

Short Answer Type Questions

1. What is regeneration of ion exchangers ? How is it carried out ?
2. Why temporary hardness gets removed on heating ? Explain the chemical reaction.
(PTU Dec. 2012, May 2014)
3. Differentiate between scale and sludge.
4. What is brackish water ? How can it be purified ?
5. Water softened by zeolites is unfit for use in boilers. Why ? (PTU May 2010)
6. Define ppm.

7. Why hardness of water is expressed in terms of CaCO_3 equivalent ? (GNDEC Dec. 2013)
8. What is degree of hardness of water ?
9. Differentiate between hard and soft water.
10. What is temporary and permanent hardness ?
11. What is break point chlorination ? (PTU May 2010)
12. What are zeolites ?
13. What is caustic embrittlement ?
14. What is boiler corrosion ?
15. What are zeolites ? Why is water softened by zeolite process unfit for use in boilers ? (PTU May 2005)
16. Give specifications for boiler feed Water. (PTU Reappear)
17. What are the salts responsible for temporary and permanent hardness of water ? (PTU May 2013)(PTU Reappear)
18. What is lime and soda ? What is its significance ? (PTU Dec. 2004)
19. Why buffer solution is used during titration of hard water against EDTA solution ? (PTU May 2005, Reappear)
20. What is the principle of lime soda process ? Explain by taking one example.
21. Give specifications of water for drinking purpose. (PTU 2009)
22. What is priming and foaming ? (PTU 2009)
23. What is cause of alkalinity of sea water ? (PTU 2009)
24. Give any two points of difference between cold and hot lime soda method. (PTU 2009)
25. Why should water be softened before use in boilers ? (PTU May 2009)
26. How water is softened by ion exchanger. (PTU May 2009)
27. Is Ca-EDTA complex soluble in water ? (PTU May 2009)
28. Give one method of prevention of caustic embrittlement. (PTU May 2009)
29. What are boiler problems caused by presence of silica in water ? (PTU Dec. 2013)
30. Give the names of three sludge forming and three scale forming compounds. (PTU Dec. 2012)
31. Why natural water should not be used for boiler ? (PTU Dec. 2012)
32. Milliequivalent per litre of hardness = ppm. Explain. (PTU May 2012)
33. Define (i) Phosphate conditioning (ii) Caustic Embrittlement. (PTU May 2013)
34. What is soft water ? Where is it required ? (GNDEC Dec. 2013)
35. Discuss caustic Embrittlement. (GNDEC, May 2016)
36. How water can be softened by Zeolite method ? (GNDEC, May 2016)
37. A water sample has 19 mg of MgCl_2 per litre of water. Calculate the hardness of water in CaCO_3 equivalent. (GNDEC, Dec. 2015)
38. Name different types of hardness of water and different impurities (salts) responsible for each type. (GNDEC, Dec. 2015, Reappear)

39. What are disadvantages of scale and sludge formation in boiler. (GNDEC, Dec. 2014)
40. Why should the presence of CO_2 be avoided in boiler feed water ? (PTU May 2016, May 2015, Dec. 2014)
41. Distinguish between prining and Foaming. (PTU May 2016)
42. Why the water softened by zeolite process, unfit use in boiler ? (PTU Dec. 2015)
43. Differentiate between scale and sludge. (PTU May 2015)

