

## Topic: Inversion, Retention, Racemization

### Section: Multiple Choice Questions

1. Which of the following terms describes the complete change in the spatial arrangement of bonds around a chiral center during a chemical reaction?

(a) Racemization

(b) Inversion

(c) Retention

(d) Epimerization

2. A reaction is said to involve 'retention of configuration' if:

(a) The product formed is an enantiomer of the reactant.

(b) The spatial arrangement of groups around the chiral center in the product is the same as in the reactant.

(c) A mixture of enantiomers is formed in equal proportions.

(d) The reactant is converted into a non-chiral product.

3. The formation of an equimolar mixture of two enantiomers from an optically active compound is known as:

(a) Inversion

(b) Retention

(c) Racemization

(d) Diastereomerization

4. Which type of nucleophilic substitution reaction typically proceeds with inversion of configuration at the chiral center?

(a) SN1 reaction

(b) SN2 reaction

(c) Both SN1 and SN2 reactions

(d) Neither SN1 nor SN2 reactions

5. A reaction involving the formation of a carbocation intermediate at a chiral carbon typically leads to which stereochemical outcome?

(a) Complete inversion

(b) Complete retention

(c) Racemization

(d) Formation of a single enantiomer

6. When (S)-2-chlorobutane reacts with a strong nucleophile like OH<sup>-</sup> in the presence of a polar aprotic solvent, the major product will predominantly have which configuration?

(a) (S) configuration

(b) (R) configuration

(c) A racemic mixture of (S) and (R) configurations

(d) An achiral product

7. (R)-3-bromo-3-methylhexane undergoes solvolysis in ethanol. What will be the stereochemical nature of the major product, 3-ethoxy-3-methylhexane?

(a) Pure (R) enantiomer

(b) Pure (S) enantiomer

(c) A racemic mixture

(d) An optically active mixture with excess (R) enantiomer

8. Which statement is correct regarding Walden inversion?

(a) It exclusively occurs in SN1 reactions.

(b) It involves the breaking and formation of bonds simultaneously in a concerted manner.

(c) It results in a racemic mixture.

(d) It refers to the preservation of configuration.

9. A nucleophilic substitution reaction of a chiral alkyl halide produces a product with the same configuration as the reactant. This implies the reaction proceeded with:

- (a) Complete inversion
- (b) Racemization
- (c) Retention of configuration
- (d) Formation of an achiral intermediate

10. For a nucleophilic substitution reaction to show observable inversion, retention, or racemization, the reactant must possess:

- (a) A tertiary carbon atom
- (b) A chiral carbon atom
- (c) A double bond
- (d) An aromatic ring

11. Which of the following conditions would generally favor racemization over inversion in a nucleophilic substitution reaction?

- (a) Primary alkyl halide
- (b) Strong nucleophile
- (c) Polar protic solvent
- (d) Polar aprotic solvent

12. A racemic mixture is characterized by:

- (a) Having a zero specific rotation.
- (b) Being optically active.
- (c) Containing only one enantiomer.
- (d) Being composed of diastereomers.

13. Consider the reaction: (R)-1-bromo-1-phenylethane + H<sub>2</sub>O → 1-phenylethanol. What is the most likely stereochemical outcome for the 1-phenylethanol product?

- (a) Predominantly (R)-1-phenylethanol
- (b) Predominantly (S)-1-phenylethanol
- (c) A racemic mixture of (R) and (S)-1-phenylethanol
- (d) An achiral product

14. If a chiral reactant undergoes a reaction where the new chiral center is formed, and the reaction proceeds via a planar intermediate (e.g., carbocation), what will be the stereochemical outcome if no chiral auxiliary is used?

- (a) Complete retention
- (b) Complete inversion
- (c) A racemic mixture
- (d) Formation of only one enantiomer

15. The stereochemical outcome of an SN2 reaction is solely dependent on:

- (a) The stability of the carbocation intermediate.
- (b) The strength of the leaving group.
- (c) The attack of the nucleophile from the backside of the leaving group.
- (d) The polarity of the solvent.

#### Answers

- 1. (b)
- 2. (b)
- 3. (c)
- 4. (b)
- 5. (c)
- 6. (b)

7. (c)

8. (b)

9. (c)

10. (b)

11. (c)

12. (a)

13. (c)

14. (c)

15. (c)

## Topic: Nucleophilic Substitution Mechanisms (SN1 and SN2)

16. The rate of an SN1 reaction depends on the concentration of:

- (a) only the substrate
- (b) only the nucleophile
- (c) both the substrate and the nucleophile
- (d) neither the substrate nor the nucleophile

17. Which of the following alkyl halides is most reactive towards SN2 reaction?

- (a)  $(\text{CH}_3)_3\text{C-Br}$
- (b)  $\text{CH}_3\text{CH}_2\text{-Br}$
- (c)  $(\text{CH}_3)_2\text{CH-Br}$
- (d)  $\text{CH}_3\text{-Br}$

18. Which of the following carbocations is most stable and thus favors an SN1 reaction?

- (a) Primary carbocation
- (b) Secondary carbocation
- (c) Tertiary carbocation
- (d) Methyl carbocation

19. An SN2 reaction proceeds with:

- (a) Racemization
- (b) Retention of configuration
- (c) Inversion of configuration
- (d) Partial racemization

20. The SN1 reaction of an optically active alkyl halide typically results in:

- (a) Inversion of configuration
- (b) Retention of configuration
- (c) Complete racemization
- (d) Partial racemization or complete racemization depending on conditions

21. Which of the following is the best leaving group in a nucleophilic substitution reaction?

- (a) -OH
- (b) -Cl
- (c) -F
- (d) -I

22. Which type of solvent is generally preferred for SN1 reactions?

- (a) Polar aprotic
- (b) Non-polar
- (c) Polar protic
- (d) Aprotic non-polar

23. Which type of solvent is generally preferred for SN2 reactions?

- (a) Polar protic
- (b) Non-polar
- (c) Polar aprotic
- (d) Highly acidic

24. Consider the reaction:  $(\text{CH}_3)_3\text{C-Br} + \text{CH}_3\text{OH} \rightarrow (\text{CH}_3)_3\text{C-OCH}_3 + \text{HBr}$ . This reaction is likely to proceed via:

