**SOLUTION**

1. *Write the formula equation if it is not given in the problem. Then write the ionic equation.*

$$KMnO_4 + FeSO_4 + H_2SO_4 \longrightarrow Fe_2(SO_4)_3 + MnSO_4 + K_2SO_4 + H_2O$$

$$K^+ + MnO_4^- + Fe^{2+} + SO_4^{2-} + 2H^+ + SO_4^{2-} \longrightarrow 2Fe^{3+} + 3SO_4^{2-} + Mn^{2+} + SO_4^{2-} + 2K^+ + SO_4^{2-} + H_2O$$

2. *Assign oxidation numbers to each element and ion. Delete substances containing an element that does not change oxidation state.*

$$\overset{+1}{K^+} + \overset{+7}{Mn}\overset{-2}{O_4^-} + \overset{+2}{Fe^{2+}} + \overset{+6}{S}\overset{-2}{O_4^{2-}} + 2\overset{+1}{H^+} + \overset{+6}{S}\overset{-2}{O_4^{2-}} \longrightarrow 2\overset{+3}{Fe^{3+}} + 3\overset{+6}{S}\overset{-2}{O_4^{2-}} + \overset{+2}{Mn^{2+}} + \overset{+6}{S}\overset{-2}{O_4^{2-}} + 2\overset{+1}{K^+} + \overset{+6}{S}\overset{-2}{O_4^{2-}} + \overset{+1}{H_2}\overset{-2}{O}$$

Only ions or molecules whose oxidation numbers change are retained.

$$\overset{+7}{Mn}\overset{-2}{O_4^-} + \overset{+2}{Fe^{2+}} \longrightarrow \overset{+3}{Fe^{3+}} + \overset{+2}{Mn^{2+}}$$

3. *Write the half-reaction for oxidation.* The iron shows the increase in oxidation number. Therefore, it is oxidized.

$$\overset{+2}{Fe^{2+}} \longrightarrow \overset{+3}{Fe^{3+}}$$

- *Balance the mass.* The mass is already balanced.

- *Balance the charge.*

$$\overset{+2}{Fe^{2+}} \longrightarrow \overset{+3}{Fe^{3+}} + e^-$$

4. *Write the half-reaction for reduction.* Manganese shows a change in oxidation number from +7 to +2. It is reduced.

$$\overset{+7}{Mn}O_4^- \longrightarrow \overset{+2}{Mn^{2+}}$$

- *Balance the mass.* Water and hydrogen ions must be added to balance the oxygen atoms in the permanganate ion.

$$\overset{+7}{Mn}O_4^- + 8H^+ \longrightarrow \overset{+2}{Mn^{2+}} + 4H_2O$$

- *Balance the charge.*

$$\overset{+7}{Mn}O_4^- + 8H^+ + 5e^- \longrightarrow \overset{+2}{Mn^{2+}} + 4H_2O$$

5. *Adjust the coefficients to conserve charge.*

$$\frac{e^- \text{ lost in oxidation}}{e^- \text{ gained in reduction}} = \frac{1}{5}$$

$$5(Fe^{2+} \longrightarrow Fe^{3+} + e^-)$$
$$1(MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O)$$