Put the first three letters of your LASTNAME in the boxes

EXAM 1 Free Response
Sparks
CH302 Spring 2014

Name:_____
EID:_____
Version Number:_____

Answers must appear on this paper in the space provided.

1. $PbBr_2$ is highly soluble in water.
   $\Delta H_{lattice}$ for $PbBr_2$ is 2460 kJ mol^{-1}
   $\Delta H_{hydration}$ for $PbBr_2$ is -2157 kJ mol^{-1}

   What is the value of :$\Delta H_{solution}$ for $PbBr_2$? (2 points) $\Delta H_{solution}$ = ____303____ kJ mol^{-1}
1 points for correct number and 1 point for correct sign

   What is the sign for $\Delta G_{solution}$? (circle one: 2 points) $\Delta G_{solution}$ > (<) = 0
2 points for correct answer

   What is the sign for $\Delta S_{solution}$? (circle one: 2 points) $\Delta S_{solution}$ (>) < = 0
2 points for correct answer

2. Now consider you have two solutions. 200mL of 0.3 M solution of $PbBr_2$ and 200mL of 0.1M solution of NaF.

a. Write out the formula unit equation, the net ionic equation that describes the changes that occurs when the two solutions are mixed together. (K_{sp} for PbF_2 is 3.3 x 10^{-8}, solubility of NaBr is 95g/100g water)

Formula Unit Equation: (1 points)

$PbBr_2\ (aq) + 2NaF\ (aq) \rightarrow PbF_2\ (s) + 2NaBr\ (aq)$
1 pt for correct equation, balanced and including phases (all or nothing)

Net Ionic Equation: (2 points)

$Pb^{2+}\ (aq) + 2F^{-}\ (aq) \rightarrow PbF_2\ (s)$

1 pt for correct reactants and products
1 point for correct balancing and correct phases

b. Determine the molar concentration of all the ions in solution at the first instant when they are mixed together. (2 points)

$Pb^{2+}\ (aq)$ = (0.3M x 200mL) / 400mL = 0.15M
$Br^{-1}\ (aq)$ = 2 x ((0.3M x 200mL) / 400mL)= 0.30M
$Na^{+}\ (aq)$ = (0.1 x 200mL) / 400mL = 0.05M
$F^{-1}\ (aq)$ =(0.1 x 200mL) / 400mL = 0.05M

1 point for correctly setting these up, showing understanding that the new concentration will be less than the original because of the new larger volume.

1 point for correctly multiplying by 2 in the bromide ion concentration calculation.

BE SURE TO COMPLETE BOTH THE FRONT AND BACK

c. Given that K_{sp} for PbF_2 is 3.3×10^{-8} and the solubility of NaBr is 95g/100g water, do you think you will form a precipitate? Why or why not? (3 points)

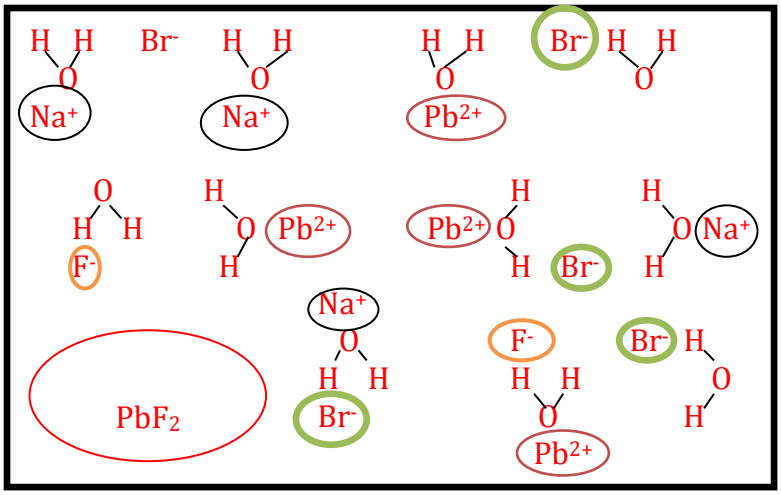
Pb^{2+} (aq) = 0.15M F^{-1} (aq) = 0.05M

$Q_{sp} = [Pb^{2+}][F^-]^2 = (0.15M)(0.05)^2 = 3.75 \times 10^{-4}$

$Q_{sp} > K_{sp}$ therefore a precipitate will form.

1 pt for precipitate forming. 2 points for valid explanation.

d. Sketch a microscopic/molecular view of the solution after the two solutions are mixed. (4 points)



1 pt for showing PbF_2 as insoluble.

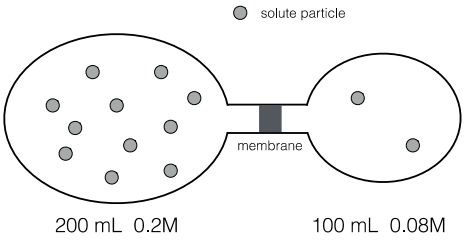
1 pt for showing some Pb^{+2} ions (there will be excess). If there are F- ions shown, it should be a very small amount). (There should be many less F- ions than the Na+ and Br- ions)

1pt for showing Na^+ and Br^-.

1 pt for showing water molecules oriented the right way to show attractions to the different ions.

3. Consider two containers with expandable walls (similar to balloons) separated by a semi permeable membrane. Initially the membrane is blocked so that no solution can flow. Container A contains 200 mL of a 0.2 M aqueous solution of potassium nitrate and Container B contains 100 mL of 0.08 M aqueous solution of potassium nitrate. The containers are at room temperature, 25 °C.

This is a schematic of the initial experimental set-up, before any flow across the membrane. (You can ignore gravity)



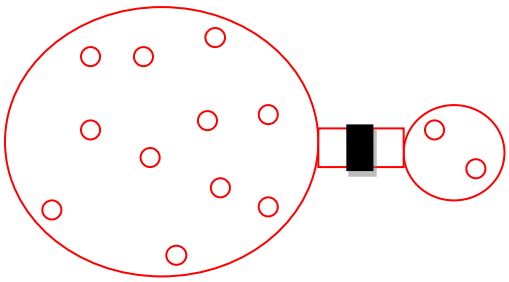
a. Which direction do you expect the water to flow (if at all) when the barrier blocking the membrane is removed? Explain this change (or lack of a change) in terms of free energy. (3 points)

BE SURE TO COMPLETE BOTH THE FRONT AND BACK

You would expect for the water to flow into Container A to equalize the concentrations. Container A has a higher concentration solution and has a lower free energy. Thermodynamically it is more stable. Therefore the solvent (i.e. water) will move to lower its free energy, going from the low concentration side to higher concentration side.

1 pt for stating water will flow into Container A. 2pt for valid explanation.

b. Draw what a schematic of what the system would look like at the end-point. (3 points). Try to represent both the volumes of the two containers and their solute concentrations (relative to the original diagram).



2pt for showing container size change. 1pt for showing correct number of solute molecules in the smaller container.

BE SURE TO COMPLETE BOTH THE FRONT AND BACK