- (a) SN1 mechanism
- (b) SN2 mechanism

(c) E1 mechanism

(d) E2 mechanism

25. Carbocation rearrangements are most likely to occur during which type of nucleophilic substitution reaction?

(a) SN1 reactions

(b) SN2 reactions

(c) Both SN1 and SN2 reactions

(d) Neither SN1 nor SN2 reactions

26. Which of the following is considered a strong nucleophile, favoring SN2 reactions?

(a) H<sub>2</sub>O

(b) CH<sub>3</sub>OH

(c) I<sup>-</sup>

(d) CH<sub>3</sub>COOH

27. The energy profile diagram for an SN1 reaction typically shows:

(a) A single transition state

(b) One intermediate and one transition state

(c) One intermediate and two transition states

(d) No intermediates or transition states

28. The energy profile diagram for an SN2 reaction typically shows:

(a) A single transition state

(b) One intermediate and two transition states

(c) Two intermediates

(d) No transition states



29. The stability of a carbocation is primarily enhanced by:

- (a) Electron-withdrawing inductive effect
- (b) Electron-donating inductive effect and hyperconjugation
- (c) Resonance effect in all cases
- (d) Steric hindrance

30. Which of the following statements is NOT a characteristic of an SN1 reaction?

- (a) It involves a carbocation intermediate.
- (b) Its rate depends only on the concentration of the substrate.
- (c) It is favored by polar aprotic solvents.
- (d) It can lead to racemization if the carbon is chiral.

#### Answers

16. (a)

17. (d)

18. (c)

19. (c)

20. (d)

21. (d)

22. (c)

23. (c)

24. (a)

25. (a)

26. (c)

27. (c)

28. (a)

29. (b)

30. (c)

## Topic: Elimination Mechanisms (E1 and E2)

### Section: Multiple Choice Questions

31. Which of the following statements is true regarding the E2 elimination mechanism?

- (a) It is a two-step process involving a carbocation intermediate.
- (b) The rate of reaction depends only on the concentration of the substrate.
- (c) It requires an anti-periplanar geometry of the leaving group and the beta-hydrogen.
- (d) It typically gives Hofmann product as the major product.

32. The rate-determining step in an E1 elimination reaction involves:

- (a) Abstraction of a beta-hydrogen by a strong base.
- (b) Formation of a carbocation by the departure of the leaving group.
- (c) Attack of a nucleophile on the carbon bearing the leaving group.
- (d) Formation of a transition state where all bonds are simultaneously broken and formed.

33. For the reaction of 2-bromopropane with a strong base like sodium ethoxide in ethanol, what is the order of the elimination reaction?

- (a) First order
- (b) Second order
- (c) Zero order
- (d) Depends on the concentration of 2-bromopropane only

34. What is the most stable carbocation intermediate that can be formed during an E1 reaction?

- (a) Primary carbocation
- (b) Secondary carbocation
- (c) Tertiary carbocation
- (d) Methyl carbocation

35. Which of the following factors does NOT favor an E1 reaction?

- (a) Weak nucleophile/base
- (b) Protic solvent
- (c) Tertiary alkyl halide
- (d) High concentration of a strong base

36. The E2 reaction of 2-bromobutane with potassium tert-butoxide (a bulky strong base) would primarily yield:

- (a) But-1-ene (Hofmann product)
- (b) But-2-ene (Zaitsev product)
- (c) 2-butanol
- (d) 2-ethoxybutane

37. Which of the following statements is INCORRECT regarding E1 elimination?

- (a) It is a unimolecular reaction.
- (b) Carbocation rearrangements are possible.
- (c) The rate of reaction depends on the concentration of both the substrate and the base.
- (d) It generally forms the more substituted alkene (Zaitsev's product).

38. An anti-periplanar arrangement is essential for which of the following elimination reactions?

- (a) E1 reaction
- (b) E2 reaction
- (c) Both E1 and E2 reactions
- (d) Neither E1 nor E2 reactions

39. Consider the reaction of 2-bromo-2-methylpropane with ethanol (weak base/nucleophile) at elevated temperature. The major organic product will be formed via:

- (a) SN1 mechanism
- (b) SN2 mechanism
- (c) E1 mechanism
- (d) E2 mechanism

40. Which type of solvent typically favors E1 and SN1 reactions over E2 and SN2 reactions?

- (a) Aprotic, polar solvent
- (b) Protic, polar solvent
- (c) Non-polar solvent
- (d) Aprotic, non-polar solvent

41. The major product obtained when 1-bromo-1-methylcyclohexane is treated with a strong base like sodium methoxide in methanol at high temperature is:

- (a) 1-methoxy-1-methylcyclohexane
- (b) 1-methylcyclohexene
- (c) Methylenecyclohexane
- (d) 1-methylcyclohexanol

42. Which carbocation intermediate is formed initially and undergoes a rearrangement during the E1 elimination of 3-bromo-2,2-dimethylbutane?

- (a)  $\text{CH}_3\text{-C}(\text{CH}_3)_2\text{-CH}_2\text{-CH}_2^+$
- (b)  $\text{CH}_3\text{-CH}(\text{CH}_3)\text{-C}^+(\text{CH}_3)_2$
- (c)  $\text{CH}_3\text{-C}(\text{CH}_3)_2\text{-C}^+(\text{H})\text{-CH}_3$
- (d)  $(\text{CH}_3)_3\text{C-C}^+(\text{H})\text{-CH}_3$

43. Which of the following conditions would favor an E2 elimination over an SN2 reaction for a secondary alkyl halide?

- (a) A weak base in a protic solvent
- (b) A strong, bulky base in an aprotic solvent

(c) A strong nucleophile in a polar protic solvent

(d) Low temperature

44. Increasing the temperature in an elimination reaction (E1 or E2) generally:

(a) Favors substitution over elimination.

(b) Favors elimination over substitution.

(c) Has no effect on the product ratio.

(d) Favors SN1 over SN2.

45. In the E2 elimination of 2-bromo-2,3-dimethylbutane, how many distinct alkene products can be formed?

(a) 1

(b) 2

(c) 3

(d) 4

#### Answers

31. (c)

32. (b)

33. (b)

34. (c)

35. (d)

36. (a)

37. (c)

38. (b)

39. (c)

40. (b)

41. (b)

42. (c)

43. (b)

44. (b)

45. (b)

## Topic: Electrophilic Addition Mechanisms (Alkenes, Alkynes)

### Section: Multiple Choice Questions

46. Which of the following species acts as an electrophile in the electrophilic addition reaction of propene with HBr?

- (a) Propene
- (b) Bromide ion ( $\text{Br}^-$ )
- (c) Hydrogen ion ( $\text{H}^+$ )
- (d) Water ( $\text{H}_2\text{O}$ )

47. The reactive intermediate formed during the hydrohalogenation of an unsymmetrical alkene following Markovnikov's rule is a:

