



FEDERAL PUBLIC SERVICE COMMISSION
COMPETITIVE EXAMINATION FOR
RECRUITMENT TO POSTS IN BS-17
UNDER THE FEDERAL GOVERNMENT, 2015

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 Pauli's Exclusion Principle? (5)
(b) Give the electronic configuration of Sodium. (5)
(c) What are Bohr's postulates and how do they explain the hydrogen atom spectrum? (10) (20)
- Q. No. 3.** (a) Define Heat of combustion. How is it experimentally determined? (10)
(b) For the combustion of 1 mole of benzene at 25 °C, the heat of reaction at constant pressure is given by (10)
$$\text{C}_6\text{H}_6(l) + 15/2 \text{O}_2(g) \rightarrow 6\text{CO}_2(g) + 3\text{H}_2\text{O}(l);$$
$$\text{H}^\circ = -326720.32 \text{ J}$$
Calculate E at 25 °C. (20)
- Q. No. 4.** (a) Describe the manufacture of Phosphorus on a large scale. (5)
(b) Draw the figure of Nitrogen cycle in nature. (5)
(c) Compare the physical properties of three allotropic forms of Carbon (10) (20)
- Q. No. 5.** (a) How is steel manufactured? Describe various chemical reactions taking place in the blast furnace. (10)
(b) Describe the electrolytic refining of Copper. (10) (20)
- Q. No. 6.** (a) What are fertilizers? Why are they needed? Describe various types of fertilizers and their uses. (10)
(b) Describe the processes of Urea manufacturing in Pakistan. (10) (20)
- Q. No. 7.** (a) What are transition metals? Discuss their characteristic features (5)
(b) Draw molecular orbital diagrams of $[\text{Co}(\text{NH}_3)_6]^{3+}$ and $[\text{CoF}_6]^{3-}$ (10)
(c) What was Rutherford's atomic model? (5) (20)
- Q. No. 8.** (a) What is Greenhouse Effect? How does it cause global warming of Earth? (10)
(b) What is meant by water pollution? Discuss various sources of water pollution. (10) (20)



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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

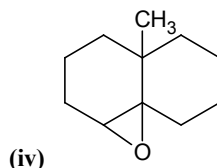
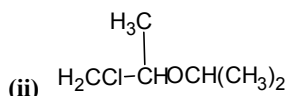
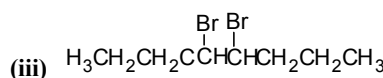
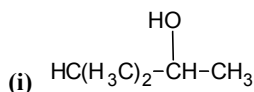
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PART-II

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) Friedal Craft alkylation

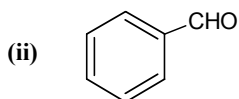
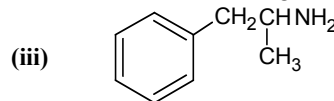
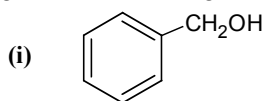
Q. No. 3. (a) How would you synthesize each of the following molecule from an alkene of appropriate structure (structure of your choice). (8)



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

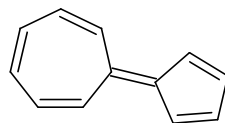
- (i) $\text{Cu}_2\text{Cl}_2, \text{O}_2, \text{pyridine}$ (iv) $\text{H}_2\text{O}, \text{HgSO}_4, \text{H}_2\text{SO}_4$
(ii) Na, ND_3 (v) Di-isoamylborane, then $\text{NaOH}, \text{H}_2\text{O}_2$
(iii) $[(\text{CH}_3)_2\text{CHCH}_2\text{CH}_2]_2\text{BD}$ then $\text{CH}_3\text{CO}_2\text{H}$ (vi) 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)



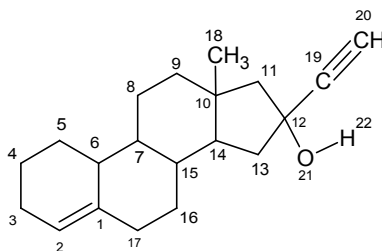
CHEMISTRY PAPER-II

- (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)