Long Answer Type Questions

1. What are lime and soda ? Why does magnesium bicarbonate require double amount of lime for softening of hard water ? (PTU Dec. 2004, May 2007)
2. Name the salts causing temporary and permanent hardness. Describe two processes to remove hardness. (PTU Reappear)
3. Discuss the treatment of ground water to be used for domestic purposes. (PTU Dec. 2012, May 2013)(PTU Reappear)
4. What is break point chlorination ? Explain showing different zones. What are the advantages of break point chlorination ? (PTU May 2005)
5. (a) What are zeolites ? How do they function in softening of water ? What are their merits and demerits ? (GNDEC May 2014)(PTU May 2006, May 2009, May 2011)
(b) Explain the method of desalination of water by Reverse Osmosis Method.
6. (a) Differentiat between hard and soft water.
(b) Why hard water does not produce lather with soap ?
(c) What are the units of hardness of water ?
7. What are the disadvantages of using hard water in boilers ?
Or
What happens when hard water is used in boilers. (PTU May 2009)
8. Give different methods for prevention of scale formation.
9. Explain Caustic Embrittlement.
10. What are ion exchange resins ? Describe in detail the ion exchange process for demineralization of water. (PTU May 2010, Dec. 2010)
Or
Describe method involved in treatment of water required for industries. (PTU May 2009)
11. Write a short note on desalination of saline water by reverse osmosis. (PTU Dec. 2010)
12. What is sterilization of water ? Explain it.
13. Compare hot and cold soda-lime process for softening of hard water. (PTU May 2007)

14. What happens when temporary hard water is boiled? Write the chemical reactions. (PTU Dec. 2010)
15. (a) What disadvantages are expected if hard water is used for steam generation in boiler? What process may be used to overcome these problems? (PTU Dec. 2013)
(b) How is water disinfected by chlorination? (PTU May 2012, May 2013)
16. What is priming and Foaming? Explain. (PTU May 2012)
17. Discuss hot lime soda process of water softening. (GNDEC May 2013)
18. How and when microorganisms are killed by chlorination? (GNDEC May 2013)
19. What is demineralized water? How it is different from soft water? (PTU Dec. 2013)
20. (a) What is specification of boiler feed water?
(b) Discuss hot lime - soda process for softening of water. (PTU May 2014)
21. Explain Purification of water for domestic use. (GNDEC, May 2016)
22. Explain the desalination of water by process of electro dialysis with a labelled diagram. (GNDEC, Dec. 2015)
23. What is scale and sludge? Explain its disadvantages to boiler and different methods to prevent its formation. (GNDEC, Dec. 2015, Reappear)
24. Explain the zeolite process for softening of water. What are its advantages? (GNDEC, Dec. 2014)
25. (a) What are major disadvantages of hard water when used for:
(i) domestic purpose (ii) Industrial purpose (iii) Steam generation in boilers.
(b) How is water disinfected by chlorination. (PTU May 2016)
26. Explain the Cold Lime-Soda process for removal of hardness of water and give the difference between cold and hot lime soda process. (PTU Dec. 2015)
27. Discuss the methods of disinfection of water. (PTU May 2016)
28. What do you understand by conditioning of boiler feed water? Explain different types of conditioning. (PTU Dec. 2014)

Unsolved Numerical Problems

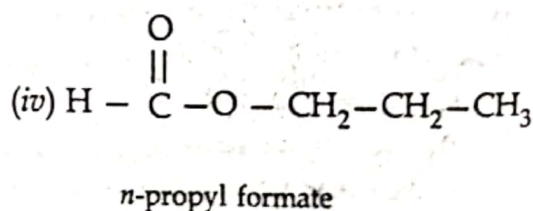
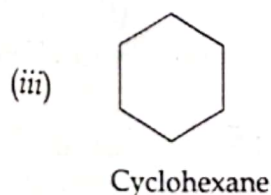
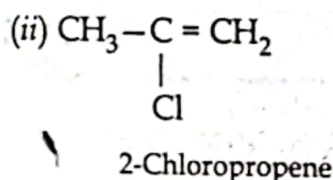
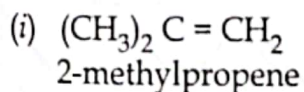
1. A sample of water was analysed and found to contain temporary magnesium hardness 25 mg/l. Permanent magnesium chloride hardness as 15 mg/l and permanent calcium sulphate hardness as 20 mg/l and SiO_2 as 300 mg/l. Calculate the lime and soda required for softening 30,000 l of hard water. (PTU May 2005)
2. Calculate the amount of lime (91% pure) and soda (91.2% pure) required for softening one million litres of water having ppm of $\text{Ca}(\text{HCO}_3)_2$ as 30.5, $\text{Mg}(\text{HCO}_3)_2$ as 35.5, MgSO_4 as 20, CaSO_4 as 24, CaCl_2 as 25 and NaCl as 10. Also calculate temporary and permanent hardness of water. (PTU Dec. 2004, Reappear)
3. A sample of water on analysis has been found to contain 10.05 mg/l $\text{Ca}(\text{HCO}_3)_2$, 12.5 mg/l $\text{Mg}(\text{HCO}_3)_2$, 7.5 mg/l CaSO_4 , 8.2 mg/l CaCl_2 , 2.6 mg/l MgSO_4 . Calculate the temporary and permanent hardness of water in ppm. (PTU May 2005 Reappear)

