K1 Level

1. The electromagnetic radiation in the frequency range $10^{19} – 10^{17}$ Hz belong to

   a) UV spectrum **b) X-rays** c) IR d) Visible

2. The radiation in the wavelength range 400 -800 nm corresponds to

   a) Ultra – Violet b) Infra – Red **c) Visible** d) Far IR

3. The ionization and fragmentation of the molecule into spectrum of fragment ions is caused by

   a) Microwaves b) IR radiations **c) electron beam impact of 70 eV** d) none of these

4. Vibrational transition exists in

   a) IR b) microwave c) Radio wave region of the spectrum d) UV

5. The total number of normal modes of vibration of a linear molecule consisting of N atoms is given by

   a) (3N -6) **b) (3N -5)** c) (3N -7) d) (3N -4)

6. For a pure rotational spectrum, the selection rule is

   a) $\Delta J = +1$ b) $\Delta J = \pm 2$

   c) $\Delta J = 0$, provided the molecule has permanent dipolemoment d) $\Delta J = -1$

7. The IR band spectra show the changes in vibrational and rotational energies of a molecule subject to selection rule

   a) $\Delta v = 0, \Delta J = \pm 1$ **b) $\Delta v = \pm 1, \Delta I = \pm 1$** c) $\Delta v = \pm 1, \Delta J = \pm 2$ d) $\Delta v = \pm 2, \Delta J = 0$

8. For a linear molecule such as HCl, the number of modes of vibration are

   a) 0 **b) 1** c) 2 d) 3

9. Foe a non-linear molecule like H_2O, the number of vibrational modes are

   a) 3 b) 4 c) 5 d) 6

10. For CO_2 molecule, number of modes of vibration are

    a) 3 b) 5 **c) 4** d) 6

11. The factors on which the wave number of adsorption depends in IR spectroscopy are

    a) Inductive effect b) Field effect c) Hydrogen bonding **d) all of these**

12. The unit of force constant in CGS unit is

    a) dyne cm^2 b) joule cm^{-1} **c) dyne cm^{-1}** d) None

13. For a same organic compound in all the three states, the absorption frequency has the least value when the compound is in

a) liquid state **b) solid state** c) vapour state d) same in all the three states

14. In IR spectroscopy, the pair of isomers, which cannot be distinguished are

a) cis – trans isomers b) functional isomers **c) enantiomers** d) position isomers

15. The cycloalkanones, the frequency of absorption for carbonyl group νc = 0 increases with

a) increase in size of the ring **b) decrease in size of the ring**

c) decrease in bond angle d) none of these

16. Primary amide ($RCONH_2$) shows 2 absorption bands between 3400 – 3500 cm^{-1}. On treatment with P_2O_5, the compound formed absorbs at

a) 3500 cm^{-1} b) 1650 cm^{-1} **c) 2256 cm^{-1}** d) 3250 cm^{-1}

17. The type of hydrogen bonding in organic compounds can be distinguished by taking the spectra after dilution with

a) water b) methyl alcohol **c) CCl_4** d) CH_3COCH_3

18. Number of translational, rotational and vibrational degrees of freedom in CO_2 molecule, respectively

a) 3,2,4 b) 3,4,2 c) 3,3,3 d) 3,3,4

19. The zero point energy of a harmonic oscillator is

a) hv b) zero **c) hv/2** d) 3/2 hv

20. Which transition is called first overtone?

a) v=o to v=1 b) v=0 to v=2 c) v=0 to v=3 d) v=1 to v=2

21. For Raman spectra, the molecule must have

a) anisotropic polarisability b) isotropic polarisability

c) oscillating dipolemoment d) Hydrogen bonding

22. The selection rule of stokes line in the rotational Raman spectrum of a molecule is

a) $\Delta J = -2$ **b) $\Delta J = +2$** c) $\Delta J = 0$ d) $\Delta J = +1$

23. The cause of Raman spectrum of a molecule is

a) Change of polarisability of the molecule b) noeffect on polarisability of the molecule

