

1. Lactic acid,  $\text{HC}_3\text{H}_5\text{O}_3$ , is a monoprotic acid that dissociates in aqueous solution, as represented by the equation above. Lactic acid is 1.66 percent dissociated in 0.50 M  $\text{HC}_3\text{H}_5\text{O}_3(\text{aq})$  at 298 K. For parts (a) through (d) below, assume the temperature remains at 298 K.

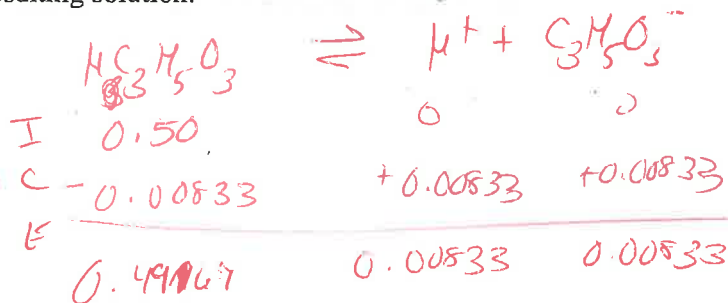
(a) Write the expression for the acid-dissociation constant,  $K_a$ , for lactic acid and calculate its value.

(b) Calculate the pH of 0.50 M  $\text{HC}_3\text{H}_5\text{O}_3$ .

(c) Calculate the pH of a solution formed by dissolving 0.045 mole of solid sodium lactate,  $\text{NaC}_3\text{H}_5\text{O}_3$ , in 250. mL of 0.50 M  $\text{HC}_3\text{H}_5\text{O}_3$ . Assume that volume change is negligible.

(d) A 100. mL sample of 0.10 M HCl is added to 100. mL of 0.50 M  $\text{HC}_3\text{H}_5\text{O}_3$ . Calculate the molar concentration of lactate ion,  $\text{C}_3\text{H}_5\text{O}_3^-$ , in the resulting solution.

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



$$K_a = \frac{(0.00833)(0.00833)}{0.49167} = 1.41 \times 10^{-4}$$

(b)  $[\text{H}^+] = 0.00833 \text{ M}$        $\text{pH} = 2.08$

(c)  $(0.250 \text{ L})(0.50 \text{ M}) = 0.125 \text{ mole HC}_3\text{H}_5\text{O}_3$

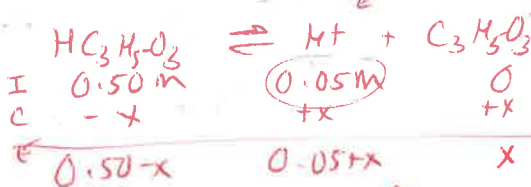
$$\text{pH} = \text{p}K_a + \log \frac{[\text{C}_3\text{H}_5\text{O}_3^-]}{[\text{HC}_3\text{H}_5\text{O}_3]}$$

$$= -\log(1.41 \times 10^{-4}) + \log \frac{0.045}{0.125} \quad (3.85 + -0.44)$$

$$= 3.41$$

(d) Hmm - not a buffer.  $\text{H}^+$  does NOT neutralize  $\text{HC}_3\text{H}_5\text{O}_3$  to form  $\text{C}_3\text{H}_5\text{O}_3^-$  from HCl

(50) Use behavior equation & ICE table



can you find  $[\text{H}^+]$ ?

$$[\text{C}_3\text{H}_5\text{O}_3^-] = 7.0 \times 10^{-4} \text{ M}$$

Ignore x in both of these → plug into  $K_a$

1. Aniline,  $C_6H_5NH_2$ , is a neutral weak base similar to ammonia.

(a) Write an equation to show the weak base behavior of aniline.

(b) Write the equilibrium constant expression  $K_b$  for the equation shown in (a).

(c) A 0.10 M solution of aniline is prepared. The pH of this solution is measured to be 8.82. Calculate the value of  $K_b$ .

(d) A 50.00 mL sample of 0.10 M aniline is titrated with 0.125 M HCl.

(i) Write a net ionic equation to show the reaction that takes place between aniline and HCl.

(ii) Calculate the volume of HCl needed to reach the equivalence point.

(iii) Calculate the pH of the titration mixture after 10.00 mL of HCl has been added.

(iv) Calculate the pH of the titration mixture at the equivalence point.



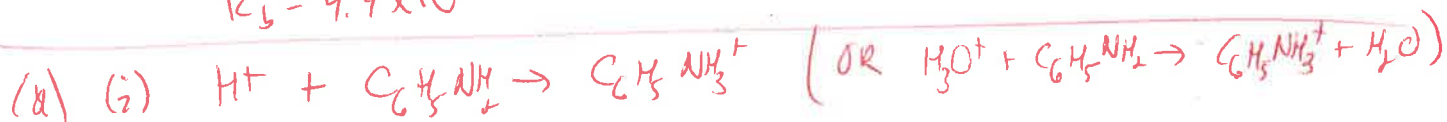
$$(b) K_b = \frac{[C_6H_5NH_3^+][OH^-]}{[C_6H_5NH_2]}$$

(c)  $pH = 8.82$  so  $[OH^-] = 6.61 \times 10^{-6} M$  (this is  $x$ )

$$K_b = \frac{(6.61 \times 10^{-6})(6.61 \times 10^{-6})}{0.10 - 6.61 \times 10^{-6}} \approx 0.10 \text{ (ignore } x \text{)}$$

*You could*

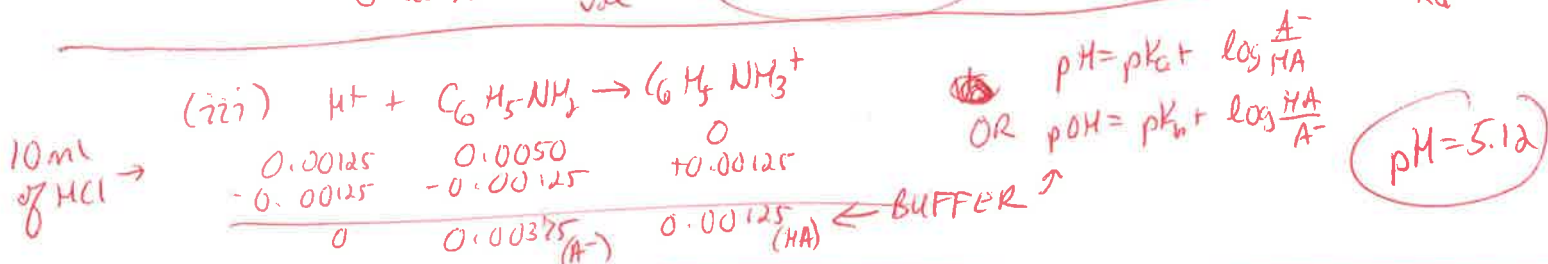
$$K_b = 4.4 \times 10^{-10}$$



(ii)  $0.05000 L (0.10 M) = 0.0050 \text{ moles } C_6H_5NH_2 \times \frac{1 H^+}{1 C_6H_5NH_2} = 0.0050 \text{ moles } H^+ \text{ needed}$

$$0.125 M = \frac{0.0050 \text{ moles}}{V_{HCl}} \quad V_{HCl} = 40 \text{ mL}$$

$$K_a = 2.3 \times 10^{-5}$$



(iv) At end point, solution is 0.0050 moles  $C_6H_5NH_3^+$  in 90 mL

Weak acid  $[C_6H_5NH_3^+] = 0.0556 M$   $K_a = 2.3 \times 10^{-5}$

$$x = [H^+] = 2.7 \times 10^{-4} M$$

$$pH = 3.6$$