

K1 level

1. The Hammett equation is
a) $\log k = \sigma \rho$ b) $\log k - \log k_0 = \sigma \rho$ c) $\log k/k_0 = \rho$ d) $\log k = \sigma$
2. Which one of the following is a carbene?
a) methylene b) methyl group **c) methyl free radical** d) ethylene
3. Which of the following is a unimolecular mechanism?
a) S_Ni **b) S_N2 (front)** c) S_N2 (back) d) S_N1
4. Which of the following is ortho-para directing in electrophilic substitution reactions?
a) $-NO_2$ group b) $-COOH$ group **c) $-NH_2$ group** d) $-CHO$ group
5. Which one of the following mechanisms is a one-step process
a) S_N^1 b) $E1$ **c) $E2$** d) $E1CB$
6. Identify the vinylic group
a) **$CH_2=CH-$** b) $CH \equiv C -$ c) $CH_3 \equiv C -$ d) CH_3CH_2-
7. What is the product obtained in the Birch reduction of benzene?
a) 1,4- cyclohexadiene b) 1,3- cyclohexadiene c) cyclohexane d) cyclohexene
8. Reaction of a silver salt of carboxylic acid with bromine is called
a) Michael reaction b) Chichibabin reaction c) MPV reaction **d) Hunsdiecker reaction**
9. [10] annulenes do not show aromatic character because
a) it does not obey Hückle rule b) only benzene derivatives are aromatic
c) it is a heterocyclic compound **d) it is not planar**

10. For a set of reaction conditions with different substituents ----- is a constant for a given reaction

- a) σ^+ b) σ^- **c) σ** d) ρ

11. Tropylium cation is

- a) antiaromatic **b) aromatic** c) nonaromatic d) homoaromatic

12. Stereo chemistry of SN2 reaction is

- a) retention of config **b) inversion of config** c) racemisation d) partial inversion

13. To findout whether the reaction is inter or intramolecular, the experiment used is

- a) isotopic labeling** b) trapping of intermediates
c) cross over experiments d) testing possible intermediates

14. The order of reactivity of SN2 reaction is

- a) methyl > primary > secondary > tertiary** b) secondary > methyl > primary > tertiary
c) tertiary > primary > methyl > secondary d) primary > secondary > tertiary > methyl

15. Chlorine on benzene ring is -----

- a) strongly activating **b) activating** c) weakly deactivating d) strongly deactivating

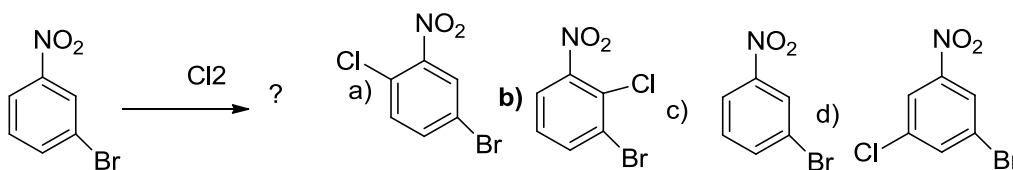
16. $-\text{CONH}_2$ group

- a) o & p-directing** b) m-directing c) o-directing d) p-directing

17. Formylation of aromatic compounds using a mixture of CO, HCL, AlCl_3 & CuCl

- a) Gattermann reaction **b) Gattermann Koch reaction**
d) Reimer-Tiemann reaction d) Klobe-Schmitt reaction

18.



