

M.Sc. CHEMISTRY  
FOURTH SEMESTER  
PHYSICAL METHODS OF ANALYSIS  
MSC – 403  
[USE OMR FOR OBJECTIVE PART]

**SET  
B**

Duration: 3 hrs.

Full Marks: 70

Time: 30 min. ( Objective )

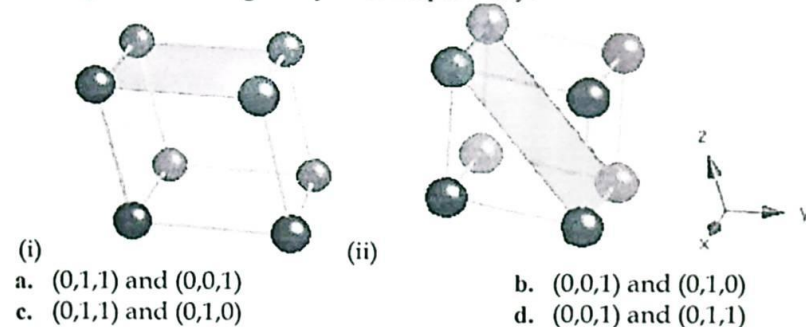
Marks: 20

*Choose the correct answer from the following:*

**1X20=20**

- Which of the following elements is commonly analyzed using AES?
  - Copper
  - Nitrogen
  - Phosphorous
  - Potassium
- UPS is commonly used to study which of the following?
  - Molecular orbitals
  - Atomic absorption spectra
  - Crystal structure
  - None of the above
- Which microscopy technique provides information about the surface topography of a sample?
  - SEM
  - TEM
  - X-ray microscopy
  - Optical microscopy
- Which microscopy technique is commonly used to study the internal structure of materials, such as crystal defects or grain boundaries?
  - SEM
  - TEM
  - Atomic force microscopy (AFM)
  - None of the above
- The DTA curve is obtained by plotting:
  - Temperature difference between the sample and reference material
  - Weight change of the sample
  - Heat flow of the sample
  - Specific heat capacity of the sample
- TGA analysis is typically performed under:
  - Vacuum conditions
  - Ambient atmospheric conditions
  - High-pressure conditions
  - Cryogenic conditions
- The resolution of SEM and TEM is mainly limited by:
  - The electron wavelength
  - The sample thickness
  - The voltage applied
  - The numerical aperture of the lens
- Which spectroscopic technique can determine the valence state of an element?
  - AAS
  - AES
  - XPS
  - UPS
- UPS is a technique used to analyze samples based on which principle?
  - Absorption of X-rays
  - Absorption of ultraviolet light
  - Emission of radiation
  - Ionization of atoms

10. Which of the following is not correct for quadrupole mass analyzer:
- |  |   |
|--|---|
| a. incorrect $m/z$ ratio of the ions will not reach to the detector        | b. $RF > DC$ , ions with higher $m/z$ ratio will reach the detector earlier   |
| c. $RF > DC$ , ions with lower $m/z$ ratio will reach the detector earlier | d. If $DC > RF$ , ions with lower $m/z$ ratio will reach the detector earlier |
11. The value of 'a' in the tangential method is:
- |       |       |
|-------|-------|
| a. 5  | b. 10 |
| c. 16 | d. 25 |
12. C8 column represents:
- |                |                |
|----------------|----------------|
| a. $C_8H_{18}$ | b. $C_8H_{17}$ |
| c. $C_8H_{16}$ | d. $C_8H_{15}$ |
13. X-ray takes place by a:
- |  |  |
|--|--|
| a. Cathode ray tube, filtered to produce monochromatic radiation | b. Anode ray tube, filtered to produce monochromatic radiation |
| c. Cathode ray tube, filtered to produce polychromatic radiation | d. Anode ray tube, filtered to produce polychromatic radiation |
14. X-Rays are:
- |  |   |
|--|---|
| a. Deflected by an electric field but not a magnetic field | b. Deflected by a magnetic field but not an electric field  |
| c. Not deflected by an electric field or a magnetic field  | d. Deflected by both an electric field and a magnetic field |
15. Identify the following two planes respectively:



