

CHEM-1105 TEST 3 NAME: _____

PLEASE BE NEAT AND ORGANIZED

1. Complete the table. (
- $K_w = 1.00 \times 10^{-14}$
- 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}

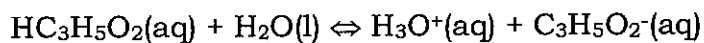
2. Complete the table: [3]

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]13.30b) 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 $\text{HC}_3\text{H}_5\text{O}_2$, propanoic acid. $K_a = 1.3 \times 10^{-5}$. [4]



$$\begin{array}{ccc} 0.150 & & 0 \\ -x & & +x \\ (0.150-x) & & x \end{array}$$

$$1.3 \times 10^{-5} = \frac{x^2}{(0.150-x)} \quad \therefore x = 1.4 \times 10^{-3}$$

$$\therefore \text{pH} = 2.85 \quad , \quad \text{pOH} = 11.15$$

$$\% \text{ION} = \frac{1.4 \times 10^{-3}}{0.150} \times 100 = \underline{0.93}$$

- b) To 100.0 mL of 0.150 M of the acid in part a are added 0.96 g of $\text{KC}_3\text{H}_5\text{O}_2$ (MM = 96.0). Calculate the pH and % ionization of the acid. [4]

$$0.96 \text{ g } \text{K } \text{C}_3\text{H}_5\text{O}_2 \times \frac{1 \text{ mol}}{112.1 \text{ g}} \times \frac{1}{0.100} = 0.086 \text{ M } (\text{C}_3\text{H}_5\text{O}_2^-)$$

$$K_a = \frac{[\text{H}_3\text{O}^+][\text{C}_3\text{H}_5\text{O}_2^-]}{[\text{HC}_3\text{H}_5\text{O}_2]}$$

$$1.3 \times 10^{-5} = \frac{[\text{H}_3\text{O}^+](0.086)}{(0.150)} \quad , \quad [\text{H}_3\text{O}^+] = 2.27 \times 10^{-5}$$

$$\therefore \text{pH} = 4.64 \quad \quad \% \text{ION} = \frac{2.27 \times 10^{-5}}{0.150} \times 100 = \underline{1.5 \times 10^{-2}}$$

- 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]

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

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

$$1.3 \times 10^{-5} = \frac{[\text{H}_3\text{O}^+](0.175)}{(0.083)}$$

$$[\text{H}_3\text{O}^+] = 6.2 \times 10^{-4}$$

$$\text{pH} = 3.21$$

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

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

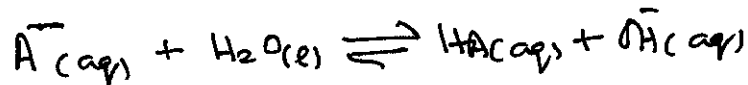
$$K_a = 1.3 \times 10^{-5} = [H_3O^+] \frac{2}{3}$$

$$[H_3O^+] = 1.95 \times 10^{-5}$$

$$pH = 2.71$$

- 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 $0.20/2 = 0.10$



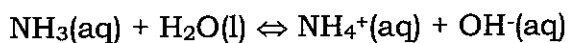
$$K_b = \frac{K_w}{K_a} = \frac{1.0 \times 10^{-14}}{1.3 \times 10^{-5}} = \frac{x^2}{(0.10-x)}$$

$$x = [OH^-] = 8.8 \times 10^{-6}$$

$$pOH = 5.06$$

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

5. The pH of a 0.100 M $\text{NH}_3(\text{aq})$ is found to be 11.13. [2]



$$K_b = \frac{(1.35 \times 10^{-3})(1.35 \times 10^{-3})}{0.10}$$

$$= 1.7 \times 10^{-5}$$

$$\text{pOH} = 2.87$$

$$\therefore [\text{OH}^-] = 1.35 \times 10^{-3}$$

$$[\text{NH}_4^+] = 1.35 \times 10^{-3}$$

$$[\text{NH}_3] \approx 0.10$$

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]

$$\Delta T_f = k_f \cdot m \left[k_f \left(4.70 \frac{^\circ\text{C}}{\text{m}} \right) \right]$$

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

$$15.0 \text{ g solvent} \times \frac{0.0511 \text{ mol solute}}{1000 \text{ g solvent}} = 7.665 \times 10^{-4} \text{ mol solute}$$

$$\text{MOLAR MASS} = \frac{0.546 \text{ g}}{7.665 \times 10^{-4} \text{ mol}}$$

$$= 712 \text{ g/mol}$$