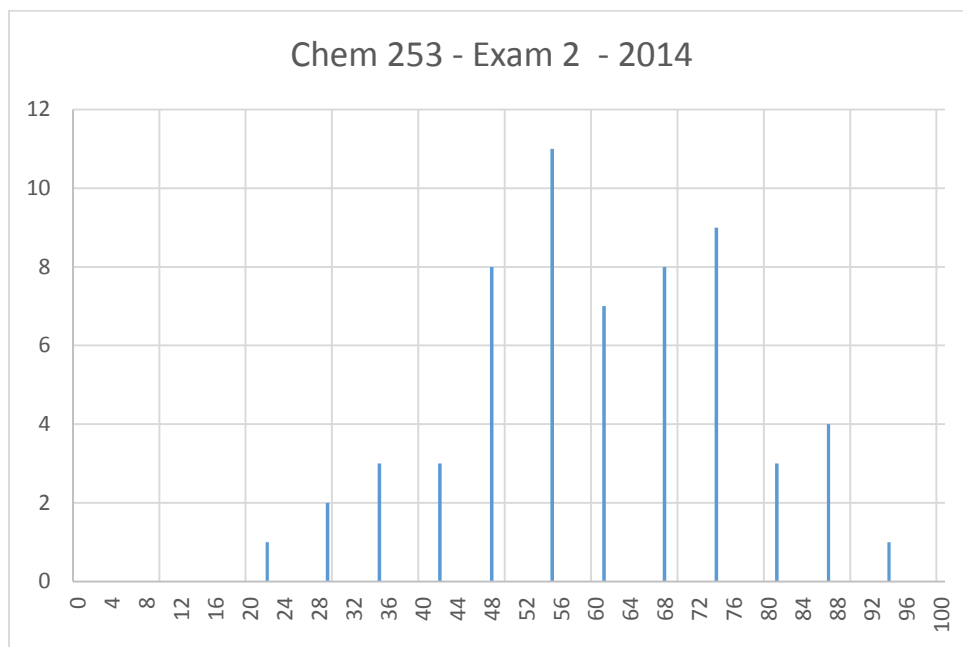
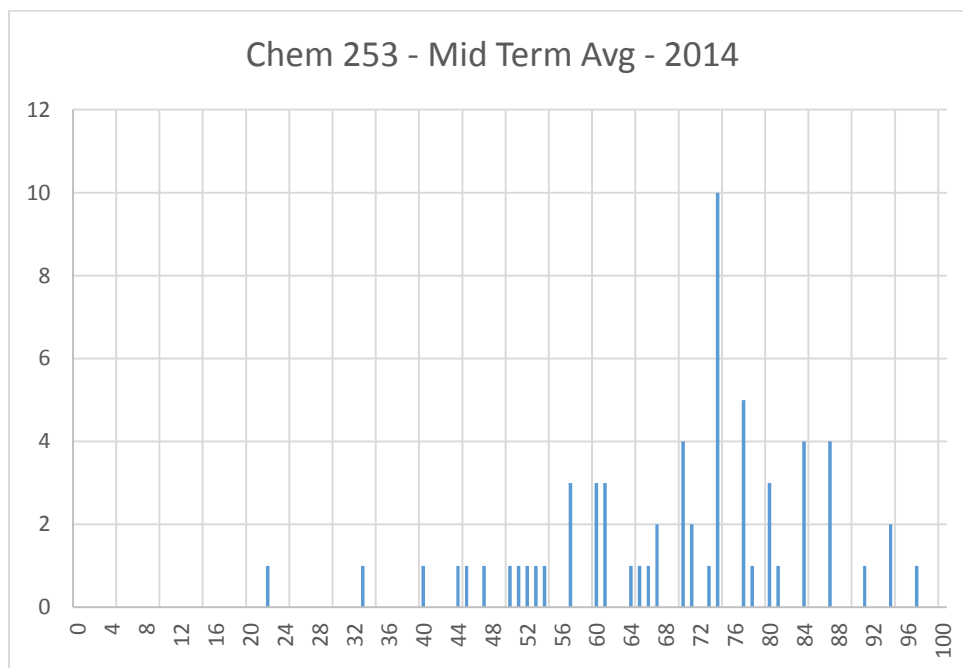


