



Register Number:

DATE:

ST. JOSEPH'S COLLEGE (AUTONOMOUS), BANGALORE-27
M.Sc. PHYSICS – IV SEMESTER
SEMESTER EXAMINATION: APRIL 2016
PH 0113: Experimental Physics

Time-3 hrs

Max Marks-100

This paper contains 2 printed pages and 1 part.

1. Explain the principle of Fourier Transform NMR spectroscopy. How can multiple pulse FT be used for measuring spin lattice relaxation? [10]
2. a) A sodium atom ($l=3/2, s=1/2$) in zero field has the Hamiltonian $H=a \mathbf{I} \cdot \mathbf{S}$. Sketch the energy levels and transitions.
b) Explain the hyperfine ESR spectrum of Benzene anion C_6H_6^- [5+5]
3. Some common laser sources for Raman Spectroscopy are shown in the table:

Laser Type	Wavelength, nm
Argon ion	488.0 or 514.5
Krypton ion	530.9 or 647.1
Helium-neon	632.8
Diode	785 or 830
Nd-YAG	1064

- a) Using the information given in the table, explain the advantages and disadvantages of Argon ion source over Helium Neon source.
 - b) Why are diode lasers and Nd-YAG lasers preferred more than other sources? Give reasons in support of your answer.
 - c) What could be the possible problem with these sources if the sample is coloured? [4+4+2]
4. a) What is the necessary condition for a vibration to be Raman active? Explain taking the vibrations of CO_2 and H_2O as examples.
b) Why anti-Stokes lines are less intense than Stokes lines? [8+2]
 5. a) Explain what do you understand by light gathering power of a monochromator. Which lens is better f-lens or $f/2$ -lens? Explain.
b) Calcium carbonate CaCO_3 exists in two different crystal structures -orthorhombic and trigonal-rhombohedral. Which technique would you use to differentiate between the two structures? Explain.
c) Why are Stokes lines used in analysis of Raman spectrum? What is the challenge faced in using these lines? [5+3+2]
 6. Draw and explain the working of a typical single beam and double beam spectrophotometer. Explain the advantages of double beam instrument over single beam instrument. [8+2]
 7. Not all the planes in a given crystalline structure give rise to diffraction. Within a cubic

crystal, only the principal planes produce Bragg's diffraction. In various cubic lattice, derive and determine the conditions for these planes. [10]

8. A powder diffraction camera of radius 114.6mm is used to obtain diffraction pattern of a cubic crystal. A monochromatic Mo-K α radiation of wavelength 0.71 Å is used. The first four "S" values (where "S" is the distance between the consecutive arcs in the diffraction pattern) are given as: 34.68mm, 40.08mm, 57mm and 67.12mm. Using this information determine the crystal structure and lattice parameter of the material. [10]
9. Identify the three different types of filaments used in Scanning Electron Microscope as shown in figure below. Compare their performance characteristics and the applications they are used for. [10]



10. a) Why is it important to set the sample height to eucentric position in TEM?
 b) In order to view a biological sample under TEM, explain how sample preparation is done.
 c) Differentiate between optical microscopes, electron microscope and atomic force microscope. [2+3+5]
11. a) Explain why interference filters are better than absorption filters. Compare their characteristics.
 b) Glass is an amorphous material but still XRD finds many application in glass industry. What do you think could be the possible uses?
 c) Explain the difference between wavelength dispersive spectroscopy and energy dispersive spectroscopy used in analysis of X-rays. Why are both used simultaneously in most of the analysis? [5+2+3]
12. Starting with 1-Dimensional Schrodinger wave equation, derive an expression for the probability of finding the electrons on the other side of the potential barrier in case of Scanning Tunnelling Microscope. Hence, find the factors on which the tunnelling current depends. [10]
13. a) At what wavelengths in nanometers would the Stokes and anti-Stokes Raman lines for CCl $_4$ ($\Delta \bar{\nu} = 218, 314, 459, 762$ and 790 cm^{-1}) appear if the source were a (i) helium-neon laser (632.8nm) (ii) an argon-ion laser (488.0 nm) ?
 b) Calculate the ratios of intensities of the anti-Stokes and Stokes lines for CCl $_4$ at (a) 218 cm^{-1} (b) 459 cm^{-1} (c) 790 cm^{-1} . [5+5]
14. Explain the working of dispersive infrared spectrometer as shown in figure. Why are we able to place the sample in between the source and the monochromator in case of IR but not in case of UV spectrometer. [8+2]

