Name Key Reox titration problem set II

When $KMnO_4(aq)$ is mixed with a solution of $FeSO_4(aq)$ and sulfuric acid (H_2SO_4), the balanced reaction can be written as shown below. Note that the spectator ions, K^+ and SO_4^{2-}, can be left out of the equation. The permanganate ion (MnO_4^-) is purple. All other species are colorless.

$$\overset{+7}{MnO_4^-}(aq) + 8H^+(aq) + 5Fe^{2+}(aq) \rightarrow 5Fe^{3+}(aq) + Mn^{2+}(aq) + 4H_2O(l)$$

(permanganate ion)

1. What is being oxidized in the above equation? $Fe^{2+} \rightarrow Fe^{3+} + e^-$
2. What is being reduced? $\overset{+7}{Mn} + 5e^- \rightarrow Mn^{2+}$
3. What is the oxidizing agent? MnO_4^-
4. What is the reducing agent? Fe^{2+}
5. If it takes 10.00 mL of 0.020 M $KMnO_4$ to oxidize 10.00 mL of $FeSO_4$ solution, what is the concentration (M) of the $FeSO_4$ solution?

$$\frac{.020 \text{ mol } KMnO_4}{1000 \text{ mL solution}} \times 10.00 \text{ mL} = \frac{.0002 \text{ mol } KMnO_4}{} \Bigg| \frac{5 \text{ mol } Fe^{2+}}{1 \text{ mol } MnO_4^-} = .001 \text{ mol } Fe^{2+}$$

$$\frac{.001 \text{ mol } FeSO_4}{.01 \text{ L solution}} = .10 \text{ M } FeSO_4$$

6. If it takes 12.45 mL of 0.025 M $KMnO_4$ to oxidize 20.00 mL of $FeSO_4$ solution, what is the concentration (M) of the $FeSO_4$ solution?

$$\frac{.025 \text{ mol } MnO_4^-}{1000 \text{ mL solution}} \times 12.45 \text{ mL solution} = \frac{.00031125 \text{ mol } MnO_4^-}{} \Bigg| \frac{5 \text{ mol } Fe^{2+}}{1 \text{ mol } MnO_4^-} = .001556 \text{ mol } Fe^{2+}$$

$$\frac{.001556 \text{ mol } FeSO_4}{.02 \text{ L solution}} = .0778 \text{ M} = .078 \text{ M } FeSO_4$$

7. How many mL of 0.25 M $KMnO_4$ solution would be required to oxidize 34.00 mL of 0.10 M $FeSO_4$?

$$\frac{.10 \text{ mol } FeSO_4}{1000 \text{ ml solution}} \times 34.00 \text{ ml} = \frac{.0034 \text{ mol } Fe^{2+}}{} \Bigg| \frac{1 \text{ mol } MnO_4^-}{5 \text{ mol } Fe^{2+}} =$$

$$\frac{.00068 \text{ mol } MnO_4}{} \Bigg| \frac{1000 \text{ ml solution}}{.25 \text{ mol}} = 2.72 \text{ ml } KMnO_4 \text{ solution}$$

$MnO_4^-(aq) + 8H^+(aq) + 5Fe^{2+}(aq) \rightarrow 5Fe^{3+}(aq) + Mn^{2+}(aq) + 4H_2O(l)$
(permanganate ion)

8. How many mL of 0.15 M $KMnO_4$ solution would be required to oxidize 5.00 mL of 0.20 M $FeSO_4$?

$\frac{.20 \text{ mol } Fe^{2+}}{1000 \text{ ml solution}} \times 5.00 \text{ ml solution} = .001 \text{ mol } Fe^{2+} \left| \frac{1 \text{ mol } MnO_4^-}{5 \text{ mol } Fe^{2+}} \right. = .0002 \text{ mol } MnO_4^-$

$.0002 \text{ mol } MnO_4^- \left| \frac{1000 \text{ ml solution}}{.15 \text{ mol } MnO_4^-} \right. = 1.333 \text{ mL}$ or $1.3 \text{ mL } KMnO_4$ solution

9. If 30.00 mL of 0.01 M $KMnO_4$ are mixed with 30.00 mL of 0.01 M $FeSO_4$, what will be the color of the resulting solution? Explain!

$\frac{.01 \text{ mol}}{1000 \text{ mL}} \times 30.00 \text{ mL} = .0003 \text{ mol } MnO_4^-$

$.0003 \text{ mol } Fe^{2+}$

MnO_4^- is in excess and Fe^{2+} is limiting, so it will be purple.

10. If 20.00 mL of 0.10 M $KMnO_4$ are mixed with 20.00 mL of 1.00 M $FeSO_4$, what will be the color of the resulting solution? Explain!

$\frac{1 \text{ mol}}{1000 \text{ ml}} \times 20.00 \text{ mL} = .02 \text{ mol } Fe^{2+}$

$\frac{.10 \text{ mol}}{1000 \text{ ml}} \times 20.00 \text{ ml} = .002 \text{ mol } MnO_4^-$

The equation requires 5X the Fe^{2+}, but we have 10X as many moles of Fe^{2+} as MnO_4^-, so Fe^{2+} is in excess – it will be clear.

A buret filled with a 0.025 M solution of $KMnO_4$ is used to titrate a $FeSO_4$ solution of unknown concentration. The data are shown below.

Molarity of $KMnO_4$ solution	0.025 M
Initial buret reading (mL)	12.00
Final buret reading (mL)	30.00
Volume of $FeSO_4$ solution in flask under buret	10.00 mL

11. What is the concentration (M) of the $FeSO_4$ solution?

$\frac{.025 \text{ mol } KMnO_4}{1000 \text{ ml solution}} \times 18 \text{ ml } KMnO_4 \text{ solution} = .00045 \text{ mol } KMnO_4 \left| \frac{5 \text{ mol } Fe^{2+}}{1 \text{ mol } KMnO_4} \right. =$

$\frac{.00225 \text{ mol } Fe^{2+}}{.01 \text{ L } FeSO_4 \text{ solution}} = .225 \text{ M } FeSO_4$