2015

CHEMISTRY

Paper : 104

SPECTROSCOPY-1

Full Marks : 80

Time : 3 hours

The figures in the margin indicates full marks for the questions

1. Answer the following : 1×10=10

a. Which of the following molecules do not have IR active vibrations?

   a. H_2
   b. NO
   c. N_2O
   d. CH_4

b. The ESR spectrum observed in the region

   a. microware
   b. radiofrequency
   c. X-ray
   d. UV/VIS

c. The Raman scattering is

   a. Elastic scattering of light

b. Inelastic scattering of light

c. Emission of light

d. Absorption of light

d. The photons of wavelength 400 nm corresponds to

a. 20000 cm^{-1}

b. 25000 cm^{-1}

c. 40000 cm^{-1}

d. 50000 cm^{-1}

e. ESR spectrum of p-benzoquinone radical anion consists of a

a. 1:2:3:2:1 quintet

b. 1:3:3:1 quartet

c. 1:4:6:4:1 quintet

d. Equally intense quintet

f. The rotational spectrum of a rigid diatomic rotor consists of equally spaced lines with spacing equal to

a. B

b. B/2

c. 3B/2

d. 2B

g. In Raman spectrum, transitions are only observed between rotational levels of ΔJ=....

a. 0, ±1

b. ±2

c. ±½

d. 0, ±2

h. The frequency of UV radiation is greater than

a. Infrared Radiation

b. Microwaves

c. Radio frequency

d. All the three

i. The ESR spectrum of anthracene radical anion consists of

a. 25 lines

b. 50 lines

c. 75 lines

d. 100 lines

j. Vibrational transitions are always accompanied by —— transitions

a. Vibrational

b. Rotational

c. Electronic

d. None of these

2. Answer the following 2×10=20

a. Describe the wave and corpuscular theory of visible light.

b. Discuss effect of H-bonding on IR stretching frequencies.

c. Explain mutual exclusion principle with examples.

d. Define hyperfine lines with example?

e. Discuss with example what you mean by shielding and deshielding in NMR spectroscopy?

f. Which of the following nuclei will show nuclear magnetic resonance and why?
^{2}H, ^{13}C, ^{14}N, ^{32}S

g. How Frank Condon Principle is useful for diatomic molecules.

h. What is chemical shift? Explain briefly.

i. What are group frequencies? Explain.

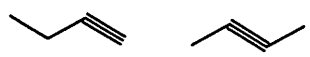
j. What is meant by the term polarizability? Explain with a suitable example.

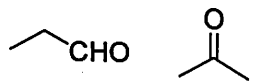
3. Answer the following (any five) 3×5=15

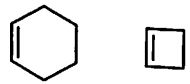
a. Write briefly about Magnetic resonance imaging (MRI) and its application.

b. Classify the molecules on the basis of their three principle moment of inertia.

c. How the following pairs can be distinguished by IR spectroscopy?

i. 

ii. 

iii. 

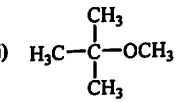
d. Explain the terms - Kramers degeneracy, Zero field splitting and hyperfine coupling constant in ESR studies.

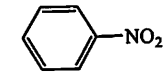
e. Deduce expressions for fundamental frequency, first overtone and second overtone. How they differ from each other?

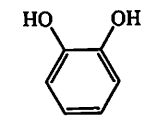
f. How many signals would you expect to see in the 1H NMR spectrum of each of the following compounds?

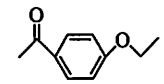
(i) $CH_3CH_2CH_2Br$

(ii) $CH_3CH_2OCH_3$

(iii) 

(iv) 

(v) 

(vi) 

4. Answer the following questions (any seven) 5×7=35

a. What is the fundamental difference between NMR and ESR? How many ESR peaks are expected for ^{14}N. Calculate the ESR frequency in MHz in a magnetic field of 25000 Gauss of g = 2 and $\beta = 9.273 \times 10^{-24}$ JT^{-1} (1T = 10000G, h = 6.626×10^{-34} Js).

b. Define Fermi resonance? Discuss different vibrational bands observed for CO_2 molecule.

c. The fundamental and first overtone transitions of $^{14}N^{16}O$ are centred at 1896.06 cm^{-1} and 3924.2 cm^{-1}, respectively. Evaluate the equilibrium vibration frequency, the anharmonicity, the exact zero-point energy, and the force constant of the molecule.

d. Find the internuclear distance of CO, if the atomic masses are given as C=19.92ß10^{-25}kg and O=26.56ß10^{-27}kg and the lines are equally spaced and

spacing between the lines is 20.8 cm^{-1}. Express the value in pm.

e. Write a short note on Stark effect.

f. Discuss about the vibration-rotation spectra of HCl.

g. State and explain the principle of Laser action.

h. What are fluorescences and phosphorescences? Explain the Jablonski diagram.