19. In nitrobenzene, benzene and toluene for which one of the energy of activation for electrophilic substitution is more
a) Benzene **b) toluene** c) nitrobenzene d) None of these
20. An ambident nucleophile is,
a) NO_2^- b) OH^- c) CH_3 d) NH_2^-
21. Which one of the following is not a neighbouring group in aliphatic nucleophilic substitution
a) COO^- b) NH_2 c) CH_3 d) COAr
22. Which acid is the most highly ionized in water?
a. $(\text{CH}_3)_2\text{CH}.\text{COOH}$ b) $\text{CH}_3.\text{CH}_2.\text{COOH}$
c) $\text{Cl}_2\text{CH}.\text{CH}_2.\text{COOH}$ **d) $\text{CH}_3.\text{CCl}_2.\text{COOH}$**
23. Rearrange the following in the increasing order of acidity
I. benzoic acid II. p-methoxy benzoic acid III. o-methoxy benzoic acid
a. $\text{I} < \text{II} < \text{III}$ b) $\text{III} < \text{I} < \text{II}$ **c) $\text{II} < \text{I} < \text{III}$** d) $\text{III} < \text{II} < \text{I}$
24. $\text{S}_\text{N}1$ reaction on optically active substrates mainly gives
a) retention in configuration b) inversion of configuration
c) racemic product d) no product
25. In E_2 elimination some compounds follow Hofmann's rule which means
a) the double bond goes to the most substituted position
b) the compound is resistant to elimination
c) no double bond is formed
d) the double bond goes mainly toward the least substituted carbon.
26. One of the modern methods of studying free radicals is

a)IR spectra b)UV spectra **c) CI DNP** d) microwave spectra

27. The number of unshared electrons on the carbene carbon is

a)1 **b)2** c)3 d)4

28. In the singlet and the triplet states of methylene radical, the unshared electrons are respectively

a) unpaired, unpaired b) paired, paired c) unpaired, paired **d) paired, unpaired**

29. For a reaction between an alkyl halide and OH^- increase in solvent polarity generally

a) increases the rate of S_N^1 reaction b) decrease the rate of S_N^1 reaction
c) Increase the rate of S_N^2 reaction d) does not alter the rate of S_N^1 and S_N^2 reaction

30. Which of the following reaction undergoes without formation of any intermediate?

a) S_N^1 Reaction b) S_N^1 reaction c) Ar S_N^1 reaction **d) S_N^2 reaction**

31. Which doesnot involve a carbocation?

a) $(\text{CH}_3)_3\text{CCl} + \text{AgNO}_3 \longrightarrow$
b) $(\text{CH}_3)_3\text{COH} + \text{HCl} \longrightarrow$
c) $(\text{CH}_3)_3\text{CH} + \text{Cl}_2 + h\nu \longrightarrow$
d) $\text{CH}_3\text{CH}=\text{CHCH}_2\text{OH} + \text{H}_3\text{O}^+ \longrightarrow$

32. Which of the following ions will be most effective in an $\text{S}_\text{N}2$ displacement on methyl bromide

a) $\text{C}_2\text{H}_5\text{O}^-$ b) HO^- c) $\text{C}_6\text{H}_5\text{O}^-$ d) CH_3COO^-

33. Which of the following is not a source of carbene?

a) CH_2N_2 b) $\text{H}_2\text{C}=\text{C}=\text{O}$ **c) CHCl_3/KOH** d) $\text{CH}_2\text{I}_2/\text{Zn}$

34. Which of the following would react fastest with N-bromosuccinimide

a) benzene b) methane c) pyridine **d) toluene**

35. The reactive intermediate in the Reimer-Tiemann reaction is
a) formal anion b) formyl carbocation c) dichloromethyl carbocation **d) dichlorocarbene**
36. The nucleophilic attack on a carbon-carbon double bond generates
a) carbanion b) carbene c) carbocation d) free radical
37. Thermal decomposition of tetrazoles give
a) carbene b) nitrene c) carbocation d) free radical
38. In singlet state of carbene carbon atom is
a) sp hybridized b) sp³ hybridised **c) sp² hybridised** d) none
39. In S_N reactions the best leaving group among the following is
a) chloride b) fluoride **c) tosylate** d) bromide
40. In E2 reaction the dihedral angle of anti periplanar conformation is
a) 0° b) 90° c) 120° **d) 180°**
41. Benzyne is generated from
a) chlorobenzene in presence of sodamide in liquid NH₃
b) benzene with sodium in liq. NH₃
c) benzene in liq. NH₃
d) action of heat on benzoic acid
43. Which one of the following undergoes nitration most readily
a) benzene **b) acetanilide** c) acetophenone d) chlorobenzene