c) Inductive effect d) none

24. Which of the following are microwave active?

a) HCl b) CO_2 c) H_2 d) O_2

25. The molecule which is IR inactive but Raman active is

a) HCl b) SO_2 **c) N_2** d) Protein

26. Raman effect is

a) absorption of light b) emission of light

c) Inelastic scattering of light d) elastic scattering of light

27. Raman spectrum of a compound is not disturbed by

a) frequency of incident radiation **b) the presence of water**

c) absence of polarisability d) none of these

28. Alkanes show which transition? (a) σ-π* **(b) σ-σ*** (c) π- π* (d) n- π*

29. Carbonyl compounds exhibit the transition

(a) σ-σ*, π-π* **(b) σ-π*, π-π*,n-π*** (c) σ-σ*, n-σ*, π-π* (d) none of these

30. Molar absorptivity Σ is given by_____

(a) A.C.l **(b) A/Cl** (c) C/Al (d) l/AC

31. Hydrogen bonding in organic compounds shifts the ultraviolet absorption to_____

(a) Shorter frequencies **(b) Shorter wavelength** (c) Remain unchanged

(d) None of these

32. The value of extinction coefficient increases with _____

(a) Increase in conjugation b) Addition of chromophore **(c) Both of these**

(d) None of these

33. Bathochromic shift implies_____

(a) A shift of longer wavelength (b) A shift of smaller wavelength

(c) An increase in intensity (d) An decrease in intensity

34. An auxochrome is one which is_____

(a) Colour enhancing (b) Extending conjugation

(c) A group or atom with lone pair of electrons (d) All of these

35. Hyperchromic shift means

(a) A shift of longer wavelength (b) A shift of smaller wavelength

(c) An increase in intensity (d) An decrease in intensity

36. The base value per Homoannular (cisoid) dienes (in nm) is_____

(a) 253 (b) 214 (c) 215 (d) 202

37. λ_{max} value for acetone_____

(a) 270 (b) 125 (c) 368 (d) 207

38. NMR Spectra are observed in _____region

a) Radio frequency b) microwave c) UV/ Visible d) X-rays

39. The NMR Spectroscopy is useful for the detection of

a) Hydrogen bonding b) aromaticity c) geometrical isomers

d) all of these

40. How many NMR signals are formed for 2- chloro propene.

a) 2 **b) 3** c) 1 d) none

41. Tell the number of NMR signals in case of 1,2 dichloropropane

a) 2 b) 3 **c) 4** d) 5

42. Write the multiplicity of the signals in $CH_3CH_2OCH_2CH_3$ in NMR Spectrum

a) 2 triplets **b) a triplet and a quartet** c) 2 singlets d) 2 singlets and 2 triplets