4. A sample of water has the following impurities in mg/l. Find the temporary and permanent hardness in ppm.
 $\text{Ca}(\text{HCO}_3)_2 = 10.00$, $\text{Mg}(\text{HCO}_3)_2 = 8.0$, $\text{CaSO}_4 = 12.0$ (PTU May 2006)
5. Calculate the amount of lime (85% pure) and soda (95% pure) required for softening 10,000 l of boiler feed water having the following impurities : $\text{Ca}(\text{HCO}_3)_2 = 16.2$ ppm, $\text{CaSO}_4 = 6.8$ ppm ; $\text{CaCl}_2 = 11.1$ ppm ; $\text{SiO}_2 = 8.0$ ppm ; $\text{MgSO}_4 = 6.0$ ppm ; $\text{NaCl} = 14.0$ ppm ; $\text{Mg}(\text{HCO}_3)_2 = 8.4$ ppm.
6. Calculate the amount of lime 90% pure and soda 98% pure for treatment of 1 million litres of water containing $\text{Ca}(\text{HCO}_3)_2 = 8.1$ ppm, $\text{CaCl}_2 = 33.3$ ppm ; $\text{HCO}_3^- = 91.5$ ppm ; $\text{MgCl}_2 = 38$ ppm and $\text{Mg}(\text{HCO}_3)_2 = 14.6$ ppm. The coagulant $\text{Al}_2(\text{SO}_4)_3$ was added at the rate of 17.1 mg/l of water.
7. A sample of water on analysis has been found to contain following in ppm :
 $\text{Ca}(\text{HCO}_3)_2 = 10.5$, $\text{Mg}(\text{HCO}_3)_2 = 12.5$, $\text{CaSO}_4 = 7.5$, $\text{CaCl}_2 = 8.2$, $\text{MgSO}_4 = 2.6$.
 Calculate the temporary and permanent hardness of water.
8. Calculate temporary hardness and total hardness of a sample of water containing ;
 $\text{Mg}(\text{HCO}_3)_2 = 7.3$ mg/l, $\text{Ca}(\text{HCO}_3)_2 = 16.2$ mg/l, $\text{MgCl}_2 = 9.5$ mg/l and $\text{CaSO}_4 = 13.6$ mg/l.
9. Calculate the amount of lime (84% pure) and soda (92% pure) required for treatment of 20,000 L of water analysed as :- $\text{Ca}(\text{HCO}_3)_2 = 40.5$ ppm, $\text{Mg}(\text{HCO}_3)_2 = 36.5$, $\text{MgSO}_4 = 30$ ppm, $\text{CaSO}_4 = 34$ ppm, $\text{CaCl}_2 = 27.75$ ppm, $\text{NaCl} = 10$ ppm. Also calculate temporary and permanent hardness. [Given atomic mass of H = 1, Na = 23, Ca = 40, Mg = 24, O = 16, S = 32, Cl = 35.5]. (PTU May 2007)
10. A water sample on analysis gave the following : $\text{Ca}^{2+} = 30$ mg/L, $\text{Mg}^{2+} = 24$ mg/L, $\text{CO}_2 = 24$ mg/L, $\text{HCl} = 50$ mg/L, $\text{K}^+ = 10$ mg/L. Calculate the quantities of lime (purity 90%) and soda (purity 94%) required to soften one million litres of water. (PTU May 2011)
11. Calculate the amount of lime and soda required per litre for chemical treatment of water containing $\text{Ca}^{2+} = 80$ ppm, $\text{Mg}^{2+} = 36$ ppm, $\text{HCO}_3^- = 244$ ppm and $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ added as coagulant = 69.5 ppm. What is total hardness of this water sample. (GNDEC, May 2016)
12. Calculate the amount of lime (91% pure) and soda (97.2% pure) required for softening of 100000 L of water containing $\text{Ca}(\text{HCO}_3)_2 = 30.5$ ppm, $\text{Mg}(\text{HCO}_3)_2 = 35.5$ ppm, $\text{MgSO}_4 = 20$ ppm, $\text{CaSO}_4 = 24$ ppm, $\text{CaCl}_2 = 25$ ppm and $\text{NaCl} = 10$ ppm. (GNDEC, Dec. 2014, Dec. 2015)
13. A water sample was found to have following impurities in mg/l: $\text{Ca}^{2+} = 30$, $\text{Mg}^{2+} = 24$, $\text{CO}_2 = 24$, $\text{HCl} = 50$, $\text{K}^+ = 10$. Calculate lime (90% pure) and soda (94% pure) required to soften one million litres of water sample. (GNDEC, Dec. 2015, Reappear)
14. Calculate the amount of lime and soda required to soften 50,000 L of water having following :
 $\text{Ca}(\text{HCO}_3)_2 = 8.1$ mg, $\text{Mg}(\text{HCO}_3)_2 = 5.0$ mg, $\text{CaSO}_4 = 13.6$ mg, $\text{MgCl}_2 = 2.0$ mg; $\text{MgSO}_4 = 12.0$ mg and $\text{NaCl} = 4.7$ mg. ***** (PTU May 2015)

