5. ACIDS AND BASES III – Weak Acids and Bases

These problems are intended to ***supplement*** the problems in the textbook, not ***replace*** them.

Data:

Acids				
Name	*Formula*	K_{a1}	K_{a2}	K_{a3}
acetic acid	$HC_2H_3O_2$	1.8×10^{-5}	x	x
ascorbic acid	$H_2C_6H_6O_6$	8.0×10^{-5}	1.6×10^{-12}	x
benzoic acid	$HC_7H_5O_2$	6.3×10^{-5}	x	x
carbonic acid	H_2CO_3	4.3×10^{-7}	5.6×10^{-11}	x
citric acid	$H_3C_6H_5O_7$	7.4×10^{-4}	1.7×10^{-5}	4.0×10^{-7}
cyanic acid	HCNO	3.5×10^{-4}	x	x
hydrocyanic acid	HCN	4.9×10^{-10}	x	x
hydrofluoric acid	HF	6.8×10^{-4}	x	x
hypochlorous acid	HClO	3.0×10^{-8}	x	x
hypobromous acid	HBrO	2.5×10^{-9}	x	x
hypoiodous acid	HIO	2.3×10^{-11}	x	x
lactic acid	$HC_3H_5O_3$	1.4×10^{-4}	x	x
oxalic acid	$H_2C_2O_4$	5.9×10^{-2}	6.4×10^{-5}	x
phosphoric acid	H_3PO_4	7.5×10^{-3}	6.2×10^{-8}	4.2×10^{-13}
sulfurous acid	H_2SO_3	1.7×10^{-2}	6.4×10^{-8}	x

Bases		
Name	*Formula*	K_b
ammonia	NH_3	1.8×10^{-5}
aniline	$C_6H_5NH_2$	4.3×10^{-10}
butylamine	$C_4H_9NH_2$	5.9×10^{-4}
dimethylamine	$(CH_3)_2NH$	5.4×10^{-4}
ethylamine	$C_2H_5NH_2$	6.4×10^{-4}
hydroxylamine	NH_2OH	1.1×10^{-8}
methylamine	CH_3NH_2	4.4×10^{-4}
pyridine	C_5H_5N	1.7×10^{-9}
trimethylamine	$(CH_3)_3N$	6.4×10^{-5}

Questions

Calculate the pH and percent ionization for the following aqueous solutions:

1. 0.150 M acetic acid
2. 0.220 M lactic acid
3. 0.00800 M hypobromous acid
4. 0.500 M ammonia
5. 0.135 M ethylamine
6. 0.0475 M aniline

Calculate the dissociation constant (K_a or K_b) for the following weak acid and base solutions at 25 °C (assume all acids are monoprotic):

7. a 0.375 M acid solution has a pH of 2.89
8. a 1.00 M acid solution has a pH of 3.67
9. a solution is initially 0.0884 M in an acid which is 21.4% ionized at equilibrium
10. a solution is initially 0.500 M in an acid which is 4.7% ionized at equilibrium
11. a 6.38 M base solution has a pH of 13.88

12. a 0.00975 M base solution has a pH of 8.95

13. a solution is initially 0.0325 M in a base which is 63.7% ionized at equilibrium

Answer the following questions.

14. What molarity of hydrocyanic acid is needed for a pH of 4.97?

15. What molarity of hydrofluoric acid is needed for a pH of 2.75?

16. How many grams of lactic acid are needed to make 5.00 L of a solution with pH = 3.00?

17. What molarity of trimethylamine is needed for a pH of 12.00?

18. How many grams of pyridine are needed to make 100.0 mL of a solution with a pH of 8.75?

<u>Answers</u>

If you cannot figure out how to get the correct answer, go to your instructor, Science Tutoring Center, etc.

1. 2.80, 1.1%
2. 2.26, 2.5%
3. 5.35, 0.056%
4. 11.48, 0.60%
5. 11.95, 6.7%
6. 8.65, 0.0095%
7. $K_a = 4.5\times10^{-6}$
8. $K_a = 4.4\times10^{-8}$
9. $K_a = 5.14\times10^{-3}$
10. $K_a = 1.2\times10^{-3}$
11. $K_b = 0.10$
12. $K_b = 8.1\times10^{-9}$
13. $K_b = 3.63\times10^{-2}$
14. 0.25 M HCN
15. 0.0066 M HF
16. 3.6 g $HC_3H_5O_3$
17. 1.6 M $(CH_3)_3N$
18. 0.14 g C_5H_5N