CH302 Worksheet 5: A charming calculator-free worksheet concerning K_{sp}, K_w, K_a & K_b and strong acids and bases.

1. Define K_{sp} for the dissolution of the following salts in water. If necessary, write a balanced chemical equation for the dissolution first.
   a. RbI,
   b. $Ca(NO_3)_2$,
   c. K_3PO_4,
   d. SrS,
   e. $Fe_2(SO_4)_3$,
   f. $K_3Fe(C_2O_4)_3$,

2. Consider each of the salts below. Express each salt's molar solubility (we'll call it x) in terms of K_{sp}. It might be useful to first write a balanced equation for each salt's dissolution and complete a RICE diagram.
   a. $Cu_3(PO_4)_2$,
   b. MgSe,
   c. Li_3PO_4,
   d. $K_3Fe(C_2O_4)_3$,

3. Estimate the actual molar solubilities of the following salts in water based on their K_{sp} values.
   a. Barium Sulfate, $BaSO_4$, $K_{sp} = 1.08 \times 10^{-10}$,
   b. Cadmium Phosphate, $Cd_3(PO_4)_2$, $K_{sp} = 2.53 \times 10^{-33}$,
   c. Lithium Carbonate, Li_2CO_3, $K_{sp} = 1.73 \times 10^{-3}$,
   d. Magnesium Ammonium Phosphate, $MgNH_4PO_4$, $K_{sp} = 2.5 \times 10^{-13}$,

4. Estimate the actual molar solubilities of the following salts in the following solutions based on the provided concentrations and Ksp values. It might be useful to first write a balanced equation for each salt's dissolution and complete a RICE diagram.
   a. Mercuric Bromide, $HgBr_2$, $K_{sp} = 8 \times 10^{-20}$, in 2 M $Hg(NO_3)_2$,
   b. Silver Chloride, AgCl, $K_{sp} = 1.56 \times 10^{-10}$, in 15 M KCl,
   c. Barium Iodate, $Ba(IO_3)_2$, $K_{sp} = 6.5 \times 10^{-10}$, in 2.5 M KIO_3,

5. Match the K_w values on the left with their corresponding pH values on the right. Assume you have a sample of completely pure water.

Kw (e-14)	pH
0.114	7.08
0.293	7.27
0.681	6.14
1.008	6.92
1.471	7.47
2.916	6.63
5.476	7.00
51.3	6.77

6. Answer the following questions concerning the autoprotolysis of water;
   a. Is the autoprotolysis of water endothermic or exothermic?

   b. What would be a simple experiment to verify this?

   c. What would be a simple way to calculate $\Delta H_{autoprotolysis}$?

7. List the 7 strong acids from memory.

8. List the 8 strong bases from memory.

9. List the 14 spectator ions from memory. The answers to questions 7 and 8 are a **really** good starting point for this problem.

10. Decide whether each of the species below is a weak acid or weak base. Note that it is possible to know this based on a chemical's name, and generally possible based on its formula.
   a. pyridinium,
   b. oxalate,
   c. HIO_3,
   d. NH_3,
   e. formic acid,
   f. hydrazine,
   g ClO^-,
   h. NH^{4+},

11. Complete the following table: (Hint: -log 0.4 = 0.4, this is a good and easy reference point to remember for the log function.)

	$[H^+]$ (M)	pH	$[OH^-]$ (M)	pOH
Solution A	0.4			
Solution B		0		
Solution C			0.1	
Solution D				12
Solution E		15		
Solution F	10^{-11}			
Solution G		5		
Solution H			0.4	
Solution I				7
Solution J	10^{-9}			

12. What would be the pH of the following solutions?
   a. 0.01 M $HClO_4$,
   b. 0.05 M $Ba(OH)_2$,

c. 10 M HNO_3,
d. 10 LiOH,

13. What would be the pOH pf the following solutions?
a. 0.1 M RbOH,
b. 0.5 M $Sr(OH)_2$,
c. 0.001 M $HClO_3$,
d. 0.4 M HI,

14. What would be the pH of the following solutions? You may approximate if necessary; you should not need a calculator.
a. 0.25 M HNO_2, $K_a = 4.0 \times 10^{-4}$,
b. 5.55 M NH_3, $K_b = 1.8 \times 10^{-5}$,
c. 0.0125 M ascorbic acid, $K_a = 7.9 \times 10^{-5}$,
d. 0.0135 M trimethylamine, $K_b = 7.4 \times 10^{-5}$,
e. 0.3 M HOCl, $K_a = 3.5 \times 10^{-8}$,

15. Consider each of the acids and bases below. Write the formula or name for each species' conjugate and calculate the K_a or K_b for that conjugate. Approximate if necessary.
a. ammonium, $K_a = 5.55 \times 10^{-10}$,
b. OCl^-, $K_b = 2.5 \times 10^{-7}$,
c. pyridine, $K_b = 1.6 \times 10^{-9}$,
d. HCN, $K_a = 4.0 \times 10^{-10}$,