

FEDERAL PUBLIC SERVICE COMMISSION
COMPETITIVE EXAMINATION-2024 FOR RECRUITMENT
TO POSTS IN BS-17 UNDER THE FEDERAL GOVERNMENT

Roll Number

CHEMISTRY, PAPER-II

TIME ALLOWED: THREE HOURS

PART-I (MCQs) : MAXIMUM 10 MINUTES

(PART-I MCQs) MAXIMUM MARKS: 20

(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.

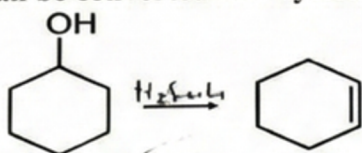
(ii) Overwriting/cutting of the options/answers will not be given credit.

(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.

1. Cyclohexanol can be converted into cyclohexene by heating with:

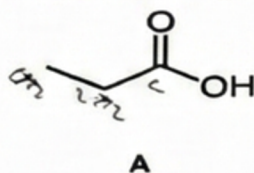


(A) Zn(Hg)/HCl

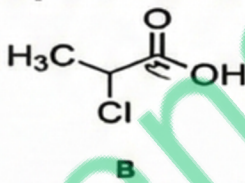
(B) Concentrated H₂SO₄(C) SOCl₂

(D) None of these

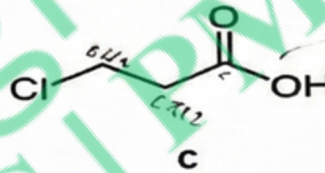
2. Identify the optically active compound from the following:



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 (B) Substitution reactions (C) Elimination 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:

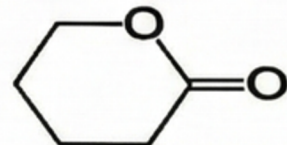
(A) HBr (B) HNO₃ (C) KMnO₄ (D) None of these

7. The order of stability of carbanions is:

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

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

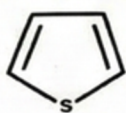
(A) Ether (B) Ester (C) Carboxylic (D) None of these



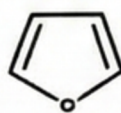
9. Homolytic fission of C-C bond leads to formation of:

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

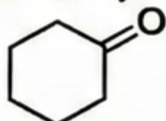
10. Which of the following is not heterocyclic compound?



A



B



C

(A) Compound A

(B) Compound B

(C) Compound C

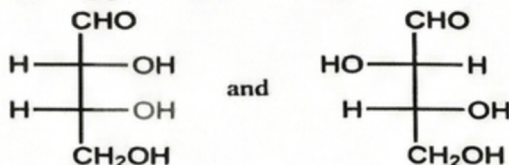
(D) None of these

11. The most stable conformation of cyclohexane is the:

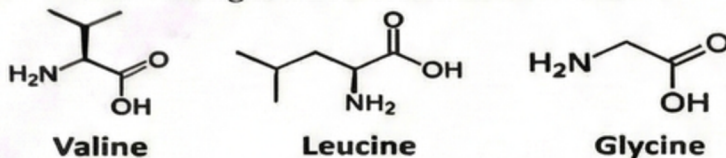
(A) Haworth form (B) Boat form (C) Newman form (D) Chair form

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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 (B) 3,4-Dimethylpentane (C) 2-Ethyl-2-methylpentane (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?

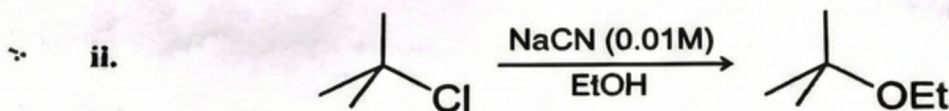
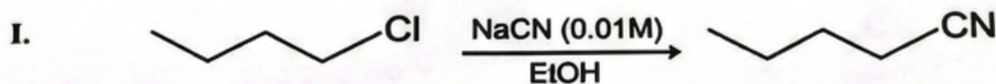


- (A) Valine (B) Leucine (C) Glycine (D) None of these
17. In gluconeogenesis, what is the primary source of carbon for the synthesis of glucose?
 (A) Pyruvate (B) Acetyl-CoA (C) Glycerol (D) None of these
18. Which of the following is an example of a saturated fatty acid?
 (A) Oleic acid (B) Linoleic 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

