Homework #4
Due: 10/20/20

1. (30) Plot the electrostatic repulsive potential, van der Waal's attractive potential and total potential versus interparticle separation, *D*, for an aqueous colloid of alumina (Al_2O_3) particles with a mean diameter of 1.0 μm. The attractive potential is given by

$$V_A = \frac{-A \cdot d}{6 \cdot D}$$

where *A* is the Hamaker constant and *d* is the particle diameter. The repulsive potential is given by

$$V_R = \pi \cdot \varepsilon \cdot d \cdot {\psi_d}^2 \cdot \exp\left(-\kappa \cdot D\right)$$

where ε is the permittivity of the liquid medium, ψ_d is the surface charge, and κ is the Debye length. The surface charge, ψ_d, can be commonly approximated by the zeta potential, ζ,, which was measured to be 40 mV at pH = 7. The Debye length, κ, can be estimated as, $\kappa = 3.288\sqrt{I}$ (nm^{-1}). *I* is the ionic strength of the medium

$$I = \frac{1}{2}\sum c_i \cdot {z_i}^2$$

where *c* is the concentration of the electrolyte and *z* is the charge of each ionic species, *i*, in the medium. Plot the attractive, repulsive and total potential showing the effects of a 0.001, 0.01, 0.1 M NaCl electrolyte concentration. Note that it will be helpful to scale your axes to approximately 0-30 nm and $\pm 10^{-18}$ J.

2. (40) Based on the Ernsting and Blanco papers, devise a table or figure to summarize the effects of NP size, shape, surface charge, and surface functionalization on NP circulation, biodistribution, clearance, and tumor uptake. Your table or figure should be no more than one page in size and may be handwritten or drawn since this is a draft/concept.

3. (30) A proprietary nanoparticle formulation was developed for targeting tumors. The binding affinity was investigated *in vitro* by incubating the nanoparticles with model tumors (spheroids). The measured mass of NPs taken up by the tumor spheroids (*V*) was observed to increase with an increased concentration of NPs (*S*) in the culture media. Three replicates were measured for each concentration. Plot the measured data as a Langmuir adsorption isotherm and measure the maximum binding (V_{max}) and equilibrium binding constant (*K*).

[*S*] (mg/L)	*V* (mg/g)
0.54	0.82
0.54	0.79
0.54	0.80
1.43	1.90
1.43	1.91
1.43	1.96
2.87	3.71
2.87	3.60
2.87	3.39
6.69	6.39
6.69	5.74
6.69	6.31
13.47	8.45
13.47	8.27
13.47	8.04
25.03	7.78
25.03	7.48
25.03	7.32