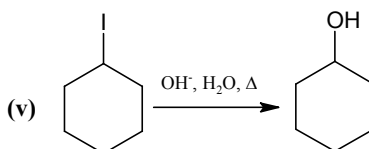
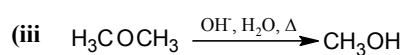
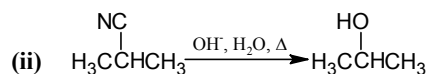
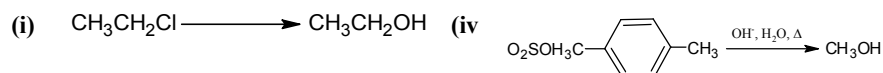


(II)

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

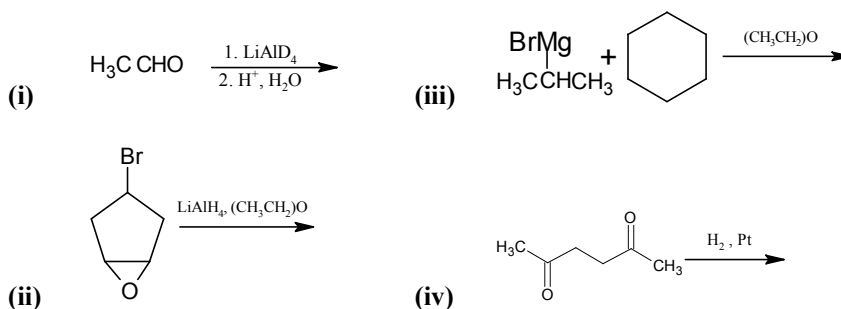
- A highly polarized covalent bond
- Sp-hybrid carbon atoms
- A nearly unpolarized covalent bond

- 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)

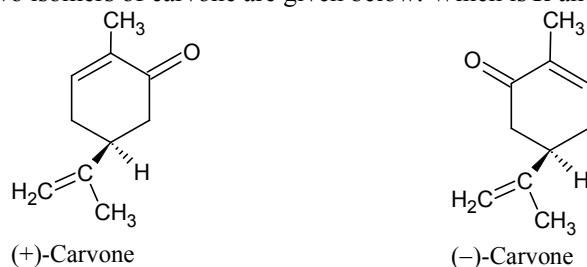


CHEMISTRY PAPER-II

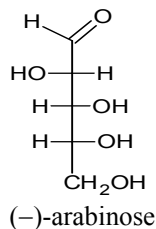
- (c) Write the major product(s) of each of the following reactions. It is implied that aqueous work-up has taken place in all those cases that require it to obtain the organic product. (8)



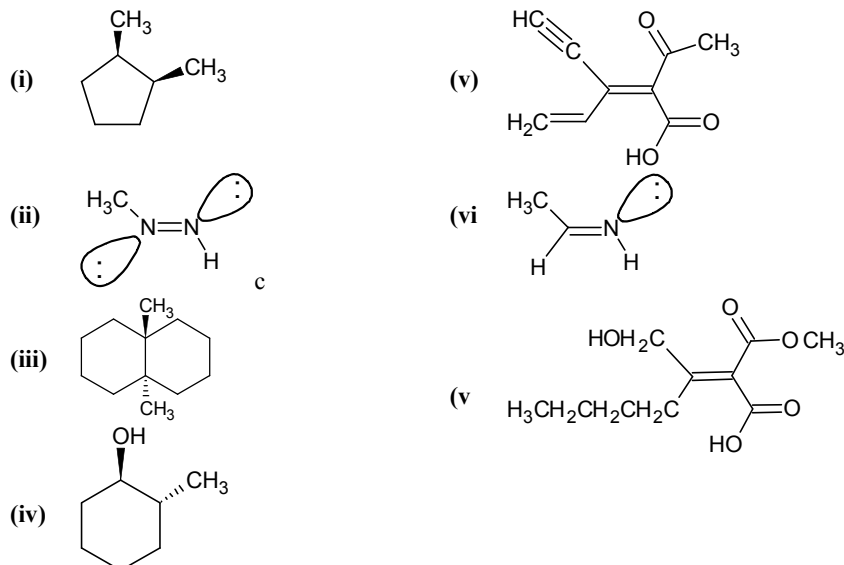
- Q. No. 6. (a) The two isomers of carvone are given below. Which is *R* and which is *S*? (2)