43. In an organic compound, the proton linked to sp^2 hybridised carbonation is more deshielded than that linked to

a) Sp hybridized carbon b) sp^3 hybridised carbon **c) both of these** d) none

44. Out of the olefinic, aldehydic and aromatic protons, the decreasing deshielding has the order

a) olefinic > aldehydic > aromatic **b) aldehydic > olefinic > aromatic**

c) aromatic > olefinic > aldehydic d) olefinic > aromatic > aldehydic

45. Write the multiplicity of the signals in CH_3CH_2OH in NMR Spectroscopy

a) singlet, triplet and quartet b) 2 triplets and a quintet c) 3 singlets

d) none of these

46. Which of the following solvents cannot be used in NMR spectroscopy?

a) CCl_4 b) CS_2 **c) $CHCl_3$** d) $(CCl_3)_2C=O$

47. The spin is an integer 1, 2,3…. For a nucleus having

a) even number of protons and neutrons b) odd mass number

c) even mass number and odd number of protons d) none of these

48. For two sets of protons for CH_3-CH_2-CO-, part of an organic compound, the value of J for these two sets will be

a) different **b) same** c) may be same or different d) zero

49. The signals for a compound like A-CH_2-CH_2-B will be

a) 2 triplets b) 2 singlets c) one singlet d) one triplet

50. Nuclear overhauser effect helps in predicting the

a) geometry of the molecule **b) two different protons in close proximity**

c) protons on adjacent carbon atoms d) olefinic protons

K2 Level

1. Identify the region in which the following energies lie:

   i) 1050cm^{-1} ii) 700 nm iii) 300 MHz

2. What happens when a substance is irradiated with IR radiation?

3. List out the various types of bending vibrations.

4. What is Hooke's law?

5. How inductive effect brings about a change in the position of absorption for a particular bond?

6. What do you mean by Finger Print Region?

7. How will you show that the compound under investigation is not aromatic? Use IR technique.

8. Which of the following diatomic molecules do not absorb in the IR region.

   HCl, ClBr, N_2, H_2, O_2

9. Why methanol a good solvent for UV but not for IR Spectroscopy?

10. What do you mean by Fundamental vibrations and overtones?

11. How will you distinguish between CH_3CONH_2 and $CH_3CH_2NH_2$?

12. How will you distinguish between CH_3CH_2CHO and CH_3COCH_3 ?

13. What is the effect of hybridization of carbon on the stretching frequency of C – H bonds?

14. What is the effect of UV or Visible light on the organic compound?

15. Define Absorbance.

16. What is the effect of Hydrogen bonding on UV absorption?

17. Tell whether a molecule can undergo more than one electronic shift.

18. What happens to the excited molecule whwn radiation is cut off?

19. How will you distinguish between cis and trans – 1,3,5-Hexatriene.

20. Describe the shift in absorption ($n \rightarrow \pi^*$) when a more polar solvent is used.

21. Which type of nuclei show magnetic properties for the purpose of NMR Spectroscopy?

22. Which property of certain atomic nuclei is involved in NMR spectroscopy?

23. How many spin states are possible for ^1H nucleus?

24. Why TMS is used as a reference standard in NMR spectroscopy?

25. What is meant by induced magnetic field?

26. Define the term chemical shift.

27. What is spin – spin splitting?

28. Define coupling constant.

29. What is meant by (n+1) rule in spin – spin coupling?

30. What do you mean by shilding and deshilding of a nucleus?

31. What do you know about magnetically non – equivalent protons?

32. List out some important characteristics of solvents used in NMR.

33. What is the effect of hydrogen bonding and rapid exchange?

34. In case of OH and NH resonances, broad signals are observed. Explain?

35. How many different types of protons are present in allyl bromide molecule?

36. How will you distinguish between equatorial and axial protons in cyclohexane?

37. Why ^{13}C is less sensitive than ^{1}H while recording NMR spectra

38. Expand DEPT used in ^{13}C-NMR spectra.

39. What are the draw backs of fully coupled and broadband decoupled spectra?

40. How will you differentiate among *o*,*m* and *p*-xylenes on the basis of their proton decoupled ^{13}C NMR

spectra?

41. ^{13}C is NMR active while ^{12}C is not. Explain.

42. Define mass spectrometry.

43. What do you mean by base peak?

44. Name some compounds in which the molecular ion peak is not often visible.

45. What is McLafferty rearrangement?

46. Which is the most abundant or the base peak in the mass spectrum of toluene?

47. How will you characterize a primary amine by means of mass spectrum?

48. Which peak is of largest abundance in primary alcohols?

49. How a molecular ion is a powerful tool for structure determination?

K3 Level

1. a) Analyze the selection rule for IR spectroscopy? Explain the factors affecting vibrational frequencies.

(OR)

b) Describe the effect of hydrogen bonding on the position of absorption frequency of a compound in IR spectroscopy.

2. a) Examine the expected IR peaks for (i) P-nitrophenol (ii) P-nitrobenzoic acid and acetic anhydride.

(OR)

b) Write notes on Fermi Resonance and Overtones

3. a) Distinguish the following pairs with the help of IR spectroscopy

(i) ethanol and dimethyl ether

(ii) cyclohex-2-enone and cyclohex-3-enone

(iii) propanal and propanone

(OR)

b) Function a double beam IR spectrophotometer.

