Chemistry 20: Acid/Bases
Ch. 6 Study Sheet

Name:

NO_3^-
I^-
Br^-
SO_4^{2-}
ClO_4^-
Cl^-

Part B

1. Use the modified Arrhenius theory to suggest a chemical equation to explain the acid properties of each of the following solutions. (write the ionization formula)
   a. $HI(aq)$ $+ H_2O \rightarrow H_3O^+ + I^-$

strong

   b. $HOCl(aq)$ $+ H_2O \rightleftharpoons H_3O^+ + OCl^-$

weak

   c. $H_3PO_4(aq)$ $+ H_2O \rightleftharpoons H_3O^+ + H_2PO_4^-$

weak $H_2PO_4^- + H_2O \rightleftharpoons H_3O^+ + HPO_4^{2-}$

$HPO_4^{2-} + H_2O \rightleftharpoons H_3O^+ + PO_4^{3-}$

2. Use the modified Arrhenius theory to suggest a chemical equation to explain the basic properties of each of the following solutions. (write the dissociation formula)
   a. $Na_2SO_4(aq)$ $\rightarrow 2Na^+ + SO_4^{2-}$

weak $SO_4^{2-} + H_2O \rightleftharpoons OH^- + HSO_4^-$ $+2Na^+$

   b. $NaCH_3COO(aq)$ $\rightarrow Na^+ + CH_3COO^-$

weak $CH_3COO^- + H_2O \rightleftharpoons OH^- + CH_3COOH$

   c. $Sr(OH)_2(aq)$ $\rightarrow Sr^{2+} + 2OH^-$

strong

3. Explain, using chemical reactions, to explain the observations listed below.
   a. A solution containing the ammonium ion turns blue litmus paper to red.

weak $NH_4^+ + H_2O \rightleftharpoons H_3O^+ + NH_3$

   b. A solution containing $HNO_3(aq)$ has a pH =5.50.

strong $HNO_3 + H_2O \rightarrow H_3O^+ + NO_3^-$

   c. A solution containing sodium hydrogen carbonate ($NaHCO_3(aq)$) turns blue litmus to red.

weak $NaHCO_3 + H_2O \rightleftharpoons H_3O^+ + CO_3^{2-} + Na^+$

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d. A solution containing $Al(OH)_3(aq)$ has a pH=14.23.

Strong $Al(OH)_3 \rightarrow Al^{3+} + 3OH^-$

e. A solution of calcium carbonate turns red litmus paper blue.

$Ca^{2+} + CO_3^{2-}$ weak $Ca^{2+} + CO_3^{2-} + H_2O \rightleftharpoons OH^- + HCO_3^- + Ca^{2+}$

4. Determine the pH and pOH of a solution with a $[H_3O^+(aq)] = 1.65\times10^{-4}\frac{mol}{L}$. (2)

$pH = -\log[1.65\times10^{-4}]$ $pH = 3.783$

$pH + pOH = 14$ $pOH = 10.217$

5. Determine the pOH and pH of a solution of $0.255\frac{mol}{L}\ Al(OH)_3(aq)$.

given: $Al(OH)_3 \rightarrow Al^{3+} + 3OH^-$ wanted.

$c = 0.255\ mol/L$

$\frac{3}{1} \times 0.255\ mol/L$

$c_{OH} = 0.765\ mol/L$.

$pOH = -\log[OH] = 0.116338$

$pH = 13.884$

6. Express the following pH values as the concentration of the hydronium ion
   a. Household ammonia: pH =11.3

$[H_3O^+] = 5\times10^{-12}\ mol/L$.

   b. Soda pop: pH =4.20

$[H_3O^+] = 6.3\times10^{-5}\ mol/L$.

   c. Oven cleaner: pH =13.755

$[H_3O^+] = 1.76\times10^{-14}\ mol/L$.

   d. Salad dressing: pH=2.55

$[H_3O^+] = 2.8\times10^{-3}\ mol/L$.

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7. An 11.8 mol/L solution of hydrochloric acid (a strong acid) is prepared.
   a. Determine the concentration of the hydronium ion in the solution.

$HCl + H_2O \rightarrow H_3O^+ + Cl^-$

$c = 11.8\ mol/L$ $\quad$ $c = 11.8\ mol/L$

   b. Determine the pH of the solution.

$pH = -\log[11.8]$ $\quad$ $pH = -1.072$

   c. Determine the pOH of the solution

$pH + pOH = 14$

$pOH = 15.072$

   d. Determine the concentration of the hydroxide ion in the solution.

$[OH^-] = 10^{-pOH}$ $\quad$ $[OH^-] = 8.47 \times 10^{-16}\ mol/L$

8. An 11.8 mol/L solution of acetic acid is prepared. What do you expect the pH of this solution to be in comparison to the pH of the solution from the above question? Explain your answer.

different: HCl is strong acid (fully ionized)

CH_3COOH is weak acid (not fully ionized)

9. If 8.50 g of barium hydroxide is dissolved to make 500mL of solution, determine the
   a. Concentration of the solution

$9.92 \times 10^{-2}\ mol/L$

   b. Concentration of the hydroxide ion

$0.198\ mol/L$

   c. pOH of the solution

$-\log[0.198] = 0.702 = pOH$

given → wanted

$Ba(OH)_2 \rightarrow Ba^{2+} + 2OH^-$

$m = 8.50\ g$

$M = 171.35\ g/mol$

$n = m/M$

$n = 0.0496\ mol$

$\frac{2}{1} \times conc.$

$c_{OH^-} = 0.198\ mol/L$

$c = n/v$ $\quad$ $c = 0.049212\ mol/L$

10. Determine the mass of aluminum hydroxide required to make a solution with a pH of 10.35. (hint: 1st determine the concentration of the hydroxide ion) $V = 1.0\ L$

$M = 78.01\ g/mol$

$pH = 10.35$

$pOH = 3.63$

$[OH^-] = 10^{-3.63} = 2.2387 \times 10^{-4}\ mol/L$

$m = M \times n$

$n = 0.0058$

$m = 5.8 \times 10^{-3}\ g$

$Al(OH)_3 \rightarrow Al^{3+} + 3OH^-$

$c = 7.762 \times 10^{-5}\ mol/L$

$V = 1.0\ L$

$n = 7.462 \times 10^{-5}\ mol$

$c = 2.2387 \times 10^{-4}\ mol/L$