

1. Please define the terminologies of (a) Spectroscopy (b) Mass-spectroscopy and (c) Diffraction techniques. (10)
2. Fourier Transform Infrared Spectroscopy (FTIR) is commonly used to analyze organic materials. (a) Explain the role of "Fourier Transform" in this technique and how it is applied to convert the raw data into a usable spectrum. (b) Describe how to interpret the data obtained from FTIR, focusing on identifying functional groups and understanding the significance of the absorption peaks in the spectrum. (10)
3. X-ray Diffraction (XRD) is a powerful technique based on Bragg's Law and is widely used to analyze crystalline materials. (a) Explain the parameters involved in Bragg's Law and their significance in XRD analysis. (b) What types of information or material properties can be obtained using the XRD technique? (15)
4. XRD peak broadening may be created by the size or strain effect. Please describe how "size" and "strain" effect generate to the full-width-half-maximum (FWHM) as a function of the incident angle of light. (5)
5. X-ray Photoelectron Spectroscopy (XPS) is a surface-sensitive technique used to analyze the elemental composition and chemical state of materials. (a) Explain the working principle of XPS, including how it detects elements and provides information on their chemical states. (b) What kind of information can be obtained from an XPS spectrum, and how can the binding energy shifts be used to interpret the chemical environment of elements in the sample? (15)
6. X-ray Fluorescence (XRF) and Energy Dispersive X-ray Spectroscopy (EDXS) are two techniques used for elemental analysis of materials. (a) Compare the working principles of XRF and EDXS, focusing on how each technique detects elements in a sample. (b) Highlight the differences in the type of data obtained from XRF and EDXS, and how the results can vary in terms of resolution and sensitivity. (10)
7. Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM) are two imaging techniques used to analyze materials at the nanoscale. (a) Compare the working principles of SEM and TEM, focusing on how each technique forms an image. (b) Discuss the differences in sample preparation for SEM and TEM, including the requirements for sample thickness, conductivity, and any coating or treatment needed

before analysis. (15)

8. Describe how the Dynamic Light Scattering (DLS) method is used to measure particle size distribution in a suspension. How does the concentration of the suspension influence the accuracy and reliability of the DLS analysis results? (10)
9. Atomic Absorption Spectroscopy (AAS) and Inductively Coupled Plasma Spectroscopy (ICP) are commonly used techniques for measuring the concentration of elements in a solution. (a) Explain the working principles of AAS and ICP. (b) Compare the differences in the type of data obtained from these two methods, including sensitivity, detection limits, and the range of elements that can be analyzed. (10)

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