

CH302H - Principles of Chemistry II: Honors
Spring 2014, Unique 51880

Quiz 4
27 March 2014

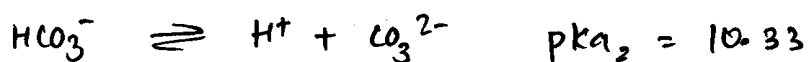
A water sample taken from the bottom of the lake had a pH of 6.80 and contained carbonates as the primary acid-base species ($pK_{a1} = 6.35$; $pK_{a2} = 10.33$). It was titrated with a strong base and the first equivalence point appeared after 7.34 mL and the 2nd equivalence point after 35.37 mL. It was determined that the original sample composition was primarily H_2CO_3 and HCO_3^- (7.45×10^{-4} M and 2.1×10^{-3} M, respectively).

- a) What was the approximate pH (+0.1 pH unit) at the first equivalence point?
- b) $MnCO_{3(s)}$ ($K_{sp} = 5.0 \times 10^{-10}$) was found in the sediment of the lake where the sample was taken. Mn^{2+} is not particularly toxic, but your boss wants an estimate of $[Mn^{2+}]$ in the water. Since you're paid to provide such information, what is the answer?
- c) If you later found out that Mn^{2+} was present in the water as a complex with a ligand originating from plant decomposition, would your value for $[Mn^{2+}]$ from b) remain the same? **Yes** or **No**

⇒ ① At 1st equivalence point,

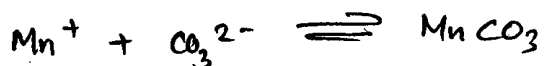
$$pH = \frac{1}{2} (pK_{a1} + pK_{a2}) = \frac{1}{2} (6.35 + 10.33) = \boxed{8.34}$$

②



$$pH = pK_a + \log \frac{[CO_3^{2-}]}{[HCO_3^-]}$$

$$6.8 = 10.33 + \log \frac{[CO_3^{2-}]}{2.1 \times 10^{-3} M} \Rightarrow [CO_3^{2-}] = 6.20 \times 10^{-9} M$$



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

$$5.0 \times 10^{-10} = 6.20 \times 10^{-9} \cdot [Mn^{2+}]$$

$$[Mn^{2+}] = \boxed{8.07 \times 10^{-4} M}$$

c) Yes