Frequency



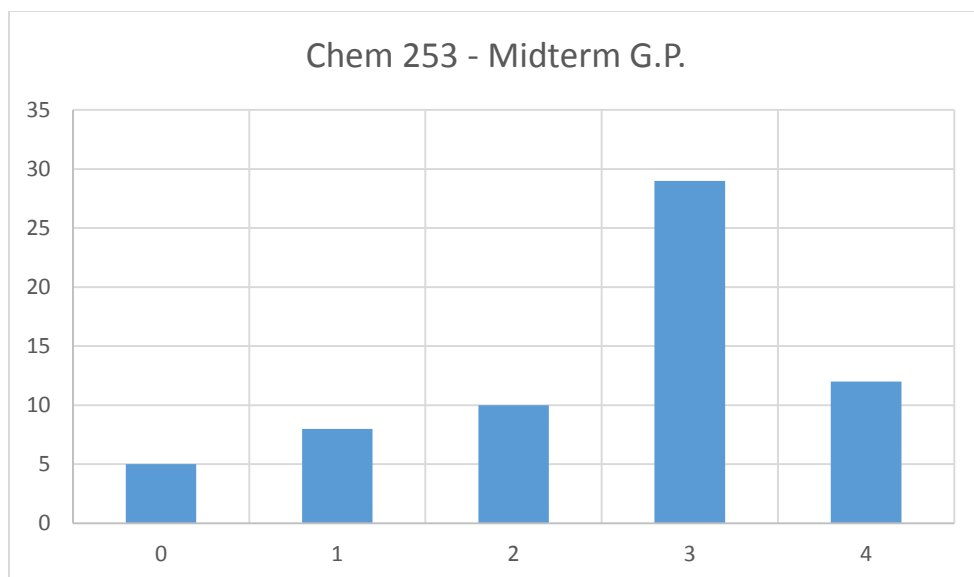
Grade

Avg = 57.4 Med = 61 Std. Dev. = 19.9 High = 94



Avg = 69, Med = 73, $\sigma = 15$

A: 100-82%, B: 81-67%, C: 66-57% D: 56-45%, F: less than 45%



Avg = 2.6, $\sigma = 1.2$

TABLE 11-1 Values of $\alpha_{Y^{4-}}$ for EDTA at 25°C and $\mu = 0.10$ M

pH	$\alpha_{Y^{4-}}$
0	1.3×10^{-23}
1	1.4×10^{-18}
2	2.6×10^{-14}
3	2.1×10^{-11}
4	3.0×10^{-9}
5	2.9×10^{-7}
6	1.8×10^{-5}
7	3.8×10^{-4}
8	4.2×10^{-3}
9	0.041
10	0.30
11	0.81
12	0.98
13	1.00
14	1.00

1] A solution of 0.100 M AgNO_3 is used to titrate a 100.00 mL solution of 0.100 M KCl. The K_{sp} of AgCl is 1.8×10^{-10} . What is pAg if 50.00 mL of the titrant is added to the KCl solution? ¹

2] What is the concentration Cl^- required to remove 97% of Ag^+ in a solution of 0.100 F AgNO_3 ? ²

3] What term best explains the solubility of CaF_2 ? ($\text{p}K_{sp} = 10.41$) ³

4] What is the pH of NaHA given the following? ⁴



5] The K_{sp} of $BaSO_4$ is 4.3×10^{-11} . The pK_{a2} of H_2SO_4 is 1.99. What would you expect with $BaSO_4$ molar solubility and between pH 5 and 10? ⁵

- a) The molar solubility decreases with pH
- b) The molar solubility increases with pH
- c) The molar solubility increases from 5 to 6.5 then decreases from 6.5 to 10.
- d) The molar solubility is constant.
- e) The molar solubility decreases from 5 to 6.5 then increases from 6.5 to 10.

6] What is the mass balance equation for 0.1 M $NaHCO_3$? Note for H_2CO_3 $pK_{a1} = 6.352$, and $pK_{a2} = 10.329$. ⁶

7] The weak acid, H_2A has $K_{a1} = 1.0 \times 10^{-4}$ and $K_{a2} = 1.0 \times 10^{-8}$. The fraction, $\alpha_{A^{2-}}$ at pH 7.00 can be calculated from which of the following? ⁷

$$\frac{[H^+]^2}{[H^+]^2 + [H^+]K_{a1} + K_{a1}K_{a2}}$$

$$\frac{K_{a1}K_{a2}}{[H^+]^2 + [H^+]K_{a1} + K_{a1}K_{a2}}$$

$$\frac{K_{a1}[H^+]}{[H^+]^2 + [H^+]K_{a1} + K_{a1}K_{a2}}$$

$$\frac{K_{a1}K_{a2}[H^+]^2}{[H^+]^2 + [H^+]K_{a1} + K_{a1}K_{a2}}$$

$$\frac{K_{a1}K_{a2}[H^+]}{[H^+]^2 + [H^+]K_{a1} + K_{a1}K_{a2}}$$

8] What is the pH of a solution containing 0.10 M NaA and 0.10 M HA ? $K_a = 1.0 \times 10^{-5}$ ⁸

9] How many milliliters of 1.0 M NaOH must be added to 1.0 L of 0.20 M NH_4Cl to produce a buffer at pH 10? $K_a = 5.7 \times 10^{-10}$ ⁹