- (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)



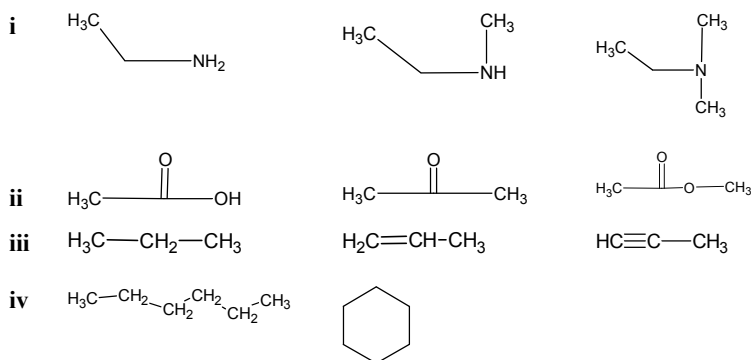
CHEMISTRY PAPER-II

- (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

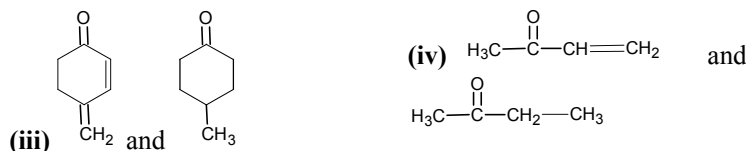
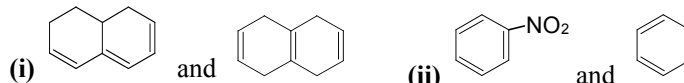
Q. No. 8. (a). Differentiate following using IR Spectroscopy? (4)



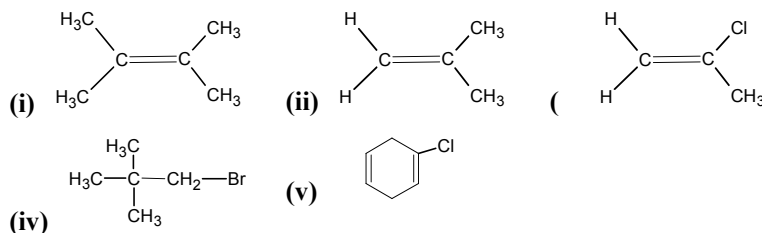
(b). What type of electronic transition are possible in the following compounds? (2)

- (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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(vii) **Use of Calculator is allowed.**

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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MAXIMUM MARKS = 20

PART-I(MCQS): MAXIMUM 30 MINUTES

PART-II

MAXIMUM MARKS = 80

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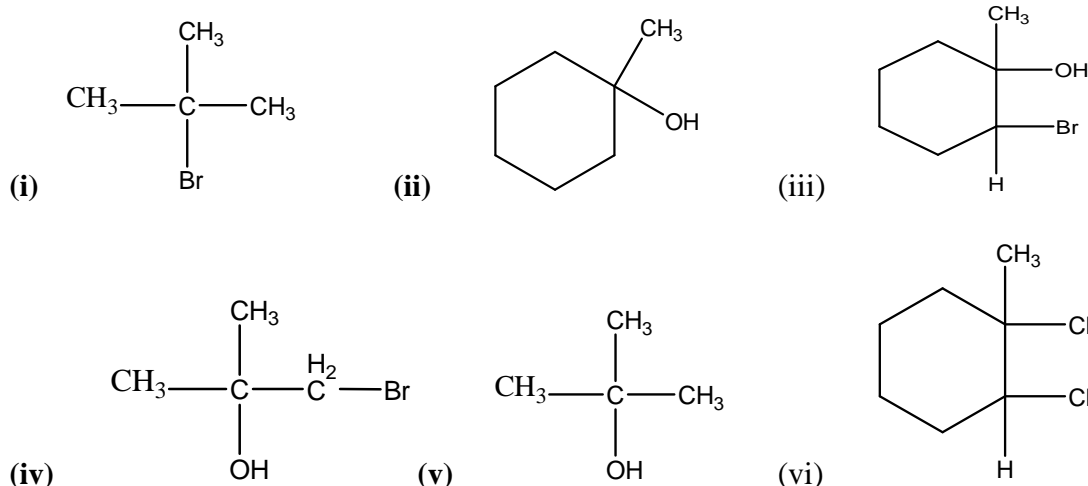
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PART-II