- (a) Carbocation
- (b) Carbanion
- (c) Free radical
- (d) Alkyl halide

48. What is the major product when propene reacts with HBr in the absence of peroxides?

- (a) 1-Bromopropane
- (b) 2-Bromopropane
- (c) 1,2-Dibromopropane
- (d) Propane

49. Arrange the following carbocations in increasing order of stability:

- I. Methyl carbocation
- II. Primary carbocation
- III. Secondary carbocation
- IV. Tertiary carbocation



(a)  $IV < III < II < I$

(b)  $I < II < III < IV$

(c)  $II < I < IV < III$

(d)  $III < IV < I < II$

50. Which of the following reactions is most likely to involve a carbocation rearrangement?

(a) Addition of HBr to ethene

(b) Addition of Br<sub>2</sub> to cyclopentene

(c) Addition of H<sub>2</sub>O/H<sup>+</sup> to 3,3-dimethyl-1-butene

(d) Hydroboration-oxidation of 1-butene

51. The addition of bromine (Br<sub>2</sub>) to trans-2-butene typically results in:

(a) Primarily syn-addition product

(b) Primarily anti-addition product

(c) Racemic mixture of syn and anti products

(d) No reaction due to steric hindrance

52. The acid-catalyzed hydration of 2-methylpropene yields predominantly:

(a) 2-methyl-1-propanol

(b) 2-methyl-2-propanol

(c) 1-butanol

(d) 2-butanol

53. Which of the following reagents is used in oxymercuration-demercuration, a reaction that follows Markovnikov's rule without carbocation rearrangement?

(a) BH<sub>3</sub>, THF followed by H<sub>2</sub>O<sub>2</sub>, NaOH

(b) H<sub>2</sub>SO<sub>4</sub>, H<sub>2</sub>O

(c)  $\text{Hg}(\text{OAc})_2$ ,  $\text{H}_2\text{O}$  followed by  $\text{NaBH}_4$

(d)  $\text{Br}_2$  in  $\text{CCl}_4$

54. Identify the statement that is INCORRECT regarding the electrophilic addition of  $\text{HBr}$  to 1-butyne.

(a) The first addition forms a vinyl carbocation.

(b) The major product after one equivalent of  $\text{HBr}$  addition is 2-bromobut-1-ene.

(c) Markovnikov's rule is followed for the first addition.

(d) After two equivalents of  $\text{HBr}$ , the final product is 2,2-dibromobutane.

55. The hydration of propyne in the presence of  $\text{H}_2\text{SO}_4$  and  $\text{HgSO}_4$  produces:

(a) Propanal

(b) Propan-1-ol

(c) Acetone

(d) Propanoic acid

56. The stability of carbocations is primarily explained by:

(a) Inductive effect and resonance effect

(b) Hyperconjugation and inductive effect

(c) Resonance effect and hyperconjugation

(d) All of the above

57. When ethene reacts with  $\text{HBr}$ , the bond broken in ethene is:

(a) Sigma bond

(b) Pi bond

(c) Both sigma and pi bonds

(d) C-H bond

58. Which of the following alkenes would react fastest with HBr?

- (a) Ethene
- (b) Propene
- (c) 2-Methylpropene
- (d) 1-Butene

59. The electrophilic addition of  $X_2$  (halogen) to an alkene in an inert solvent proceeds via which type of intermediate?

- (a) Carbocation
- (b) Carbanion
- (c) Halonium ion
- (d) Free radical

60. Which of the following statements is true regarding electrophilic addition reactions?

- (a) They involve the attack of a nucleophile on an electron-rich center.
- (b) They typically involve the breaking of a sigma bond and the formation of two pi bonds.
- (c) They are characteristic reactions of compounds with pi bonds, such as alkenes and alkynes.
- (d) They always result in the formation of a racemic mixture.

#### Answers

46. (c)

47. (a)

48. (b)

49. (b)

50. (c)

51. (b)

52. (b)

53. (c)

54. (b)

55. (c)

56. (d)

57. (b)

58. (c)

59. (c)

60. (c)

## Topic: Nucleophilic Addition Mechanisms (Carbonyl Compounds)

61. What is the primary characteristic of the carbonyl carbon atom in an aldehyde or ketone that makes it susceptible to nucleophilic attack?

- (a) It is electron-rich due to the oxygen atom.
- (b) It is  $sp^2$  hybridized and planar.
- (c) It is electron-deficient due to the electronegativity of the oxygen atom.
- (d) It has a partial negative charge.

62. Arrange the following carbonyl compounds in decreasing order of reactivity towards nucleophilic addition:

I. Acetaldehyde ( $CH_3CHO$ )

II. Acetone ( $CH_3COCH_3$ )

III. Formaldehyde ( $HCHO$ )

- (a)  $III > I > II$
- (b)  $I > II > III$
- (c)  $II > I > III$
- (d)  $III > II > I$

63. Which of the following statements is true regarding the role of an acid catalyst in the nucleophilic addition to carbonyl compounds?

- (a) It deprotonates the nucleophile, making it stronger.
- (b) It increases the steric hindrance around the carbonyl carbon.
- (c) It protonates the carbonyl oxygen, increasing the electrophilicity of the carbonyl carbon.
- (d) It converts the carbonyl group into an enol.

64. The reaction of acetaldehyde with  $HCN$  followed by hydrolysis yields a product containing which two functional groups attached to the same carbon atom?

- (a) Carboxylic acid and hydroxyl

(b) Nitrile and hydroxyl

(c) Carboxylic acid and aldehyde

(d) Ketone and hydroxyl

65. When a Grignard reagent ( $\text{RMgX}$ ) adds to a ketone followed by hydrolysis, what type of alcohol is formed?

(a) Primary alcohol

(b) Secondary alcohol

(c) Tertiary alcohol

(d) Both primary and secondary alcohol

66. Nucleophilic addition of sodium bisulfite ( $\text{NaHSO}_3$ ) to carbonyl compounds typically forms a crystalline adduct. This reaction is most characteristic for:

(a) All ketones and aldehydes.

(b) Aldehydes and methyl ketones.

(c) Only aldehydes.

(d) Only methyl ketones.

67. What type of product is formed when an aldehyde reacts with a primary amine ( $\text{R-NH}_2$ ) in the presence of a trace amount of acid?

(a) Amide

(b) Imine (Schiff's base)

(c) Nitrile

(d) Oxime

68. Which of the following factors contributes to the lower reactivity of ketones compared to aldehydes towards nucleophilic addition?

