant role to conclude the basic and acidic strengths of molecules. Discuss with relevant examples. (12)
 (b) How the Hyperconjugation alters the properties of molecules? Discuss. (8)
- Q.3.** (a) Outline the following reactions of alkenes with suitable examples. (4 each) (16)
 i) Hydrohalogenation ii) Hydration
 iii) Epoxidation iv) Free-radical Polymerization
 (b) Although the halogens are deactivator for electrophillic aromatic substitution but still they are *ortho* and *para* directors. Explain. (4)
- Q.4.** (a) How primary, secondary and tertiary amines can be differentiated by the Hinsberg's method? (9)
 (b) Ethanol is the only primary alcohol which gives a positive iodoform test. Outline the mechanism of this reaction. (6)
 (c) Phenol is converted to salicylaldehyde by the famous Reimer-Tiemann reaction. Draw the mechanism of this reaction. (5)
- Q.5.** (a) Discuss various classes of compounds which do not have any chiral carbon atoms but still they show chirality. (9)
 (b) Why 1,2- and 1,3-methylcyclohexanecarboxylic acid are optically active but 1,4-methylcyclohexanecarboxylic acid is not? Elaborate. (5)
 (c) Allocate the priority to various groups with the help of sequence rules and then assign R or S configuration (whichever is applicable) to the following molecules. (6)
- i)

$$\begin{array}{c} \text{Ph} \\ | \\ \text{H} - \text{C} - \text{Cl} \\ | \\ \text{CH}_2\text{OH} \end{array}$$

ii)

$$\begin{array}{c} \text{Vinyl} \\ | \\ \text{H}_2\text{N} - \text{C} - \text{Et} \\ | \\ \text{CH}_3 \end{array}$$
- Q.6.** (a) Elucidate a structure that is consistent with each set of ^1H -NMR data. (10)
 i) $\text{C}_{11}\text{H}_{12}\text{O}_4$: δ 10.1 (1H, br s), 7.75 (1H, d, $J = 16$ Hz), 7.13 (1H, dd, $J = 2.1$, 8.1 Hz), 7.08 (1H, d, $J = 2.1$ Hz), 6.89 (1H, d, $J = 8.1$ Hz), 6.36 (1H, d, $J = 16$ Hz), 3.92 (3H, s) and 3.87 (3H, s).
 ii) $\text{C}_{10}\text{H}_{10}\text{O}_5$: δ 7.71 (1H, d, $J = 16$ Hz), 6.76 (2H, s), 6.38 (1H, d, $J = 16$ Hz), and 3.78 (3H, s).
 (b) Sketch out the mass fragmentation pattern in $\text{CH}_3\text{CH}_2\text{COCH}_2\text{CH}_2\text{CH}_3$ molecule. (6)
 (c) How can you distinguish between following pairs of compounds with the help of IR spectroscopy? PhCONH_2 and PhCH_2NH_2 (4)
- Q.7.** (a) Discuss the chemistry of fatty acids and glyceryl trialkanoates in detail. (10)
 (b) How the numbering in steroids is carried out? Discuss the reactions and biological functions of cholesterol. (10)
- Q.8.** (a) Draw a flow-sheet diagram and elaborate the manufacturing and processing of paper in the paper industry. (16)
 (b) Elaborate why the fertilizers are necessary for proper plant growth. (4)