Short Answer Type Questions

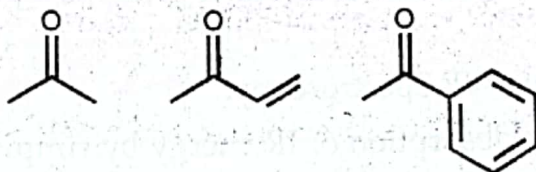
1. What is electromagnetic Radiation ?
2. What is meant by spectrum ?
3. What is difference between atomic and molecular spectrum ?
4. What is difference between absorption and emission Spectrum ?
5. What are the main components of a spectrophotometer ?

6. What is dispersing element in spectrophotometer ?
7. What is difference between single beam and double beam spectrophotometer ?
8. What do you understand by U.V. spectroscopy ? (PTU May 2005)
9. What do you understand by IR spectra ? (PTU Dec. 2004)
10. What is line width of a spectrum ? (PTU Dec. 2004)
11. What is selection scale for absorption spectroscopy ?
12. What is effect of size of halogen atom on $n \rightarrow \sigma^*$ transitions of alkyl halides ?
13. What is the effect of H-Bonding (in alcohols/amines) on the λ absorbed ?
14. Define chromophore quote one example. (PTU May 2014)
15. What is an auxochrome ? (PTU May 2014)
16. Define Franck Condon Principle.
17. What are Isobestic points ?
18. Define Hooke's law ?
19. What is selection rule for SHO in IR spectroscopy ?
20. What is zero point energy of SHO.
21. Why vibrational energy levels in anharmonic oscillator are more closely spaced as compare to harmonic oscillator ?
22. What are overtones ?
23. What is UV spectrum ? Give various regions associated with UV spectrum. (PTU May 2007)
24. What is importance of IR spectroscopy in finger print region ? (PTU May 2007)
25. What is coupling constant ? (PTU Dec. 2008)
26. What is selection rule for IR ? (PTU May 2009)
27. What is the significance of the term resonance in NMR ?
28. Which type of nuclei can show NMR ? (GNDEC, Dec. 2015)(PTU May 2013)
29. What is flipping of nucleus ?
30. What are equivalent and non-equivalent protons ?
31. What is chemical shift ? What are its units ?
32. Why usually TMS is used as reference standard ? (PTU May 2010)
33. Why $\delta = 0$ for TMS ?
34. Which of the following compounds will have multiplets in their spectra ?