4. a) Explain with illustrations types of stretching and bending vibrations of linear and non-linear molecule.

(OR)

b) What are the factors affecting the vibrational frequencies? Illustrate with examples.

5. a)Comment on the following: a) Hydrogen bonding raises the wavelength of IR absorption b) $\upsilon_{C=O}$ frequency for ethyl acrylate is lower than that for ethyl propionate

(OR)

b) Calculate the number of fundamental vibrations in the following molecules:

i) Methane ii) Ethanol iii) Acetylene iv) Ethylene v) Oxygen

6. a) Distinguish the Rayleigh, Stoke's and Antistoke's lines.

(OR)

b) Explain why N_2 is Raman active?

7. a) Inference how does Raman effect help in the calculation of moment of Inertia and the bond length?

(OR)

b) Examine which one of the following molecule will show rotational spectra and why?

8. a) Distinguish the Raman effect with Fluorescence.

(OR)

b) Categorize the advantages of Raman Spectroscopy over IR Spectroscopy.

9. a) Define electronic spectroscopy. What is its absorption range? Write the relationship between wavelength, frequency and wave number.

(OR)

b) Explain the absorption laws.

10. a) Explain the effect of polar solvents on (*i*) $n \rightarrow \pi^*$ (*ii*) $\pi \rightarrow \pi^*$ transitions

(OR)

b) Describe the following terms:

(*i*) Bathochromic shift (*ii*) Hypsochromic shift (*iii*) A chromophore

(*iv*) Hyperchromic effect (*v*) Auxochrome

11. a) Explain transition probability. (OR)

b) Analyze the symmetry restrictions in electronic transitions

12. a) Identify the type of transition in each of the following compounds:

(*i*) Ethanol = 290 nm ε_{max} 17

(*ii*) Acetic anhydride = 227 nm ε_{max} 44

(*iii*) 1, 3-pentadiene = 224 nm ε_{max} 22650

(*iv*) Crotonaldehyde = 214 nm ε_{max} 15850

(*v*) Styrene = 282 nm ε_{max} 450

(OR)

b) Classify the types of absorption bands.

13. a) Illustrate with an example, how steric hindrance and coplanarity affect *cis* and *trans* isomers

(OR)

b) Discuss the UV spectra of the following: (i) 1,3-butadiene (ii) naphthalene

14. a) Calculate the absorption maximum for the following based on the woodward-fieser rule:

(i) (ii)

(OR)

b) Discuss about Electromagnetic Spectrum.

15. a) Justify the position of absorption of acetone shifts in different solvents. 279 nm (hexane), 272 nm (ethanol) and 264.5 nm (water).

(OR)

b) How will you distinguish between K – band and R- band which arise due to electronic excitations in the carbonyl group of ketones?

16. a) Describe briefly the theory of NMR spectrometry.

(OR)

b) Illustrate with an examples of the shilding and the deshilding effects involved in NMR spectroscopy.

17. a) Explain the chemical shift. Describe the factors affecting chemical shift.

(OR)

b) Explain why NMR spectrum of benzene is observed at a lower field whereas that of acetylene is observed at a higher field strength.

18. a) Distinguish between inter and intra-molecular hydrogen bonding on the basis of ^{1}H NMR Spectroscopy.

(OR)

b) Explain the proton exchange reactions. How does spin decoupling occurs in certain groups?

19. a) Distinguish between Cis and Trans isomers with the help of NMR.

(OR)

b) Explain the Nuclear Overhauser Effect.

20. a) Discuss how will you distinguish cis and trans-stilbene by means of NMR Spectroscopy.

(OR)

a) Explain acetylene protons are more shielded than ethylenic protons.

