Strong Acid and Base Problems

In the following questions data is given to help calculate the four values of pH, pOH, $[H^+]$ and $[OH^-]$. Please calculate all values not given.

1. A 0.100 M solution of HCl.

2. A 0.100 M solution of NaOH.

3. A 0.00250 M NaOH solution.

4. A 0.00250 M KOH solution.

5. A 0.00150 M solution of nitric acid (HNO_3).

6. The pH of a solution of hydrochloric acid is 1.530.

7. The pOH of a solution of perchloric acid ($HClO_4$) is 13.910.

8. The pH of a solution of NaOH is 13.900.

9. The $[OH^-]$ concentration is 0.00100 M.

10. Calculate $[H^+]$ and $[OH^-]$ in pure water at 25 °C. Hint: $K_w = 1.00 \times 10^{-14}$

11. What are the pH and pOH for pure water? Hint: $pK_w = 14.00$

12. The K_a of HCl is known to be about 10^7. What is [HCl] of a 1.00 M solution? (This is a tough question the type of which is not on the test.)

Weak Acid and Base Problems

13. Acetic acid has a $K_a = 1.78 \times 10^{-5}$. Determine the pH of a 0.100 M solution.

14. Calculate the hydronium ion ($[H_3O^+]$) concentration of a 0.25 M solution of benzoic acid, $HC_7H_5O_2$, $K_a = 6.46 \times 10^{-5}$

15. Hydrocyanic acid, HCN, has a K_a of 4.93×10^{-10}. Find the pOH and $[H_3O^+]$ of a 0.100 M solution of hydrocyanic acid.

16. The weak base analine, $C_6H_5NH_2$, has a K_b of 4.26×10^{-10}. Find the pH, pOH and $[H_3O^+]$ of a 0.100 M solution of analine.

17. Calculate the pH of a 0.75 M solution of a methylamine, CH_3NH_2 whose $K_b = 4.54 \times 10^{-4}$.

18. Calculate the pH of a 0.155 M ammonia solution. $K_b = 1.77 \times 10^{-5}$

19. What is the pH of a solution of picric acid that is 0.100 M? $K_a = 4.2 \times 10^{-1}$.

20. Chloroacetic acid, $ClCH_2COOH$, has a K_a of 1.40×10^{-3}. Find the pH and $[OH^-]$ of a 0.30 M solution of chloroacetic acid.

More Acid-Base Problems

I. The Relationship of $[H^+]$, $[OH^-]$, pH and pOH

Determine all three other values when one of the above four is given.

1) pH = 10.850

2) pOH = 11.140

3) pH = 3.750

4) pOH = 4.450

5) $[H^+] = 2.45 \times 10^{-4}$

6) $[OH^-] = 7.40 \times 10^{-5}$

7) $[H^+] = 3.87 \times 10^{-11}$

8) $[OH^-] = 7.15 \times 10^{-10}$

Here is a listing of the relevant equations to use in solving the above problems

1) $pH = -\log [H^+]$

2) $pOH = -\log [OH^-]$

3) $K_w = [H^+][OH^-] = 1.00 \times 10^{-14}$

4) $pK_w = pH + pOH = 14$

5) $[H^+] = 10^{-pH}$

6) $[OH^-] = 10^{-pOH}$

II. K_a and K_b Problems

1) The weak acid HA has a $K_a = 3.35 \times 10^{-8}$. What is the pH of a 0.250 M solution? HA ionizes in water according to the following equation: $HA + H_2O \text{ <==> } H_3O^+ + A^-$

2) The weak base B has a $K_b = 2.80 \times 10^{-6}$. What is the pH of a 0.200 M solution? B ionizes in water according to the following equation: $B + H_2O \text{ <==> } HB^+ + OH^-$

III. The Relationship of K_a and K_b to K_w

The weak acid HA ionizes as above in part II, number 1. The conjugate base of HA is A^- and it ionizes as follows: $A^- + H_2O \text{ <==> } HA + OH^-$

1) Write the K_a expression for HA.

2) Write the K_b expression for A^-.

3) Use the two expressions to prove the statement $K_aK_b = K_w$.

IV. Bonus Question

The pH of a 0.100 M solution of an unknown, monoprotic weak acid is found to be 2.870. Calculate the value for its K_a.