35. What is 'J' ?
36. How NMR is useful in identification of structural isomers ?
37. How NMR is useful in distinguishing between geometrical isomers ?
38. Why alkenes show high value of δ while alkynes show low value ?
39. What is meant by shielding and deshielding of protons in $^1\text{H NMR}$?
(PTU May 2005)
40. Give the high resolution $^1\text{H NMR}$ spectrum of ethanol.
41. Indicate the number and type of $^1\text{H NMR}$ signals expected in $\text{CH}_3-\text{CH}=\text{CH}_2$?
(PTU Dec. 2005)
42. How many kinds of signal are obtained in NMR spectrum of $\text{CH}_3\text{CH}_2\text{OH}$?
(PTU Dec. 2005)
43. How many $^1\text{H NMR}$ signals are expected for ethyl acetate molecule ? Show the splitting pattern.
(PTU May 2005 (Reappeared))
44. How will you verify that a particular signal in NMR spectrum arises from $-\text{O}-\text{NH}$ or $-\text{SH}$ groups ?
(PTU May 2005)
45. What is coupling constant ?
(PTU Dec. 2005)
46. What is cause of chemical shift in NMR ?
(PTU Dec. 2005)
47. What do you understand by bathochromic and hypsochromic shift ?
(PTU Dec. 2015)(PTU May 2005)
48. Match each absorption band with the following groups :
- | | | | | |
|-------------------------|---------------------|--------------|--------------|----------------------------|
| Functional group = | $\text{C}=\text{O}$ | $-\text{NH}$ | $-\text{OH}$ | $-\text{C}\equiv\text{C}-$ |
| $\nu \text{ cm}^{-1}$ = | 3400 | 2050 | 1700 | 3350 |
- (PTU May 2005)
49. The absorption band in UV - Vis spectroscopy is broad. Explain. (PTU Dec. 2005)
50. What is range of peak identification region in IR spectrum ? (PTU May 2005)
51. How $^1\text{H NMR}$ can be used to distinguish *p* - $\text{CH}_3\text{C}_6\text{H}_4\text{CH}_3$ from $\text{C}_2\text{H}_5\text{C}_6\text{H}_5$?
(PTU Dec. 2005)
52. Arrange the following in increasing order of UV absorption maxima ?
-
- (PTU Dec. 2005)
53. Give one example in each case of $\sigma \rightarrow \sigma^*$, $n \rightarrow \pi^*$, $\pi \rightarrow \pi^*$, $n \rightarrow \sigma^*$. (PTU Dec. 2005)
54. Discuss the principle of UV/vis spectroscopy. (PTU Dec. 2005)
55. HCl can undergo stretching only, while CO_2 can show both stretching and bending. Explain. (PTU Dec. 2005)
56. The $^1\text{H NMR}$ of $\text{C}_2\text{H}_4\text{Br}_2$ has only one signal. What could be its structure ?
(PTU Dec. 2005)
- (PTU May 2005)

57. Why permanent magnets are not used in NMR ? (PTU Dec. 2015)
58. Calculate the number of vibrational degree of freedom in CO_2 and SO_2 . (PTU May 2015)
59. Which of the following exhibit IR spectra ? Why ? N_2 , HCl , O_2 , CO_2 . (PTU May 2015)
60. Explain the Selection Rules of UV-Vis spectroscopy. (PTU Dec. 2014)
61. Which of the following will absorb at higher wave number for $\text{C}=\text{O}$ Stretching ? (PTU Dec. 2014)