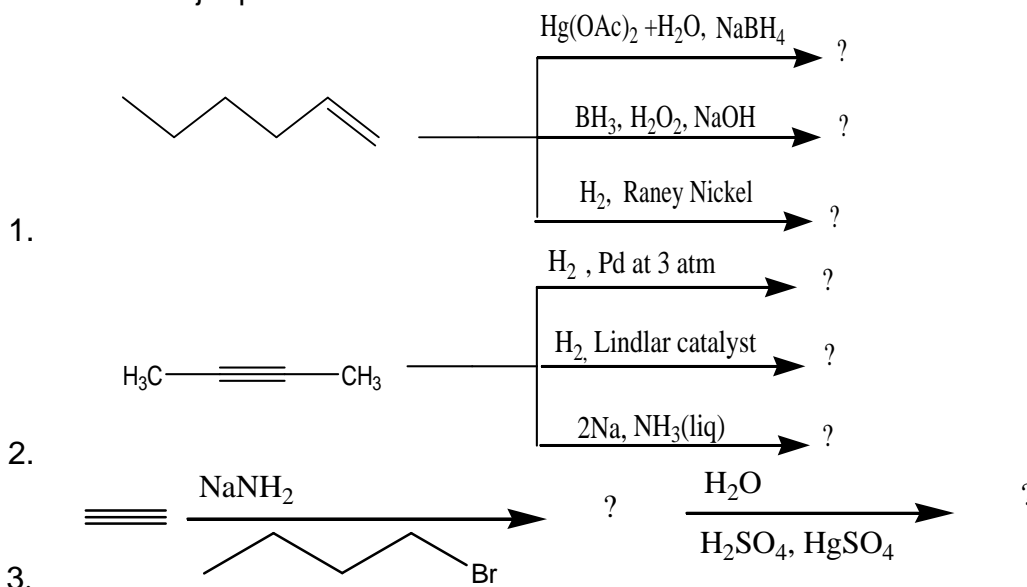
Q. No. 2. Write brief notes on the following (2 each) (20)

- (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)

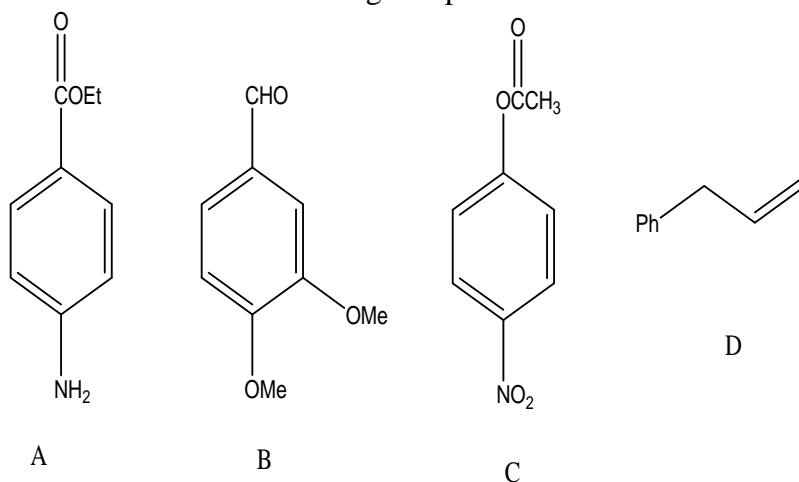


(b) Write the Major product for these Reactions. (8)