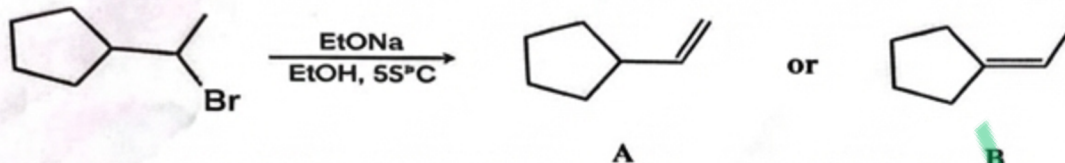
- NOTE: (i) Part-II is to be attempted on the separate Answer Book.
 (ii) Attempt ONLY FOUR questions from PART-II. ALL questions carry EQUAL marks.
 (iii) All the parts (if any) of each Question must be attempted at one place instead of at different places.
 (iv) Write Q. No. in the Answer Book in accordance 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.
 (a) Provide an explanation for this behavior.
 (b) Show how your answer accounts for the following: (6)



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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)
- Reduction of propyl bromide
 - Synthesis of acetone from propene
 - Synthesis of cyclohexane from phenol
 - Oxidation of ethylene in hot and cold KMnO_4

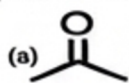
- (c) A compound with molecular formula $\text{C}_4\text{H}_8\text{O}$ has a strong IR absorption at 1730 cm^{-1} . Its mass spectrum is tabulated below, and includes key peaks at m/z 44 (the base peak) and m/z 29. Propose a structure for the compound and write fragmentation equations showing how peaks 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	$M^{++} + 1$ 4.5
29	54.0	74	$M^{++} + 2$ 0.3
39	23.0		
41	60.0		
42	12.0		Recalculated to base on M^{++}
43	79.0		
44	100.0 (base)		
72	73.0 M^{++}		
73	3.3		
74	0.2		

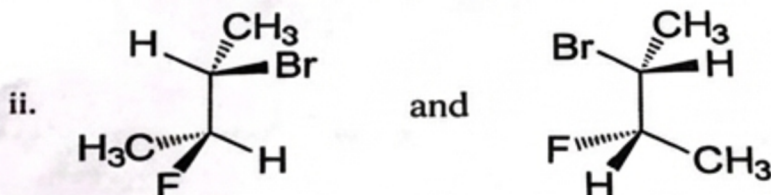
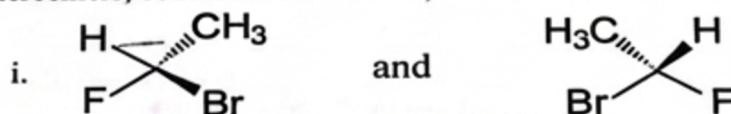
- Q.4. (a) Answer the following: (2 marks each) (10)

- 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.
- 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.
- Identify the nucleophilic center of each molecule.



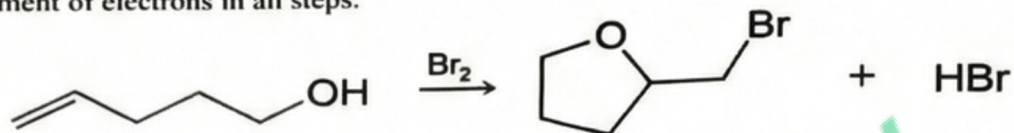
- Write the structures of two chair conformations of 1-tert-butyl-1-methylcyclohexane. Which conformation is more stable? Explain your answer.
- Why alkenes are more reactive than alkanes in chemical reactions.

- (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.

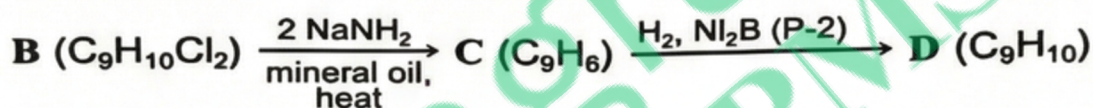
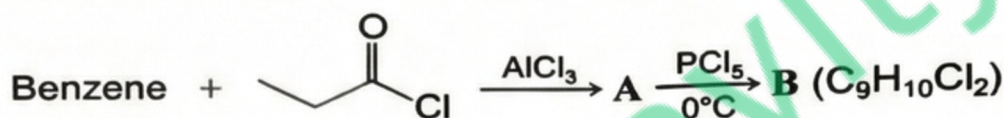


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- (e) Write a mechanism for the following reaction. Include formal charges and curved arrows to show the movement of electrons in all steps.

