RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

B. Sc. (Four - Year) Degree in Applied Sciences
Fourth Year - Semester I Examination – September / October 2019

PHY 4308 – CHARACTERIZATION TECHNIQUES

Time: 2 hours

Answer all questions

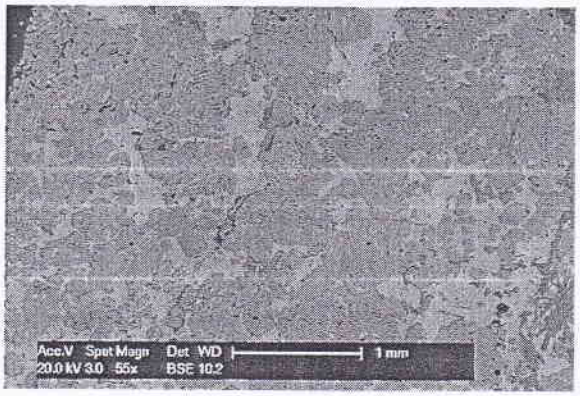
1. (a) State and explain the *Rayleigh Criterion* for the resolution of two point sources. **(10 marks)**

(c) A woman views an approaching car at night. Her apertures of her eyes are each of diameter 3.0 mm. The headlamps of the car are separated by a distance of 1.2 m and emit light of wavelength 400 nm.

Calculate the distance of the car from the woman at which the images of the two headlamps are just resolved. **(40 marks)**

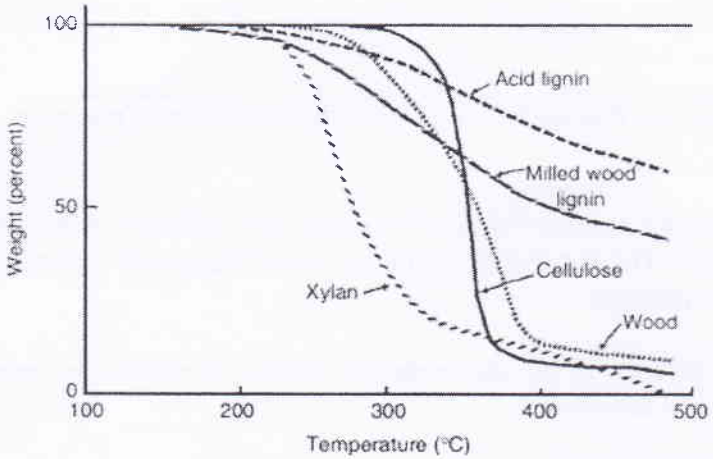
(d) Briefly explain the image contrast mechanisms employed in Scanning Electron Microscopy (SEM). **(30 marks)**

(e) The Backscattered scanning electron micrograph of a polished cross section of a mixed chalcopyrite ($CuFeS_2$) / pyrite (FeS_2) composite is shown in the figure. Comment on the phase distribution and the porosity of the composite. [Atomic Numbers are: Cu (29), Fe (26) and S (16)]. **(20 marks)**



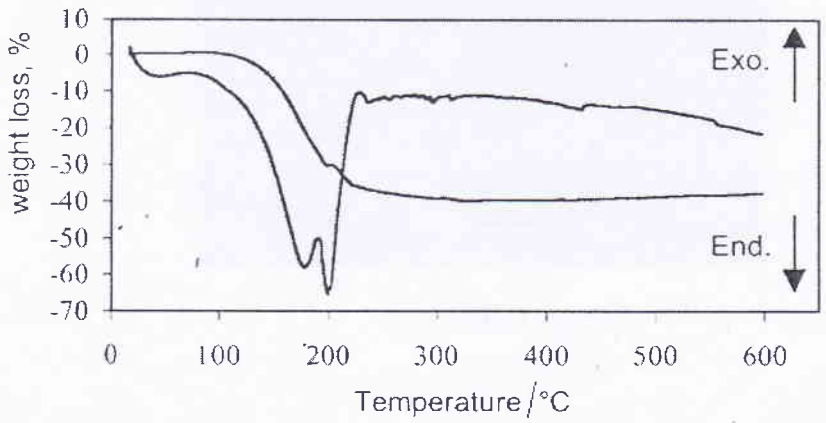
(a) Thermogravimetric Analysis (TGA) and Differential Thermal Analysis (DTA) are two methods commonly used in studying thermal behavior of a material as a function of temperature. Describe briefly the differences between the two methods and explain the advantages and disadvantages of both in determining the melting point of a substance. **(50 marks)**

(b) The given below is the Thermogravimetric Analysis (TGA) of cottonwood and its cell wall components. Comment on TG curve of each material. **(30 marks)**



(c) Briefly discuss two applications of TG in chemical analysis. **(20 marks)**

(a) TG analysis of prepared powder of $Na_2B_4O_7.10H_2O$ gave 43.69% weight loss between 50 and 350 °C as given below. Analyze all the TG curves with corresponding chemical equations where necessary. (Relative atomic weight of Na=23, B= 11, O =16, H=1) **(40 marks)**



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(b) $CaC_2O_4.H_2O$ decomposes to CaO in several stages. Draw a Derivative Thermogravimetric (DTG) curve for the decomposition of $CaC_2O_4.H_2O$ and deduce the decomposition route with relevant equations. **(40 marks)**

(c) Compare and contrast between DTA and Differential Scanning Calorimetry (DSC) **(20 marks)**

4. (a) By way of a clear diagram, explain why the *Wehnelt cylinder* is biased to a more negative voltage (typically – 200 to – 300 V) relative to the heated cathode of the electron gun used in an electron microscope. **(20 marks)**

(b) Write a comprehensive note on "Electron interaction with matter" paying special attention on produced primary electrons and secondary electrons. **(30 marks)**

(c) "The moving electrons experience a circular motion in the x, y plane and a linear motion in the z direction (a helical path) in a magnetic lens". Substantiate this statement. **(30 marks)**

(d) Briefly discuss the process of image formation in scanning electron microscopy. **(20 marks)**

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