I. Steric hindrance

II. +I effect of alkyl groups

III. -I effect of alkyl groups

- (a) I only
- (b) II only
- (c) I and II
- (d) I and III

69. The reaction of propanone with methanol in the presence of dry HCl gas forms:

- (a) Hemiacetal
- (b) Acetal
- (c) Ketal
- (d) Enol

70. Which of the following carbonyl compounds will be least reactive towards nucleophilic addition?

- (a) Ethanal
- (b) Propanal
- (c) Butanone
- (d) 2,2-Dimethylpropanal

71. Consider the nucleophilic addition of water to a carbonyl compound to form a hydrate. Which carbonyl compound would form the most stable hydrate?

- (a) Acetone
- (b) Acetaldehyde
- (c) Formaldehyde
- (d) Propanal

72. A compound X reacts with hydrazine ( $\text{NH}_2\text{NH}_2$ ) to form a hydrazone, which upon heating with KOH/ethylene glycol undergoes reduction. This series of reactions is known as:

- (a) Clemmensen reduction
- (b) Wolff-Kishner reduction
- (c) Rosenmund reduction
- (d) Aldol condensation

73. Which of the following nucleophiles is generally considered to be a strong nucleophile for addition to carbonyl compounds under neutral or basic conditions?

- (a)  $\text{H}_2\text{O}$
- (b)  $\text{CH}_3\text{OH}$
- (c)  $\text{CN}^-$
- (d)  $\text{H}^+$

74. The nucleophilic addition of hydrogen cyanide to carbonyl compounds is an example of:

- (a) A reversible reaction
- (b) An irreversible reaction
- (c) An acid-catalyzed reaction only
- (d) A reaction that always forms a racemic mixture

75. In the mechanism of nucleophilic addition to a carbonyl group, which step occurs first when the reaction is base-catalyzed?

- (a) Protonation of the carbonyl oxygen.
- (b) Nucleophilic attack on the carbonyl carbon.
- (c) Removal of a proton from the alpha-carbon.
- (d) Formation of an enolate ion.

Answers

61. (c)



62. (a)

63. (c)

64. (b)

65. (c)

66. (b)

67. (b)

68. (c)

69. (c)

70. (d)

71. (c)

72. (b)

73. (c)

74. (a)

75. (b)

## Topic: Electrophilic Aromatic Substitution (EAS)

### Section: Multiple Choice Questions

76. Which step is generally the rate-determining step in an electrophilic aromatic substitution reaction?

- (a) Formation of the electrophile.
- (b) Attack of the electrophile on the aromatic ring to form a sigma complex.
- (c) Deprotonation of the sigma complex to restore aromaticity.
- (d) Rearrangement of the electrophile.

77. What is the electrophile generated during the nitration of benzene using concentrated nitric acid and concentrated sulfuric acid?

- (a)  $\text{NO}^+$
- (b)  $\text{NO}_2^+$
- (c)  $\text{NO}_3^-$
- (d)  $\text{H}_3\text{O}^+$

78. Which of the following reagent combinations is used for the nitration of benzene?

- (a) Conc.  $\text{HNO}_3$  and Conc.  $\text{HCl}$
- (b) Conc.  $\text{H}_2\text{SO}_4$  and Conc.  $\text{HCl}$
- (c) Conc.  $\text{HNO}_3$  and Conc.  $\text{H}_2\text{SO}_4$
- (d) Dil.  $\text{HNO}_3$  and Dil.  $\text{H}_2\text{SO}_4$

79. For the bromination of benzene, which of the following is the correct set of reagents?

- (a)  $\text{Br}_2$  in  $\text{CCl}_4$
- (b)  $\text{Br}_2$  and  $\text{H}_2\text{O}$
- (c)  $\text{Br}_2$  and  $\text{FeBr}_3$
- (d)  $\text{HBr}$  and  $\text{FeBr}_3$

80. In Friedel-Crafts alkylation of benzene, what is the primary role of a Lewis acid like anhydrous  $\text{AlCl}_3$ ?

- (a) To act as a nucleophile.
- (b) To generate the carbocation electrophile.
- (c) To protonate the aromatic ring.
- (d) To abstract a proton from the sigma complex.

81. What is the major product when toluene undergoes monobromination in the presence of  $\text{FeBr}_3$ ?

- (a) Bromobenzene
- (b) o-Bromotoluene and p-Bromotoluene
- (c) m-Bromotoluene
- (d) Benzyl bromide

82. Which position will be preferentially substituted during the mononitration of nitrobenzene?

- (a) Ortho position
- (b) Meta position
- (c) Para position
- (d) Both ortho and para positions equally

83. Which of the following groups is an activating group for electrophilic aromatic substitution?

- (a)  $-\text{NO}_2$
- (b)  $-\text{COOH}$
- (c)  $-\text{OCH}_3$
- (d)  $-\text{CN}$

84. A deactivating group for electrophilic aromatic substitution will generally:

- (a) Increase the electron density in the ring.

- (b) Decrease the electron density in the ring.
- (c) Have no effect on electron density.
- (d) Only direct the incoming electrophile to ortho/para positions.

85. The  $\text{-NH}_2$  group is a strong activating group and an ortho/para director. Which of the following best explains its directing effect?

- (a) It is electron-withdrawing by induction.
- (b) It can donate electrons to the ring by resonance.
- (c) It is a bulky group that prefers ortho/para.
- (d) It forms a hydrogen bond with the incoming electrophile.

86. Which of the following substituents is a meta-director for electrophilic aromatic substitution?

- (a)  $\text{-CH}_3$
- (b)  $\text{-OH}$
- (c)  $\text{-SO}_3\text{H}$
- (d)  $\text{-NH}_2$

87. Which of the following aromatic compounds is most reactive towards nitration?

- (a) Nitrobenzene
- (b) Benzoic acid
- (c) Toluene
- (d) Chlorobenzene

88. Friedel-Crafts alkylation or acylation reactions generally do not occur on strongly deactivated aromatic rings. Which of the following rings would be least reactive towards Friedel-Crafts reactions?

- (a) Anisole
- (b) Chlorobenzene

(c) Toluene

(d) Nitrobenzene

89. The intermediate formed during electrophilic aromatic substitution is a resonance-stabilized carbocation. What is this intermediate commonly known as?