62. Methanol is a good solvent for UV but not for IR studies. Why ? (PTU May 2016)
63. What is finger print Region in IR spectroscopy. (GNDEC, Dec. 2014, Dec. 2015)
64. A compound having molecular formula $\text{C}_3\text{H}_6\text{O}$ show only one singlet in its NMR. Comment on its structure. (GNDEC, Reappear 2015)
65. How can the vibrations of $\text{C}-\text{C}$ and $\text{O}-\text{H}$ groups be differentiated by using principles of IR ? (GNDEC, Dec. 2015 Reappear)
66. What is internal standard used in NMR ? Why ? (GNDEC, May 2016)
67. How can the $\text{C}=\text{O}$ group be differentiated among the following molecules by using IR spectroscopy : HCHO , CH_3CHO and CH_3COCH_3 . (GNDEC, May 2016)

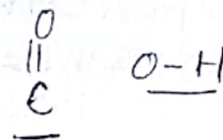
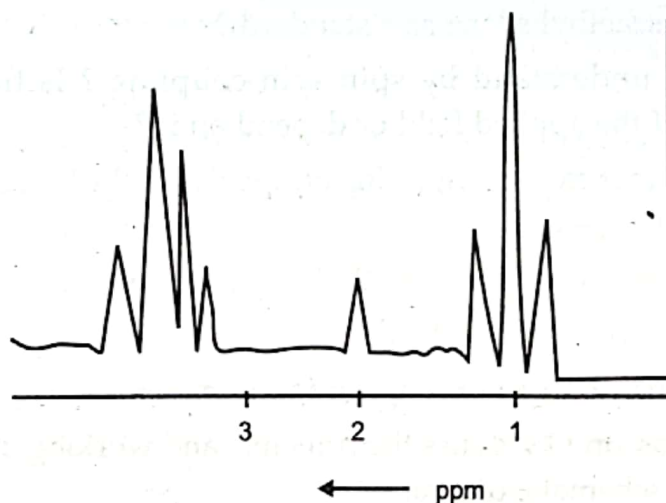
Long Answer Type Questions

- Write a short note on experimental technique of the absorption spectroscopy.
- What do you understand by term line width ? Explain different factors responsible for line width. (PTU May 2010, 2012)
- Explain the principle of UV-visible spectroscopy.
- Write a short note on different possible transitions which are affected by absorption of UV-visible spectroscopy. (PTU May 2010)
- Explain the following : (PTU May 2005)
 - Franck-Condon principle
 - Chromophore and auxochrome.
- Explain the following w.r.t. UV-visible spectroscopy. (GNDEC Dec. 2013)
 - Bathochromic shift
 - Blue shift
 - Hyperchromic shift (PTU)
- Which of the following will show high value of λ_{abs} and why ?
 - $\text{CH}_2 = \text{CH}_2$
 - $\text{CH}_3 - \text{CH} = \text{CH} - \text{CH} = \text{CH}_2$

