Name _____   Period _____

Reactions and K$_{sp}$

Procedure

Part 1

1. Put on your laboratory apron, safety goggles, and plastic gloves.
2. One well of the microplate will be for this reaction. Place one drop of $Pb(NO_3)_2$ in one of the wells.
3. Add one drop of NaBr and record your observations of the Report Sheet.
4. Add one drop of NaI to the same well. Record your observations.
5. Finally add one drop of Na_2CO_3 to the well. Stir with a toothpick.
6. Break the toothpick in half and put it into the container designated by your teacher.

Part 2

1. One well of the microplate will be used for this reaction. Place one drop $Pb(NO_3)_2$ in one of the wells.
2. Add one drop NaI to the same well and stir. Record your observations.
3. Add one drop NaBr to the same well and stir. Record your observations. Stir with a toothpick.
4. Dispose of the toothpick in the designated container.

Part 3

1. One well of the microplate will be used for this reaction. Start by placing one drop $AgNO_3$ in a clean well.
2. Add one drop Na_2CO_3, stir with a toothpick, and record your observations on the Report Sheet.
3. Add one drop NaCl and stir. Record your observations on the Report Sheet.
4. Add one drop NaI, stir well, and record your observations.
5. Break the toothpicks and dispose of them in the designated container. Empty the solution into the designated waste container. Clean the microplate by using a cotton swab to remove any precipitate residue. Discard the cotton swabs in the same container used for the toothpicks.
6. Before leaving the laboratory, clean up all other materials and wash your hands thoroughly with soap and water.

PRELAB QUESTIONS

1. Write equations for the dissociation of each of the following compounds in solution

   $AgNO_3(s)$

   $NaBr(s)$

   $Pb(NO_3)_2$ (s)

   Na_2CO_3 (s)
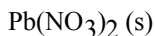
2. What is the concentration of each ion when equal volumes of 0.1 M solutions of $AgNO_3$ and NaBr are mixed?

3. What is the concentration of each ion when equal volumes of 0.1M solutions of $Pb(NO_3)_2$ and NaBr are mixed?

DATA

Part 1
Observations
Addition of NaBr
Addition of NaI
Addition of Na_2CO_3

Part 2
Addition of NaI
Addition of NaBr
Part 3
Addition of Na_2CO_3
Addition of NaCl
Addition of NaI

CALCULATIONS

Table 1 - Calculate the molar concentration of the following ions after the solutions are mixed in Part 1.

	Total drops	Pb^{2+}	NO_3^-	Na^+	Br^-	CO_3^{2-}
step 3						
step 5						

Analysis and Conclusions

1. Which ion is present in the highest concentration after the solutions are mixed in step 5 of part 1?

2. List all of the original ions present and the formulas for the possible compounds that can be formed in each of the following steps in Part 1. Underline the new compounds that can form in each step.

Table 2

Step	Ion Present	Possible Compounds
3		
4		
5		

3. Refer to the table of solubilities at the end of this document to determine which of the possible compounds in each step has low solubility.

Step 3

Step 4

Step 5

4. What experimental evidence allows you to determine which of the two possible compounds is the solid in step 4?

5. Identify the solid formed in step 4.

6. Based on your experimental observations, what must be the identify of the solid formed in step 5?

7. Why is PbI_2 in all steps of Part 2?

8. Write the net ionic equations for the formation of each precipitate in Part 1.

9. Which of the three compounds formed has the lowest solubility?

10. Arrange the solids formed in order of decreasing solubility.

11. Which two ions are spectator ions in all the reactions in Part 1?

12. List the formulas for the new compounds that are formed in each of the steps in Part 3. Consult the table of solubilities in a of textbook to determine which are insoluble. Underline these compounds.

Step 2   Step 3   Step 4

13. Which is less soluble, AgI or Ag_2CO_3?

14. Arrange the solids formed in Part 3 in order of decreasing solubility.

15. List the lead compounds and the silver compounds formed in order of decreasing solubility in two columns. Look up the K_{sp} of each compound and write it next to each compound.

Lead Compounds   Silver Compounds

16. What discrepancy is evident in the data?

17. Use the solubility product constants for $PbCO_3$ to calculate the concentration of Pb^{2+} necessary to achieve a saturated solution if CO_3^{-2} ion concentration is 2.5×10^{-2} M.

18. Calculate the concentration of Pb^{2+} necessary to achieve a saturated solution when the I^- ion concentration is 2.5×10^{-2} M.

19. Based on your calculations in 17 and 18, for equal concentrations of anion, which requires less Pb^{2+} to achieve a saturated solution, PbI_2 or $PbCO_3$?

20. If a solid substance forms when Pb^{2+}, I^-, and CO_3^{2-} ions are present, what must be the identity of the solid ?

21. Calculate the concentration of Ag^+ necessary to achieve a saturated solution of AgCl when the Cl^- ion concentration is 2.5×10^{-2}M.

22. Calculate the concentration of Ag^+ necessary to achieve a saturated solution of Ag_2CO_3 when the CO_3^{2-} ion concentration is 2.5×10^{-2}M.

23. Based on your calculations, for equal concentrations of anion, which requires a lower concentration of Ag^+ to produce a saturated solution, AgCl or Ag_2CO_3 ?

24. Why must the Ag+ concentration be greater for Ag_2CO_3 than for the AgI?

25. If a solid substance forms when Ag+, Cl^-, and CO_3^{2-} ions are present, what must be the identity of the solid?

26. If two compounds contain the same metal ion (cation), can their relative solubilities always be determined by direct comparison of the numerical values of their K_{sp} ?

27. Based on what you have observed and calculated in this experiment, under what conditions can the K_{sp} values for compounds of a particular metal be directly compared to determine their relative solubilities?

Solubility Products for relevant compounds:

$PbCO_3$	7.4×10^{-14}
$PbBr_2$	7.9×10^{-5}
$PbCl_2$	1.6×10^{-5}
PbI_2	1.4×10^{-8}
AgBr	7.7×10^{-13}
Ag_2CO_3	6.2×10^{-12}
AgCl	1.6×10^{-10}