44. Chlorine on benzene ring is -----group

- a) strongly activating b) Activating c) **weakly deactivating** d) Strongly deactivating

45. Hybridisation of alkyl carbanion is

- a) **sp^3** b) sp^2 c) sp d) sp^2d

46. Carbenes are

- a) **Electron deficient species** b) Electron rich species c) Bases d) Lewis acids

47. E_2 elimination is a

- a) Syn elimination b) **Anti elimination** c) 1,1 elimination d) 1,3 elimination

48. Pick out the nucleophile which is not ambident

- a) CN^- b) NCO^- c) **$^-OCH_3$** d) $R_2C^- -NO_2$

49. Nucleophilic rearrangement with allylic rearrangement is taking place in

- a) SN^i rxn b) **SN^1 rxn** c) SN^2 rxn d) None

50. In aromatic nucleophilic substitution reaction----- is a very good leaving group among halides

- a) Cl^- b) **F^-** c) Br^- d) I^-

K2 level

1. Define antiaromaticity
2. What is non aromaticity? Give example
3. What are thermodynamic stable compounds
4. Define Hammond postulate
5. What primary kinetic isotopic effect
6. What are secondary kinetic isotopic effect
7. What do you know about cross over experiment
8. How will you find out the reaction is intramolecular with help of isotopic labeling
9. How stereochemical evidence helpful for predicting reaction mechanism
10. Write any two criteria for aromaticity
11. What are homoaromatic compounds
12. Write the difference between intermediate and transition state.
13. Write any two factors affecting electrophilic substitution reaction.
14. Define ipso attack
15. Define ortho para ratio
16. Write any one example for Jacobson reaction
17. Write any two applications for Gattermann-Koch reaction.
18. What electron withdrawing groups? give examples
19. Write any four electron donating groups
20. How e-I effect and +I effect determine the orientation of the incoming groups in substitution reactions.
21. Write any two examples for hydrogen exchange reactions
22. Write the stereochemistry of the SN2 reaction.
23. How neighbouring groups affect the reactivity of nucleophilic substitution?.
24. What are ambident nucleophiles?
25. What are ambident substrates?
26. What is pyrolytic elimination?
27. Outline the evidences for SN2 mechanism.
28. How will you differentiate substitution and elimination reactions

29. Define benzyne reaction.
30. Demonstrate Ziegler alkylation
31. Explain cis elimination
32. What is Cope elimination
33. Define Bredt's rule
34. Define Cinn substitution.
35. Define Hoffman rule
36. Define Saytzeff rule.
37. Give example for dehydrohalogenation
38. Abbreviate AlCl_3 , AlCl_2 , AlCl and Al .
39. Define classical carbocation
40. Define non classical carbocation.
41. Write the structure of nitrenes, carbenes and carbanions.
42. How will you identify free radicals?
43. Write any two reactions of Sandmeyer mechanism.
44. Define Michael addition
45. Compare addition and elimination reactions.
46. Write any two addition reaction to carbonyl reaction.
47. Write the product of addition reaction with triple bonds.
48. Define Diels Alder reaction.
49. Write any two reactions for hydroxylation.
50. Define hydroboration.

K3 Level

1. a. Inspect the Non-benzenoid aromatic compounds.

(OR)

- b. Explain the Kinetic and thermodynamic control of chemical reactions.

2. a. Test the Taft equation for meta substituted compounds.

(OR)

- b. Predict the Methods of determining intermediates.

3. a. Discuss the benzyne mechanism with suitable examples.

(OR)

- b. Write in detail about the S_Ni and S_N2 reaction with examples.

4. a. Explain Houben-Hoesch reaction mechanism.

(OR)

- b. What is the effect of substance and leaving group on S_E1 & S_E2 reactions.

5. a. How could you differentiate S_E1, S_E2 & S_Ei mechanisms.

(OR)

- b. Explain Taft equation for substituted compounds.

6. a. What is primary kinetic isotopic effect? How does it differ from secondary kinetic Isotopic effect? Explain with examples.

(OR)

- b. Discuss Hammond Postulate.

