Chemistry Grade 12 — Chapter 8

Hydrocarbons

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Independent practice MCQs from the supplied Class 12 Chemistry notes pack. Total: 50 questions.

A. Important / Main Topics

1. Benzene was discovered by:

(A) Michael Faraday
(B) Kekulé
(C) Linus Pauling
(D) Johannes Thiele

Correct Answer: A

Explanation: The notes state that benzene was discovered by Michael Faraday.

2. The molecular formula of benzene is:

(A) mathrmC□H□□
(B) C□H□
(C) mathrmC□H□□
(D) C□H□

Correct Answer: B

Explanation: The molecular formula of benzene is C□H□.

3. The carbon-carbon bond length in benzene is:

(A) 1.54 AA
(B) 1.30 AA
(C) 1.39 AA
(D) 1.20 AA

Correct Answer: C

Explanation: The C-C bond length in benzene is 1.39 AA, intermediate between single and double bonds.

4. The resonance energy of benzene is approximately:

(A) 120 kJ/mol
(B) 208 kJ/mol
(C) 360 kJ/mol
(D) 152 kJ/mol

Correct Answer: D

Explanation: The resonance energy of benzene is 152 kJ/mol.

5. Benzene primarily undergoes:

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

Correct Answer: A

Explanation: Benzene primarily undergoes Substitution reactions.

6. The intermediate formed during electrophilic aromatic substitution is called:

(A) Carbocation
(B) Arenium ion
(C) Carbanion
(D) Free radical

Correct Answer: B

Explanation: The intermediate is the arenium ion (sigma complex).

7. Which of the following is an ortho/para-directing group?

(A) -NO□
(B) -COOH
(C) -OH
(D) -CN

Correct Answer: C

Explanation: The hydroxyl group (-OH) is an ortho/para-directing group.

8. Which of the following is a meta-directing group?

(A) -CH□
(B) -NH□
(C) -OH
(D) -NO□

Correct Answer: D

Explanation: The nitro group (-NO□) is a meta-directing group.

9. The structure of benzene is a:

(A) Resonance hybrid of two Kekulé structures
(B) Single Lewis structure with fixed double bonds
(C) Mixture of two Kekulé structures
(D) Structure with localized double bonds

Correct Answer: A

Explanation: The true structure is a resonance hybrid of two Kekulé structures.

10. What is the hybridization of carbon atoms in benzene?

(A) sp
(B) sp^2
(C) sp^3
(D) sp^3d

Correct Answer: B

Explanation: The carbon atoms in benzene are sp^2 hybridized.

11. The C-C-C bond angle in benzene is:

(A) 180^circ
(B) 90^circ
(C) 120^circ
(D) 109.5^circ

Correct Answer: C

Explanation: The bond angle in benzene is 120^circ due to sp^2 hybridization.

12. Which electrophile is used in the bromination of benzene?

(A) Bromide ion
(B) Aluminium bromide
(C) Bromine molecule
(D) Bromonium ion

Correct Answer: D

Explanation: The electrophile is the bromonium ion (Br□).

13. The electrophile used in Friedel-Craft acylation is:

(A) Acylium ion
(B) Arenium ion
(C) Hydrogen ion
(D) Nitronium ion

Correct Answer: A

Explanation: The electrophile in Friedel-Craft acylation is the acylium ion (RCO□).

14. The prefix "ortho" indicates which substitution pattern?

(A) 1,3-
(B) 1,2-
(C) 1,4-
(D) 1,5-

Correct Answer: B

Explanation: 1,2- — this correctly answers the question.

15. The prefix "para" indicates which substitution pattern?

(A) 1,2-
(B) 1,3-
(C) 1,4-
(D) 1,5-

Correct Answer: C

Explanation: 1,4- — this correctly answers the question.

16. What is the expected enthalpy of hydrogenation of benzene if it had three localized double bonds?

(A) -120 kJ/mol
(B) -208 kJ/mol
(C) -152 kJ/mol
(D) -360 kJ/mol

Correct Answer: D

Explanation: The expected value is 3 × (-120) = -360 kJ/mol.

17. What is the actual enthalpy of hydrogenation of benzene?

(A) -208 kJ/mol
(B) -120 kJ/mol
(C) -360 kJ/mol
(D) -152 kJ/mol

Correct Answer: A

Explanation: The actual enthalpy of hydrogenation of benzene is -208 kJ/mol.

18. How many Kekulé structures does benzene have?

(A) 1
(B) 2
(C) 3
(D) 4

Correct Answer: B

Explanation: 2 — this correctly answers the question.

19. What is the shape of the pi electron cloud in benzene?

(A) Linear
(B) Spherical
(C) Two torus shapes above and below the ring
(D) A single torus above the ring

Correct Answer: C

Explanation: Two torus shapes above and below the ring — this correctly answers the question.

20. Which of the following is NOT a resonance structure of benzene?

(A) A structure with alternating single and double bonds.
(B) A structure with a circle inside a hexagon.
(C) The two Kekulé structures.
(D) A structure with a triple bond.

Correct Answer: D

Explanation: A structure with a triple bond. — this correctly answers the question.

