Homework #2
Due: 9/8/20

1. (25) Consider a case of heterogeneous nucleation during solidification of particles where the contact angle $\theta = 100°$. A chemical is added to the melt which reduces γ_{sl} by a factor of two, but does not affect either γ_{ml} or γ_{sm}. For the same amount of undercooling, does the chemical additive cause ΔG^*_{het} to increase or decrease? Use a calculation to justify your answer taking into account changes in both the shape factor $S(\theta)$ and ΔG^*_{hom}.

2. (25) Calculate the critical nuclei size, r^*, for the homogeneous precipitation of $BaSO_4$ from aqueous solution. Assume that precipitation occurs at a supersaturation of 2 at 25°C, and $\gamma_{sl} = 0.116$ J/m^2.

3. (25) $BaSO_4$ particle suspensions are used clinically as a gastrointestinal contrast agent for radiography or computed tomography. The solubility product for $BaSO_4$ is 1.08×10^{-10} at 25°C. Will barium sulfate precipitate if 10.0 mL of 0.0020 M Na_2SO_4 is added to 100 mL of 3.2×10^{-4} M $BaCl_2$? Note that NaCl is highly soluble in water.

4. (25) Write balanced reaction equations for the hydrothermal synthesis of: (a) Calcium hydroxyapatite, $Ca_5(PO_4)_3OH$, from $Ca(OH)_2$ and H_3PO_4, and (b) $Ba_xSr_{1-x}TiO_3$ from $BaCl_2{\cdot}2H_2O$, $SrCl_2{\cdot}6H_2O$, TiO_2, and NaOH. (c) In (b), what is the role of NaOH? (d) Is it realistic to think that particle of TiO_2(s) can be directly converted into $Ba_xSr_{1-x}TiO_3$(s)? If not what intermediates might you expect?