

1. (8 Pts) Determine the  $[H^+]$ ,  $[OH^-]$ , pH, and the  $pOH$  of each of the following.

a. 50.0 mL of 0.015 M  $Ba(OH)_2$  solution. *Strong Base*  $Ba(OH)_2 \xrightarrow{H_2O} Ba^{2+} + 2OH^-$   
 $= 2 \times 0.015 = 0.030 M$   $pOH = -\log[0.030] = 1.52$

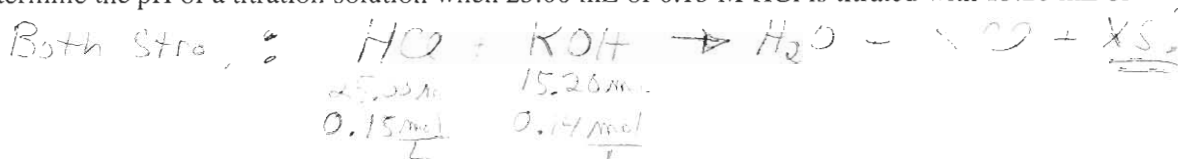
$$[H^+] = \frac{10^{-14}}{0.030} = 3.3 \times 10^{-13} M \quad pH = 12.48$$

b. 75.00 mL of 0.025 M  $HNO_3$  solution. *Strong Acid*  $HNO_3 \xrightarrow{H_2O} H^+ + NO_3^-$

$$[H^+] = 0.025 M \quad pH = 1.60$$

$$[OH^-] = \frac{10^{-14}}{0.025} = 4.0 \times 10^{-13} M \quad pOH = 12.40$$

2. (6 Pts) Determine the pH of a titration solution when 25.00 mL of 0.15 M HCl is titrated with 15.20 mL of 0.14 M KOH. *Both Strong*



$$\text{mol } H^+ = \frac{25.00 mL \times 0.15 M}{1000 mL/L} = 0.375 \text{ mol } H^+$$

$$\text{mol } OH^- = \frac{15.20 mL \times 0.14 M}{1000 mL/L} = 0.2128 \text{ mol } OH^-$$

$$pH = -\log \left[ \frac{0.001622 \text{ mol } H^+}{0.4020 \text{ L}} \right] = 1.394$$

3. (6 Pts) Lactic acid,  $HC_3H_5O_2$ , has one acidic hydrogen. A 0.10 M solution of lactic acid has a pH of 2.44. Calculate the  $K_a$  for lactic acid.

	$HLac$	$+ H_2O$	$\rightleftharpoons$	$H_3O^+$	$+ Lac^-$
I	0.10	N/A		0	0
C	-x			+x	+x
E	0.10-x			x	x

$$K_a = \frac{[H_3O^+][Lac^-]}{[HLac]}$$

$$K_a = \frac{(0.00363)^2}{(0.10 - 0.00363)}$$

$$K_a = 1.367 \times 10^{-4}$$

$$x = 10^{-2.44}$$

$$0.10 - 0.00363 = 0.09637 \quad x = 0.00363$$

4. (5 Pts) The acid-dissociation constant for benzoic acid,  $HC_7H_5O_2$ , is  $6.3 \times 10^{-5}$ . Calculate the pH of a 0.050 M benzoic acid solution.

	$HBz$	$+ H_2O$	$\rightleftharpoons$	$H_3O^+$	$+ Bz^-$
I	0.050	N/A		0	0
C	-x			+x	+x
E	0.050-x			x	x

$$K_a = \frac{[H_3O^+][Bz^-]}{[HBz]}$$

$$6.3 \times 10^{-5} = \frac{x^2}{0.050 - x}$$

*try dropping*

$$x = 0.00177 = [H^+]$$

$$pH = -\log([H^+]) = 2.75$$

1. (8 Pts) Determine the  $[H^+]$ ,  $[OH^-]$ , pH, and the  $pOH$  of each of the following.

