Exercise

(A) Choose the correct alternative for each of the following and rewrite the sentence :

1. The systematic method of retrosynthesis was developed by …….
   (a) Prof. Elias J. Corey (b) Woodward
   (c) Fisher (d) Woodward and Fisher
2. Retrosynthetic is also called as …….
   (a) Antithetic analysis (b) Amphothetic analysis
   (c) Qualitative analysis (d) all of these
3. The construction of a synthetic tree by working backward from the target molecule is called as …….
   (a) Antithetic analysis (b) Retrosynthetic analysis
   (c) Disconnection approach (d) all of these
4. …… is a hypothetical unit within a target molecule.
   (a) Synthetic equivalent (b) Synthon
   (c) Reagent (d) SM
5. …… is a d^2 synthon.
   (a) ^{-}CN (b) $^{-}CH_2CN$
   (c) ^{-}CHO (d) $^{+}NO_2$
6. …… is acceptor synthon.
   (a) ^{-}CN (b) $^{-}CH_2CN$
   (c) ^{-}CHO (d) $^{+}NO_2$

Answers : 1. (a), 2. (a), 3. (d), 4. (b), 5. (b), 6. (d)

(B) Answer in one sentence (One mark for each question) :

1. Target molecule (TM)
2. Disconnection
3. Synthon
4. Synthetic equivalence
5. Functional Group Interconversion (FGI)
6. One group disconnection
7. Retrosynthesis

(C) Short Answer Type Questions : Give retrosysnthesis of following molecules :

1. Cinnamaldehyde
2. Cyclohexene
3. Para methoxy acetophenone
4. Methyl-3-phenyl propionate,
5. α,α-dimethyl benzyl alcohol
6. Paracetamol.

(D) Long Answer Type Questions :

1. Explain the terms involved in retrosynthesis with examples.
2. Define various terms involved in disconnection approach and give retrosynthesis of following molecules :
   (a) Cyclohexene, (b) Cinnamaldehyde.

1. Retrosynthesis is defined as:

A) Analysis of chemical structure only
B) The design of synthetic pathways by working backward from the target molecule
C) Synthesis of molecules using available reagents
D) A purification technique in organic chemistry

Answer: B

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2. The main purpose of retrosynthetic analysis is to:

A) Purify the target compound
B) Determine the IR spectrum
C) Break down a complex molecule into simpler precursor structures
D) Predict NMR signals

Answer: C

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3. In retrosynthetic terminology, the starting material is called:

A) Target molecule
B) Synthon
C) Precursor
D) Intermediate

Answer: C

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4. Which of the following statements is TRUE about a synthon?

A) It is always a real compound.
B) It is an idealized fragment used for retrosynthetic planning.
C) It is an intermediate formed during the synthesis.
D) It is the final product.

Answer: B

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5. A disconnection in retrosynthesis refers to:

A) Bond formation
B) Breaking a bond to simplify the structure
C) Elimination reaction
D) Oxidation of a compound

Answer: B

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6. The arrow used in retrosynthesis is:

A) →
B) ⇌
C) ⇒
D) ⟶

Answer: C

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7. The first step in retrosynthetic analysis is generally:

A) Deciding the reagents
B) Choosing the reaction conditions
C) Identifying strategic bonds to disconnect
D) Drawing the NMR spectrum

Answer: C

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8. Which of the following is a common strategy in retrosynthesis?

A) Functional group interconversion (FGI)
B) UV analysis
C) Diels-Alder reaction only
D) Crystallization

Answer: A

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9. What is meant by 'synthetic equivalent' in retrosynthesis?

A) The target molecule
B) The real reagent corresponding to a synthon
C) The solvent used
D) The base catalyst

Answer: B

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10. Which of the following reactions is most commonly used in C-C bond-forming steps during synthesis?