21. Which of the following is an activating group?

(A) -OH
(B) -NO□
(C) -CN
(D) -COOH

Correct Answer: A

Explanation: The hydroxyl group (-OH) is an activating group.

22. Which of the following is a deactivating group?

(A) -OH
(B) -NO□
(C) -NH□
(D) -CH□

Correct Answer: B

Explanation: The nitro group (-NO□) is a deactivating group.

23. Why is benzene less reactive than alkenes towards addition reactions?

(A) Because benzene is a solid.
(B) Because benzene has no double bonds.
(C) Because benzene has a stable delocalized pi system.
(D) Because benzene is non-polar.

Correct Answer: C

Explanation: Because benzene has a stable delocalized pi system. — this correctly answers the question.

24. What is the directing effect of the -COOH group?

(A) Ortho/para
(B) Both ortho and meta
(C) No directing effect
(D) Meta

Correct Answer: D

Explanation: Meta — this correctly answers the question.

25. When methylbenzene is nitrated, what is the major product?

(A) 2-nitromethylbenzene
(B) 3-nitromethylbenzene
(C) 4-nitromethylbenzene
(D) All are equal

Correct Answer: A

Explanation: The major product is 2-nitromethylbenzene (ortho), with 58% yield.

B. Less Important / Secondary Topics

26. Which of the following is an incorrect statement about the reactivity of benzene?

(A) Benzene does not react with electrophiles.
(B) Benzene undergoes addition reactions easily.
(C) Benzene undergoes substitution reactions to preserve aromaticity.
(D) Benzene is more reactive than alkenes.

Correct Answer: A

Explanation: Benzene does react with electrophiles, but only in the presence of a catalyst.

27. Which of the following is a correct statement about the directing effect of halogens?

(A) They are activating and ortho/para-directing.
(B) They are deactivating and ortho/para-directing.
(C) They are deactivating and meta-directing.

(D) They are activating and meta-directing.

Correct Answer: B

Explanation: Halogens are deactivating but ortho/para-directing.

28. What is the role of aluminium chloride in Friedel-Craft alkylation?

(A) It acts as a nucleophile.
(B) It acts as a base.
(C) It acts as a Lewis acid and halogen carrier.
(D) It acts as a solvent.

Correct Answer: C

Explanation: AlCl□ acts as a Lewis acid and halogen carrier.

29. Which of the following is a correct statement about the E/Z system?

(A) It is used for alkanes.
(B) It is used for alkynes.
(C) It is used for benzene.
(D) It is used for alkenes with different groups on each carbon.

Correct Answer: D

Explanation: The E/Z system is used for alkenes with different groups on each carbon.

30. What is the relationship between the stability of cis and trans isomers?

(A) Trans isomers are generally more stable than cis isomers due to less steric hindrance.
(B) Cis isomers are generally more stable than trans isomers.
(C) Both isomers have the same stability.
(D) Stability depends only on the molecular weight.

Correct Answer: A

Explanation: Trans isomers are generally more stable than cis isomers due to less steric hindrance. — this correctly answers the question.

31. Which of the following compounds can show geometric isomerism?

(A) 1-butene
(B) 2-butene
(C) Propene
(D) Ethene

Correct Answer: B

Explanation: 2-butene — this correctly answers the question.

32. What is the product of the reaction of benzene with bromine in the presence of FeBr□?

(A) Benzene bromide
(B) Dibromobenzene
(C) Bromobenzene
(D) Bromomethane

Correct Answer: C

Explanation: Bromobenzene — this correctly answers the question.

33. What is the product of the reaction of benzene with chlorine in the presence of FeCl□?

(A) Benzene chloride
(B) Dichlorobenzene
(C) Chloromethane
(D) Chlorobenzene

Correct Answer: D

Explanation: Chlorobenzene — this correctly answers the question.

34. Which of the following is an example of an electrophilic aromatic substitution reaction?

(A) Nitration of benzene
(B) Hydrogenation of benzene

(C) Oxidation of benzene
(D) Combustion of benzene

Correct Answer: A

Explanation: Nitration is an electrophilic aromatic substitution reaction.

35. What is the intermediate formed in the electrophilic substitution of benzene?

(A) Carbocation
(B) Arenium ion
(C) Carbanion
(D) Free radical

Correct Answer: B

Explanation: The intermediate is the arenium ion (sigma complex).

36. Why does the reaction of toluene with nitric acid give a mixture of ortho, meta, and para products, with ortho and para being the major products?

(A) Because the methyl group is electron-withdrawing and meta-directing.
(B) Because the methyl group is neutral.
(C) Because the methyl group is electron-donating and ortho/para-directing.
(D) Because the reaction is random.

Correct Answer: C

Explanation: Because the methyl group is electron-donating and ortho/para-directing. — this correctly answers the question.

37. Which of the following is the correct order of reactivity of substituted benzenes towards electrophilic substitution?

(A) Nitrobenzene > Benzene > Phenol
(B) Benzene > Phenol > Nitrobenzene
(C) Phenol > Nitrobenzene > Benzene
(D) Phenol > Benzene > Nitrobenzene

Correct Answer: D

Explanation: Phenol is activated (most reactive), benzene is neutral, and nitrobenzene is deactivated (least reactive).