a. 85.00 mL of 0.035 M  $HNO_3$  solution. Strong Acid  $HNO_3 \xrightarrow{H_2O} H^+ + NO_3^-$

$$[H^+] = \underline{0.035} \quad pH = -\log [0.035] = \underline{1.46}$$

$$[OH^-] = \frac{10^{-14}}{0.035} = \underline{2.86 \times 10^{-13}} \quad pOH = \underline{12.54}$$

b. 60.0 mL of 0.025 M  $Ba(OH)_2$  solution. Strong Base:  $Ba(OH)_2 \xrightarrow{H_2O} Ba^{2+} + 2OH^-$

$$[OH^-] = 2(0.025) = \underline{0.050M} \quad pOH = \underline{1.30}$$

$$[H^+] = \frac{10^{-14}}{0.050} = \underline{2.0 \times 10^{-13}} \quad pH = \underline{12.70}$$

2. (6 Pts) Determine the pH of a titration solution when 25.00 mL of 0.18 M HCl is titrated with 19.20 mL of 0.14 M NaOH. Strong Acid + Strong Base  $HCl_{aq} + NaOH_{aq} \rightarrow H_2O(l) + NaCl_{aq}$

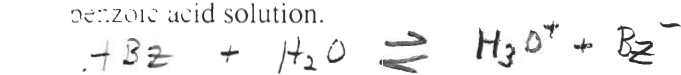
Net Ionic Eq.  $H^+ + OH^- \rightarrow H_2O(l)$  1:1 ratio

$$\text{Find moles } H^+ : \frac{25.00 \text{ mL} \times 0.18 \text{ mol HCl}}{1000 \text{ mL HCl}} \times \frac{1 \text{ mol } H^+}{1 \text{ mol HCl}} = 0.0045 \text{ mol } H^+$$

$$\text{Find moles } OH^- : \frac{19.20 \text{ mL} \times 0.14 \text{ mol NaOH}}{1000 \text{ mL NaOH}} \times \frac{1 \text{ mol } OH^-}{1 \text{ mol NaOH}} = 0.00269 \text{ mol } OH^-$$

$$pH = -\log \left[ \frac{0.001812 \text{ mol } H^+}{44.20 \times 10^{-3} \text{ L}} \right] = \underline{1.387}$$

3. (5 Pts) The acid-dissociation constant for benzoic acid,  $HC_7H_5O_2$ , is  $6.3 \times 10^{-5}$ . Calculate the pH of a 0.060 M benzoic acid solution.



$$C \quad 0.060 \quad NA \quad 0 \quad 0$$

$$E \quad -x \quad \quad +x \quad +x$$

$$E \quad 0.060 - x \quad \quad x \quad x$$

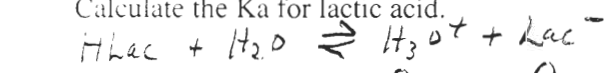
$$K_a = \frac{[H_3O^+][Bz^-]}{[Bz]}$$

$$6.3 \times 10^{-5} = \frac{x^2}{0.060 - x} \quad \leftarrow \text{try dropping}$$

$$x = 0.00194 = [H_3O^+] \quad \text{quad } (0.00191)$$

$$pH = 2.71 \quad \underline{2.718}$$

4. (6 Pts) Lactic acid,  $HC_3H_5O_2$ , has one acidic hydrogen. A 0.10 M solution of lactic acid has a pH of 2.44. Calculate the  $K_a$  for lactic acid.



$$C \quad 0.10 \quad NA \quad 0 \quad 0$$

$$E \quad -x \quad \quad +x \quad +x$$

$$E \quad 0.10 - x \quad \quad x \quad x$$

$$K_a = \frac{(0.003631)^2}{(0.10 - 0.003631)}$$

$$K_a = 1.37 \times 10^{-4}$$

$$\text{from } pH \rightarrow x = 10^{-2.44} = 0.003631$$