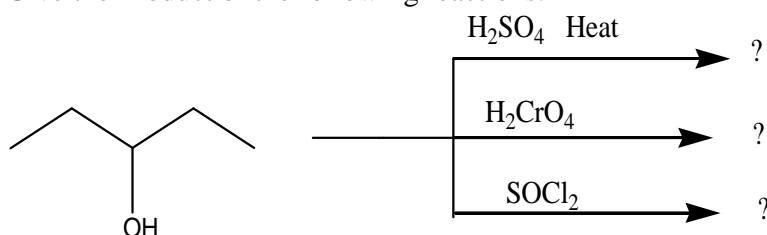
CHEMISTRY PAPER-II

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

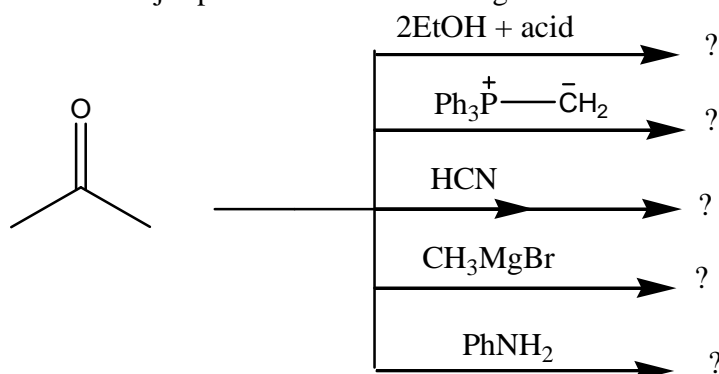


- (c) Write the reaction and mechanism of Friedel Craft alkylation and acylation reaction. (10)

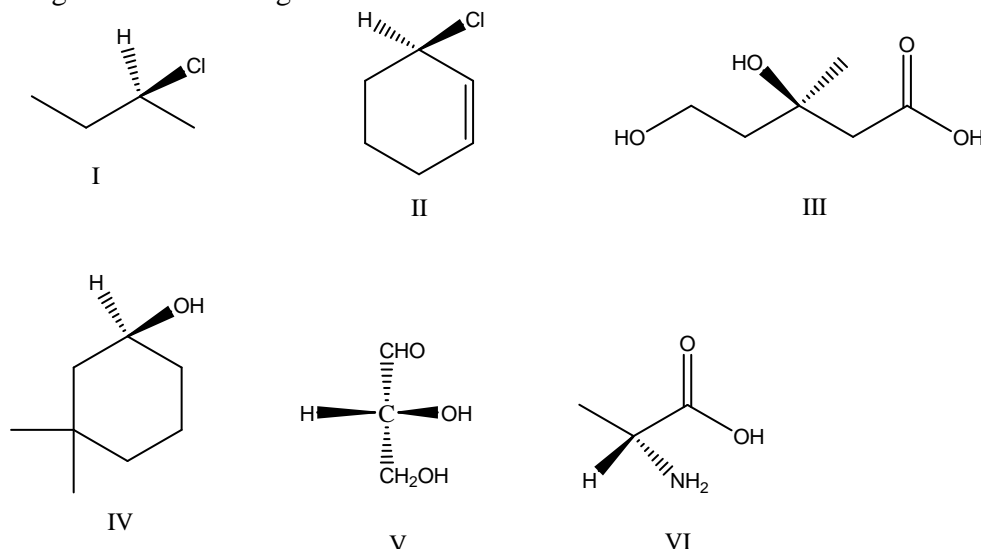
- Q. No. 5.** (a) What is Grignard reagent? What are its applications? How would you prepare Grignard reagent starting from an alkyl halide of your choice. (8)
 (b) Give the Product of the following reactions: (3)