7. a. Discuss the arenium ion mechanism with evidences.

(OR)

- b. What is Hofman- Martius reaction? Prove the reaction as intermolecular.

8. a. What are antiaromatic and homoaromatic compounds? Give examples (OR).

(OR)

- b. With the help of cross over experiments how would you show that the reaction is intermolecular or intramolecular.

9. a. What is hydroboration reaction? Explain with an example. What are its uses?
(OR)
- b. How do aldehydes and ketones react with Grignard reagent?
10. a. What is Bischler- Napieralski reaction. Give its mechanism.
(OR)
- b. Explain the Gattermann, and Gattermann-Koch reaction.
11. a. Illustrate the factors affecting reactivity of SE reaction.
(OR)
- b. Explain the mechanism of neighbouring group participation with an example.
12. a. Explain aromaticity in five membered ring compounds with a suitable example.(OR)
- b. Discuss E1CB mechanism.
13. a. Explain the mechanism of addition of bromine to an alkene.
(OR)
- b. Explain SE2 mechanism of aliphatic electrophilic substitution.
14. a. Interpret cross over experiments, isotope labeling, stereochemical evidence.
(OR)
- b. Examine Alternate and non-alternant hydrocarbons?
15. a. Write a note on aromaticity of benzenoid compounds.
(OR)
- b. Illustrate about Non-benzenoid aromatic compounds.
16. a. Examine factors affecting reactivity in SE reactions
(OR)
- b. Explain SE1 and SE2 reaction mechanism.
17. a. What is benzyne?. Discuss the benzyne mechanism.
(OR)
- b. What is E1 mechanism?. Give an evidence for the mechanism.
18. a. Give a method of generation of carbenes. Explain the structure of carbenes.
(OR)

b. What are cross over experiments? Explain with example.

19. a. Explain the Arenium ion mechanism.

(OR)

b. Write a note on Diazonium coupling.

20. a. Explain (i) Why cyclopentadiene is acidic? (ii) cycloheptatrienyl bromide is ionic.

(OR)

b. Explain the Bischler-Napieralski reaction.

21. a. Give the effect of solvent in aliphatic nucleophilic substitution reaction.

(OR)

b. Extend the hydrogen exchange reactions and migration of double bond.

22. a. Analyze the orientation and reactivity in mono substituted benzene rings

(OR)

b. Evaluate steric effects, ortho/para ratios and ipso attack

23. a. Write a note on effect of leaving group in aromatic nucleophilic substitution reaction.

(OR)

b. Write a note on (i) Jacobson reaction.

24. a. Explain Cope elimination with example.

(OR)

b. Give any five methods of generation of nitrenes

25. a. Distinguish between configuration & conformation

b. Examine decarboxylation of aliphatic acids.

26. a. What is Jacobsen reaction? Explain the significance of this reaction in Aromatic electrophilic substitution reaction.

(OR)

b. Compare S_N^1 & S_N^2 reaction

27. a. Explain Chloro benzene & vinyl Chloride are inert towards nucleophilic substitution reaction.

(OR)

b. Account for the following rate of amination of aryl halides with KNH_2 in liquid

NH₃ is in the order ArBr > ArI > ArCl > ArF.

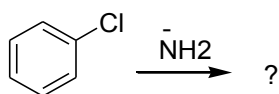
28. a. (i) Elimination of HBr from cis 4-tert-butyl cyclohexyl bromide is several times faster than Trans form –Why.

(ii) Explain 2-butanone on dehydration give mainly 2-butene

(OR)

b. (i). Discuss the various factors that influence the extent of elimination & substitution

29. a. Complete the following reaction and explain the mechanism.



(OR)

b. Discuss the effect of solvents in aliphatic nucleophilic substitution reactions.

30. a. Elaborate the Friedel Crafts alkylation & acylation mechanism

(OR)

b. Examine the Vilsmeier-Haack reaction mechanism.

31. a). Propose the Jacobson reaction.

b) Interpret the Bischler-Napieralski reaction.

32. a. Examine the orientation in di-substituted benzene rings.

