

Uva Wellassa University of Sri Lanka
Faculty of Science and Technology
Department of Science and Technology
300 level 2nd Semester Examination – Jan 2019
SCT 356-2 Materials Characterization Techniques-II



Instructions to candidates

Duration: 02 hours

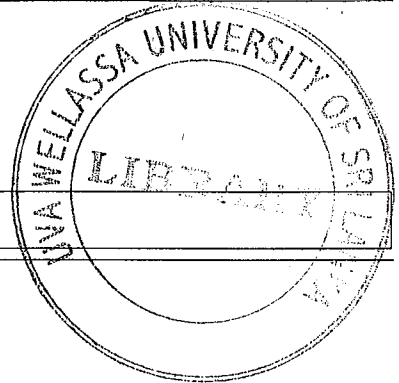
Number of questions: 3 Essay Questions

Mark allocation: 100 marks

Answer all questions.

Scientific calculators are allowed.

Index No:



1.

- i. Write down the Bragg's law and derive the equation using a suitable schematic diagram. (04 marks)
- ii. The d spacing of 020 plane of a cubic lattice is 2.7 Å.
 - a. Determine the peak position related to this plane. X ray wavelength is 1.5406 Å.
 - b. Determine the lattice parameter a. (08 marks)
- iii. Systematic absences of hkl planes will decide the centring type. How do you distinguish four centring types depending on the observed peaks corresponding to hkl planes. (04 marks)
- iv. In the NaCl cubic lattice, a sodium atom appears at the fractional coordinate (1/2,1/2,0) while a chlorine atom at (1/2,1/2,1/2) . Calculate the interatomic distance. Lattice parameter a = 5.4 Å. (04 marks)
- v. In addition to elemental peaks, other peaks can also be appeared in the XRF spectra. Name five such other peak types. (05 marks)

2.

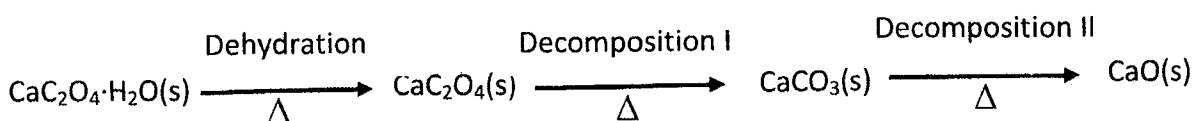
- i. Write down the broglie's equation which explains a possibility to enhance the resolution of an electron microscope image and define the terms. (05 marks)
- ii. Compare the optical microscope and electron microscope. (05 marks)

- iii. Explain the edge effect in SEM using a suitable diagram. (05 marks)
- iv. Discuss three major differences between SEM and TEM (06 marks)
- v. Explain the sample preparation method for solid sheets to take a TEM image. (04 marks)

3.

- i. Explain what is meant by "Thermal Analysis Techniques". (06 marks)
- ii. Name four main thermal analysis techniques and describe what quantity is measured using each technique. (08 marks)
- iii. List the types of physical/chemical changes that can produce exothermic and endothermic peaks in Differential Scanning Calorimetry (DSC). (04 marks)
- iv. Describe an application of DSC in biotechnology and protein engineering. (06 marks)
- v. Calcium oxalate monohydrate ($\text{CaC}_2\text{O}_4 \cdot \text{H}_2\text{O}$) is commonly used as a standard to test the performance of Thermogravimetric Analysis (TGA) technique due to its well-known decomposition steps and products.

When heated, $\text{CaC}_2\text{O}_4 \cdot \text{H}_2\text{O}$ decomposes via three well defined steps.



	Temperature range (°C)	Mass loss (%)
1. Dehydration	100–226	-----
2. Decomposition I	346–420	-----
3. Decomposition II	660–840	-----

The following table summarises some data about $\text{CaC}_2\text{O}_4 \cdot \text{H}_2\text{O}$ and its decomposition products.

Compound	Decomposition temperature ($^{\circ}\text{C}$)	Molar mass (g mol^{-1})
$\text{CaC}_2\text{O}_4 \cdot \text{H}_2\text{O}(\text{s})$	200	146
$\text{CaC}_2\text{O}_4(\text{s})$	400	128
$\text{CaCO}_3(\text{s})$	750	100
$\text{CaO}(\text{s})$	-----	56

- a. Write down all the balanced equations involved with decomposition of $\text{CaC}_2\text{O}_4 \cdot \text{H}_2\text{O}$.
(04 Marks)
- b. Sketch the expected Thermogravimetric (TGA) and Differential Thermogravimetric (DTG) patterns when a 25.0 mg sample of $\text{CaC}_2\text{O}_4 \cdot \text{H}_2\text{O}$ is heated from room temperature (25°C) to 1000°C .
(16 marks)
- c. Calculate the **mass loss %** for all three steps of the decomposition of $\text{CaC}_2\text{O}_4 \cdot \text{H}_2\text{O}$.
(06 marks)

