

# Oxidation and Reduction Half-Reactions

## **Why?**

Oxidation and reduction reactions (redox) involve the loss and gain of electrons. Half-reactions are a way for us to keep track of how many electrons are gained or lost by a particular species during a chemical reaction. These half-reactions can be useful in understanding how batteries work, and how other reactions that occur in your body and in nature work as well.

## **Success Criteria**

- Write balanced half-reactions, given a redox reaction.
- State which species is oxidized and which species is reduced.
- Use balanced half-reactions to determine how many electrons have been lost or gained by each species in the reaction.

## **Prerequisites**

- Oxidation numbers
- Balancing equations

## **New Concepts & Vocabulary**

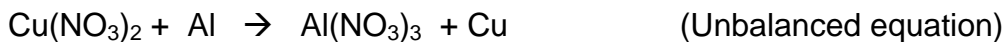
- Oxidization
- Reduction
- Conservation of charge

## **Definitions**

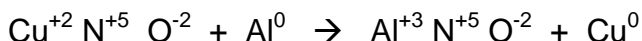
- Oxidation
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**Model: Strategy for Balancing Redox Equations**

Redox reactions can be balanced using the steps listed below:

**Sample redox reaction:**

**Step 1:** Assign oxidation numbers to each species in the equation



**Step 2:** Identify the species with an increase in charge

$\text{Al}^0$  (on left side of equation) increases to  $\text{Al}^{+3}$  (on right side of equation)

**Oxidation Half-reaction:**

*Note that the overall (net) charge on both sides of the half reaction is equal*

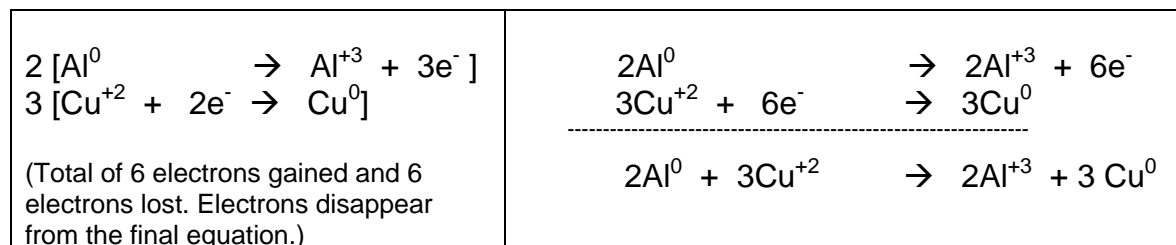
**Step 3:** Identify the species with reduction in charge

$\text{Cu}^{+2}$  (on left side of equation) reduced to  $\text{Cu}^0$  (on right side of equation)

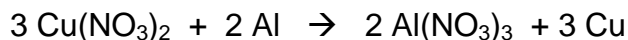
**Reduction Half-reaction:**

*Note that the overall (net) charge on both sides of the half reaction is equal*

**Step 4:** Multiply each half-reaction by a factor to make the number of electrons gained in one half-reaction equal to the number of electrons lost in the other. Add the two half-reactions together.



**Step 5:** Balance the overall equation.



**Key Questions**

1. In the model, are electrons lost or gained during oxidation?

Are electrons lost or gained during reduction?

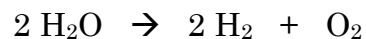
2. In the model, what happens to oxidation number during oxidation?

What happens to the oxidation number during reduction?

3. What is the relationship between the number of electrons gained and the number of electrons lost in the reaction?
4. What part of the equation can you change if the reaction is not balanced as written?

**Exercises**

1. Assign an oxidation number to each species in the redox reaction below.

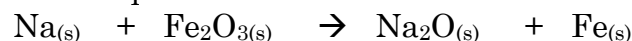


2. For the reaction above, identify the following:
  - a. Species oxidized:
  - b. Species reduced:

3. Write the half-reaction for oxygen and the half-reaction for hydrogen in the redox reaction above.
  - a. Oxygen half-reaction-
  - b. Hydrogen half-reaction-
4. Number of electrons lost/gained by each species:

### **Problem**

1. Redox reactions save lives! Airbags in automobiles are inflated with nitrogen gas produced by two redox reactions. The gas generator in some bags contains sodium azide ( $\text{NaN}_3$ ) and iron (III) oxide ( $\text{Fe}_2\text{O}_3$ ). The mixture is automatically ignited during a head-on collision. When this happens, the sodium azide decomposes in a redox reaction to form sodium and nitrogen. The sodium produced by this reaction then reacts with the iron (III) oxide as represented in the unbalanced equation:



Write the balanced oxidation and reduction half-reactions for the above redox reaction.

2. Balance the equation for the reaction shown in Problem 1.

### **Reflection on Learning**

Name three insights that your team discovered about oxidation and reduction half-reactions after examining the model.