(OR)

b. Explain the reactions of carbanions.

33. a. Explain S_Ni reactions and mechanisms with examples.

(OR)

b. Categorize the ambident nucleophiles and ambident substrates.

34. a. Evaluate the Substitution at vinyl carbon and allylic carbon

(OR)

b. Explain the hydrolysis of esters A_{Ac}1.

35. a. Evaluate the mechanism of Wurtz reaction.

(OR)

b. Prioritize Claisen and Dieckmann condensation - Williamson reactions.

36. a. Outline the Aromatic nucleophilic substitution.

(OR)

b. Analyze the Zeigler alkylation mechanism.

37. a. Interpret the mechanism of Chichibabin reaction.

(OR)

b. Examine the Vonbraun reaction

38. a. Evaluate the Cine substitution reaction

(OR)

b. Compare the hydrolysis of esters A_{Ac2} and B_{Al1}

39. a. Determine Stereochemistry of $E2$ elimination

(OR)

b. Outline the Hofmann and Saytzeff's rules.

40. a. Distinguish between elimination and substitution

(OR)

b. Analyze pyrolytic cis elimination.

41. a. Explain with example of Chugaev reaction.

(OR)

b. Examine Hofmann degradation and Cope elimination

42. a. Determine the generation and stability of reactive intermediates.

(OR)

b. Compare classical and non-classical carbocations

43. a. Explain the importance of Carbanions, carbenes and nitrenes as intermediate.

(OR)

b. How will you identify free radicals by spectral and chemical methods?

44. a. Examine free radical halogenations with examples.

(OR)

b. Interpret Sandmeyer and Gomberg reaction mechanism.

45. a. Explain Ullman and Pschor reactions with applications.

(OR)

b. Examine the Hunsdiecker reaction mechanism.

46. a. Determine Electrophilic addition to double bonds.

(OR)

b. Examine addition to triple bonds.

47. a. Explain hydration reactions with examples

(OR)

b. Extend the hydroxylation reactions with examples

48. a. Illustrate the Michael addition with its applications

(OR)

b. How will you explain hydroboration additions with examples.

49. a. Demonstrate the epoxidation reactions with examples.

(OR)

b. Evaluate the addition to carbonyl compounds with suitable examples.

50. a. Illustrate neighbouring group participation with four examples.

(OR)

b. Discuss different mechanisms of hydrolysis.

K4 Level

1. (i).Discuss the use of non- kinetic methods in determining reaction mechanism.
(ii).Discuss the concept of anti aromaticity with suitable example.
2. (i).Determine the aromaticity of annulenes.
(ii). Discuss the use of the following in the determination of the mechanism.
(i) Isotope labeling (ii) product analysis.
3. (i) Write notes on Gattermann-Koch synthesis Hoffmann Maritius reaction.
(ii)Explain cyclophanes with example.
4. (i) Explain the theory of orientation in mono substituted benzene rings towards aromatic electrophilic substitution reaction.
(ii) Explain Reimer-tiemann reaction.
5. (i)Explain the stereochemistry of nucleophilic substitution reaction.
(ii)what are ambident nucleophiles ?Give example.
6. (i) Examine benzyne mechanism.
(ii)Write SN/Ar mechanism of aromatic nucleophilic substitution. Give evidence.
7. (i)What are carbenes. How are they generated? Discuss any three reaction of it.
(ii)State & Explain Saytzeff & Hoffmann rules.
8. (i) Compare elimination Vs Substitution reaction.
(ii)Explain Hoffmann degradation with suitable example.
9. (i) Write an explanatory note on the aromaticity of Nonbenzenoid aromatic compounds.
(ii)Explain the usefulness of isotopic labeling and stereochemical studies in the study of Reaction mechanism.
10. (i)Explain the mechanism of the following
(i) knoevengal condensation (ii) Dieckmann condensation reaction.
11. i) Predict the major mono nitration products of the following compounds
(a) *o*-cresol (b) *p*-nitro toluene (c) *m*-chloro nitro benzene
(ii)Write a note on Stork-Enamine reaction

