CHEM-1105 TEST 3 NAME:_____

PLEASE BE NEAT AND ORGANIZED

1. Complete the table. (K_w = 1.00 x 10^{-14} at 25°C). **[3]**

PH	pOH	$[H_3O^+]$	$[OH^-]$
10.75	3.25	5.62×10^{-4}	1.78×10^{-11}
0.70	13.30	0.200	5.0×10^{-14}

2. Complete the table: **[3]**

ACIDS	NH_3	$H_2PO_4^-$	HCO_3^-
BASE	NH_2^-	HPO_4^{2-}	CO_3^{2-}

3. Calculate the pH for the following solutions.

a) 0.10 M $Ca(OH)_2(aq)$ **[1]** 13.30

b) A mixture of 100.0 mL of 0.10 M HBr(aq) and 50.0 mL of 0.20 M KOH. **[2]**

7.00

4. a) Calculate the pH, pOH, and % ionization of 0.150 M $HC_3H_5O_2$, propanoic acid. $K_a = 1.3 \times 10^{-5}$. **[4]**

$HC_3H_5O_2(aq) + H_2O(l) \Leftrightarrow H_3O^+(aq) + C_3H_5O_2^-(aq)$

0.150	0	0
$-x$	$+x$	$+x$
$(0.150-x)$	x	x

$1.3\times10^{-5} = \frac{x^2}{(0.150-x)}$ $\therefore x = 1.4\times10^{-3}$

$\therefore pH = 2.85$, $pOH = 11.15$

$\%\ ION = \frac{1.4\times10^{-3}}{0.150}\times100 = 0.93$

b) To 100.0 mL of 0.150 M of the acid in part a are added 0.96 g of $KC_3H_5O_2$ (MM = 96.0). Calculate the pH and % ionization of the acid. **[4]**

$0.96\,g\ KC_3H_5O_2 \times \frac{1\,mol}{112.1\,g} \times \frac{1}{0.100} = 0.086\ M(C_3H_5O_2^-)$

$K_a = \frac{[H_3O^+][C_3H_5O_2^-]}{[HC_3H_5O_2]}$

$1.3\times10^{-5} = \frac{[H_3O^+][0.086)}{(0.150)}$, $[H_3O^+] = 2.27\times10^{-5}$

$\therefore pH = 4.64$ $\%\ ION = \frac{2.27\times10^{-5}}{0.150}\times100 = 1.5\times10^{-2}$

c) Calculate the pH of a solution made by mixing 250.0 mL of 0.20 M propanoic acid and 350.0 mL of 0.30 M sodium propanoate. **[4]**

NCN $[PROPANOIC\ ACID] = \frac{250.0\,mL \times 0.20\,M}{(250.0+350.0)\,mL} = 0.083\ M$

NCN $[PROPANOATE] = \frac{(350.0\,mL)(0.30\,M)}{(250.0+350.0)\,mL} = 0.175\ M$

$1.3\times10^{-5} = \frac{[H_3O^+][0.175)}{(0.083)}$

$[H_3O^+] = 6.2\times10^{-5}$

$pH = 3.21$

d) A 25.00 mL of a 0.20 M propanoic acid solution is titrated with 0.20 M solution of KOH.

i) Calculate the pH after you have added only 10.00 mL of the KOH solution to 25.00 mL of the acid. **[4]**

VOL OF KOH needed to reach EQUIVALENCE POINT = 25.00 mL

$$\therefore \frac{[A^-]}{[HA]} = \frac{10}{25-10} = \frac{2}{3}$$

$$K_a = 1.3\times10^{-5} = [H_3O^+]\ \frac{2}{3}$$

$$[H_3O^+] = 1.95\times10^{-5}$$

$$pH = 2.71$$

ii) Calculate the pH at the equivalence point in the titration of 25.00 mL of the acid with KOH. **[4]**

AT EQUIVALENCE POINT ONLY A^- AND ITS CONC IS $0.20/2 = 0.10$

$$A^-_{(aq)} + H_2O_{(l)} \rightleftharpoons HA_{(aq)} + OH^-_{(aq)}$$

$$K_b = \frac{K_w}{K_a} = \frac{1.0\times10^{-14}}{1.3\times10^{-5}} = \frac{x^2}{(0.10-x)}$$

$$x = [OH^-] = 8.8\times10^{-6}$$

$$pOH = 5.06$$

$$pH = 14.00 - 5.06 = \underline{8.94}$$

5. The pH of a 0.100 M $NH_3(aq)$ is found to be 11.13. **[2]**

$NH_3(aq) + H_2O(l) \Leftrightarrow NH_4^+(aq) + OH^-(aq)$

$$K_b = \frac{(1.35\times10^{-3})(1.35\times10^{-3})}{0.10}$$

$$= 1.7\times10^{-5}$$

$pOH = 2.87$

$\therefore [OH^-] = 1.35\times10^{-3}$

$[NH_4^+] = 1.35\times10^{-3}$

$[NH_3] \approx 0.10$

6. Thyroxine is a hormone that controls metabolism. A sample weighing 0.546 g was dissolved in 15.0 g of chloroform, and the freezing point depression was determined to be 0.240 °C. Calculate the molar mass of thyroxine. K_f of chloroform is 4.70 °C/m. **[4]**

$$\Delta T_f = k_f \cdot m \quad \left[k_f = 4.70\ \frac{°C}{m}\right]$$

$$m = \frac{\Delta T_f}{k_f} = \frac{0.240\ °C}{4.70\ °C/m} = 0.0511\ m = 0.0511\ \frac{mol}{kg\ solvent}$$

$$15.0\ g\ \text{SOLVENT} \times \frac{0.0511\ mol\ \text{SOLUTE}}{1000\ g\ \text{SOLVENT}} = 7.665\times10^{-4}\ mol\ \text{solute}$$

$$\text{MOLAR MASS} = \frac{0.546\ g}{7.665\times10^{-4}\ mol}$$

$$= 712\ g/mol$$