38. Which of the following is a correct statement about the resonance energy of benzene?

(A) It is the extra stability gained from the delocalization of pi electrons.
(B) It is the energy required to break the C-C bonds.
(C) It is the energy of the C-H bonds.
(D) It is the energy released during combustion.

Correct Answer: A

Explanation: Resonance energy is the extra stability gained from delocalization.

39. Which of the following is a correct statement about the orientation of substituents in electrophilic aromatic substitution?

(A) Electron-donating groups are meta-directing.
(B) Electron-donating groups are ortho/para-directing.
(C) Electron-withdrawing groups are ortho/para-directing.
(D) All groups are ortho/para-directing.

Correct Answer: B

Explanation: Electron-donating groups are ortho/para-directing.

40. What is the major product of the reaction of chlorobenzene with nitric acid and sulfuric acid?

(A) m-Nitrochlorobenzene
(B) Chloronitrobenzene
(C) o-Nitrochlorobenzene and p-nitrochlorobenzene
(D) No reaction

Correct Answer: C

Explanation: O-Nitrochlorobenzene and p-nitrochlorobenzene — this correctly answers the question.

41. Why is the C-Cl bond in chlorobenzene stronger than in chloroethane?

(A) Because chlorine is more electronegative in chlorobenzene.
(B) Because the carbon atom in chlorobenzene is sp^3 hybridized.
(C) Because chlorobenzene is a smaller molecule.
(D) Because of the resonance effect that gives partial double bond character to the C-Cl bond.

Correct Answer: D

Explanation: Because of the resonance effect that gives partial double bond character to the C-Cl bond. — this correctly answers the question.

42. Which of the following is a correct statement about the halogenation of benzene?

(A) It requires a Lewis acid catalyst.
(B) It does not require a catalyst.
(C) It produces an addition product.
(D) It is a free radical reaction.

Correct Answer: A

Explanation: Halogenation of benzene requires a Lewis acid catalyst such as $FeBr_3$ or $FeCl_3$.

43. Which of the following is a correct statement about the nitration of benzene?

(A) It requires only nitric acid.
(B) It requires a mixture of concentrated nitric and sulfuric acids.
(C) It requires only sulfuric acid.
(D) It requires a Lewis acid catalyst.

Correct Answer: B

Explanation: Nitration uses a mixture of concentrated nitric and sulfuric acids to generate the nitronium ion.

44. What is the product of the reaction of benzene with ethanoyl chloride in the presence of $AlCl_3$?

(A) Ethylbenzene
(B) Benzoic acid
(C) Phenylethanone
(D) Benzene ethanoate

Correct Answer: C

Explanation: Phenylethanone — this correctly answers the question.

45. Which of the following is a correct statement about the relative stability of benzene and cyclohexene?

(A) Cyclohexene is more stable than benzene.
(B) Both have the same stability.
(C) Stability depends on the solvent.
(D) Benzene is more stable than cyclohexene.

Correct Answer: D

Explanation: Benzene is more stable than cyclohexene. — this correctly answers the question.

46. Which of the following is a correct statement about the addition reactions of benzene?

(A) Benzene undergoes addition reactions under harsh conditions.
(B) Benzene undergoes addition reactions easily.
(C) Benzene does not undergo addition reactions.
(D) Benzene undergoes addition reactions without a catalyst.

Correct Answer: A

Explanation: Benzene undergoes addition reactions under vigorous conditions (e.g., hydrogenation with Ni catalyst at high temperature and pressure).

47. Which of the following is a correct statement about the oxidation of alkylbenzenes?

(A) The aromatic ring is oxidized.

(B) The alkyl side chain is oxidized to a carboxylic acid.
(C) The alkyl side chain is reduced.
(D) No reaction occurs.

Correct Answer: B

Explanation: The alkyl side chain is oxidized to a carboxylic acid. — this correctly answers the question.

48. Which of the following is a correct statement about the Friedel-Craft alkylation of benzene?

(A) It produces a carboxylic acid.
(B) It requires a strong base.
(C) It requires a Lewis acid catalyst.
(D) It produces an alcohol.

Correct Answer: C

Explanation: Friedel-Craft alkylation requires a Lewis acid catalyst such as AlCl□.

49. Which of the following is a correct statement about the Friedel-Craft acylation of benzene?

(A) It introduces an alkyl group onto the ring.
(B) It introduces a nitro group onto the ring.
(C) It introduces a halogen onto the ring.
(D) It introduces an acyl group onto the ring.

Correct Answer: D

Explanation: It introduces an acyl group onto the ring. — this correctly answers the question.

50. Which of the following is a correct statement about the orientation of substituents in electrophilic aromatic substitution?

(A) Ortho/para attack is favored for electron-donating groups.
(B) Ortho/para attack is favored for electron-withdrawing groups.
(C) Meta attack is favored for electron-donating groups.
(D) The position is independent of the substituent.

Correct Answer: A

Explanation: Electron-donating groups stabilize the arenium ion for ortho/para attack, making these positions favored.