Chemistry 30

Acids and Bases 70

I. Multiple Choice 20

1. D	6. C	11. C	16. C
2. C	7. B	12. A	17. C
3. D	8. A	13. B	18. D
4. B	9. B	14. B	19. D
5. D	10. C	15. B	20. C

II. Short Answer 50

1. Determine $[H^+]$ in a 0.02 M solution of perchloric acid, $HClO_4$. Perchloric acid is a very strong acid.

   $[H^+] = [HClO_4] = 0.02$ M **2**

2. Write the K_a expressions for each of these acids. Assume that only one hydrogen is ionized. **2**

   a) hydrofluoric acid, HF

   $$K_a = \frac{[H^+][F^-]}{[HF]}$$

   b) formic acid, $HCHO_2$

   $$K_a = \frac{[H^+][CHO_2^-]}{[HCHO_2]}$$

3. Calculate the pH for the following solutions. Read the information provided carefully. Identify each as acidic, basic, or neutral. **8**

	pH	acid, base, or neutral
a) $[H^+] = 1.0 \times 10^{-10}$	10	B
b) $[OH^-] = 1.0 \times 10^{-10}$	4	A
c) $[OH^-] = 1.0 \times 10^{-1}$	13	B
d) $[H^+] = 1.0 \times 10^{-5}$	5	A

4. a) Calculate the hydrogen-ion concentration $[H^+]$ for an aqueous solution in which $[OH^-]$ is 1.0×10^{-11} M.

   $[H^+] = 1 \times 10^{-3}$ M

   b) Is the solution acid, basic, or neutral? **3**

   acidic

6. Calculate $[H^+]$ in a 0.005 M solution of $NaOH_{(aq)}$. **3**

$$[H^+] = \frac{1\times10^{-14}}{0.005} = 2\times10^{-12}\ \text{M}$$

7. A student dissolves 250 g of hydrofluoric acid, HF, in enough water to make one litre of solution.

a) Calculate the concentration of this solution in mol•L^{-1}. ***2***

$$[HF] = \frac{250\ \text{g}}{1}\times\frac{\text{mol}}{20.0\ \text{g}}\times\frac{1}{1\ \text{L}} = 12.5\ \text{M}$$

b) Calculate $[H^+]$ for this solution, given that K_a for hydrofluoric acid is 6.7×10^{-4}. ***3***

Begin by writing a balanced equation.

$HF \rightleftharpoons H^+ + F^-$

$$K_A = \frac{[H^+][F^-]}{[HF]} \qquad 6.7\times10^{-4} = \frac{x^2}{12.5} \qquad x = [H^+] = 0.0915\ \text{M}$$

c) Determine $[OH^-]$ for this solution. **2**

$$[OH^-] = \frac{1\times10^{-14}}{0.915} = 1.09\times10^{-13}\ \text{M}$$

d) Determine the pH of this solution. **1**

pH = -log(0.0915) = 1.04

7. Hydrosulfuric acid, H_2S, is a weak acid with $K_a = 9.5 \times 10^{-8}$. This acid ionizes as follows:

$$H_2S \rightleftharpoons H^+ + HS^-$$

Determine the pH of a 0.25 M solution of this acid. (Hint: $[H_2S] = 0.25$ M. Find $[H^+]$) ***4***

$$K_A = \frac{[H^+][HS^-]}{[H_2S]} \qquad 9.5\times10^{-8} = \frac{x^2}{0.25} \qquad x = [H^+] = 1.54\times10^{-4}\ \text{M}$$

pH = -log(1.54×10^{-4}) = 3.8

8. $Ca(OH)_2$ is a strong base. Determine the pH of a 0.11 M solution of $Ca(OH)_2$. ***4***

(Hints: $[Ca(OH)_2] = 0.11$. Begin by finding $[OH^-]$)

$[OH^-] = 2 \times 0.11\ M = 0.22\ M$

$$[H^+] = \frac{1\times10^{-14}}{0.22} = 4.5\times10^{-14}\ \ M$$

$pH = -\log(4.5 \times 10^{-14}) = 13.3$

9. Determine each of the following: ***3***

a) Find $[H^+]$ of a solution whose pH is 8.3

$[H^+] = \text{antilog}(-8.3) = 5.01 \times 10^{-9}\ M$

b) Find $[H^+]$ in a solution with a pOH of 3.75

$pH = 14 - pOH = 10.25$ $\qquad$ $[H^+] = \text{antilog}(-10.25) = 5.62 \times 10^{-11}\ M$

c) Calculate $[OH^-]$ in a solution with a pH of 9.2

$pOH = 14 - pH = 4.8$ $\qquad$ $[OH^-] = \text{antilog}(-4.8) = 1.6 \times 10^{-5}\ M$

10. Determine the concentration of a solution of KOH for which the pH is 11.89.
KOH is a strong base. ***3***

$pOH = 14 - pH = 2.11$ $\qquad$ $[OH^-] = 7.762 \times 10^{-3}\ M = [KOH]$

or

$[H^+] = \text{antilog}(-11.89) = 1.29 \times 10^{-12}\ M$

$$[OH^-] = \frac{1\times10^{-14}}{1.29\times10^{-12}} = 7.762\times10^{-3}\ \ M = [KOH]$$

11. A 0.24 M solution of the weak acid H_2CO_3 has a pH of 3.49. Determine K_a for H_2CO_3. H_2CO_3 dissociates according to:

4

$$H_2CO_{3\,(aq)} \rightleftharpoons H^+_{(aq)} + HCO_3^-{}_{(aq)}$$

$[H^+]$ = antilog(-3.49) = 3.24×10^{-4} M This is also $[HCO_3^-]$

$$K_A = \frac{[H^+][HCO_3^-]}{[H_2CO_3]} = \frac{(3.24\times10^{-4})(3.24\times10^{-4})}{0.24} = 4.36\times10^{-7}$$

12. A neutral solution is produced when 41.32 mL of a 0.1077 M HCl solution was used to titrate 50.00 mL of a NaOH solution. Calculate the concentration of the sodium hydroxide solution before titration.

3

$HCl + NaOH \rightarrow NaCl + H_2O$

$M_AV_A = M_BV_B$

$(0.1077)(41.32) = M_B\,(50.00)$

$M_B = 0.0890$ M

13. A 30.0 mL sample of sulfuric acid, H_2SO_4, is titrated to an end point with 90.0 mL of 0.40 M NaOH. What is the concentration of the sulfuric acid? ***3***

$H_2SO_4 + 2\,NaOH \rightarrow Na_2SO_4 + 2\,H_2O$

$2M_AV_A = M_BV_B$

$2(M_A)(30) = (0.40)(90.0)$

$M_A = 0.600$ M