(a) Carbanion

(b) Free radical

(c) Arenium ion or sigma complex

(d) Enolate ion

90. When benzene reacts with 1-chloropropane in the presence of anhydrous  $\text{AlCl}_3$ , the major alkylated product is often isopropylbenzene (cumene) instead of n-propylbenzene. This is an example of:

(a) Aromatic halogenation

(b) Carbocation rearrangement

(c) Free radical substitution

(d) Nucleophilic attack on benzene

## Answers

76. (b)

77. (b)

78. (c)

79. (c)

80. (b)

81. (b)

82. (b)

83. (c)

84. (b)

85. (b)

86. (c)

87. (c)

88. (d)

89. (c)

90. (b)

## Topic: Electrophilic Addition Reaction

91. Which of the following species acts as an electrophile in an electrophilic addition reaction?

(a)  $\text{OH}^-$

(b)  $\text{CN}^-$

(c)  $\text{H}^+$

(d)  $\text{NH}_3$

92. The pi ( $\pi$ ) bond in alkenes acts as a:

(a) Nucleophile

(b) Electrophile

(c) Free radical

(d) Leaving group

93. The major product formed when propene reacts with HBr is:

(a) 1-bromopropane

(b) 2-bromopropane

(c) 1,2-dibromopropane

(d) Propyl bromide

94. Arrange the following carbocations in increasing order of stability:

I. Methyl carbocation

II. Primary carbocation

III. Secondary carbocation

IV. Tertiary carbocation

(a)  $\text{I} < \text{II} < \text{III} < \text{IV}$

(b)  $IV < III < II < I$

(c)  $II < I < III < IV$

(d)  $I < II < IV < III$

95. In the addition of HCl to 3,3-dimethyl-1-butene, the major product will involve:

(a) Formation of a primary carbocation

(b) Hydride shift rearrangement

(c) Methyl shift rearrangement

(d) Elimination reaction

96. Anti-Markovnikov addition of HBr to an alkene occurs in the presence of:

(a) Peroxides

(b) UV light

(c) Anhydrous  $AlCl_3$

(d)  $H_2SO_4$

97. When bromine water ( $Br_2/H_2O$ ) is added to ethene, the major product formed is:

(a) 1,2-dibromoethane

(b) 2-bromoethanol

(c) Ethylene glycol

(d) Bromoethane

98. The intermediate formed during the acid-catalyzed hydration of an alkene is a:

(a) Carbanion

(b) Free radical

(c) Carbocation

(d) Alkoxide ion



99. Which of the following alkenes would react fastest with HBr?

- (a) Ethene
- (b) Propene
- (c) 2-methylpropene
- (d) 1-butene

100. The addition of HBr to ethyne (acetylene) gives mainly:

- (a) 1,1-dibromoethane
- (b) 1,2-dibromoethane
- (c) Bromoethene
- (d) 2-bromoethene

101. Which of the following correctly describes the first step of electrophilic addition of HBr to propene?

- (a) HBr attacks the carbocation.
- (b) Br<sup>-</sup> attacks the pi bond.
- (c) H<sup>+</sup> attacks the pi bond to form a carbocation.
- (d) Br<sup>•</sup> attacks the pi bond.

102. Electron-donating groups attached to the double bond of an alkene generally:

- (a) Decrease the rate of electrophilic addition.
- (b) Increase the rate of electrophilic addition.
- (c) Have no effect on the rate.
- (d) Convert the reaction into a substitution reaction.

103. The addition of Br<sub>2</sub> to an alkene proceeds via a cyclic intermediate and results in:

- (a) Syn addition

- (b) Anti addition
- (c) Rearrangement
- (d) Elimination

104. Which of the following carbocations is most stable?

- (a)  $\text{CH}_3^+$
- (b)  $\text{CH}_3\text{CH}_2^+$
- (c)  $(\text{CH}_3)_2\text{CH}^+$
- (d)  $(\text{CH}_3)_3\text{C}^+$

105. Hydroboration-oxidation of propene yields:

- (a) 1-propanol
- (b) 2-propanol
- (c) Propanal
- (d) Propanoic acid

#### Answers

91. (c)

92. (a)

93. (b)

94. (a)

95. (c)

96. (a)

97. (b)

98. (c)

99. (c)

100. (a)

101. (c)

102. (b)

103. (b)

104. (d)

105. (a)

## Topic: Free Radical Addition Reaction

### Section: Multiple Choice Questions

106. Which of the following statements is true regarding free radical addition reactions?

- (a) They involve the initial attack of an electrophile on the pi bond.
- (b) They proceed via carbocation intermediates.
- (c) They are initiated by homolytic fission of a covalent bond.
- (d) They typically follow Markovnikov's rule in the presence of peroxides.

107. The primary role of organic peroxides in the anti-Markovnikov addition of HBr to alkenes is to:

- (a) Stabilize the carbocation intermediate.
- (b) Act as a Lewis acid to activate the alkene.
- (c) Undergo homolytic cleavage to produce free radicals.
- (d) Catalyze the formation of a nucleophile.

108. Arrange the following free radicals in increasing order of their stability:

I. Methyl radical

II. Tertiary butyl radical

III. Isopropyl radical

IV. Ethyl radical

- (a)  $I < IV < III < II$
- (b)  $II < III < IV < I$
- (c)  $I < III < IV < II$
- (d)  $IV < I < III < II$

109. What is the major product formed when propene reacts with HBr in the presence of benzoyl peroxide?

- (a) 2-Bromopropane
- (b) 1-Bromopropane
- (c) 1,2-Dibromopropane
- (d) 2,2-Dibromopropane

110. Which of the following represents an initiation step in the free radical addition of HBr to an alkene?

- (a)  $\text{R-O} \cdot + \text{CH}_2=\text{CH-R}' \rightarrow \text{R-O-CH}_2\text{-CH}\cdot\text{-R}'$
- (b)  $\text{R-O-O-R} \rightarrow 2 \text{R-O}\cdot$
- (c)  $\text{R-O-CH}_2\text{-CH}\cdot\text{-R}' + \text{H-Br} \rightarrow \text{R-O-CH}_2\text{-CH}_2\text{-R}' + \text{Br}\cdot$
- (d)  $\text{Br}\cdot + \text{CH}_2=\text{CH-R}' \rightarrow \text{Br-CH}_2\text{-CH}\cdot\text{-R}'$

111. A propagation step in a free radical addition reaction involves:

- (a) Formation of two free radicals from a non-radical species.
- (b) Reaction of two free radicals to form a non-radical species.
- (c) Reaction of a free radical with a non-radical species to form a new free radical and a new non-radical species.
- (d) Reaction of a free radical with a non-radical species to form two new non-radical species.

