Half-Reactions

A **half-reaction** is one of the two parts of a redox reaction—the oxidation half alone, or the reduction half alone. Half-reactions can be written by following the steps below:

1. Write the chemical formulas for the reactants and products.

2. Balance all atoms, other than O and H.

3. Balance O by adding H_2O.

4. Balance H by adding H^+.

5. Balance the charge on each side by adding e^- and cancel anything that is the same on both sides.

For basic solutions only.

6. Add OH^- to both sides to equal the number of H^+ present.

7. Combine H^+ and OH^- on the same side to form H_2O. Cancel equal amounts of H_2O from both sides.

Example 1
Nitrous acid can be reduced in an acidic solution to form nitrogen monoxide gas. What is the reduction half-reaction for nitrous acid?

Example 2

Copper metal can be oxidized in a basic solution to form copper(I) oxide. What is the half-reaction for this process?

Half-Reaction Method

Now that we know how to write half-reaction equations, we can use these to determine the balanced redox reaction. To do so, follow the steps below:

1. Separate the skeleton equation into the start of two half-reaction equations.

2. Balance each half-reaction equation.

3. Multiply each half-reaction equation by simple whole numbers to balance the electrons lost and gained.

4. Add the two half-reaction equations, cancelling the electrons and anything else that is exactly the same on both sides of the equation.

For basic solutions only.

5. Add OH^- to both sides to equal the number of H^+ present.

6. Combine H^+ and OH^- on the same side to form H_2O. Cancel equal amounts of H_2O from both sides.

Example 3

In a chemical analysis, a solution of dichromate ions is reacted with an acidic solution of iron(II) ions. The products formed are iron(III) and chromium(III) ions as shown by the following skeleton equation.

$$Fe^{2+}(aq) + Cr_2O_7^{2-}(aq) \rightarrow Fe^{3+}(aq) + Cr^{3+}(aq)$$

Balance the equation.

Example 4

Permanganate ions and oxalate ions react in a basic solution to produce carbon dioxide and manganese(IV) oxide.

$$MnO_4^-(aq) + C_2O_4^{2-}(aq) \rightarrow CO_2(aq) + MnO_2(aq)$$

Write the balanced redox equation for this reaction.