10] What is the pH of a titration solution that is a combination of 10.00 mL of 0.100 M H_2A and 15.00 mL of 0.100 M NaOH? $K_{a1} = 1.00 \times 10^{-3}$, $K_{a2} = 1.00 \times 10^{-6}$ ¹⁰

11] What is the pH of a titration solution that is a combination of 10.00 mL of 0.100 M H_2A and 25.00 mL of 0.100 M NaOH? $K_{a1} = 1.00 \times 10^{-3}$, $K_{a2} = 1.00 \times 10^{-6}$ ¹¹

12] What is the pH of a titration solution that is a combination of 10.00 mL of 0.100 M H_2A and 10.00 mL of 0.100 M NaOH? $K_{a1} = 1.00 \times 10^{-3}$, $K_{a2} = 1.00 \times 10^{-6}$ ¹²

13] What is the pH of a titration solution that is a combination of 10.00 mL of 0.100 M H_2A and 20.00 mL of 0.100 M NaOH? $K_{a1} = 1.00 \times 10^{-3}$, $K_{a2} = 1.00 \times 10^{-6}$ ¹³

14] What is the fraction of EDTA at Y^{4-} at pH 7? ¹⁴

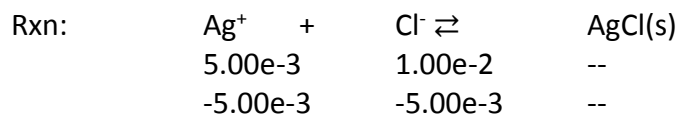
15] What is the charge balance equation for a solution containing Na_2SO_4 and HCl? You may ignore K_w . ¹⁵

Answers

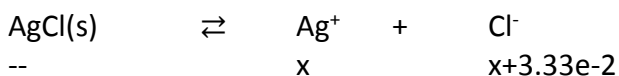
¹ Titration Rxn: $\text{Ag}^+ + \text{Cl}^- \rightleftharpoons \text{AgCl(s)}$

$$\text{Mol of Ag}^+ = 0.05000 \text{ L} * 0.100 \text{ M AgNO}_3 = 5.00\text{e-}3$$

$$\text{Mol of Cl}^- = 0.10000 \text{ L} * 0.100 \text{ M KCl} = 1.00\text{e-}2$$



$$[\text{Cl}^-] = 5.00\text{e-}3 \text{ mol Cl}^- / 0.1500 \text{ L} = 3.33\text{e-}2$$



$$x(3.33\text{e-}2) \cong 1.8\text{e-}10$$

$$x = 5.4\text{e-}9 \text{ M}$$

$$\text{pAg} = 8.27$$

$$^2 [\text{Ag}^+] = (1-0.97) 0.100 \text{ F} = 3.00\text{e-}3 \text{ M} \quad K_{\text{sp}} = [\text{Ag}^+][\text{Cl}^-] = 1.8\text{e-}10 = 3.00\text{e-}3 \text{ M} * [\text{Cl}^-] \rightarrow [\text{Cl}^-] = 6.0\text{e-}8 \text{ M}$$

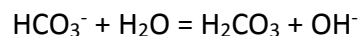
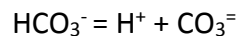
$$^3 [\text{Ca}^{2+}]$$

$$^4 \quad \text{pH} = \frac{1}{2}(\text{pKa}_1 + \text{pKa}_2) \quad \text{pKa}_1 = -\log(6.1\text{e-}4) = 3.21 \quad \text{pKa}_2 = -\log(1.1\text{e-}9) = 8.96$$

pH = 6.09

⁵ Molar Solubility stays constant as the predominate form of sulfate is SO_4^{2-} in this pH range. SO_4^{2-} doesn't hydrolyze as it's the conjugate base of a strong acid.

⁶ initial $[\text{Na}^+] = [\text{HCO}_3^-]$ then consider hydrolysis



$$\text{final } [\text{Na}^+] = [\text{H}_2\text{CO}_3] + [\text{HCO}_3^-] + [\text{CO}_3^{2-}]$$

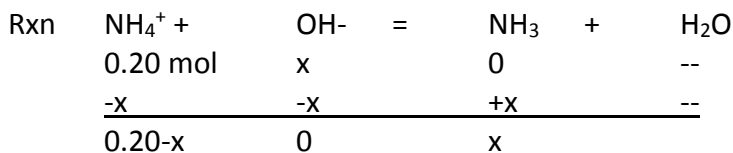
⁷

$$\frac{K_{a1}K_{a2}}{[\text{H}^+]^2 + [\text{H}^+]K_{a1} + K_{a1}K_{a2}}$$

⁸ $K_a = [H^+][A^-] / [HA]$ $1.0 \times 10^{-5} = [H^+] 0.10 / 0.10$ $[H^+] = 1.0e-5$ $pH = 5.00$

