KEY

Redox Titrations

1. Which of the following could be used to determine the [Fe^{+2}] by a redox reaction?

   A. I_2 B. Cl^- C. Cu^{2+} D. MnO_4^- (acidified)

2. Which of the following could be used to determine the acidified [BrO_3^-] by a redox reaction?

   A. NO_3^- (acidified) B. I^- C. Cu^{2+} D. MnO_4^- (acidified)

3. Which of the following could be titrated using acidified MnO_4^- ions?

   A. Na^+ B. IO_3^- C. SO_4^{2-} D. H_2O_2

4. The titration of a $25.0\ mL$ $SnCl_2$ sample, in acidic solution, requires $14.4\ mL$ of $0.030\ M$ $K_2Cr_2O_7$. The balanced equation for the reaction is shown below:

   $$Cr_2O_7^{2-} + 14H^+ + 3Sn^{2+} \rightarrow 3Sn^{4+} + 2Cr^{3+} + 7H_2O$$

   What is the number of moles of $SnCl_2$ in the original sample?

   A. $1.4 \times 10^{-4}\ mol$ B. $4.3 \times 10^{-4}\ mol$ C. $1.3 \times 10^{-4}\ mol$ D. $5.2 \times 10^{-2}\ mol$

5. A $10.0\ mL$ water sample was analyzed for [Fe^{+2}] using a redox titration with acidified $KMnO_4$. The equation for the reaction is: $MnO_4^- + 5Fe^{2+} + 8H^+ \rightarrow Mn^{2+} + 5Fe^{3+} + 4H_2O$

A $10.0\ mL$ sample was titrated with $12.5\ mL$ of $0.10\ M$ $KMnO_4$ solution. What is the [Fe^{+2}] in the water sample?

   A. $0.025\ M$ B. $0.13\ M$ C. $0.28\ M$ D. $0.63\ M$

6. Acidified potassium permanganate ($KMnO_4$) solution is often used in redox titrations. Permanganate reacts with Sn^{+2} as follows: $2MnO_4^- + 5Sn^{2+} + 16H^+ \rightarrow 2Mn^{2+} + 5Sn^{4+} + 8H_2O$

   A $10.0\ mL$ solution containing Sn^{+2} is titrated with $19.3\ mL$ of $0.10\ M$ $KMnO_4$. What is the [Sn^{+2}]?

   Answer - $0.0193\ L \times \frac{0.10\ mol\ MnO_4^-}{1\ L\ MnO_4^-} \times \frac{5\ mol\ Sn^{+2}}{2\ mol\ MnO_4^-} \times \frac{1}{0.010\ L\ Sn^{+2}} = 0.4825\ M$ $[Sn^{+2}] = 0.48\ M$

7. In the process of extracting tin from a sample of ore, the tin is removed as Sn^{2+} ions. A titration requires $21.43\ mL$ of $0.0170\ M$ $K_2Cr_2O_7$ to reach the equivalence point with the Sn^{2+} in a $0.750\ g$ sample of the ore.

   $$3Sn^{2+} + Cr_2O_7^{2-} + 14H^+ \rightarrow 3Sn^{4+} + 2\ Cr^{3+} + 7H_2O$$

   Using the reaction above, calculate the percent mass of tin in the ore sample.

   Answer - $0.02143\ L \times \frac{0.0170\ mol\ Cr_2O_7}{1\ L\ Cr_2O_7} \times \frac{3\ mol\ Sn^{+2}}{1\ mol\ Cr_2O_7} \times \frac{118.71\ g\ Sn^{+2}}{1\ mol\ Sn^{+2}} = 0.12974\ g\ Sn^{+2}$ $\frac{0.12974\ g\ Sn^{+2}}{0.750\ g} \times 100$

   $Sn^{+2} = 17.29889\%$ $Sn^{+2} = 17.3\%$

8. Consider the following redox reaction in acidic solution:

$$\underline{2}\ KMnO_4 + \underline{5}\ H_2O_2 + \underline{3}\ H_2SO_4 \rightarrow K_2SO_4 + \underline{2}\ MnSO_4 + \underline{8}\ H_2O + \underline{5}\ O_2$$

a. Balance the above redox reaction.

b. The above reaction was used for a redox titration. At the equivilence point $5.684 \times 10^{-4}\ mol$ $KMnO_4$ was required to titrate $5.00\ mL$ of H_2O_2 solution. Calculate $[H_2O_2]$.

Answer - $5.684 \times 10^{-4} \times \frac{5\ mol\ H_2O_2}{2\ mol\ MnO_4^-} \times \frac{1}{0.00500\ L\ H_2O_2} = 0.2842\ M$ $[H_2O_2] = 0.284\ M$

9. A titration is performed to determine the $[Fe^{+2}]$ in $25.00\ mL$ of an $FeSO_4$ solution. It requires $22.52\ mL$ of $0.015\ M$ $KMnO_4$ to reach the equivilence point in which Mn^{+2} and Fe^{+3} are produced.

a. balance the redox reaction: $\underline{8}\ H^+ + MnO_4^- + \underline{5}\ Fe^{2+} \rightarrow Mn^{2+} + \underline{5}\ Fe^{3+} + \underline{4}\ H_2O$

b. Calculate the $[Fe^{+2}]$

Answer - $0.02252\ L \times \frac{0.15\ mol\ MnO_4^-}{1\ L\ MnO_4} \times \frac{5\ mol\ Fe^{+2}}{1\ mol\ MnO_4^-} \times \frac{1}{0.02500\ L\ Fe^{+2}} = 0.675\ M$ $[Fe^{+2}] = 0.68\ M$