HW 3	Inorganic Materials Chemistry	Name:	
Points:	**C7780**	**Date:**	
Max. 100 points	**Fall 2014**	**A**	

1. (20 pts) Mixed metal oxides could be prepared by sol-gel reactions from aqueous solutions of metal salts.

a) (10 pts.) Order these ions Al^{3+}, Ba^{2+}, Cs^{+}, H^{+}, Li^{+}, Mg^{2+} according to the increasing value of hydration enthalpy: $M^{z+} + n\ H_2O \rightarrow [M(H_2O)_n]^{z+}$ $\Delta H_{hydration}$

b) (10 pts.) For a hydrolytic reaction $[M(H_2O)_N]^{z+} + h\ H_2O \rightarrow [M(OH)_h(H_2O)_{N-h}]^{(z-h)+} + h\ H_3O^{+}$

$\Delta H^{\circ} = (75.2 - 9.6\ z)$ kJ mol^{-1} and $\Delta S^{\circ} = (-148.4 + 73.1\ z)$ J K^{-1} mol^{-1}

Write equation that gives a measure of spontaneity of reaction. (Write a formula relating this function to ΔH° and ΔS°). Calculate, for which of the above listed ions is this reaction spontaneous?

2. (20 pts) Green light-emitting diodes can be made from solid solution of GaP and AlP. These two compounds have band gaps of 2.26 and 2.43 eV, respectively. What composition would be needed to prepare $Ga_{1-x}Al_xP$ with emitted light wavelength of 520 nm? Band gap varies linearly with composition. Name the law governing this case.
1 eV = 1.602 10^{-19} J. Show your calculation.

3. (20 pts) Mesoporous material MCM-41 consists of regular cylindrical pores of uniform diameter. Relate its total pore volume V_p to its surface area SA and pore radius r.

4. (20 pts) Alkaline precipitation method for the preparation of mixed ferrites $(Mn_xZn_{1-x})Fe_2O_4$ presents difficulties due to the varying solubilities of the metal hydroxides. $Fe(OH)_3$ starts to precipitate early at pH 2.6, while $Mn(OH)_2$ precipitates at a much higher pH of 9.4. The Zn^{2+} cations precipitate at pH 7.6, but begin to redissolve at pH 9.
a) Write chemical equations for the precipitation and dissolution of Zn^{2+} cations.

b) What pH should be used to obtain homogeneous precipitate of mixed hydroxides?

5. (20 pts) What is the relation between the diameter of a spherical nanocrystal (D_c, large spheres) and the size of tetrahedral pores (D_p, small sphere). Nanocrystals touch each other, they are close packed. Show your calculation.