112. Which of the following is most likely to be a termination step in the free radical addition of HBr to an alkene?

- (a)  $\text{R-O}\cdot + \text{HBr} \rightarrow \text{ROH} + \text{Br}\cdot$
- (b)  $\text{Br}\cdot + \text{Br}\cdot \rightarrow \text{Br}_2$
- (c)  $\text{Br}\cdot + \text{CH}_2=\text{CH}_2 \rightarrow \text{BrCH}_2\text{-CH}_2\cdot$
- (d)  $\text{CH}_3\text{-CH}_2\cdot + \text{HBr} \rightarrow \text{CH}_3\text{-CH}_3 + \text{Br}\cdot$

113. Why does HCl not undergo anti-Markovnikov addition to alkenes in the presence of peroxides, unlike HBr?

- (a) The H-Cl bond is too strong, making the first propagation step endothermic.

- (b) Chlorine radical is too stable to react with the alkene.
- (c) The C-Cl bond formation is highly exothermic, hindering the reaction.
- (d) HCl is a strong acid and reacts differently with peroxides.

114. Free radical addition reactions typically require which of the following conditions?

- (a) Presence of a strong acid catalyst.
- (b) High pressure and low temperature.
- (c) UV light or peroxides for initiation.
- (d) Polar solvent to stabilize carbocations.

115. What type of reactive intermediate is formed during the propagation steps of a free radical addition reaction?

- (a) Carbocation
- (b) Carbanion
- (c) Free radical
- (d) Transition state

116. The anti-Markovnikov regioselectivity observed in the peroxide-catalyzed addition of HBr to unsymmetrical alkenes is primarily due to the formation of a more stable:

- (a) Carbocation intermediate.
- (b) Free radical intermediate.
- (c) Carbanion intermediate.
- (d) Electrophilic species.

117. Identify the major product of the reaction:



- (a)  $\text{CH}_3\text{-CH(Br)-CH}_3$

- (b)  $\text{CH}_3\text{-CH}_2\text{-CH}_2\text{Br}$
- (c)  $\text{CH}_2(\text{Br})\text{-CH=CH}_2$
- (d)  $\text{CH}_3\text{-CH=CH-Br}$

118. Which of the following compounds is most likely to undergo free radical addition polymerization?

- (a) Benzene
- (b) Methane
- (c) Ethene
- (d) Ethyne

119. What effect does the presence of light or heat have on the initiation step of a free radical reaction?

- (a) It promotes heterolytic cleavage of the initiator.
- (b) It provides the energy for homolytic cleavage of the initiator.
- (c) It stabilizes the free radicals formed.
- (d) It acts as a catalyst for the overall reaction.

120. Which of the following is a key difference between electrophilic addition and free radical addition reactions of alkenes?

- (a) Electrophilic addition forms free radicals, while free radical addition forms carbocations.
- (b) Electrophilic addition is always anti-Markovnikov, while free radical addition is always Markovnikov.
- (c) Electrophilic addition proceeds via carbocations, while free radical addition proceeds via free radicals.
- (d) Electrophilic addition requires peroxides, while free radical addition does not.

#### Answers

106. (c)

107. (c)

108. (a)

109. (b)

110. (b)

111. (c)

112. (b)

113. (a)

114. (c)

115. (c)

116. (b)

117. (b)

118. (c)

119. (b)

120. (c)



## Topic: Electrophilic Substitution Reaction

121. Which of the following best describes an electrophilic substitution reaction?

- (a) A nucleophile replaces an atom or group from the substrate.
- (b) An electrophile replaces an atom or group from the substrate.
- (c) A free radical replaces an atom or group from the substrate.
- (d) Two molecules combine to form a single product.

122. In the nitration of benzene, the electrophile involved is:

- (a)  $\text{NO}_2^+$
- (b)  $\text{NO}^+$
- (c)  $\text{N}_2\text{O}_4$
- (d)  $\text{HNO}_3$

123. Which of the following groups is an ortho-para directing and activating group in electrophilic aromatic substitution?

- (a)  $-\text{NO}_2$
- (b)  $-\text{COOH}$
- (c)  $-\text{OH}$
- (d)  $-\text{CN}$

124. The product formed when toluene undergoes nitration is primarily:

- (a) m-nitrotoluene
- (b) o-nitrotoluene and p-nitrotoluene
- (c) a mixture of all three isomers
- (d) p-nitrotoluene only

125. The correct order of reactivity towards electrophilic substitution for benzene, chlorobenzene, and toluene is:

(a) Toluene > Benzene > Chlorobenzene

(b) Benzene > Toluene > Chlorobenzene

(c) Chlorobenzene > Benzene > Toluene

(d) Benzene > Chlorobenzene > Toluene

126. Which of the following is NOT a limitation of Friedel-Crafts alkylation?

(a) Rearrangement of carbocations can occur.

(b) Polyalkylation can occur.

(c) The reaction requires a Lewis acid catalyst.

(d) It cannot be performed on strongly deactivated aromatic rings.

127. Aniline does not undergo Friedel-Crafts reactions due to:

(a) The amino group being an ortho-para director.

(b) The amino group being a strong activator.

(c) Formation of a complex with the Lewis acid catalyst ( $\text{AlCl}_3$ ).

(d) Steric hindrance from the amino group.

128. In electrophilic aromatic substitution, the rate-determining step involves the formation of:

(a) a free radical

(b) a carbocation

(c) a carbanion

(d) an alkoxide ion

129. Which set of reagents is used for Friedel-Crafts acylation?

(a)  $\text{R-Cl} / \text{AlCl}_3$

(b)  $\text{R-CO-Cl} / \text{AlCl}_3$

(c)  $\text{HNO}_3 / \text{H}_2\text{SO}_4$

(d)  $\text{Br}_2 / \text{FeBr}_3$

130. Considering the stability of carbocations, which intermediate is formed in the electrophilic attack on an aromatic ring?

(a) A benzylic carbocation.

(b) A sigma complex (arenium ion).

(c) A pi complex.

(d) A primary carbocation.

131. Which of the following compounds would undergo electrophilic substitution reaction at the slowest rate?

(a) Toluene

(b) Anisole

(c) Nitrobenzene

(d) Phenol

132. Halogenation of benzene requires a Lewis acid catalyst because:

(a) The Lewis acid makes the benzene ring more reactive.

(b) The Lewis acid helps in generating the electrophile (e.g.,  $\text{Br}^+$ ).

(c) The Lewis acid removes the halogen from the product.

(d) The Lewis acid activates the aromatic ring to attack by a nucleophile.

133. Sulfonation of benzene is a reversible reaction. Which of the following conditions would favor desulfonation (removal of  $-\text{SO}_3\text{H}$  group)?

(a) Heating with fuming  $\text{H}_2\text{SO}_4$ .

(b) Heating with dilute  $\text{H}_2\text{SO}_4$  or steam.

