Lecture Quiz 1 Key

The precipitation titration of 15.0 mL of $AgNO_3$ required 25.0 mL of .0360 M NaCl to reach equivalence. The K_{sp} of AgCl is 1.8×10^{-10}.

(1) What is the pAg^+_{free} when 5.0 mLs of the NaCl titrant has been added to the $AgNO_3$ analyte?

Answer B. 2.07

Solution: first get $[Ag]_o$:

Write the titration reaction: $Ag^+ + Cl^- \rightarrow AgCl(s)$ (presumed to be 100% completed)

At equivalence, #mol Ag = #mol Cl : so $M_1V_1 = M_2V_2$

$[Ag]_o = M_{Cl}V_{Cl}/V_{Ag} = (.0360M)(25.0mL)/(15.0mL) = .0600M\ Ag^+$

So after only 5 mLs of Cl^- has been added:

$[Ag] = [Ag]_o(\text{fraction})(\text{dilution}) = (0.0600)(5/25)(15/20) = 0.00900M$

$\Rightarrow pAg^+ = -\log[pAg^+] = -\log(.00900) = \mathbf{2.05}$

(2) What is the pAg^+_{free} when 25.0 mLs of the NaCl titrant has been added to the $AgNO_3$ analyte?

Answer: D 4.87

Solution: We note that 25.0 mLs is exactly equal to the equivalence point. That is the point at which we use the K_{sp} equilibrium (otherwise, we would continue to use the assumption that the precipitation is 100% completed and that would leave no Ag^+ left in soution, which is violates the Ksp equilibrium).

The Ksp equilibrium is: $AgCl(s) \Longleftrightarrow Ag^+ + Cl^-$.

Let $x = [Ag^+]$ x x

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

$[Ag]^2 = 1.8 \times 10^{-10} \Rightarrow [Ag^+] = 1.34 \times 10^{-5}M \Rightarrow \mathbf{4.87}$

(3) OK: here's another one. (don't look at the answer just do the problem)
What is the pAg^+_{free} when 35.0 mLs of the NaCl titrant has been added to the $AgNO_3$ analyte?

Solution: first, get $[Cl^-]$: $[Cl^-] = [Cl]_o(\text{excess vol})/\text{total vol} = (0.0360)(10)/(50)$

$[Cl^-] = .00720 \Rightarrow AgCl(s) \Longleftrightarrow Ag^+ + Cl^-$

x .00720+x

so $x(.00720) \approx 1.8 \times 10^{-10}$: $x \approx (1.8 \times 10^{-10})/(.00720) = 2.5 \times 10^{-8}M \Rightarrow pAg = 7.6$