16. An element exists in two crystallographic modifications with FCC and BCC structure. The ratio of the densities of the FCC and BCC modifications in terms of the volume of their unit cell ( $V_{FCC}$  and  $V_{BCC}$ ) is:
- |                         |                         |
|-------------------------|-------------------------|
| a. $V_{BCC} : V_{FCC}$  | b. $2V_{BCC} : V_{FCC}$ |
| c. $V_{BCC} : 2V_{FCC}$ | d. None of the above    |
17. For constructive interference, path difference is equal to:
- |                 |                     |
|-----------------|---------------------|
| a. $n\lambda/2$ | b. $n\lambda$       |
| c. $2n\lambda$  | d. Both (a) and (b) |

18. In TOF mass analyzer the heaviest and lightest ions will reach to the detector:
- a. First & last respectively
  - b. Last & first respectively
  - c. Both at a same time
  - d. Randomly
19. If there are four compounds like C-I, C-II, C-III, & C-IV with MW 15000, 30000, 50000, 100000 respectively, the compound will have least retention time in GPC process:
- a. C-I
  - b. C-II
  - c. C-III
  - d. C-IV
20. Which of the following elements is commonly analyzed using AAS?
- a. Oxygen
  - b. Carbon
  - c. Sodium
  - d. Fluorine

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**( Descriptive )**

Time : 2 hrs. 30 mins.

Marks : 50

*[Answer question no.1 & any four (4) from the rest]*

1.
  - a. The lattice parameter of an element stabilized in a FCC structure is  $4.04 \text{ \AA}$ . Calculate the atomic radius for the cubic lattice system. 2+2+3+3  
=10
  - b. What is the full form of HPLC? How many types of HPLC is known? Write the working principle of GPC.
  - c. Explain the principle of Atomic Absorption Spectroscopy (AAS) and how it is used for quantitative analysis.
  - d. Draw schematic diagram of the instrumental technique used in SEM explaining the different components.
  
2. Answer the followings: 2.5+5+2.5  
=10
  - a. Define Bragg's Law.
  - b. Why do we observe peaks of different heights in the XRD pattern?
  - c. Write the basic principle of photoluminescence.
  
3.
  - a. What Information does the XRD pattern of a crystal provide? 2+3+5  
=10
  - b. Draw the structure of the following lattices and identify their axial length and axial angle parameters:
    - (i) Cubic lattice
    - (ii) Monoclinic lattice
  - c. Discuss (i) capacity factor and (ii) selectivity factor in reference to a chromatogram obtained after HPLC analysis of a sample having two compounds.
  
4. Write a note on the columns & detectors for the GC analysis. 10  
Discuss the basic components of GC-MS.

5. a. Discuss the instrumental setup required for XPS analysis, including the X-ray source, analyzer, and detector. **5+3+2  
=10**
- b. Explain the concept of Ultraviolet Photoelectron Spectroscopy (UPS) and how it differs from XPS in terms of the energy of the incident photons.
6. a. Compare and contrast the applications of AAS and AES in elemental analysis, highlighting their strengths and limitations. **3+2+5  
=10**
- b. What is the fundamental difference between electron spectroscopy and other types of spectroscopy?
- c. Draw TGA and DTG curve obtained after heating calcium oxalate with proper equations. Comment on stability of calcium oxalate from the diagram.
7. a. Define Crystallite Size? What are the selection rules for different lattice types for diffraction to occur? **3+3+2+  
2=10**
- b. Discuss how the MW of unknown sample is identified by GPC technique?
- c. Define binding energy? Why XPS is also known as ESCA?
- d. What information can be obtained from TGA and DSC measurements?
8. a. Draw schematic diagram of the instrumental technique used in TEM explaining the different components. **5+5=10**
- b. Explain different phenomena which occur after electron beam interacts with sample in SEM.

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