21. a) Predict the structure of an organic compound with molecular mass 88 whose ^{1}H NMR data is given below:

(i) a triplet (1.23 δ) 3H (ii) a singlet (1.97 δ) 3H

(iii) a quartet (4.06δ) 2H

(OR)

b) Comparison between the chemical equivalence and magnetic equivalence

22. a) What is meant by off-resonance decoupling

(OR)

b) What are the different types of ^{13}C-NMR spectra.

23. a)What is meant by proton noise decoupled spectrum in ^{13}C-NMR spectroscopy?

(OR)

b) Comment on the carbon chemical shifts of carbonyl carbons in ^{13}C-NMR spectra

24. a) Writes notes on ^{1} H-^{13}C COSY spectra in ^{13}C-NMR spectroscopy.

(OR)

b) An organic compound with molecular formula C_4H_9Br contains the following signals in ^{1}H and ^{13}C NMR spectra: Identify the compound and explain the data.

PMR data:

(a) doublet δ = 1.04 ppm (6H)

(b) multiplet δ = 1.95 ppm (1H)

(c) doublet δ = 3.33 ppm (2H)

CMR data: (a) quartet δ = 20.9 ppm

(b) doublet δ = 30.7 ppm

(c) triplet δ = 42.2 ppm

25. a) Explain briefly on the NOESY Spectroscopy.

(OR)

b) Distinguish o, m, p-xylenes on the basis of their proton decoupled ^{13}C NMR

26. a) Justify $CDCl_3$ exhibits a triplet at δ 76, 77, 78 in its ^{13}C-NMR spectrum. Explain.

(OR)

b) Sketch and explain COSY spectrum of m-dinitrobenzene.

27. a) Explain the HMQC spectrum.

(OR)

b) Explain the HMBC spectrum.

28. a) Explain the theory of mass spectroscopy.

(OR)

b) Discuss the .molecular ion in mass spectrum explain with some important features.

29. a) Prove that Nitrogen rule with two examples.

(OR)

b) Distinguish between.three isomeric butanols on the basis of mass spectrometry.

30. a) Determine the structure of the compound whose m/e values are 74(molecular ion), 56, 43 and 31 (base peak)

(OR)

b) Justify the origin of signals. In the mass spectru, of toluene, strong peaks are formed at m/e 91 and m/e 65. Also a broad peak appears at 46.4

31. a) Describe some important features of the mass spectra of (i) aldehydes (ii) ketones

(OR)

b) Explain the important features of the mass spectra of the Hydrocarbons only alkanes and alkenes

32. a) Distinguish between 3-methyl and 4-methyl cyclohexene on the basis of mass spectrometry.

(OR)

b) Explain the fragmentation modes of aromatic nitro compounds.

33. a) Explain Retro-Diels Alder reaction associated with the fragmentation pattern of molecules in mass spectrometry.

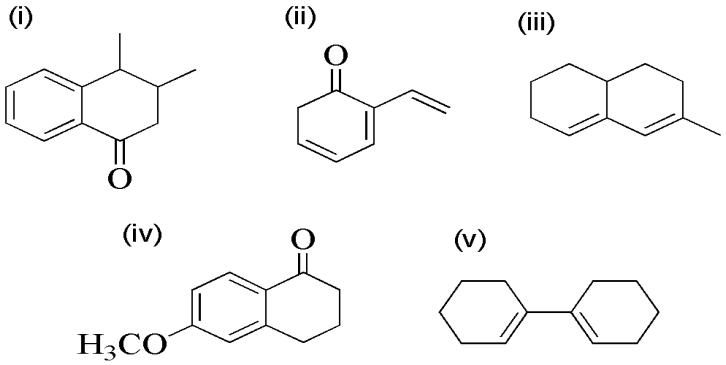
(OR)

b) Explain the fragmentation pattern associated with Phenol in Mass spectrometry.

