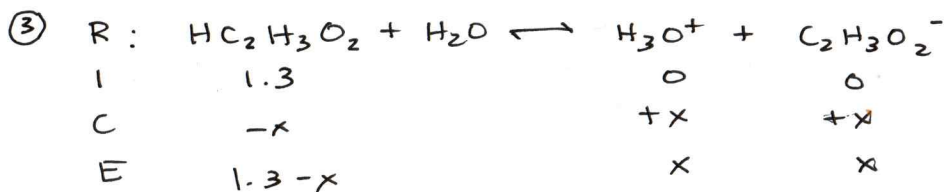


Answers to Chapter 16

① only choice B has H_3O^+ as one of the products so that's K_a

② $\uparrow K_a \uparrow$ strength of weak acid

$HC_2H_3O_2 < HOCN < HF$ strongest weak acid



$$K_a = \frac{[H_3O^+][C_2H_3O_2^-]}{[HC_2H_3O_2]} = 1.8 \times 10^{-5} = \frac{(x)(x)}{1.3-x} \approx 1.3$$

$\frac{1.3}{1.8 \times 10^{-5}} > 1000$ so $1.3-x \approx 1.3$

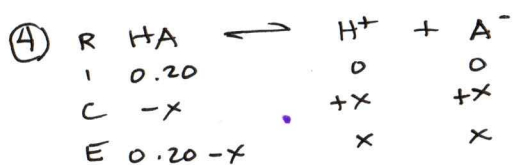
$$(1.8 \times 10^{-5})(1.3) = x^2$$

$$2.4 \times 10^{-5} = x^2$$

$$\sqrt{2.4 \times 10^{-5}} = x = 4.9 \times 10^{-3}$$

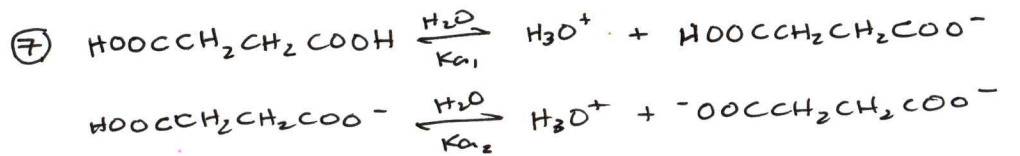
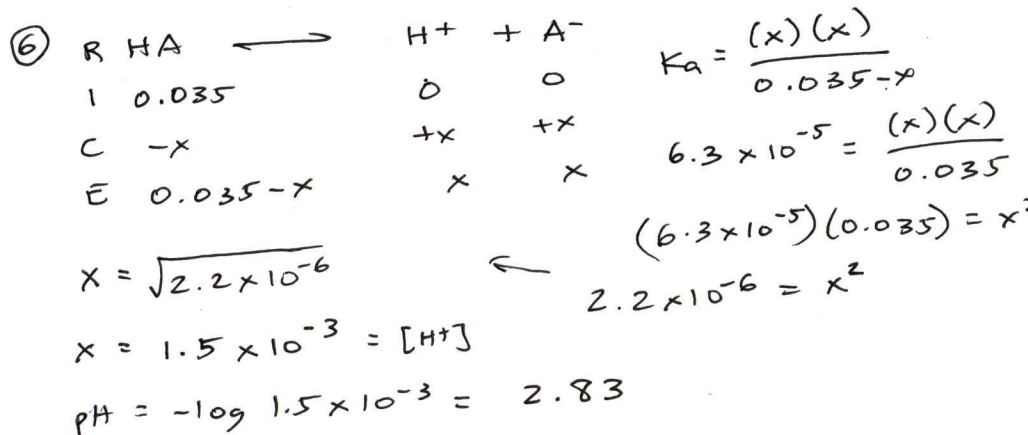
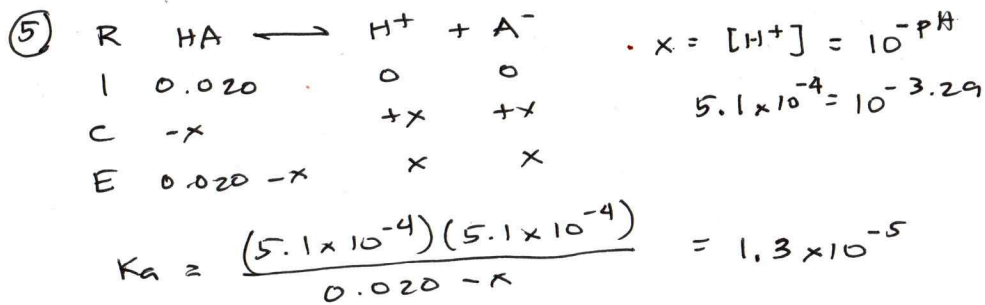
$$\% \text{ ionized} = \frac{x}{[HA]_i} \times 100 = \frac{4.9 \times 10^{-3}}{1.3} \times 100 = 0.38\%$$