12. (i) Explain the epoxidation and Sharpless epoxidation reaction.
(ii) Explain the mechanism of Vilsmeier-Haack formylation reaction.
13. (i) How is isoquinoline synthesized by Bischler-Napieralski reaction?
(ii) Explain the following (i) Hofmann-Martius reaction. (ii) Jacobson's reaction.
14. Discuss the effect of structure of the substrate and solvent on the aliphatic nucleophilic Substitution reaction.
15. Write briefly on (i) Chichibabin reaction (ii) Ziegler alkylation.
16. Discuss the aromaticity of annulenes on the basis of Huckel's rule of aromaticity.
17. (i) How is aromaticity detected using NMR spectroscopy?
(ii) State and Explain Hammett equation giving examples.
18. Discuss the stereochemistry of S_N^1 and S_N^2 reaction.
19. Discuss the different mechanism of aromatic nucleophilic substitution reaction.
20. Bring out the importance of stereochemical studies and isotope labeling techniques in detecting the mechanism of a reaction.
21. Halogens are ring deactivators *O* & *P*-directors Explain.
22. Explain the following observation.
23. (i) Toluene through a faster reaction gives mainly *o* & *p*- nitro toluene.
(ii) Nitrobenzene through a slower reaction gives mainly *m*-dinitrobenzene.
24. Explain mechanism, different reagent, limitations and two important applications of Friedel-Crafts alkylation and acylation reaction.
25. a. Discuss definition, mechanism and applications of Friedel-Crafts alkylation How the limitation of alkylation are rectified in acylation?.
26. Explain the study of intermediates in determining the mechanism of a reaction.
27. Discuss the mechanism of addition of hydrogen halides to carbon-carbon double bond system.

28. Discuss the mechanism of Vonbraun and Wurtz reaction reactions.
29. Explain neighbouring group mechanism with example.
30. (i) Describe E1 mechanism. Bring out evidences in favour of mechanism.
(ii) State and explain Hoffmann and Saytzeff rules.
31. Explain the following reaction: (i) Michael reaction (ii) 1, 3 dipolar addition.
32. Discuss in detail about S_NAr and S_N1 aromatic nucleophilic substitution reaction.
33. Discuss the conformation and stability of mono and distributed cyclohexanes.
34. What is neighboring group participation? Discuss in detail about various group and bonds as a neighbor.
35. Discuss nucleophilic substitution on trigonal carbon. Write in detail about various mechanism of ester hydrolysis.
36. Examine generation and stability of carbanions and carbenes.
37. Discuss in detail about E1 & E2 mechanism.
38. (i) What is Chugaev reaction? Discuss its mechanism. (ii) Explain cope elimination.
39. (i) Discuss the aromaticity in heterocyclic compounds with two examples.
(ii) Explain the use of studying intermediates in determining mechanism of reaction.
40. (i) Discuss primary and secondary isotopic effects.
(ii) Give Hammett equation. Discuss its significance.
41. (i) Discuss the effect of substrate structure on the reactivity of aliphatic electrophilic substitution reaction.
(ii) Explain Bischler-Napieralski reaction.
42. Explain Vilsmeier-Haack, Ullman and Pschorr reactions.
43. Evaluate Substitution at vinyl carbon and allylic carbon.

44. Justify the role of ambident nucleophiles and ambident substrates in substitution reaction.
45. Determine the following hydrolysis of esters AAc1, AAc2, and BAc2.
46. Explain hydrogen exchange reaction and halogenation of carbonyl compounds.
47. Though $-OH$ and $-NH_2$ groups are electron withdrawing groups, phenol and aniline are more reactive than benzene towards electrophilic substitution and chief products are *o*- & *p*- isomers. Show how reactivity and orientation can be accounted for on the basis of resonance?
48. Explain why E2 reaction is most common elimination reaction among E2, E1 and E1cb.
49. Chlorobenzene is far less reactive than aniline in electrophilic substitution although chlorine and nitrogen have almost the same electronegativity. Explain.
50. Explain why the bromination of toluene is five times faster than that of *t*-butyl benzene?