KEY

Applications of Solubility

1.) When $25.0\ mL$ of NaCl solution having an unknown concentration is titrated with $0.100\ M\ AgNO_3$, using chromate ion as an indicator, $36.8\ mL$ of the $AgNO_3$ solution are required to reach the equivalence point. What is the $[Cl^-]$?

$AgCl_{(s)} \leftrightarrow Ag^+_{(aq)} + Cl^-_{(aq)} \quad \therefore [Ag^+] = 0.100\ M$

Answers - $\frac{0.100\ mol\ Ag^+}{1\ L} \times 0.0368\ L = \quad 0.00368\ mol\ Ag^+ \quad \therefore Cl^- = 0.00368\ mol$

$0.00368\ mol\ Cl^- \times \frac{1}{0.0250\ L} \quad [Cl^-] = 0.1472\ M \quad \underline{[Cl^-] = 0.147\ M}$

2.) What volume of $0.0988\ M\ Cl$ solution is required to titrate $25.0\ mL$ of $0.0750\ M\ AgNO_3$, using chromate indicator?

$AgCl_{(s)} \leftrightarrow Ag^+_{(aq)} + Cl^-_{(aq)} \quad 1:1\ ratio\ for\ Ag^+ : Cl^-$

Answers - $mol\ Ag^+ = \frac{0.0750\ mol}{1\ L} \times 0.0250\ L \quad mol\ Ag^+ = 0.001875 \quad \therefore Cl^- = 0.001875\ mol$

$0.001875\ mol\ Cl^- \times \frac{1\ L}{0.0988\ mol} \quad volume\ of\ Cl^- = 0.018977\ L \quad \underline{Cl^- = 19.0\ mL}$

3.) A solution of potassium chloride is made by dissolving $3.25\ g\ KCl$ in water and diluting to $500.0\ mL$. If $9.48\ mL\ AgNO_3$ solution is required to titrate $25.00\ mL$ of the KCl solution, what is the molar concentration of the $AgNO_3$?

$AgCl_{(s)} \leftrightarrow Ag^+_{(aq)} + Cl^-_{(aq)} \quad 1:1\ ratio\ for\ Ag^+ : Cl^-$

Answers - $mol\ Cl^- = \frac{3.25\ g\ KCl}{0.500\ L} \times \frac{1\ mol}{74.55\ g} \times 0.025\ L \quad mol\ Cl^- = 0.002179\ mol \quad \therefore Ag^+ = 0.002179\ mol$

$0.002179\ mol\ Ag^+ \times \frac{1}{0.00948\ L} \quad [Ag^+] = 0.22993\ M \quad \underline{[Ag^+] = 0.230\ M}$

4.) A student is assigned the task of finding the K_{sp} value for silver acetate. Several grams of $AgCH_3COO_{(s)}$ are added to distilled water and stirred overnight. The next day a $50.0\ mL$ sample of the saturated $AgCH_3COO$ solution is titrated with $30.6\ mL\ of\ 0.100\ M\ NaCl$. What is the value of K_{sp} for $AgCH_3COO$?

Answers - $AgCH_3COO_{(s)} \leftrightarrow Ag^+_{(aq)} + CH_3COO^-_{(aq)} \quad 1:1\ ratio\ for\ Ag^+ : CH_3COO^-$

$mol\ Cl^- = \frac{0.100\ mol\ NaCl}{1\ L} \times 0.0306 \quad mol\ Cl^- = 0.00306 \quad \therefore Ag^+ = 0.00306\ mol$

$0.00306\ mol\ mol\ Ag^+ \times \frac{1}{0.0500\ L} \quad [Ag^+] = 0.612\ M$

$K_{sp} = (0.612)(0.612) \quad K_{sp} = 3.74544 \times 10^{-3} \quad \underline{K_{sp} = 3.75 \times 10^{-3}}$

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5.) A $4.75\ g$ silver coin was dissolved in nitric acid and the resulting solution diluted to $250.\ mL$. When a $25.0\ mL$ sample of $0.200\ M\ NaCl$ was titrated with the silver solution, using chromate indicator, $28.8\ mL$ of silver solution was required. What was the percentage purity of the silver in the coin, assuming any impurities present were unreactive? $AgCl_{(s)} \leftrightarrow Ag^{+}_{(aq)} + Cl^{-}_{(aq)}$ $1:1\ ratio\ for\ Ag^{+}:Cl^{-}$

Answers - $mol\ Cl^{-} = \frac{0.200\ mol\ NaCl}{1\ L} \times 0.0250\ L$ $mol\ Cl^{-} = 0.00500$ $\therefore Ag^{+} = 0.00500\ mol$

$0.00500\ mol\ mol\ Ag^{+} \times \frac{1}{0.0288\ L}$ $[Ag^{+}] = 0.173611\ M$

$\frac{0.17636\ mol\ Ag^{+}}{1\ L} \times \frac{107.87\ g}{1\ mol} \times 0.250\ L$ $Ag = 4.681857\ g$ $\%\ Ag = \frac{4.681857}{4.75} \times 100$ $\%\ Ag = 98.6\ \%$

6.) A $95.6\ g$ sample of chicken from a restaurant was checked for Cl^{-} (in the form of NaCl) as follows. The chicken was blended with water and suction filtered. The solution obtained was then diluted to $1.00\ L$. A $25.0\ mL$ sample of the solution was titrated with $0.0200\ M\ AgNO_3$ solution, using chromate indicator, and $15.3\ mL$ was found to be needed.

a.) What was the $[Cl^{-}]$ in the solution? $AgCl_{(s)} \leftrightarrow Ag^{+}_{(aq)} + Cl^{-}_{(aq)}$ $1:1\ ratio\ for\ Ag^{+}:Cl^{-}$

Answers - $mol\ Ag^{+} = \frac{0.0200\ mol\ Ag^{+}}{1\ L} \times 0.0153\ L$ $mol\ Ag^{+} = 3.06 \times 10^{-4}$ $\therefore Cl^{-} = 3.06 \times 10^{-4}\ mol$

$3.06 \times 10^{-4}\ mol\ Cl^{-} \times \frac{1}{0.0250\ L}$ $[Cl^{-}] = 0.01224\ M$ $[Cl^{-}] = 0.0122\ M$

b.) How many grams of the NaCl were extracted from the meat?

Answers - $\frac{0.01224\ mol\ Cl^{-}}{1\ L} \times \frac{58.44\ g}{1\ mol} \times 1\ L$ $NaCl = 0.715305\ g$ $NaCl = 0.715\ g$

c.) What was the percentage of NaCl in the original chicken sample?

Answers - $\%\ NaCl = \frac{0.715305}{95.6} \times 100$ $\%\ NaCl = 0.748\ \%$