Chem 1062

Note Title 7/28/2008

* Today is the last day to withdraw
* Mistake in Key to Ch 17 Homework Quiz #8 (17.72) has been fixed. Let me know if you believe your answer is correct and it was marked wrong.
* ACS Final Exam Handout
* Exam 3 tomorrow – Ch. 16, 17, 18
  * may begin at 7:45 – lecture resumes at 9:10

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look @ p. 721

What is the pH of a solution to which 5.0 mL of 0.100 M NaOH is added to 25.0 mL of 0.100 M HCl?

(moles)	$NaOH_{(aq)}$	+ $HCl_{(aq)}$	→ $NaCl_{(aq)}$	+ $H_2O_{(l)}$
Init	0.00050	0.00250	0	
Change	−0.00050	−0.00050	+0.00050	
End	0	0.00200	0.00050	

$$25.0\,\text{mL} \times \frac{0.100\,\text{mol HCl}}{1000\,\text{mL}} = 0.00250\ \text{mol HCl}$$

$$5.0\,\text{mL} \times \frac{0.100\,\text{mol NaOH}}{1000\,\text{mL}} = 0.00050\ \text{mol NaOH}$$

$$\frac{0.00200\,\text{mol HCl}}{0.0300\,\text{L}} = 0.067\ M\ HCl$$

30.0 mL → 0.0300 L

for a strong acid $\Rightarrow [H_3O^+] = [\text{acid}]$

$[H_3O^+] = 0.0667$

$pH = -\log[H_3O^+] = -\log(0.0667) = \boxed{1.176}$

30.0 mL of 0.100 M + 55.0 mL + 25.0 mL of 0.100 M

$NaOH_{(aq)} + HCl_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)}$

(moles)			
Init	0.00300	0.00250	0
Change	−0.00250	−0.00250	+0.00250
End	0.00050	0	0.00250

$30.0 \text{ mL} \times \frac{0.100 \text{ mol}}{1000 \text{ mL}} = 0.00300 \text{ mol NaOH}$

$\frac{0.00050 \text{ mol NaOH}}{0.0550 \text{ L}} = 0.00909 \text{ M NaOH}$

$[OH^-] = 0.00909 \text{ M}$

$pOH = -\log[OH^-] = -\log(0.00909) = 2.04$

14.00

11.96

In the lab, we will discuss the <u>halfway point</u> - half the volume of titrant required to reach the <u>equivalence point</u>.

Solubility Equilibria

$Ca(NO_3)_{2(aq)} + Na_2CO_{3(aq)} \rightarrow CaCO_{3(s)} + 2NaNO_{3(aq)}$

$$CaCO_3(s) \rightleftharpoons Ca^{2+}(aq) + CO_3^{2-}(aq)$$

$$K_{sp} = [Ca^{2+}][CO_3^{2-}]$$

Solubility product constant

$$Mg(OH)_2(s) \rightleftharpoons Mg^{2+}(aq) + 2OH^-(aq)$$

$$K_{sp} = [Mg^{2+}][OH^-]^2$$

$$Al_2(CO_3)_3(s) \rightleftharpoons 2Al^{3+}(aq) + 3CO_3^{2-}(aq)$$

$$K_{sp} = [Al^{3+}]^2[CO_3^{2-}]^3$$

Ch. 16 Quiz ⇒ #3 (16.52) - the tolerance was set too low, so you may have had it marked wrong. I will manually score this question.

Determine the molar solubility of $CaCO_3$. Then determine its solubility in g/L.

(equil M)

$$CaCO_3(s) \rightleftharpoons Ca^{2+}(aq) + CO_3^{2-}(aq)$$

$$x \qquad\qquad x$$

$$K_{sp} = [Ca^{2+}][CO_3^{2-}]$$

$$\sqrt{3.8 \times 10^{-9}} = \sqrt{x^2} = x = 6.16 \times 10^{-5}\ M = [Ca^{2+}] = [CO_3^{2-}]$$

Molar solubility is 6.2×10^{-5} M.

$$\frac{6.16 \times 10^{-5} \text{ mol } CaCO_3}{L} \times \frac{100.09 \text{ g } CaCO_3}{1 \text{ mol } CaCO_3} = \boxed{0.0062 \frac{g}{L}}$$

Stalactite & stalagmite

Find molar solubility of $Mg(OH)_2$. Then find its solubility in g/L.