⁹ Find pH using $K_a = [H^+][NH_3] / [NH_4^+]$ $[H^+] = 1.0e-10$

initial mol NH_4^+ = $0.20 \text{ M} \cdot 1.0 \text{ L} = 0.20 \text{ mol}$



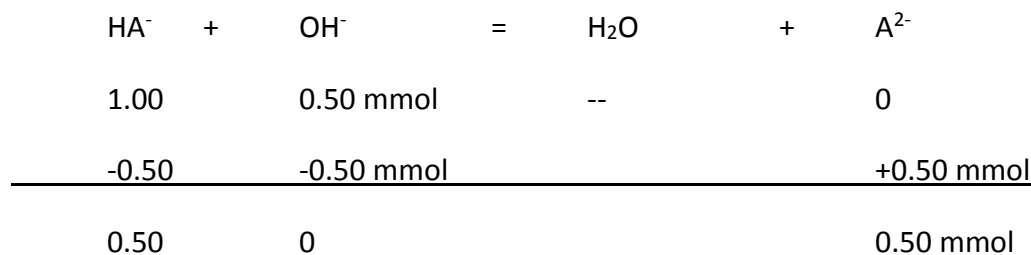
$K_a = [H^+][NH_3] / [NH_4^+] = 5.7e-10 = 1.0e-10 x / (0.20-x)$

$x = 0.030 \text{ mol } OH^-$ requires 0.170 L

¹⁰ initial mol $H_2A = 10.00 \cdot 0.100 = 1.00 \text{ mmol}$

added mol $NaOH = 15.00 \cdot 0.100 = 1.50 \text{ mmol}$

Past the 1st eq. pt. excess $OH^- = 0.50 \text{ mmol}$



buffer system $[HA^-] = [A^{2-}] = 0.50 \text{ mmol} / 25.00 \text{ mL}$

$K_{a2} = 1.00e-6 = [H^+][A^{2-}] / [HA^-] = [H^+]$

$pH = 6.00$

¹¹ past 2nd eq. pt. initial mol $H_2A = 10.00 \cdot 0.100 = 1.00 \text{ mmol}$

added mol $NaOH = 25.00 \cdot 0.100 = 2.50 \text{ mmol}$

excess $\text{OH}^- = 0.50 \text{ mmol}$

$[\text{OH}^-] = 0.50 \text{ mmol} / 35.00 \text{ mL} = 1.43\text{e-}2 \text{ M}$

$\text{pOH} = 1.845$ $\text{pH} = 12.15$

12 initial mol $\text{H}_2\text{A} =$ added mol OH^- first eq. pt.

$[\text{HA}^-] = 1.000 \text{ mmol} / 20.00 \text{ mL} = 5.000\text{e-}2 \text{ M}$

Amphoteric Species

$\text{HA}^- + \text{H}_2\text{O} = \text{H}_2\text{A} + \text{OH}^-$ & $\text{HA}^- = \text{H}^+ + \text{A}^{2-}$

$\text{pH} = \frac{1}{2} (\text{pK}_{a1} + \text{pK}_{a2}) = \frac{1}{2} (3.000 + 6.000) = 4.500$

13 2 eq. pt.

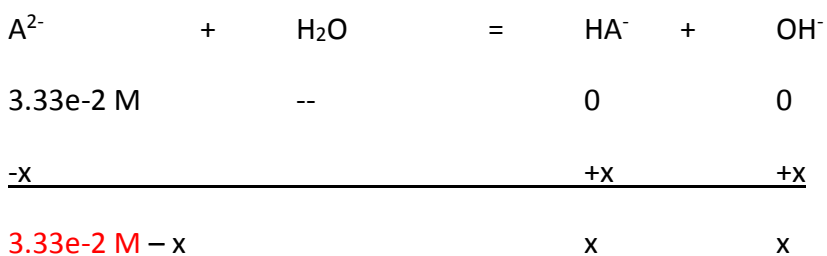
Initial mol $\text{H}_2\text{A} = 10.00 \text{ mL} * 0.100 \text{ M} = 1.00 \text{ mmol}$

Added $\text{OH}^- = 20.00 \text{ mL} * 0.100 \text{ M} = 2.00 \text{ mmol}$

This is the 2nd eq. pt.

So $[\text{A}^{2-}] = 1.00 \text{ mmol} / 30.00 \text{ mL} = 3.33\text{e-}2 \text{ M}$

Now must consider:



$K_b = K_w / K_{a2} = 10^{-14} / 1.00 \times 10^{-6} = [x^2] / 3.33\text{e-}2 \text{ M}$ $x = 1.82\text{e-}5 = [\text{OH}^-] \text{ pH} = 9.261$

14 $3.8\text{e-}4$ see the attached Table

$$^{15} [\text{Na}^+] + [\text{H}^+] = 2 [\text{SO}_4^{2-}] + [\text{Cl}^-]$$