(c) Reaction with  $\text{SOCl}_2$ .

(d) Reaction with  $\text{NaOH}$ .

134. Which of the following groups is a meta-directing and deactivating group?

- (a)  $\text{-CH}_3$
- (b)  $\text{-OCH}_3$
- (c)  $\text{-Cl}$
- (d)  $\text{-COOH}$

135. The attacking species in an electrophilic substitution reaction is always:

- (a) Electron-rich
- (b) Electron-deficient
- (c) Neutral
- (d) A free radical

#### Answers

121. (b)

122. (a)

123. (c)

124. (b)

125. (a)

126. (c)

127. (c)

128. (b)

129. (b)

130. (b)

131. (c)

132. (b)

133. (b)

134. (d)

135. (b)

## Topic: Free Radical Substitution Reaction

136. Which type of bond fission primarily occurs during the initiation step of a free radical substitution reaction?

- (a) Heterolytic fission
- (b) Homolytic fission
- (c) Ionic fission
- (d) Electrostatic fission

137. Which of the following alkyl free radicals is the most stable?

- (a) Methyl radical
- (b) Primary alkyl radical
- (c) Secondary alkyl radical
- (d) Tertiary alkyl radical

138. The free radical halogenation of alkanes is typically initiated by:

- (a) Presence of strong acid
- (b) High pressure
- (c) UV light or heat
- (d) Transition metal catalyst

139. In the free radical chlorination of methane, which of the following represents a propagation step?

- (a)  $\text{Cl}_2 \rightarrow 2\text{Cl}\cdot$
- (b)  $\text{CH}_3\cdot + \text{Cl}_2 \rightarrow \text{CH}_3\text{Cl} + \text{Cl}\cdot$
- (c)  $\text{CH}_4 + \text{Cl}\cdot \rightarrow \text{CH}_3\cdot + \text{HCl}$
- (d)  $\text{CH}_3\cdot + \text{CH}_3\cdot \rightarrow \text{CH}_3\text{-CH}_3$

140. When propane undergoes free radical monochlorination, how many possible structural isomers of monochloropropane can be formed?

(a) 1

(b) 2

(c) 3

(d) 4

141. Bromination of alkanes via free radical substitution is generally more selective than chlorination. This is primarily due to:

(a) Bromine being a smaller atom than chlorine.

(b) The C-H bond breaking in bromination being more endothermic.

(c) The bromine radical being less reactive and more stable than the chlorine radical.

(d) Higher concentration of bromine used.

142. What is the correct order of reactivity of hydrogen atoms towards free radical halogenation?

(a) Primary H > Secondary H > Tertiary H

(b) Tertiary H > Secondary H > Primary H

(c) Secondary H > Primary H > Tertiary H

(d) Primary H = Secondary H = Tertiary H

143. Which of the following is NOT a characteristic feature of free radical substitution reactions?

(a) Proceed through a chain mechanism.

(b) Involve homolytic bond cleavage.

(c) Are typically favored by high temperatures or UV light.

(d) Involve carbocation intermediates.

144. Which of the following alkanes will yield only one monobrominated product upon free radical bromination?

(a) n-Butane

(b) Isobutane

(c) Ethane

(d) Propane

145. The free radical monochlorination of methane produces chloromethane. What is the main byproduct during the propagation steps?

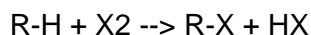
(a) HCl

(b) H<sub>2</sub>

(c) CH<sub>3</sub>-CH<sub>3</sub>

(d) Cl<sub>2</sub>

146. Consider the free radical mechanism for the reaction:



Which of the following sequence correctly represents the three main steps?

(a) Propagation, Initiation, Termination

(b) Termination, Propagation, Initiation

(c) Initiation, Propagation, Termination

(d) Initiation, Termination, Propagation

147. In the reaction of methane with chlorine in the presence of UV light, the highly reactive intermediate formed that attacks methane is:

(a) Methyl carbocation

(b) Chloronium ion

(c) Chlorine free radical

(d) Methyl carbanion

148. The stability of alkyl free radicals is explained by:

(a) Inductive effect only



(b) Resonance effect only

(c) Hyperconjugation and inductive effect

(d) Steric hindrance

149. To minimize polysubstitution (formation of di-, tri-substituted products) during the free radical halogenation of an alkane, which of the following conditions is generally employed?

(a) Use a large excess of alkane.

(b) Use a large excess of halogen.

(c) Conduct the reaction at very low temperatures.

(d) Add an inhibitor.

150. If you perform free radical bromination of 2,2,4-trimethylpentane, how many different monobrominated products (structural isomers) could theoretically be formed?

(a) 2

(b) 3

(c) 4

(d) 5

## Answers

136. (b)

137. (d)

138. (c)

139. (c)

140. (b)

141. (c)

142. (b)

143. (d)

144. (c)

145. (a)

146. (c)

147. (c)

148. (c)

149. (a)

150. (d)

## Topic: Tautomerism

151. Which of the following statements best describes tautomerism?

- (a) It involves the interconversion of isomers that differ in the arrangement of atoms in space.
- (b) It involves the interconversion of isomers that differ in the position of a proton and a double bond.
- (c) It involves the interconversion of isomers that differ in their connectivity of atoms, leading to different functional groups.
- (d) It involves the delocalization of pi electrons within a molecule without changes in atomic positions.

152. Consider the keto-enol tautomerism of 2,4-pentanedione (acetylacetone). Which factor primarily contributes to the high percentage of its enol form at equilibrium?

- (a) Steric hindrance in the keto form.
- (b) Intramolecular hydrogen bonding in the enol form.
- (c) Increased resonance stabilization of the keto form.
- (d) Higher electronegativity of oxygen in the keto form.

153. Which of the following compounds will exhibit keto-enol tautomerism?

- (a) 2,2-Dimethylpropanal
- (b) Benzophenone
- (c) Cyclohexanone
- (d) Trimethylacetic acid

154. Which of the following compounds is least likely to exhibit keto-enol tautomerism?

- (a) Acetaldehyde
- (b) Acetone
- (c) Benzaldehyde
- (d) Ethyl acetoacetate

155. The tautomerism observed in nitromethane ( $\text{CH}_3\text{-NO}_2$ ) is an example of:

- (a) Keto-enol tautomerism
- (b) Lactam-lactim tautomerism
- (c) Nitro-aci-nitro tautomerism
- (d) Amide-iminol tautomerism

156. In the acid-catalyzed enolization of a ketone, which step involves the protonation of the carbonyl oxygen?

- (a) Loss of alpha-hydrogen from the carbon.
- (b) Attack of a nucleophile on the carbonyl carbon.
- (c) Formation of an enolate ion.
- (d) Activation of the carbonyl group for subsequent deprotonation.