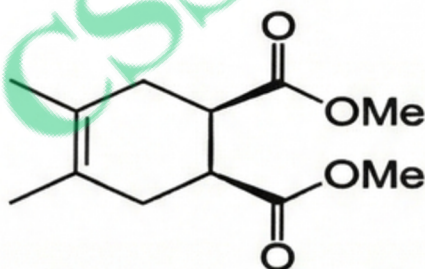


- Q.5. (a) Give structures (including stereochemistry where appropriate) for compounds A–D. (5)

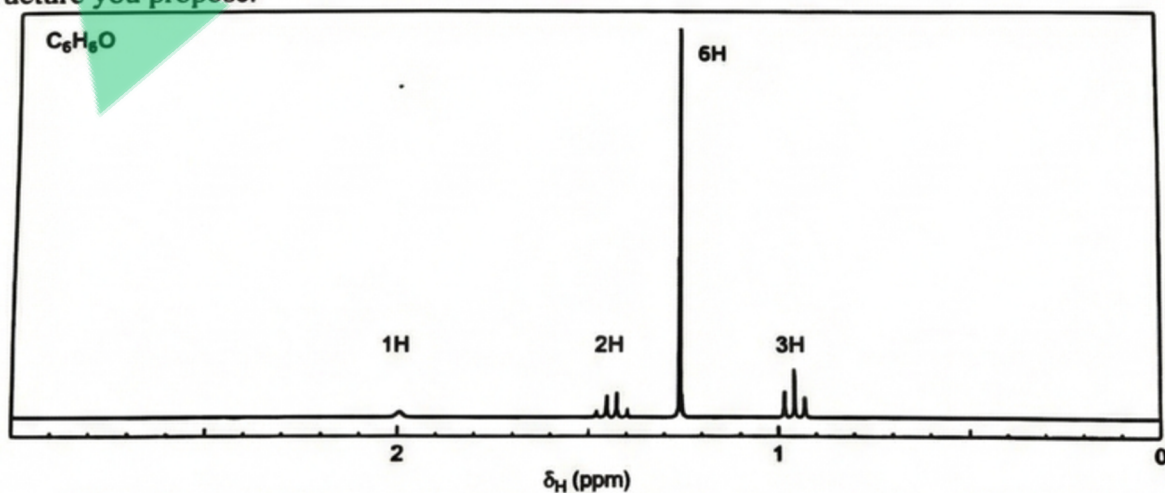


[Hint: The ^1H NMR spectrum of compound C consists of a multiplet at δ 7.20 (5H) and a singlet at δ 2.0 (5H).]

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



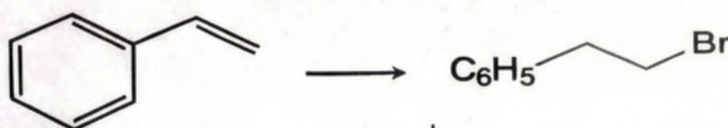
- (c) Propose a structure for an alcohol with molecular formula $\text{C}_3\text{H}_{13}\text{O}$ that has the ^1H NMR spectrum given in Figure below. Assign the chemical shifts and splitting patterns to specific aspects of the structure you propose. (5)



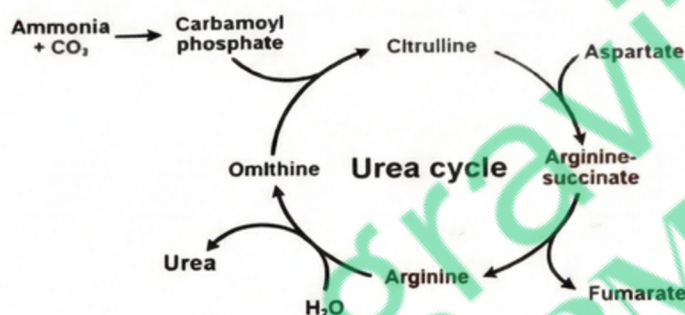
- (d) What are the common by-products generated during sugar manufacturing process. Discuss the applicability of each by-product in perspective of Pakistan. (5)

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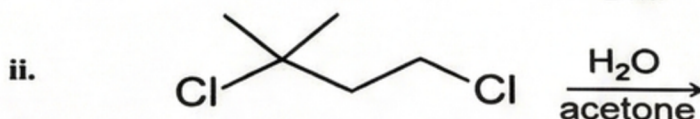
- (a) Starting with styrene, outline a synthesis of 1-bromo-2-phenylethane. (5)



- (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)



- (e) Illustrate the mechanism for dehydrating an alcohol to produce an alkene, using ethanol as a specific example. (5)
- (a) 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)
