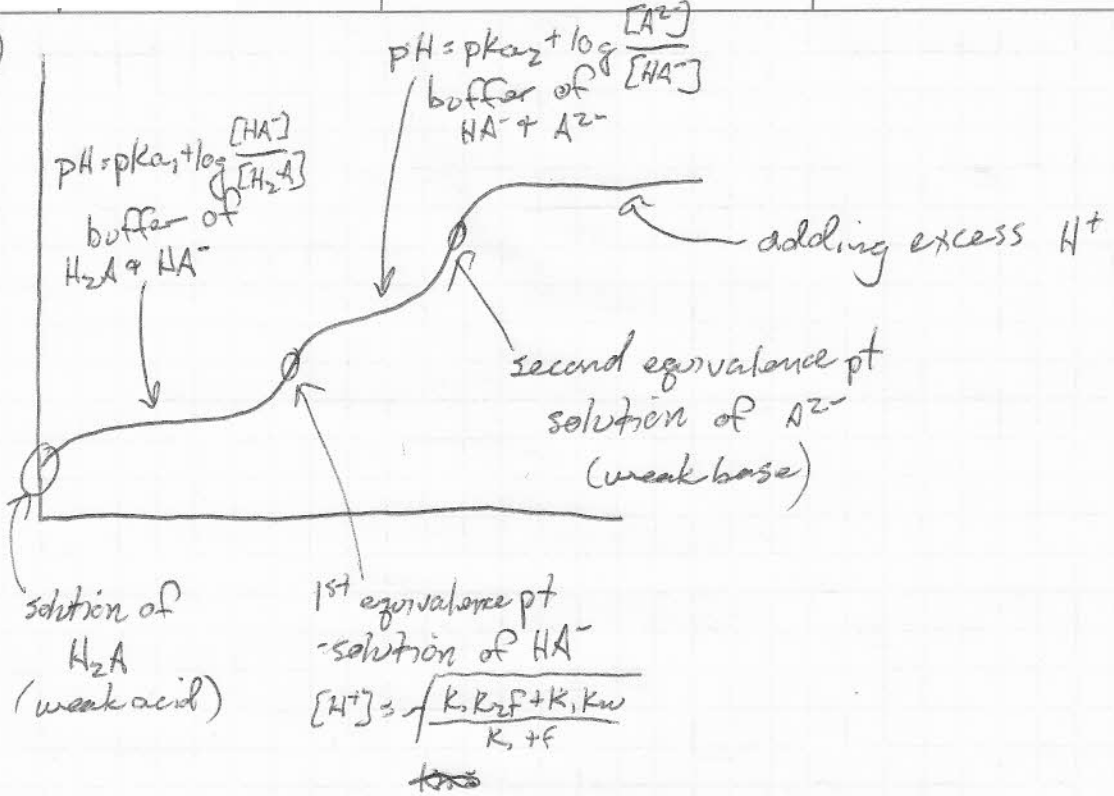
(19)



(23). $V_a = 0$ mL $\quad \frac{x^2}{0.100 - x} = 10^{-4}$ $\quad pH = -\log\left(\frac{10^{-14}}{3.11 \times 10^{-3}}\right) = \boxed{11.49}$

$x^2 + 10^{-4}x - 10^{-5} = 0$

$x = 0.00311\ M = [OH]$

$pKa_2 = 14 - pKb_1 = 10$

$V_a = 1$ mL $\quad 100\ mL \left| \frac{0.100\ mmol}{1\ mL} \right| = 10.0\ mmol\ A^{2-}$ $\quad 10.0 - 1.00 = 9.00\ mmol\ A^{2-}$

$1.00\ mmol\ HA^-$

$1\ mL \left| \frac{1\ mmol\ H^+}{1\ mL} \right| = 1\ mmol\ H^+$ $\quad pH = 10.00 + \log \frac{9}{1} = \boxed{10.95}$

$V_a = 5$ mL $\quad 5\ mmol\ H^+$ $\quad A^{2-} = 10 - 5 = 5\ mmol$

$HA = 5$ $\quad pH = 10.00 + \log \frac{5}{5} = \boxed{10.00}$

$V_a = 9$ mL $\quad 9.00\ mmol\ H^+$ $\quad A^{2-} = 10 - 9 = 1.00\ mmol$

$HA^- = 9.00\ mmol$ $\quad pH = 10.00 + \log \frac{1}{9} = \boxed{9.05}$

$V_a = 10$ mL $\quad 10\ mmol\ H^+ \rightarrow$ 1st equivalence pt

$[H^+] = \sqrt{\frac{(10^{-6})(10^{-10})(0.0909) + (10^{-6})(10^{-14})}{10^{-6} + 0.0909}}$ $\quad F = \frac{10\ mmol}{110\ mL} = 0.0909\ M$

$= 1.00 \times 10^{-8} \rightarrow pH = \boxed{8.00}$

23 (cont)

