HEM 1220-204
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Quiz 10

Name KEY
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Assume all solutions are aqueous at 25°C. $K_w = 1.0 \times 10^{-14}$

1. A 25.0 mL sample of 0.150 M hydrofluoric acid is titrated with a 0.100 M NaOH solution. The K_a of hydrofluoric acid is 3.5×10^{-4}.

   a) What volume of NaOH solution is needed to neutralize the hydrofluoric acid? Show your method. (4 pts)

$$V_{NaOH} = \frac{V_A M_A}{M_B} = \frac{(25.0mL)(.150M)}{.100M} = 37.5mL$$

   b) Will the pH at the equivalence point be greater than, less than, or equal to 7.00? (2 pt) > 7

   c) Write the balanced net-ionic chemical reaction that occurs at the equivalence point, and causes the pH in part (b) above. (4 pts)

$$F^-_{(aq)} + H_2O_{(l)} \rightleftharpoons HF_{(aq)} + OH^-_{(aq)}$$

   d) Calculate the pH at the equivalence point. Be sure to include an ICE equation, K expression, assumptions made, etc. (8 pts)

$$K_b = \frac{[HF][OH^-]}{[F^-]} = \frac{K_w}{K_a} = \frac{1.0\times10^{-14}}{3.5\times10^{-4}} = 2.86\times10^{-11}$$

$$[F^-]_0 = \frac{(25.0mL)(.150M)}{25.0mL + 37.5mL} = \frac{(25.0mL)(.150M)}{62.5mL} = 6.00\times10^{-2}M$$

	F^-	HF	OH^-
I	6.00×10^{-2}	0	0
C	$-x$	$+x$	$+y$
E	$6.00\times10^{-2} - x$	x	x

$$\frac{6.00\times10^{-2} - 1.3\times10^{-6}}{6.0\times10^{-2}} \qquad \frac{(x)(x)}{6.00\times10^{-2} - x \approx 0} = 2.86\times10^{-11}$$

assume x is small b/c K is small

$$x^2 = 1.7\times10^{-12}$$
$$x = 1.3\times10^{-6}$$

$x = [OH^-] = 1.3\times10^{-6}$

$pOH = -\log(1.3\times10^{-6}) = 5.88$

$pH = 14.00 - 5.88 = 8.12$

Answer: pH= 8.12

2. 25.00 mL of a solution of sulfuric acid is completely neutralized by 29.80 mL of 0.5567 M NaOH . Calculate the molarity of the sulfuric acid solution Show your work, including a balanced chemical reaction. (8 pts)

$2NaOH_{(aq)} + H_2SO_{4(aq)} \rightarrow Na_2SO_{4(aq)} + 2H_2O_{(l)}$

$\text{moles NaOH} = 29.80\text{mL}\left(.5567\ \frac{\text{mol}}{\text{L}}\right) = 1.659\times10^{-2}\ \text{moles NaOH}$

$1.659\times10^{-2}\ \text{mmol NaOH} \times \frac{1\ \text{mmol } H_2SO_4}{2\ \text{mmol NaOH}} = 8.295\ \text{mmol } H_2SO_4$

$[H_2SO_4] = \frac{8.295\ \text{mmol } H_2SO_4}{25.00\ \text{mL } H_2SO_4} =$ Answer: .3318 M

3. Calculate the molar solubility of calcium fluoride in water at 25°C if the K_{sp} for calcium fluoride is 1.5×10^{-10}.

a) Write the chemical reaction that corresponds to K_{sp} for calcium fluoride. Be sure to include ionic charges and physical state (s, l, aq, etc). (4 pts)

$CaF_{2(s)} \overset{H_2O}{\rightleftharpoons} Ca^{2+}_{(aq)} + 2F^-_{(aq)}$

b) Write the Ksp expression for calcium fluoride. (4 pts)

$K_{sp} = [Ca^{2+}][F^-]^2 = 1.5\times10^{-10}$

c) Calculate the molar solubility of calcium fluoride. Clearly show your method. (6 pts)

molar sol = x

$[Ca^{2+}] = x$

$[F^-] = 2x$

$1.5\times10^{-10} = (x)(2x)^2$

$1.5\times10^{-10} = 4x^3$

$3.75\times10^{-11} = x^3$

$3.3\times10^{-4}\ M = x$

Answer: $3.3\times10^{-4}\ M$