

10.3 Balancing Half Reactions

Steps to balancing redox equations. NO shortcuts. This format must be followed in the given sequence.

Step 1 Write separate equations for the oxidation and reduction half-reactions.

Step 2 For each half reaction:

- Balance all the elements except hydrogen and oxygen
- Balance oxygen using H_2O .
- Balance hydrogen using H^+ .
- Balance the charge using electrons.

Step 3 If necessary, multiply one or both balanced half-reactions by an integer to equalize the number of electrons transferred in the two half-reactions.
electrons lost = # electrons gained.

Step 4 Add the half-reactions, and cancel identical species.

Step 5 Check that the elements and charges are balanced.

If the redox reaction is occurring in a **basic solution** continue on.

Step 6 To both sides of the equation obtained above, add a number of OH^- ions that is equal to the number of H^+ ions. (one wants to eliminate H^+ by forming water.)

Step 7 Form H_2O on the side containing H^+ and OH^- ions, and eliminate the number of H_2O molecules that appear on both sides of the equation.

Step 8 Check that the elements and charges are balanced.

Let's try an example:

In acidic solution, balance the equation $\text{ClO}_4^- + \text{NO}_2 \rightarrow \text{Cl}^- + \text{NO}_3^-$

Assign oxidation numbers.

Is it a redox?

Which was Oxidized?

Which was Reduced?

Write the half reactions separately.

OXIDIZED

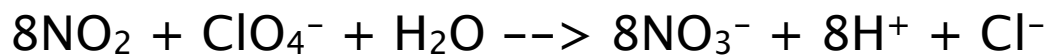
REDUCED

Balance other atoms

Balance with H_2O

Balance with H^+

Balance with e^-



REDOX WORKSHEET

Balance the following redox reactions. Assume all are in acidic solutions unless otherwise indicated.

- $\text{NO}_3^- + \text{Cu} \rightarrow \text{NO}_2 + \text{Cu}^+$
- $\text{IO}_3^- + \text{AsO}_3^{3-} \rightarrow \text{I}^- + \text{AsO}_4^{3-}$
- $\text{SO}_4^{2-} + \text{Zn} \rightarrow \text{Zn}^{2+} + \text{SO}_2$
- $\text{NO}_3^{1-} + \text{Zn} \rightarrow \text{NH}_4^+ + \text{Zn}^{2+}$
- $\text{Cr}^{3+} + \text{BiO}_3^{1-} \rightarrow \text{Cr}_2\text{O}_7^{2-} + \text{Bi}^{3+}$
- $\text{I}_2 + \text{OCl}^{1-} \rightarrow \text{IO}_3^{1-} + \text{Cl}^{1-}$
- $\text{Mn}^{2+} + \text{BiO}_3^{1-} \rightarrow \text{MnO}_4^{1-} + \text{Bi}^{3+}$
- $\text{MnO}_4^{1-} + \text{C}_2\text{O}_4^{2-} \rightarrow \text{CO}_2 + \text{MnO}_2$ (basic)
- $\text{ClO}_3^{1-} + \text{N}_2\text{H}_4 \rightarrow \text{NO} + \text{Cl}^{1-}$
- $\text{NiO}_2 + \text{Mn}(\text{OH})_2 \rightarrow \text{Mn}_2\text{O}_3 + \text{Ni}(\text{OH})_2$
- $\text{SO}_3^{2-} + \text{CrO}_4^{2-} \rightarrow \text{SO}_4^{2-} + \text{CrO}_2^{1-}$ (basic)
- $\text{Au} + \text{CN}^{1-} + \text{O}_2 \rightarrow \text{Au}(\text{CN})_4^{1-} + \text{OH}^{1-}$ (basic)