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

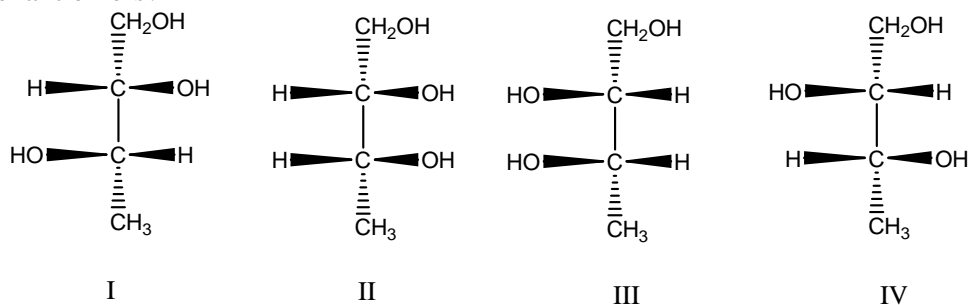


- Q. No. 6.** (a) What is stereoisomerism? Give an account of different types of stereoisomerism. (5)
 (b) Assign an R or S configuration to the chiral center in each molecule. (9)

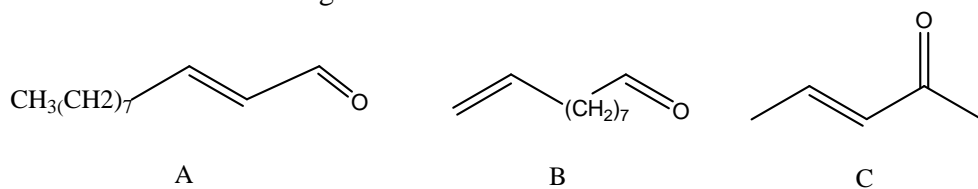


CHEMISTRY PAPER-II

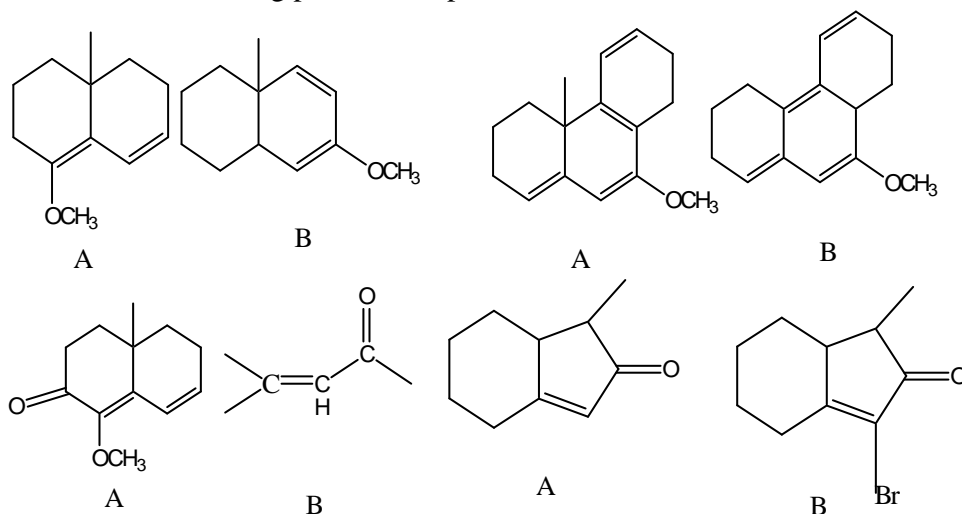
- (c) In the following molecules identify that which are diastereomers and which are enantiomers? (6)



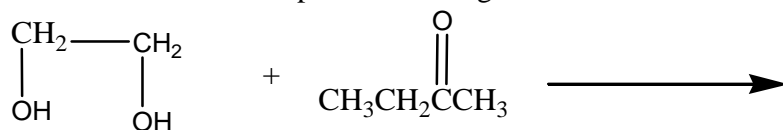
- Q. No. 7. (a) What is the difference between Dispersive IR Spectrometer and Fourier Transform (FT)-IR Spectrometer. (5)
 (b) Differentiate the following on the basis of IR. (3)



- (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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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) 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). 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 $\text{H}_2\text{O}(\ell)$ 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
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) Candidate must write Q. No. in the Answer Book in accordance with Q. No. in the Q.Paper.
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(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) $\text{CH}_3\text{-C}\equiv\text{CH}_3 + \text{Na} / \text{lig NH}_3 \longrightarrow$
(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 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) 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)**