8. Out of benzene and aniline, which is expected to show high value of λ_{abs} and Why.
9. Write a short note on auxochrome. (PTU May 201)
10. What is the effect of extension of conjugation on the λ_{abs} value? Explain.
11. Explain the factors responsible for the blue and red shift.
12. Write a short note on application of UV-visible spectroscopy.
13. On the basis of IR spectroscopy, how can you distinguish among 1-hexyne, 1-hexene and hexane. (GNDEC May 2013)
14. How can one establish whether a carbonyl group is a part of an aldehyde, ester or ketone? (PTU May 2006)
15. Explain the principle of IR spectroscopy. (PTU May 2013)
16. Write a short note on absorption of IR energy by simple harmonic oscillators.
17. Define and explain Hooke's law. What are its applications?
18. Write a short note on vibrations shown by a polyatomic molecule.
19. Write a short note on factors affecting $\bar{\nu}$ of a molecule.
20. Explain application of IR spectroscopy. (PTU May 2012)
21. How the following can be explained in context of IR spectroscopy?
 - (a) H-bonding
 - (b) Keto-enol Tautomerism.
22. What modes of vibrations are active in IR absorption spectrum and why? Taking nitro group as an example show various types of vibration which will be observed in IR spectra. (PTU May 2009)
23. What type of molecules give vibrational-rotational spectra and why? (PTU May 2007)
24. Using IR spectroscopy, how will you determine whether the oxygen in an organic compound is present as a carbonyl or hydroxyl group. (GNDEC May 2014)(PTU Dec. 2013, May 2007)
25. (a) Give examples of $\sigma \rightarrow \sigma^*$, $n \rightarrow \sigma^*$, $\pi \rightarrow \pi^*$, $n \rightarrow \pi^*$ transitions.
 - (b) What is effect of α , β unsaturation on carbonyl absorption in UV spectrum.
 - (c) What are different modes of vibrations in IR spectroscopy?
 - (d) Which type of molecules show vibrational-rotational spectra? Why? (PTU Dec. 2008)
26. Describe briefly the theory of NMR spectrometry. What information can be obtained from NMR absorption peaks?
27. What do you understand by the positions of the signals in an NMR spectrum? How many signals are expected in each of the following compounds?

(a) Propane	(b) Isobutane	(c) Ethanol	(d) Cyclobutane
(e) Ethylmethylether	(f) Ethyl acetate	(g) Butanal.	

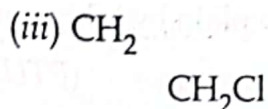
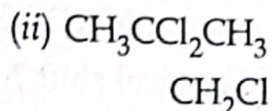
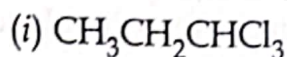
28. (a) What is meant by chemical shift? (PTU May 2013)
 (b) Write with examples, the shielding and deshielding effects involved in NMR. (GNDEC Dec. 2013)
29. Explain different factors which affect the magnitude of chemical shift?
30. What do you understand by term splitting of signals? Explain by taking an example. (PTU Dec. 2012)
31. Write a short note on use of solvents in NMR.
32. Write a short note on chemical exchange as observed in NMR.
33. Write a short note on two of the following :
 (a) Chemical shift (b) Spin-spin coupling (c) Coupling constant.
34. Explain why NMR spectrum of benzene is observed at high δ value whereas that of acetylene is at low δ value?
35. Describe briefly the various applications of NMR.
36. (a) Which of the following atoms do not exhibit NMR
 C^{12} , O^{16} , N^{14} , N^{15} , H^2 , F^{19} , C^{13} , P^{31}
 (b) How many types of 'H' are there in :
 (i) $CH_3-CH_2-CH_3$ (ii) $CH_2=CH_2$
 (iii) $CH_3-CH=CH_2$ (iv) $C_6H_5-CH_3$
37. Draw the NMR of following :
 (a) CH_3CH_2Cl (b) CH_2Br-CH_2Br (c) $(CH_3)_2CH-CH_3$
 (d) $CH_3-\underset{\substack{| \\ Cl}}{C}H-COCH_3$
38. A compound on analysis has found to have molecular formula C_2H_6O . Write down the possible structure of the compound. The proton NMR spectrum of the molecule is as :



Identify the molecule.

(PTU May 2005 Reappear)

39. (a) Draw a low and high resolution NMR spectra of :



(b) Explain the application of NMR to any one of the following :

(i) Hydrogen Bonding

(ii) Structural Diagnosis.

40. (a) State and explain principle of NMR.

(b) Explain the term J with examples.

41. (a) Predict NMR of $\text{CH}_3\text{CH}_2\text{OH}$, $\text{CH}_2\text{Cl}-\text{CHCl}_2$, $\text{CH}_3-\text{CH}_2-\overset{\text{O}}{\parallel}{\text{C}}-\text{CH}_3$.

(b) In relation to NMR. Explain any one of the following :

(i) Chemical shift and TMS

(ii) Shielding and Deshielding.