157. For a compound to exhibit keto-enol tautomerism, it must possess:

- (a) A carbonyl group and at least one alpha-hydrogen atom.
- (b) A double bond and a hydroxyl group.
- (c) Only a carbonyl group.
- (d) A carbon atom with four different substituents.

158. The tautomeric forms of DNA bases, particularly guanine and thymine, are crucial because their minor tautomeric forms can lead to:

- (a) Increased solubility in water.
- (b) Changes in the DNA backbone structure.
- (c) Mismatching during DNA replication and transcription.
- (d) Enhanced stability of the double helix.

159. Which of the following compounds exists predominantly in its enol form due to aromaticity?

- (a) Phenol

(b) Cyclohex-2-en-1-one

(c) Acetylacetone

(d) Acetaldehyde

160. Tautomerism is a specific type of isomerism where two isomers are in dynamic equilibrium. How does it fundamentally differ from resonance?

(a) Tautomers involve movement of electrons only, while resonance involves movement of atoms.

(b) Tautomers are real, distinct molecules in equilibrium, while resonance structures are hypothetical contributors to a single hybrid.

(c) Tautomers have the same functional groups, while resonance structures have different functional groups.

(d) Tautomerism involves delocalization of charge, while resonance involves only delocalization of pi electrons.

161. Pyridin-2-ol and Pyridin-2(1H)-one are tautomers. This interconversion involves the movement of:

(a) An electron pair.

(b) A hydroxyl group.

(c) A proton and an electron pair.

(d) A methyl group.

162. Which of the following represents a prototropic tautomerism?

(a) Allylic rearrangement

(b) Keto-enol tautomerism

(c) Ring-chain tautomerism

(d) Valence tautomerism

163. A system where the mobile proton moves between two atoms linked by a single intervening atom is classified as a:

(a) Dyad system

(b) Triad system

(c) Pentad system

(d) Hexad system

164. In keto-enol tautomerism, the equilibrium is generally shifted towards the keto form in:

(a) Highly polar, protic solvents.

(b) Non-polar solvents.

(c) Solutions with strong bases.

(d) Solutions with strong acids.

165. Consider the compound cyclopropanone. Which statement about its keto-enol tautomerism is correct?

(a) It readily forms an enol due to angle strain relief.

(b) It does not exhibit keto-enol tautomerism due to the absence of alpha-hydrogens.

(c) It forms an enol but the equilibrium strongly favors the keto form due to high enol instability.

(d) Its enol form is aromatic, making it highly stable.

## Answers

151. (b)

152. (b)

153. (c)

154. (c)

155. (c)

156. (d)

157. (a)

158. (c)

159. (a)

160. (b)

161. (c)

162. (b)

163. (b)

164. (a)

165. (c)

## Topic: Summary (quick revision)

### Section: Multiple Choice Questions

166. Homolytic bond fission typically results in the formation of:

- (a) Carbocations
- (b) Carbanions
- (c) Free radicals
- (d) Transition states

167. Which of the following species can act as a nucleophile?

- (a)  $\text{CH}_3^+$
- (b)  $\text{H}_3\text{O}^+$
- (c)  $\text{NH}_3$
- (d)  $\text{BF}_3$

168. An electrophile is an electron-deficient species that typically accepts electrons. Which of the following is an electrophile?

- (a)  $\text{OH}^-$
- (b)  $\text{CN}^-$
- (c)  $\text{H}_2\text{O}$
- (d)  $\text{NO}_2^+$

169. The stability of carbocations follows the order:

- (a) Methyl > Primary > Secondary > Tertiary
- (b) Tertiary > Secondary > Primary > Methyl
- (c) Primary > Secondary > Tertiary > Methyl
- (d) Secondary > Primary > Tertiary > Methyl



170. Which electronic effect involves the delocalization of pi electrons through conjugation, where electron-donating groups stabilize carbocations and destabilize carbanions?

- (a) Inductive effect
- (b) Hyperconjugation
- (c) Mesomeric effect (+M)
- (d) Electromeric effect

171. Hyperconjugation is also known as:

- (a) No-bond resonance
- (b) Pi-bond resonance
- (c) Inductive resonance
- (d) Sigma-bond induction

172. Which of the following is a characteristic feature of an SN1 reaction?

- (a) Involves a single transition state
- (b) Rate is dependent on the concentration of both alkyl halide and nucleophile
- (c) Proceeds via a carbocation intermediate
- (d) Leads to inversion of configuration

173. An SN2 reaction primarily involves:

- (a) Racemization
- (b) A carbocation intermediate
- (c) A single, concerted step
- (d) A polar protic solvent

174. In an E1 elimination reaction, the rate-determining step involves:

- (a) Abstraction of a proton by a base

- (b) Formation of a carbanion
- (c) Formation of a carbocation
- (d) Attack by a nucleophile

175. Which statement is true for an E2 elimination reaction?

- (a) It is a two-step process involving a carbocation intermediate.
- (b) The rate depends only on the concentration of the substrate.
- (c) It requires a strong base.
- (d) It is favored by polar protic solvents.

176. The addition of HBr to propene in the absence of peroxides follows:

- (a) Free radical addition mechanism
- (b) Electrophilic addition mechanism
- (c) Nucleophilic addition mechanism
- (d) Elimination mechanism

177. The bond fission that generates two species, each with an unpaired electron, is called:

- (a) Heterolytic cleavage
- (b) Homolytic cleavage
- (c) Ionic dissociation
- (d) Electron transfer

178. The formation of an equimolar mixture of enantiomers from a single enantiomer or an achiral starting material is known as:

- (a) Inversion
- (b) Retention
- (c) Racemization

(d) Diastereomerization

179. Carbocation rearrangements, such as hydride or alkyl shifts, typically occur to:

(a) Form a less stable carbocation

(b) Form a more stable carbocation

(c) Facilitate nucleophilic attack

(d) Achieve steric hindrance

180. Which of the following factors generally stabilizes a carbanion?

(a) Presence of electron-donating groups (+I or +M effect)

(b) Presence of electron-withdrawing groups (-I or -M effect)

(c) Increase in steric hindrance

(d) Formation of an sp hybridized carbon center

## Answers

166. (c)

167. (c)

168. (d)

169. (b)

170. (c)

171. (a)

172. (c)

173. (c)

174. (c)

175. (c)

176. (b)

177. (b)

178. (c)

179. (b)

180. (b)