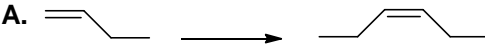
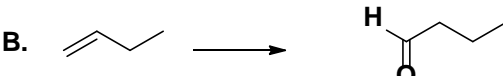
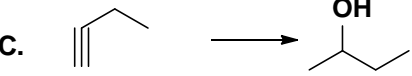
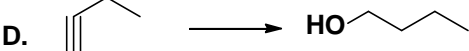
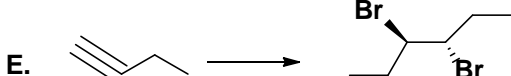
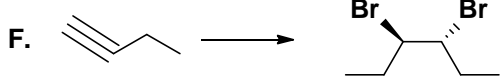
FEDERAL PUBLIC SERVICE COMMISSION
COMPETITIVE EXAMINATION-2019
FOR RECRUITMENT TO POSTS IN BS-17
UNDER THE FEDERAL GOVERNMENT

Roll Number

CHEMISTRY, PAPER-II

TIME ALLOWED: THREE HOURS PART-I(MCQS): MAXIMUM 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. 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. 
- B. 
- C. 
- D. 
- E. 
- F. 
- (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) S_N1 reaction between bromoethane and NaOH.
(ii) S_N2 reaction between 2-chloro-2-methyl propane and NaCN.
(b) Discuss the various factors, nature of substrate, solvent, catalyst, and the leaving group in S_N2 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
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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
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UNDER THE FEDERAL GOVERNMENT

Roll Number

CHEMISTRY, PAPER-II

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) 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-2022
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) 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) **(20)**
- (c) Write a short note on thin layer chromatography.



FEDERAL PUBLIC SERVICE COMMISSION
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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.
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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)**



FEDERAL PUBLIC SERVICE COMMISSION
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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)** 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



FEDERAL PUBLIC SERVICE COMMISSION
COMPETITIVE EXAMINATION-2023
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.
(vii) **Use of calculator is allowed.**

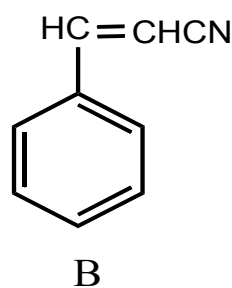
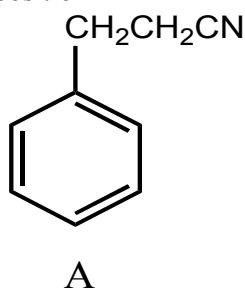
PART-II

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

- 1-hexene
- cis-3-hexene
- trans-3-hexene
- 2-methyl-2-pentene
- 2,3-dimethyl-2-butene

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

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

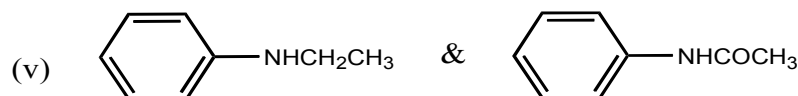
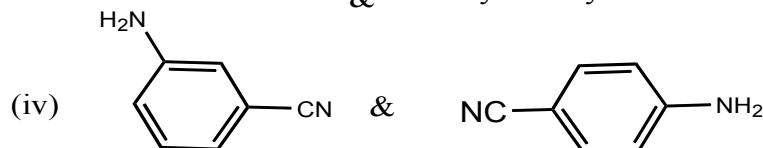


(c) Compare the basicity of: **(5)**

(i) $(\text{CH}_3)_3\text{N}$ & $(\text{CCl}_3)_3\text{N}$

(ii) $\text{C}_6\text{H}_5\text{CH}_2\text{NH}_2$ & $\text{CH}_3\text{C}_6\text{H}_4\text{NH}_2$

