EX/PG/CHE/T/114A/5/2017

M. CHEM ENGG 1ST SEM. EXAM. - 2017

Interfacial Science and Technology

Time: Three Hours | Full marks: 100

Answer <u>any four</u> questions.
<u>Assume any missing data.</u>
Write all assumptions clearly.

1. (a) How would you combine sedimentation and diffusion measurements to determine the mass of a particle without any information on the shape of the particle? Derive necessary equations.
(b) A material of density ρ, exists as uniform cylindrical particles of radius R, and length L. Derive an expression for specific surface area, for this material and examine the limiting forms when either R, or L is very small.
(c) What should be the speed of an ultracentrifuge so that the boundary associated with the sedimentation of a particle of molecular weight 60,000 g $mole^{-1}$ moves from r_1 = 6.314 cm to r_2 = 6.367 cm in 10 min? The densities of the particle and the medium are 0.998 and 0.728 g cm^{-3} respectively and the friction factor of the molecule is 5.3×10^{-11} $kg.s^{-1}$. [10+7+8]

2. (a)) Explain the basic principle behind porosimetry. How would you use a porosimetry experiment to measure the contact angle of a liquid with powdered solid? What are the limitations of this approach?
(b) From Kelvin equation explain why capillary depression is observed for mercury.
(c) Derive the Laplace equation for pressure difference across a surface (i) for spherical surface, (ii) for cylindrical surface, and for (iii) planar surface. [8+7+10]

3. (a) Explain Cassie-Baxter model.
(b) Water at 20°C rests on solid naphthalene with a contact angle of 90°, while a water-ethanol solution of surface tension 35dyn/cm shows an contact angle 30°. Calculate work of adhesion of water to naphthalene, (b) γ^d for naphthalene.
(c) Why does a drop of pentane spread into a thin film when placed on a water surface, whereas a larger hydrocarbon such as dodecane breaks up into smaller droplets? [8+10+7]

4. (a) What are the three van der Waals forces, and what is the molecular origin of each of them?
(b) Explain different steps of sol-gel technique with the help of an example.
(c) Explain steps of CVD technique with appropriate diagrams. [10+8+7]

5. (a) Describe the conditions under which the Hamaker constant 'between two interacting colloidal particles is always positive. When can it be negative?

(b) Define zeta potential and explain the effect of pH on zeta potential.

(c) Explain DLVO theory and draw the energy curves for different conditions of colloid stability. [8+7+10]