RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

Four Year Degree in Applied Sciences
Fourth Year - Semester II Examination – October / November 2017

PHY 4308 – CHARACTERIZATION TECHNIQUES

Answer all 05 questions **Time: 03 hours**

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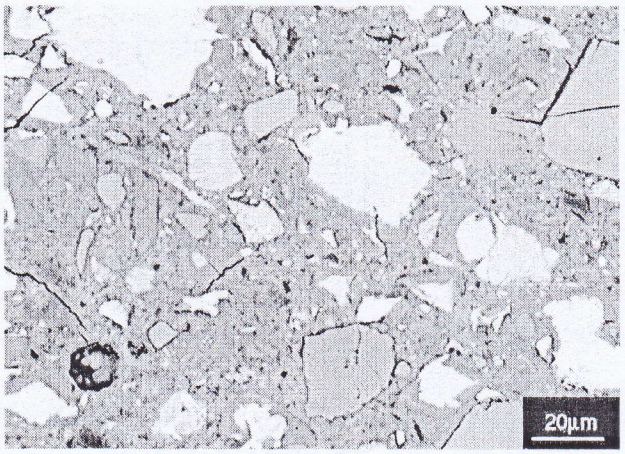
01. (a) State and explain the *Rayleigh Criterion* for the resolution of two point sources.

(b) 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.

(c) Briefly explain the image contrast mechanisms employed in Scanning Electron Microscopy (SEM).

(d) Discuss the following backscattered electron image of a polished section of concrete showing; un-hydrated cement grains (bright); silica sand (grey) and cement hydration products (grey matrix - background).



02. Explain the following statements.

(a) Divergent magnetic lenses do not exist.

(b) Using X-Ray microanalysis, the identification of isotopes is not possible

(c) Biological samples should be used in "low vacuum" Environmental Scanning Electron Microscopes (ESEM).

(d) Secondary electros are of lower energy than that of primary electrons (backscatterd electrons) and hence secondary electron mode in SEM is better as far as the study of surface morphology of a given sample is concerned.

03.

(a) An electrolyte is sandwiched between perfectly non-blocking electrodes. By using an appropriate equivalent circuit, prove that the impedance of the electrolyte represent a semicircle in the complex impedance plane.

(b) Show that the bulk resistance of the electrolyte is given by the intercept of the real axis.

(c) Prove that the real and imaginary parts of the impedance of the equivalent circuit given in the Figure 1.1 are given by $\frac{R}{1+\omega^2 R^2 C^2}$ and $-\left(\frac{\omega R^2 C}{1+\omega^2 C^2 R^2}+\frac{2}{\omega C_e}\right)$ respectively. Symbols have their usual meanings.

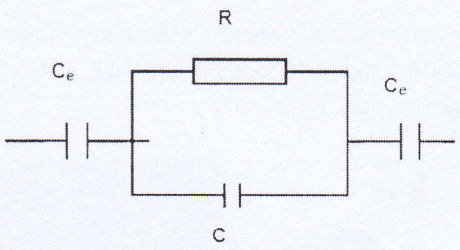
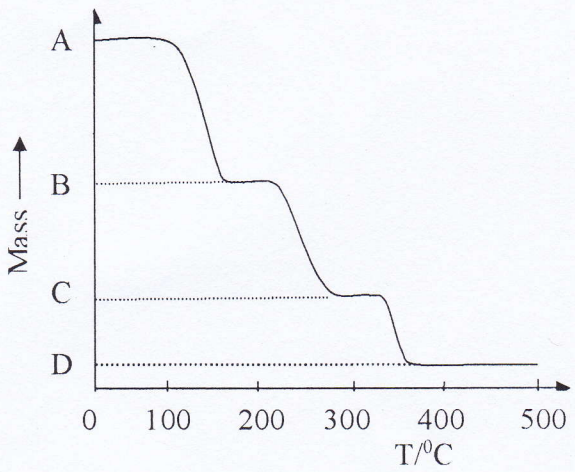


Figure 1.1

04.

(a) Compare and contrast the TG and DTA in terms of (i) their thermograms, (ii) Instrument used and (iii) nature of sample and reference.

(b) The figure below was obtained by subjecting $CuSO_4 \cdot nH_2O$ to thermal gravimetric analysis (TGA). The transition from A to D represents the loss of all water of crystallization. The sample masses at points A and D were 12.484 and 7.980 mg respectively. Estimate the value of n at each of the point A, B, C and D.



(c) A sample of 350.0 mg was subjected to a thermogravimetric analysis and showed a loss of 182.0 mg. How would you investigate whether the sample contains MgO, $MgCO_3$ or MgC_2O_4 if the following are the relevant possible reactions?

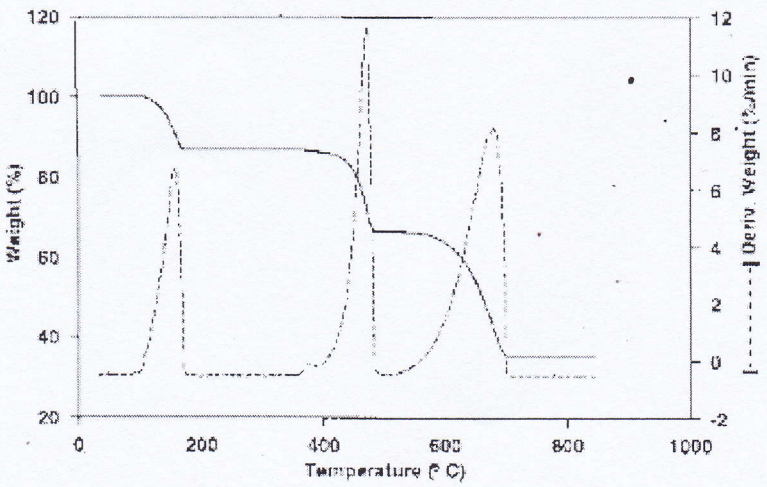
$$MgO \rightarrow No\ reaction$$
$$MgCO_3 \rightarrow MgO + CO_2$$
$$MgC_2O_4 \rightarrow MgO + CO_2 + CO$$

(Relative atomic mass: C =12, Mg= 24, O = 16)

05. (a) Compare and contrast the Differential Thermal Analysis (DTA) and Differential Scanning Calorimetry (DSC).

(b) What information can you obtain from DTA and DSC curves

(c) With the help of following TG curves, explain the decomposition of $CaC_2O_4.H_2O$.



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