(iii) Aniline & Cyclohexyl amine



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

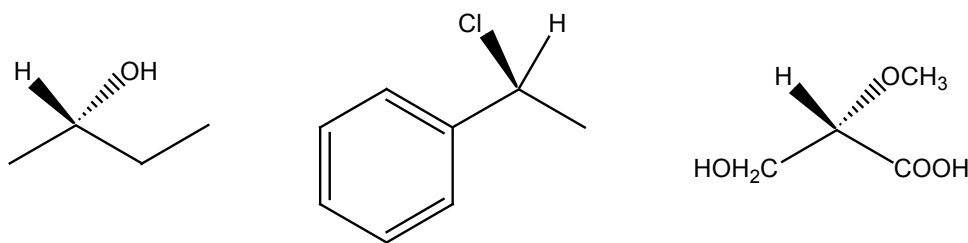
- Tertiary carbocation is more stable than primary.
- Ethanol has higher boiling point than diethyl ether.

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

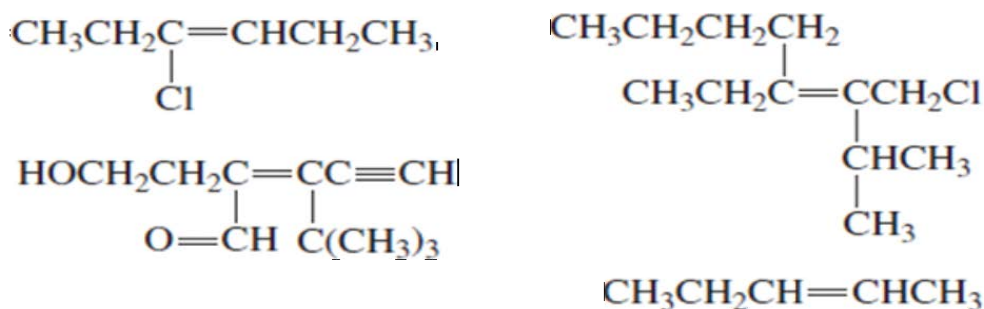
- trans*-1-Fluoro-3-methylcyclohexane,
- cis*-1-Iodo-4-methylcyclohexane
- cis*-1-*tert*-Butyl-4-methylcyclohexane,
- cis*-1,3,5-Trimethylcyclohexane

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.

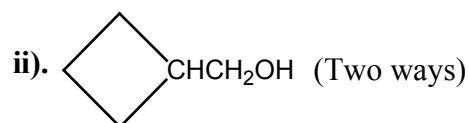
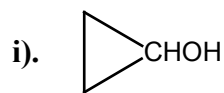
- Q. 5. (a) Write down the reagents, conditions and mechanisms of the following reactions. (10 each) (20)
- Kolbe reaction.
 - Williamson synthesis
 - Dow Process
 - Reimer-Tiemann reaction
 - Bromination of phenol
- (b) Outline all steps involved in the synthesis of the following compounds from benzene 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)

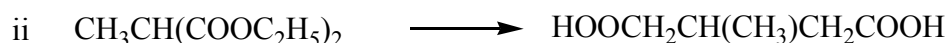
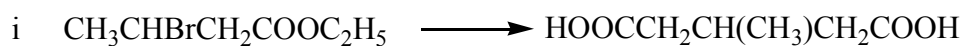
CHEMISTRY, PAPER-II

- (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

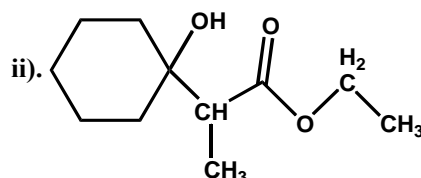
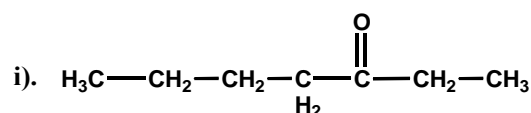
- Q. 7. (a) How can you prepare each of the following substances by a reaction involving Grignard reagent? (5)



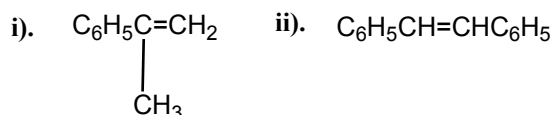
- (b) How will you bring about the following conversions? (5)



- (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