42. (a) What is principle behind NMR ?

(b) Write short note on :

(i) Spin-Spin splitting

(ii) Chemical shift

43. How will you differentiate between primary, secondary and tertiary alcohol.

44. Give brief account of significance of chemical shift in NMR.

45. Why TMS is taken as standard for measuring chemical shift ?

Can we take tetraethyl silane as a standard ?

46. What do you understand by spin-spin coupling ? Is the coupling constant independent of the applied field or depend on it ?

47. Indicate diagrammatically the splitting of signals in NMR spectra of $\text{CH}_2\text{Br}-\text{CHBr}_2$, $\text{CH}_3-\text{CHBr}_2$, $\text{CH}_3-\text{CH}_2\text{Br}$.

48. Explain high resolution NMR of ethyl methyl ether.

49. Write short note on : chemical shift.

50. Describe UV-Vis double beam spectrophotometer.

51. What is spectroscopy ? Discuss the principle and working of a spectrophotometer with help of a schematic diagram ?

52. Draw and explain ^1H NMR for $\text{Cl}_2\text{CH} - \text{CHCl} - \text{CHCl}_2$. (PTU Dec. 2011)
53. (a) Define auxochrome. Explain the effect of addition of auxochrome to a chromophore by taking one example.
(b) Explain high resolution NMR of $\text{ClCH}_2\text{CH}_2\text{CH}_2\text{Cl}$. (GNDEC Dec. 2012)
54. (a) Define Bathochromic shift. How is it caused by presence of an auxochrome? Explain.
(b) Draw and Explain high resolution NMR of $\text{CH}_3 - \text{CO} - \text{CH}_2 - \text{CH}_3$. (GNDEC May 2014)
55. (a) Explain Principle of NMR.
(b) What information can be obtained from UV vis spectrum? (PTU May 2014)
56. What are different kinds of electronic transitions? Explain each type with suitable examples. (PTU May 2016)
57. (a) Explain the selection Rules of UV-Vis spectroscopy.
(b) "Butadiene shows absorption at higher wavelength than ethene". Explain with respect to MO diagram and wave function. (PTU Dec. 2015)
58. (a) State and explain Franck-Condon principle.
(b) Why butadiene shows absorption at higher wavelength than ethene? Give suitable energy level diagram. (PTU May 2015)
59. (a) "IR spectra is often characterized as molecular finger prints". Justify this statement.
(b) Calculate the number of vibrational degree of freedom in following compounds.
(i) CO_2 (ii) SO_2 (iii) CH_4
(c) Which of the following molecules will show IR spectra and why :
 H_2 , HCl , CH_4 , CO_2 , H_2O (PTU Dec. 2014)
60. (a) What do you understand by shielding and deshielding of protons in NMR?
(b) Describe bathochromic shift and hypsochromic shift by using suitable example. (GNDEC, Dec. 2014)
61. (a) How IR can distinguish between 1-hexyne, 1-hexene and hexane.
(b) Explain Bathochromic shift and Hypsochromic shift with suitable examples. (GNDEC, Dec. 2015)
62. (a) Explain and draw high resolution NMR of $\text{CH}_3\text{CH}_2\text{COCH}_3$.
(b) Define an auxochrome and discuss how it causes Bathochromic shift. (GNDEC, May 2016)

Unsolved Numerical Problems

1. Calculate of iorce K for N_2 , given that the fundamental vibrational frequency is 2358 cm^{-1} . [Ans. 2298.2 N/m].
2. HBr given absorpion maximum at 3.77μ . Calculate the force const of H-Br bond. Take Mass of H = 1.008 amu and mass of Br = 79.90 amu. [Ans. 412.8 N/m]
3. Calculate the force constant for HCl^{35} when its fundamental vibrational frequency is $8.667 \times 10^{13} / \text{sec}$. How does the force const. of HCl^{37} compare with it.
(PTU May 2006) [Ans. Force constant for $HCl^{35} = 483 \text{ kg/sec}^2$]