$V_a = 11$ mL   11.00 mmol H^+ (1.00 mmol past equiv. pt)

$HA^- = 10 - 1 = 9.00$ mmol $pK_{a1} \approx 14 - pK_{b2}$

$H_2A = 1.00$ mmol $pH = 6.00 + \log \frac{9}{1} = \boxed{6.95}$

$V_a = 15$ mL $HA^- = 10 - 5 = 5$ mmol $pH = 6.00 + \log \frac{5}{5} = \boxed{6.00}$

$H_2A = 5$ mmol

$V_a = 19$ mL $HA^- = 10 - 9 = 1$ mmol $pH = 6.00 + \log \frac{1}{9} = \boxed{5.05}$

$H_2A = 9$ mmol

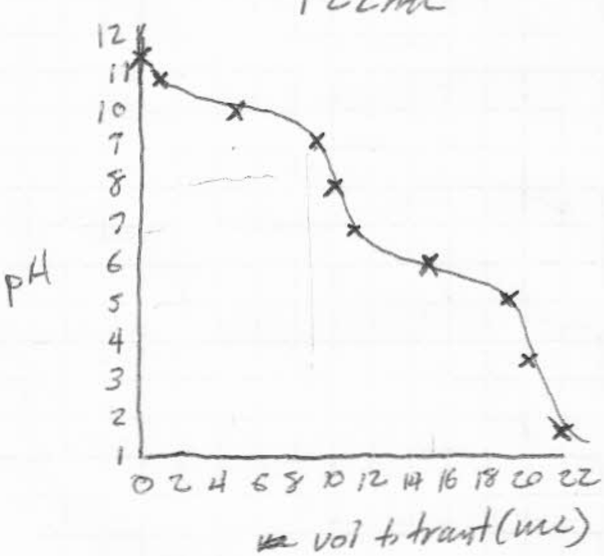
$V_a = 20$ mL   20.00 mmol H^+ = 2nd equivalence pt. solution of H_2A

$$[H_2A] = \frac{10\text{ mmol}}{120\text{ mL}} = 8.33 \times 10^{-2} M$$

$$\frac{x^2}{8.33 \times 10^{-2} - x} = 10^{-6}$$ $pH = \boxed{3.54}$

$x =$ ~~3.46×10^{-3}~~ 2.89×10^{-4} $M = [H^+]$

$V_a = 22$ mL $\frac{2 \text{ excess mmol } H^+}{122 \text{ mL}} = 0.0164 M\ H^+$ $pH = \boxed{1.79}$



(26) $25.0\,mL \left| \frac{0.0200\,mmol}{1\,mL} \right| = 0.500\,mmol$ base (intermediate form)
-0.1635
$= 0.3365\,mmol$ base

$10.9\,mL \left| \frac{0.0150\,mmol\,H^+}{1\,mL} \right| = 0.1635\,mmol\,H^+ \rightarrow mmol$ acid

$pH = 4.70 + \log \frac{0.3365}{0.1635} = \boxed{5.01}$

(29) $\frac{0.0100\,M}{0.00400\,M} = 2.5$ times more H^+

equivalence pt conc. $= \frac{0.0100}{3.5} = 2.86 \times 10^{-3}\,M$

$\frac{x^2}{2.86 \times 10^{-3} - x} = 3.9 \times 10^{-3}$

$x^2 + 3.9 \times 10^{-3}x - 1.11 \times 10^{-5}$ $\quad pH = \boxed{2.72}$

$x = 1.91 \times 10^{-3} = [H^+]$

(31) oxalic acid $pka_2 = 4.266$

$4.40 = 4.266 + \log \frac{base}{acid}$

$\frac{base}{acid} = 1.36$ $\quad \frac{base}{16} = 1.36$

$base = 21.76$

acid $= 20.0\,mL \left| \frac{0.800\,mmol}{1\,mL} \right| = 16\,mmol$

total oxalate $= 16 + 21.76$

$= 37.8\,mmol$ oxalate

$37.8\,mmol \left| \frac{166.22 \times 10^{-3}\,g}{1\,mmol} \right| = \boxed{6.28\,g}$

(36) when pH = pka, there are equal ~~forms~~ amounts of acid and base forms. When pH = pka ± 1 there is 10 times more of one or the other form. This should be sufficient to see a definite color change

(41) a. red b. orange c. yellow

(43) No, the pH at the equivalence pt will be above 7.

(47) $14.22\,mL \left| \frac{0.1063\,mmol\,H^+}{1\,mL} \right| \frac{1\,mmol\,NH_3}{1\,mmol\,H^+} \left| \frac{17.031\,mg\,NH_3}{1\,mmol\,NH_3} \right| = \frac{25.74\,mg\,NH_3}{4.373 \times 10^3\,mg\,soln} \times 100$

$= 0.589\%$ in diluted soln

dilution factor $= \frac{10.231}{(10.231 + 39.466)} = 0.206$ $\quad \frac{0.589\%}{0.206} = \boxed{2.86\%}$