A) Friedel-Crafts reaction
B) Grignard reaction
C) Cannizzaro reaction
D) Baeyer-Villiger oxidation

Answer: B

Retrosynthesis is mainly used for:
A) Structure elucidation
B) Spectral analysis
C) Synthesis planning
D) Reaction mechanism

Answer: C

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2. The term retrosynthesis was popularized by:
A) R. B. Woodward
B) E. J. Corey
C) Grignard
D) Claisen

Answer: B

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3. The arrow used for retrosynthetic disconnection is:
A) →
B) ⇌
C) ⇒
D) ↔

Answer: C

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4. The key objective of retrosynthetic analysis is to:
A) Break all bonds
B) Identify suitable disconnections
C) Change functional groups
D) Purify a compound

Answer: B

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5. The term "target molecule" refers to:
A) A reactant
B) The molecule to be synthesized

C) A reagent
D) A catalyst

Answer: B

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6. Synthon is:
A) Real chemical reagent
B) A spectroscopic tool
C) Idealized fragment generated during retrosynthesis
D) An intermediate

Answer: C

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7. Synthetic equivalent means:
A) Actual reagent corresponding to synthon
B) A spectroscopic parameter
C) Final product
D) None

Answer: A

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8. The major goal of retrosynthetic disconnection is:
A) To identify the longest carbon chain
B) To predict the melting point
C) To reduce a complex molecule into simple starting materials
D) To get UV spectrum

Answer: C

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9. Which is the correct retrosynthetic step for alcohol synthesis?
A) Ketone + Grignard reagent
B) Acid + Amine
C) Alkene + H2
D) Aldehyde + Acid

Answer: A

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10. Which bond is broken in a retrosynthetic step?
A) π-bond
B) σ-bond

C) Any bond that simplifies the structure
D) Hydrogen bond

Answer: C

Section B: Synthon & Disconnection

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11. In retrosynthesis, synthon is:
A) A stable compound
B) A theoretical fragment
C) An actual reagent
D) A catalyst

Answer: B

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12. A nucleophilic synthon carries:
A) Positive charge
B) Negative charge
C) No charge
D) Radical character

Answer: B

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13. Functional Group Interconversion (FGI) is used to:
A) Create aromaticity
B) Change functional group into another
C) Improve melting point
D) Perform chromatography

Answer: B

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14. Common synthon for carbonyl group is:
A) Electrophilic carbon
B) Nucleophilic oxygen
C) Neutral carbon
D) Radical oxygen

Answer: A

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15. For aldehyde synthesis, retrosynthesis often involves:
A) Alcohol oxidation
B) Alcohol reduction
C) Nitration
D) Halogenation

Answer: A

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16. The key to successful retrosynthesis is:
A) Purification
B) Strategic bond disconnection
C) Color change
D) Acid-base titration

Answer: B

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17. Disconnection refers to:
A) Breaking strategic bonds
B) Making new bonds
C) Separation of layers
D) Solvent evaporation

Answer: A

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18. Chemoselectivity in retrosynthesis refers to:
A) Preferential formation of one enantiomer
B) Selective transformation of a particular functional group
C) Electrophile selection
D) Nucleophile selection

Answer: B

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19. Retrosynthesis is a:
A) Forward approach
B) Backward approach
C) Neutral approach
D) Random approach

Answer: B

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20. The key idea behind retrosynthesis is to:
A) Disconnect the most polar bond
B) Remove the most strained bond
C) Disconnect bonds to generate easily available precursors
D) Avoid functional groups

Answer: C

Section C: Reaction-Based Retrosynthesis

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21. Williamson synthesis is associated with:
A) Ether formation
B) Ester formation
C) Amide formation
D) Alkene formation

Answer: A

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22. Aldol condensation is useful in:
A) Alcohol synthesis
B) Carbon-carbon bond formation
C) Nitro compound synthesis
D) Oxidation

Answer: B

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23. Friedel–Crafts reaction is widely used in retrosynthesis of:
A) Alkanes
B) Alcohols
C) Aromatic ketones
D) Amides

Answer: C

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24. Wittig reaction is used for:
A) Alcohol formation
B) Ketone formation
C) Alkene formation
D) Amine formation

Answer: C

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25. Paal-Knorr synthesis is useful for preparing:
A) Aldehydes
B) Alcohols
C) 5-membered heterocycles
D) Carboxylic acids

Answer: C

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26. Grignard reagent is a:
A) Nucleophilic oxygen synthon
B) Nucleophilic carbon synthon
C) Electrophilic carbon synthon
D) Free radical synthon

Answer: B

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27. One of the simplest disconnections in ester synthesis is:
A) Acid + Alcohol
B) Aldehyde + Alcohol
C) Alkene + Water
D) Acid + Ether

