CHE152
Lab #10 Precipitation & Complexation of Silver Ion

1.

$$[Ni^{2+}] = \frac{0.020\ \text{mol NiCl}_2}{\text{L}} \text{ x } \frac{1\ \text{mol Ni}^{2+}}{1\ \text{mol NiCl}_2} \text{ x } \frac{100.0\ \text{mL}}{110.0\ \text{mL}} = 0.018_{18}\ \text{M}$$

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$$[CO_3^{2-}] = \frac{0.28\ \text{mol Na}_2\text{CO}_3}{\text{L}} \text{ x } \frac{1\ \text{mol CO}_3^{2-}}{1\ \text{mol Na}_2\text{CO}_3} \text{ x } \frac{10.0\ \text{mL}}{110.0\ \text{mL}} = 0.025_{45}\ \text{M}$$

$Q = [0.018_{18}][0.025_{45}] = 4.6 \times 10^{-4}$; $Q > K_{sp}$; $NiCO_3$ will ppt.

	$NiCO_3$ (s)	$\rightleftharpoons$	Ni^{2+} (aq)	+	CO_3^{2-} (aq)
I			0.018_{18}		0.025_{45}
C			-0.018_{18}		-0.018_{18}
I			0		0.007_{27}
C			+x		+x
E_x			x		0.007_{27} + x
E					$\approx 0.007_{27}$

$$K_{sp} = [Ni^{2+}][CO_3^{2-}] = 1.3 \times 10^{-7} = [Ni^{2+}]0.007_{27}; [Ni^{2+}] = 1._{79} \times 10^{-5}\ \text{M}$$

$$\frac{0.018_{18}\ \text{mmol Ni}^{2+}}{\text{mL}} \text{ x } \frac{110.0\ \text{mL}}{1} \text{ x } \frac{1\ \text{mmol NiCO}_3}{1\ \text{mmol Ni}^{2+}} = 2.0\ \text{mmol NiCO}_3$$

2. (a)

$$[Ni^{2+}] = \frac{0.020\ \text{mol NiCl}_2}{\text{L}} \text{ x } \frac{1\ \text{mol Ni}^{2+}}{1\ \text{mol NiCl}_2} \text{ x } \frac{100.0\ \text{mL}}{120.0\ \text{mL}} = 0.016_{67}\ \text{M}$$

$$[CO_3^{2-}] = \frac{0.28\ \text{mol Na}_2\text{CO}_3}{\text{L}} \text{ x } \frac{1\ \text{mol CO}_3^{2-}}{1\ \text{mol Na}_2\text{CO}_3} \text{ x } \frac{10.0\ \text{mL}}{120.0\ \text{mL}} = 0.023_{33}\ \text{M}$$

$$[NH_3] = \frac{15.0\ \text{mol NH}_3}{\text{L}} \text{ x } \frac{10.0\ \text{mL}}{120.0\ \text{mL}} = 1.25\ \text{M}$$

	Ni^{2+} (aq)	+	6 NH_3 (aq)	$\rightleftharpoons$	$[Ni(NH_3)_6]^{2+}$ (aq)
I	0.016_{67}		1.25		0
C	-0.016_{67}		$-6(0.016_{67})$		$+0.016_{67}$
I	0		1.15		0.016_{67}
C	+x		+6x		-x
E_x	x		1.15 + 6x		0.016_{67} - x
E			≈ 1.15		$\approx 0.016_{67}$

$$K_f = \frac{[[Ni(NH_3)_6]^{2+}]}{[Ni^{2+}][NH_3]^6} = 5.5 \times 10^8 = \frac{0.016_{67}}{[Ni^{2+}](1.15)^6}; [Ni^{2+}] = 1.3_1 \times 10^{-11}\ \text{M}$$

$[Ni(NH_3)_6]^{2+} = 0.016_{67}$ M; $[NH_3] = 1.15$ M

(b)
$Q = [1.3_1 \times 10^{-11}][0.023_{33}] = 3.1 \times 10^{-13}$; $Q < K_{sp}$; $NiCO_3$ will not ppt. NH_3 dissolves all of it.

3.
(a)

$$[Ni^{2+}] = \frac{0.020 \text{ mol } NiCl_2}{L} \times \frac{1 \text{ mol } Ni^{2+}}{1 \text{ mol } NiCl_2} \times \frac{100.0 \text{ mL}}{130.0 \text{ mL}} = 0.015_{38} \text{ M}$$

$$[S^{-2}] = \frac{1.30 \text{ mol } Na_2S}{L} \times \frac{1 \text{ mol } S^{-2}}{1 \text{ mol } Na_2S} \times \frac{10.0 \text{ mL}}{130.0 \text{ mL}} = 0.100 \text{ M}$$

$$[NH_3] = \frac{15.0 \text{ mol } NH_3}{L} \times \frac{10.0 \text{ mL}}{130.0 \text{ mL}} = 1.15_{385} \text{ M}$$

$Q = [Ni^{2+}][S^{2-}] = 1.3_1 \times 10^{-11} \times .100 = 1.3_1 \times 10^{-12}$ $Q > K_{sp}$; NiS will ppt.

	NiS (s)	$\rightleftharpoons$	Ni^{2+} (aq)	+	S^{2-} (aq)
I			0.015_{38}		0.100
C			$- 0.015_{38}$		$- 0.015_{38}$
I			0		0.084_{62}
C			+x		+x
E_x			x		0.084_{62} +x
E					$\approx 0.084_{62}$

$K_{sp} = [Ni^{2+}][S^{2-}] = 4.0 \times 10^{-20} = [Ni^{2+}]\ 0.084_{62}$; $[Ni^{2+}] = 4.7_{27} \times 10^{-19}$ M

(b)

$$\frac{0.015_{38} \text{ mmol } Ni^{2+}}{mL} \times \frac{130.0 \text{ mL}}{1} \times \frac{1 \text{ mmol } NiS}{1 \text{ mmol } Ni^{2+}} = 2.0 \text{ mmol } NiS$$

(c)

$$K_f = \frac{[[Ni(NH_3)_6]^{2+}]}{[Ni^{2+}][NH_3]^6} = 5.5 \times 10^8 = \frac{[[Ni(NH_3)_6]^{2+}]}{(4.7_{27} \times 10^{-19})(1.15_{385})^6}$$

$$[[Ni(NH_3)_6]^{2+}] = 6.1 \times 10^{-10} \text{ M}$$