K4 Level

1. Discuss in detail about the vibration spectra of diatomic molecules.
2. Illustrate the principle and theory of IR spectroscopy. Sketch and describe IR spectrophotometer.
3. Justify the overtones and combination bands. Discuss the applications of IR spectra to organic compounds.
4. Explain with suitable examples why hydrogen bonding and inductive effect raises the wave number of absorption in IR spectroscopy.
5. Evaluate the applications of IR spectroscopy to inorganic compounds.
4. Discuss the applications of IR spectroscopy for the identification of functional groups with suitable examples.
5. Explain force constant and zero point energy. How many fundamental vibrational frequencies would you expect in the IR spectrum of CO_2?
6. Elaborate on the following: a) Stretching and bending vibrations b) Fingerprint region c) Fermi resonance
7. (i) Discuss the effect of Temperature on rotation spectra.
   (ii) Explain the factors affecting the intensity of spectral lines.
8. Elaborate the applications of Raman spectra in structure elucidation.
9. Evaluate the Pure Rotational Raman spectra and Pure Vibrational Raman spectra of diatomic molecules.
10. Discuss briefly the quantum theory of Raman effect.
13. Briefly explain instrumentation of UV spectrophotometer with diagram.
14. Discuss the various types of electronic transitions and explain the effect of the polarity of the solvent on each type of transition.
15. Elaborate the various applications of the ultra-violet spectroscopy.
16. (a) Describe the Woodward-Fieser rules for calculating absorption maximum in dienes.
    (b) Which solvents are generally used in UV spectroscopy and why?
17. (i) Classify the various types of transitions involved in the UV spectrum.
    (ii) Evalute the effect of hydrogen bonding on UV absorption?
18. Defend the electronic transitions as applied to
    (i) Fluorescence and phosphorescence (ii) Charge- transfer complexes.
19. Describe Woodward-Fieser rules for calculating absorption maximum in α, β-unsaturated Carbonyl compounds.

20. Determine the λ_{max} for the following based on the Wood-ward rule:



21. (i) Iodine in benzene is brown while it is violet in n-hexane. Explain?

    (ii) o-nitroacetanilide is deep yellow but para-nitro acetanilide is yellow. Explain?

22. (i) While trans-stilbene absorbs at λ_{max} 294 nm, the cis isomer does at λ_{max} 274 nm. Explain why?

    (ii) Anilne has λ_{max} 230 nm in neutral medium while 203 nm in acedic medium. Why?

23. Evaluate the spin – spin coupling and spin – spin splitting with examples

24. Discuss briefly on Solvents effect in NMR Spectroscopy.

25. (i) Illustrate the Deuterium Exchange Reactions.

    (ii) Describe the Hetero nuclear Coupling.

26. Elaborate the applications of ^{1}H NMR Spectroscopy.

27. Explain the double resonance in NMR

28. Illustrate the Principle and Instrumentation of ^{1}H NMR.

29. Comparison between the instrumentation of Continuous Wave NMR and FT- NMR

30. Elaborate the 2D NMR spectroscopy

31. Explain briefly on DEPT spectrum.What is its application?

32. Discuss the structural applications of ^{13}C-NMR spectroscopy in detail.

33. Explain heteronuclear correlation spectrum in detail with example.

34. A compound with molecular weight 116 gave the following spectral information:

    (i) UV: 283 mμ ε_{max} 22.

    (ii) IR: 3000 – 2500 (b), 1715 (s), 1342 cm^{-1} (w)

    (iii) NMR : 7.88 τ Singlet (3H), 7.40 τ Triplet (2H), 7.75 τ Triplet (2H) and -1.1 τ Singlet (1H)

    Find the structure of the compound.

35. Elaborate the HETCOR Spectroscopy explain with suitable examples.

36. Discuss the magnetic moment and natural abundance of ^{13}C NMR.

37. Describe the Broad Band Decoupling.and Deuterium decoupling.

38. Elaborate the basic principles and Instrumentation of mass spectrometry.

39. Discuss the determination of molecular formula with some examples.

40. Evaluate the McLaferty Rearrangement with suitable examples.

41. Describe the metastable ions or peaks. Explain the importance of metastable peaks.

42. Construct the general fragmentation modes, explain with examples.