Answer: A

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28. Reduction of ketone gives:
A) Alkene
B) Ester
C) Alcohol
D) Acid

Answer: C

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29. Diels-Alder reaction is commonly used for:
A) Linear molecule synthesis
B) Aromatic compound formation
C) 6-membered ring synthesis
D) Nitro compound synthesis

Answer: C

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30. Which of the following is most often used for C–N bond formation?
A) Wittig reaction
B) Mannich reaction
C) Aldol reaction
D) Cannizzaro reaction

Answer: B

Section D: Advanced Concepts

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31. A 1,3-dicarbonyl compound is often used in retrosynthesis for:
A) Alkane synthesis
B) Alkene synthesis
C) Heterocycle synthesis
D) Halide synthesis

Answer: C

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32. Protecting groups are used in retrosynthesis to:
A) Block functional groups temporarily
B) Increase molecular weight
C) Change hybridization
D) Perform FGI

Answer: A

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33. A 2-carbon electrophilic synthon is generally derived from:
A) Ethylene oxide
B) Acetyl chloride
C) Ethanol
D) Acetone

Answer: B

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34. For ether synthesis, retrosynthesis suggests:
A) Alcohol + Alcohol

B) Alcohol + Alkyl halide
C) Acid + Alcohol
D) Ketone + Alcohol

Answer: B

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35. A common disconnection of β-lactams involves:
A) Amide bond
B) Ester bond
C) Nitrile bond
D) Alkene bond

Answer: A

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36. In retrosynthesis, "retron" means:
A) Reactant
B) Functional group responsible for a reaction
C) Reaction byproduct
D) Purified product

Answer: B

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37. FGI is essential when:
A) Target molecule lacks reactive functional groups
B) Starting materials are expensive
C) Spectroscopy is difficult
D) Product is colored

Answer: A

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38. Retrosynthetic disconnection of an amide often gives:
A) Acid + Alcohol
B) Acid chloride + Amine
C) Ester + Amine
D) Nitrile + Alcohol

Answer: B

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39. The synthetic equivalent of nucleophilic carbon synthon is:
A) Grignard reagent

B) Aldehyde
C) Carboxylic acid
D) Nitro compound

Answer: A

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40. When an alkene is needed from carbonyl compound, which reaction is suggested in retrosynthesis?
A) Friedel–Crafts reaction
B) Wittig reaction
C) Aldol condensation
D) Cannizzaro reaction

Answer: B

Section E: Mixed Questions

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41. A common synthon for carboxylic acid is:
A) Carbocation
B) Nucleophilic hydroxide
C) Acyl anion equivalent
D) Nucleophilic nitrogen

Answer: C

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42. Which reaction involves diene and dienophile?
A) Mannich reaction
B) Wittig reaction
C) Diels-Alder reaction
D) Claisen condensation

Answer: C

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43. The ultimate goal of retrosynthesis is to identify:
A) Analytical method
B) Synthesis cost
C) Pathways to synthesize target molecule
D) Color of compound

Answer: C

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44. A key advantage of retrosynthesis is:
A) Predicting melting point
B) Simplifying synthesis to available precursors
C) Avoiding all side reactions
D) Increasing reaction rate

Answer: B

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45. In retrosynthesis, heterocycles are often formed by:
A) Perkin reaction
B) Paal-Knorr synthesis
C) Wittig reaction
D) Cannizzaro reaction

Answer: B

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46. Protecting groups should be:
A) Easily removable
B) Non-removable
C) Stable forever
D) Non-selective

Answer: A

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47. Aromatic ketones are often synthesized by:
A) Grignard reaction
B) Friedel–Crafts acylation
C) Perkin reaction
D) Wittig reaction

Answer: B

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48. For the synthesis of quinoline derivatives, retrosynthesis often involves:
A) Skraup synthesis
B) Paal-Knorr synthesis
C) Mannich reaction
D) Wittig reaction

Answer: A

49. A typical C=O disconnection gives:
A) Two acids
B) Nucleophile and electrophile synthons
C) Two alcohols
D) Carbanion only

Answer: B

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50. The overall advantage of retrosynthesis is to:
A) Find unknown compounds
B) Generate spectral data
C) Plan an efficient, economical synthesis
D) Avoid organic synthesis

Answer: C