0.37% closest among choices



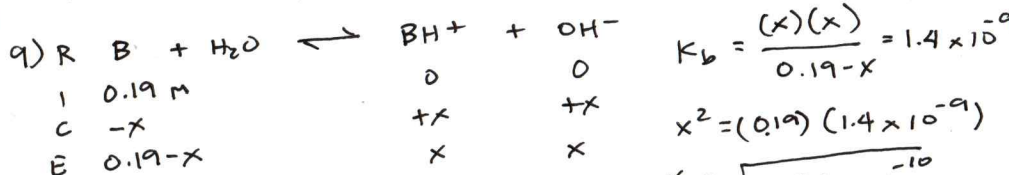
$$K_a = \frac{(4.0 \times 10^{-4})(4.0 \times 10^{-4})}{0.20 - 4.0 \times 10^{-4}} = 8.0 \times 10^{-7}$$

$x = 0.20 \times 0.0020 = 4.0 \times 10^{-4}$
 ↑
 obtained from 0.20%

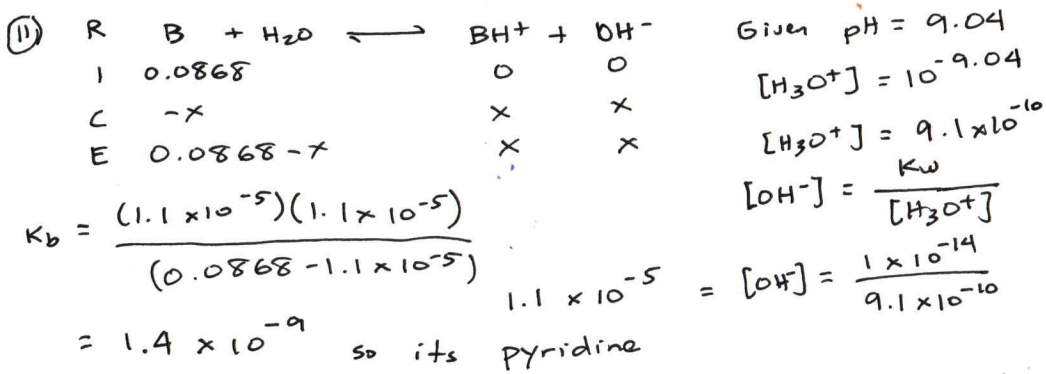
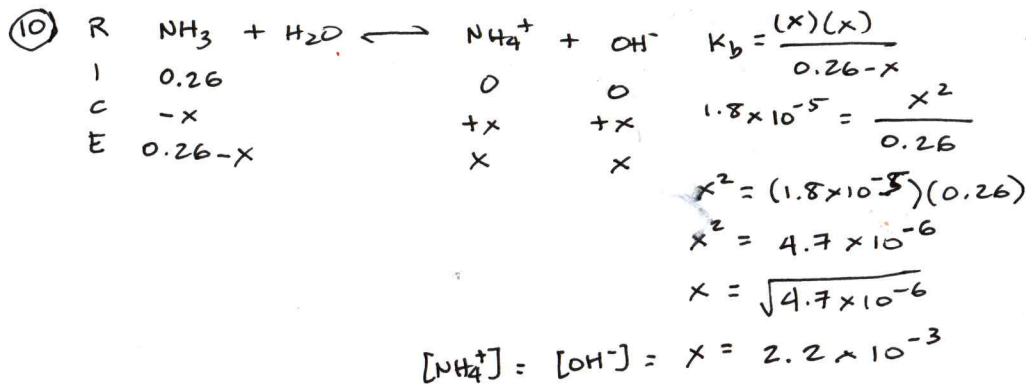


since K_a values are so small only small amount dissociated so the species present in highest concentration is $HOOCCH_2CH_2COOH$.

