

## Homework 7 Properties of Materials

- 1)
  - a) Obtain an expression for the sedimentation velocity using a force balance between viscous drag and gravity
  - b) Use a similar force balance and the definition of mobility to obtain an expression relating mobility and the zeta potential.
  - c) Explain what the streaming potential is and how the zeta potential can be obtained from electro-osmotic measurements.
  - d) How can colloidal particle size be obtained using static light scattering or neutron scattering?
  - e) How can colloidal particle size be obtained using dynamic light scattering?
  
- 2) In class the relationship between the Boltzmann equation and the Debye screening equation was discussed.
  - a) The equation  $S = k \log W$  is carved on Boltzmann's grave in the Central Grave Yard of Vienna.  $W$  is the number of states that a system can have. How was the Boltzmann equation used in class and how does the form shown in Vienna relate to the form used in class?
  - b) The Gaussian function (bell shaped curve or normal distribution) is another exponential distribution function. Give the Gaussian function and explain why it is a symmetric function. Is the Debye screening equation a symmetric function?
  - c) The Gaussian function (normal distribution function) is used to describe the probability of finding a metal atom about a crystal lattice position due to thermal motion of the atom where the standard deviation is a function of temperature. (This is called Debye thermal broadening of an XRD peak). Explain why you think that this symmetric function is needed to describe thermal motion in a crystal while it is not appropriate to describe charge distribution due to thermal motion at an interface.
  - d) Explain how the Debye screening length relates to the exponential decay function.
  - e) Describe the relationship between the Debye screening length and the ability to hold a conversation in a crowded room.
  
- 3).
  - a) Give an expression for the DLVO theory describing the potential between two spherical particles.
  - b) Could a colloidal system be made stable by adjusting the Hamaker constant in DLVO theory? Explain using the equation in part a.
  - c) Could a colloidal system be made stable by adjusting the electrolyte concentration? Explain using the equation in part a.
  - d) Define the critical coagulation concentration.
  - e) Explain the following terms: bridging flocculation, steric stabilization, depletion flocculation, depletion stabilization.