

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.

- RbI,
- $\text{Ca}(\text{NO}_3)_2$,
- K_3PO_4 ,
- SrS,
- $\text{Fe}_2(\text{SO}_4)_3$,
- $\text{K}_3\text{Fe}(\text{C}_2\text{O}_4)_3$,

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.

- $\text{Cu}_3(\text{PO}_4)_2$,
- MgSe,
- Li_3PO_4 ,
- $\text{K}_3\text{Fe}(\text{C}_2\text{O}_4)_3$,

3. Estimate the actual molar solubilities of the following salts in water based on their K_{sp} values.

- Barium Sulfate, BaSO_4 , $K_{sp} = 1.08 \times 10^{-10}$,
- Cadmium Phosphate, $\text{Cd}_3(\text{PO}_4)_2$, $K_{sp} = 2.53 \times 10^{-33}$,
- Lithium Carbonate, Li_2CO_3 , $K_{sp} = 1.73 \times 10^{-3}$,
- 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 K_{sp} values. It might be useful to first write a balanced equation for each salt's dissolution and complete a RICE diagram.

- Mercuric Bromide, HgBr_2 , $K_{sp} = 8 \times 10^{-20}$, in 2 M $\text{Hg}(\text{NO}_3)_2$,
- Silver Chloride, AgCl , $K_{sp} = 1.56 \times 10^{-10}$, in 15 M KCl,
- Barium Iodate, $\text{Ba}(\text{IO}_3)_2$, $K_{sp} = 6.5 \times 10^{-10}$, 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.

K_w (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;
- Is the autoprotolysis of water endothermic or exothermic?
 - What would be a simple experiment to verify this?
 - What would be a simple way to calculate $\Delta H_{\text{autoprotolysis}}$?
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.
- pyridinium,
 - oxalate,
 - HIO_3 ,
 - NH_3 ,
 - formic acid,
 - hydrazine,
 - ClO^- ,
 - 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.)

	$[\text{H}^+]$ (M)	pH	$[\text{OH}^-]$ (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?
- 0.01 M HClO_4 ,
 - 0.05 M $\text{Ba}(\text{OH})_2$,

- c. 10 M HNO₃,
- d. 10 LiOH,

13. What would be the pOH of the following solutions?

- a. 0.1 M RbOH,
- b. 0.5 M Sr(OH)₂,
- c. 0.001 M HClO₃,
- 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 HNO₂, $K_a = 4.0 \times 10^{-4}$,
- b. 5.55 M NH₃, $K_b = 1.8 \times 10^{-5}$,
- 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, $K_a = 4.0 \times 10^{-10}$,