(equil / M)

$$Mg(OH)_2 (s) \rightleftharpoons Mg^{2+}_{(aq)} + 2OH^-_{(aq)}$$

x $\quad$ $2x$

$$K_{sp} = [Mg^{2+}][OH^-]^2$$

$$1.8 \times 10^{-11} = (x)(2x)^2$$

$$\frac{1.8 \times 10^{-11}}{4} = \frac{4x^3}{4}$$

$$\sqrt[3]{4.5 \times 10^{-12}} = \sqrt[3]{x^3} \Rightarrow x = [Mg^{2+}] = 1.65 \times 10^{-4} \text{ M}$$

$[Mg(OH_2)]$

Molar solubility of $Mg(OH)_2$ is 1.7×10^{-4} M.

$$\frac{1.65 \times 10^{-4} \text{ mol } Mg(OH)_2}{L} \times \frac{58.33 \text{ g } Mg(OH)_2}{1 \text{ mol } Mg(OH)_2} = \boxed{0.0096 \frac{g\ Mg(OH)_2}{L}}$$

(18.25)

(equil / M)

$$Cu(IO_3)_2 (s) \rightleftharpoons Cu^{2+}_{(aq)} + 2\,IO_3^-{}_{(aq)}$$

x $\quad$ $2x$

$$K_{sp} = [Cu^{2+}][IO_3^-]^2$$

$$= (x)(2x)^2$$

$$K_{sp} = 4x^3 = 4(0.00315)^3 = \boxed{1.2 \times 10^{-7}}$$

$$\frac{0.13\ g\ Cu(IO_3)_2}{100\ mL} \times \frac{1\ mol\ Cu(IO_3)_2}{413.34\ g\ Cu(IO_3)_2} \times \frac{1000\ mL}{1\ L} = 0.00315\ \frac{mol\ Cu(IO_3)_2}{L}$$

$x = [Cu^{2+}]$ 1:1

Common Ion Effect

Find the solubility of $CaCO_3$, in g/L, in 0.010 M $CaCl_2$.

	$CaCO_3(s)$	$\rightleftharpoons$	$Ca^{2+}(aq)$	+	$CO_3^{2-}(aq)$
equil M			$0.010 + x$		x

$$K_{sp} = [Ca^{2+}][CO_3^{2-}]$$

$$\frac{3.8 \times 10^{-9}}{0.010} = \frac{(0.010 + x)(x)}{0.010}$$

Assume $x \ll 0.010$

Assumption is valid.

$$3.8 \times 10^{-7}\ M = x = [CO_3^{2-}] = [CaCO_3]$$

$$\frac{3.8 \times 10^{-7}\ mol\ CaCO_3}{L} \times \frac{100.09\ g\ CaCO_3}{1\ mol\ CaCO_3} = 3.8 \times 10^{-5}\ \frac{g\ CaCO_3}{L}$$

(18.35) What is the solubility of MgF_2 in 0.020 M NaF? The solubility of MgF_2 is 0.016 g/L in water.

in water

	$MgF_2(s)$	$\rightleftharpoons$	$Mg^{2+}(aq)$	+	$2\ F^-(aq)$
equil M			x		$2x$

$$K_{sp} = [Mg^{2+}][F^-]^2$$

$= (x)(2x)^2$

$= 4x^3 = 4(2.57\times10^{-4})^3$

$K_{sp} = 6.77\times10^{-11}$

$$\frac{0.016\ g\ MgF_2}{L} \times \frac{1\ mol\ MgF_2}{62.31\ g\ MgF_2} = 2.57\times10^{-4}\ \frac{mol\ MgF_2}{L}$$

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

in 0.020 M NaF

	$MgF_2(s)$	$\rightleftharpoons$	$Mg^{2+}(aq)$	+	$2F^-(aq)$
(equil) M			x		$0.020+2x$

$K_{sp} = [Mg^{2+}][F^-]^2$

Assume $2x \ll 0.020$

$$\frac{6.77\times10^{-11}}{(0.020)^2} = \frac{(x)(0.020+2x)^2}{(0.020)^2}$$

$1.69\times10^{-7} M = x = [Mg^{2+}] \rightarrow [MgF_2]$

$$1.69\times10^{-7}\ \frac{mol\ MgF_2}{L} \times \frac{62.31\ g\ MgF_2}{1\ mol\ MgF_2} = \boxed{1.1\times10^{-5}\ g/L}$$