

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT
TEST-3 EXAMINATIONS-2022
B.Tech-II Semester (BT/BI)

COURSE CODE (CREDITS): 18B11PH212 (4)

MAX. MARKS: 35

COURSE NAME: Bioinstrumentation Techniques

COURSE INSTRUCTORS: Dr. Ragini Raj Singh

MAX. TIME: 2 Hours

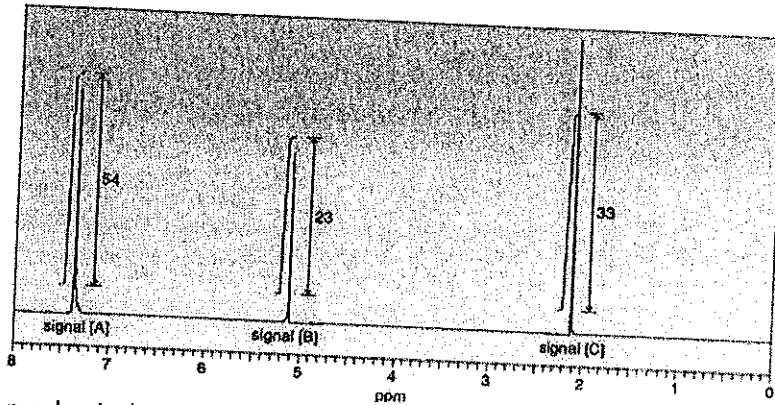
Note: All questions are compulsory. Marks are indicated against each question in square brackets.

Q.1. Solve the following problems for light spectroscopy:

- a. A molecule phosphoresces with a single peak wavelength of 550 nm. The single fluorescence peak is at 500 nm. The absorption peak is at 425 nm. Sketch a rough Jablonski diagram based on this information, labeling transitions and calculating differences in each energy state in nm and cm^{-1} . (CO:2-5) [2]
- b. You have been given luminescence measurements for an important molecule in your biochemistry-lab. The report describes the fluorescence of the molecule with a peak at 675 nm, absorption peak at 455 nm, and phosphorescence peak at 560 nm. What is wrong with this information? (CO:2-5) [1]
- c. Obtain the de- Broglie wavelength of a neutron of Kinetic energy 150eV. (mass of neutron = 1.675×10^{-27} Kg). (CO:2-5) [2]
- d. A quantum of EMR has an energy of 2 keV. What is the associated wavelength? (CO:2-5) [2]

Q.2. Solve the following problems:

- a. The fundamental vibrational transition ($v = 0 \rightarrow v = 1$) for CO is 2170.2 cm^{-1} . Treat CO as a harmonic oscillator, and determine the harmonic force constant k in g/s^2 . (CO:2-5) [2]
- b. Consider the diatomic molecule LiH to be an anharmonic oscillator. Use the spectroscopic constants for LiH, $\omega_e = 1405.7 \text{ cm}^{-1}$ and $x_e = 0.0165$. (CO:2-5) [3]
Determine:
a) the fundamental vibrational transition.
b) the first and second overtone transitions. Express your answers in wavenumbers.
- c. A compound of molecular formula $\text{C}_9\text{H}_{10}\text{O}_2$ gives the following integrated ^1H NMR spectrum. How many protons give rise to each signal? (CO:2-5) [2]



- Q.3. (a) On which mechanical model does stretching vibrations can be explained? Discuss the modified-Hooke's law to calculate wavenumber. (CO:2, 3) [2]
 (b) From biological samples IR spectroscopy is capable to deduce which information. (CO:3, 4) [2]
- Q.4. (a) Discuss classical theory of Raman Scattering along with necessary diagram. (CO: 2, 3) [2]
 (b) Draw and explain polarizability ellipsoids of CO₂ and H₂O. (CO: 4, 5) [4]
- Q.5. (a) Differentiate between ¹H NMR and ¹³C NMR. (CO: 2-4) [2]
 (b) What do you understand by Chemical shift in NMR? (CO: 2, 3) [2]
- Q.6. (a) If you wish to analyze biological molecules using mass spectrometry, which ionization method will you prefer and why. Explain in detail your method of choice. (CO: 3-5) [2]
 (b) Discuss the whole process of protein sequencing using mass spectrometry. (CO: 4, 5) [2]
- Q.7. (a) What is the difference between paper and ion exchange chromatography? (CO:2,3) [1.5]
 (b) What are the fields in which Ion Exchange chromatography is applicable? (CO:4,5) [1.5]