⑧ For K_b , find the reaction that has OH^- as one of the products.



$pOH = -\log 1.6 \times 10^{-5}$
 $= 4.79$
 $[OH^-] = x = 1.6 \times 10^{-5}$



⑫ The one that hydrolyses are conjugate base of weak acid and conjugate acid of weak base. The ions are NH_4^+ and Cl^- so only NH_4^+ will hydrolyze. The Cl^- will not hydrolyze since its conjugate base of a strong acid

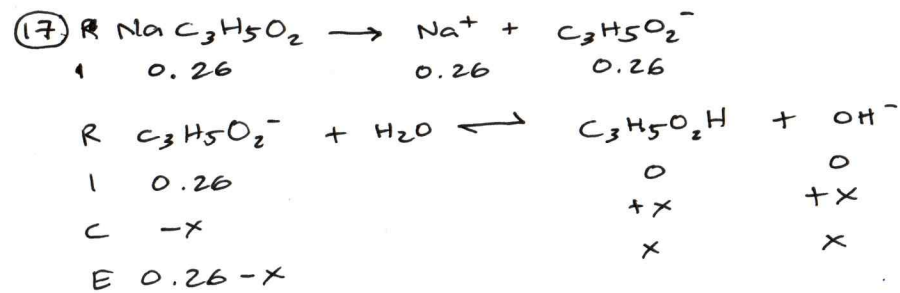
$$\text{NH}_4^+ + \text{H}_2\text{O} \rightleftharpoons \text{NH}_3 + \text{H}_3\text{O}^+$$

⑬ The correct choice here is the one with the conjugate base coming from weak acid. All choices have conjugate base from strong acids except D.

⑭ Find the salt that will give acidic soln. This will be the one that has a conjugate base from a strong acid and conjugate acid from a weak base. NH_4Cl

⑮ $K_a K_b = K_w$ $K_a = \frac{K_w}{K_b} = \frac{1 \times 10^{-14}}{1.8 \times 10^{-5}} = 5.6 \times 10^{-10}$

⑯ Just like #15 $K_b = \frac{K_w}{K_a} = \frac{1 \times 10^{-14}}{5.0 \times 10^{-4}} = 2.0 \times 10^{-11}$



$$K_b = \frac{(x)(x)}{0.26-x} = \frac{1 \times 10^{-14}}{1.3 \times 10^{-5}} = \frac{x^2}{0.26-x} \approx 0.26$$

$$7.7 \times 10^{-10} = \frac{x^2}{0.26} \quad (7.7 \times 10^{-10})(0.26) = x^2$$

$$2.0 \times 10^{-10} = x^2$$

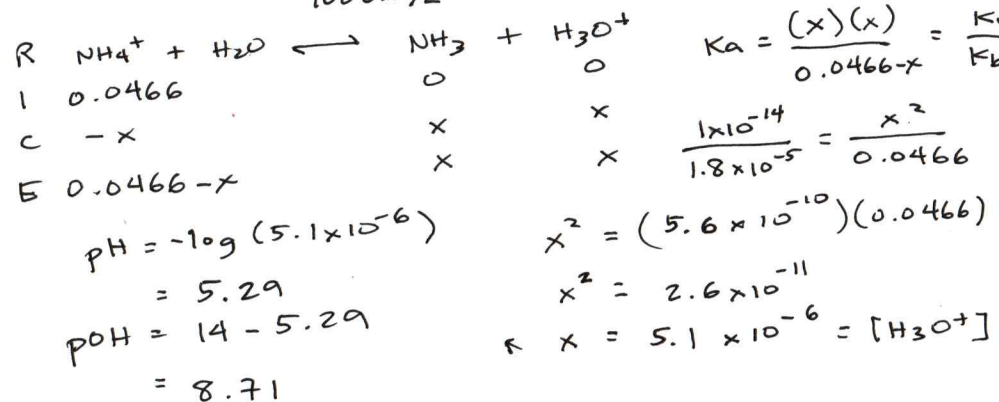
$$[\text{OH}^-] = \sqrt{2.0 \times 10^{-10}} = x$$

$$= 1.4 \times 10^{-5}$$

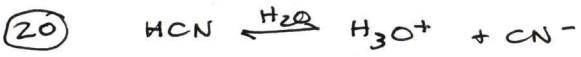
pOH = $-\log 1.4 \times 10^{-5}$
 $= 4.8$
 pH = $14 - 4.2$
 $= 9.2$

⑱ $\text{NH}_4\text{Br} = \frac{0.799}{97.94 \text{ g/mol}} = 0.0466 \text{ M}$

\downarrow
 $\text{NH}_4^+ + \text{Br}^-$ $\frac{175 \text{ mL}}{1000 \text{ mL/L}}$



⑲ $\text{NH}_3 + \text{H}_2\text{O} \rightleftharpoons \text{NH}_4^+ + \text{OH}^-$
 Adding NaOH will increase $[\text{OH}^-]$. This common ion will favor backward rxn causing the percent ionization of ammonia to decrease.



$\text{pH} = \text{pK}_a + \log \frac{[\text{CN}^-]}{[\text{HCN}]}$

$= \text{pK}_a + \log \frac{[\text{CN}^-]}{[\text{HCN}]}$ if $[\text{CN}^-] = [\text{HCN}]$

Only choice B is false.

21) Find the pKa of acid in buffer system closest to the pH.

Choice D pKa is closest to pH 4.45.

22) Buffer is made up of weak acid and its conjugate base or weak base and its conjugate acid. Only choice D fulfill this definition of a buffer.



after addn of H^+ $\text{H}^+ + \text{F}^- \rightleftharpoons \text{HF}$
 F^- will react with added H^+ from HCl

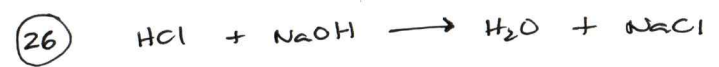


NaOH will dissociate to Na^+ & OH^- and OH^- reacts with acid component of the buffer

25) $\text{pH} = \text{pK}_a + \log \frac{[\text{base}]}{[\text{acid}]}$
 $= -\log 1.8 \times 10^{-5} + \log \frac{0.032}{0.032}$

$\text{pH} = 4.74 + \log 1$

$[\text{H}^+] = 10^{-4.74} = 1.8 \times 10^{-5}$



$(0.18 \text{ M}) \left(\frac{700 \text{ mL}}{1000 \text{ mL/L}} \right) = 0.126 \text{ mol H}^+$

$(0.51 \text{ M}) \left(\frac{300 \text{ mL}}{1000 \text{ mL/L}} \right) = 0.153 \text{ mol OH}^-$
 $0.027 \text{ mol OH}^- \text{ left}$

$\frac{0.027 \text{ mol}}{1.0 \text{ L}} = 0.026 \text{ M}$

$\text{pOH} = -\log 0.027 = 1.57$

$[\text{OH}^-] = 10^{-\text{pOH}} = 0.027$

$[\text{H}^+] = \frac{1 \times 10^{-14}}{0.027} = 3.7 \times 10^{-13}$

27) Only choice D is true where at equivalence point, the solution is composed of the conjugate base of the weak acid.

28) For indicator choices, look at the pH region being analyzed. The indicator whose transition range is close to the pH region being analyzed is the best indicator.

For the question, a weak acid is titrated with strong base and since equivalence point is higher than $7 = \text{pH}$, choice D is the most appropriate.

29) The equivalence point is the steepest point so correct choice is C or III.

30) $\text{mol OH}^- = \left(0.125 \frac{\text{mol}}{\text{L}} \right) \left(\frac{41.36 \text{ mL}}{1000 \text{ mL/L}} \right) = 5.17 \times 10^{-3}$

$\text{mol} = CV$

$C = \frac{\text{mol}}{V} = \frac{5.17 \times 10^{-3} \text{ mol}}{25.00 \text{ mL}} = 0.2068 \text{ M}$
 original concn of propionic acid



$[\text{A}^-] = \frac{5.17 \times 10^{-3}}{\left(\frac{41.36 + 25.00 \text{ mL}}{1000 \text{ mL/L}} \right)}$

$= 0.0779 \text{ M} = \text{concentration of propionate ion at the equivalence point}$