

Review: Worksheet on Balancing Redox Equations

Two methods are often mentioned for balancing redox reactions: the half reaction method and the change in oxidation method. They actually involve the same procedure. In the first case you separate out the oxidation and reduction half reaction and in the second case, you do it all at once. I prefer the latter. The half reaction method is shown in the text but I will explain the change in oxidation method here.

Change in Oxidation Procedure:

- Write out as much of the unbalanced reaction as possible
- Assign oxidation numbers
- Draw brackets to connect the atoms that are oxidized and the atoms that are reduced. Write the net increases and decreases in electrons.
- Find the factors that create the least common multiple and use these to assign balanced stoichiometry for the reaction.

Example 1 (no O or H atoms in equation):

- | | | |
|----|---|--|
| a. | $\text{FeCl}_2 + \text{SnCl}_4 \rightarrow \text{SnCl}_2 + \text{FeCl}_3$ | Write out unbalanced equation |
| b. | $\text{FeCl}_2 + \text{SnCl}_4 \rightarrow \text{SnCl}_2 + \text{FeCl}_3$ | Assign oxidation numbers |
| c. | $\text{FeCl}_2 + \text{SnCl}_4 \rightarrow \text{SnCl}_2 + \text{FeCl}_3$ | Draw brackets connecting redox atoms |
| d. | $\text{FeCl}_2 + \text{SnCl}_4 \rightarrow \text{SnCl}_2 + \text{FeCl}_3$ | Find common factor, assign stoichiometry |

Complication. pH-dependent redox reactions.

Very often we will work with redox reactions that are dependent on the acidity or basicity of a reaction. When this occurs, we need to balance the numbers of O and H atoms that appear in H^+ , OH^- and H_2O species in the reaction.

For example, in acid $\text{MnO}_4^- \rightarrow \text{Mn}^{++}$ a 5 electron process
In base $\text{MnO}_4^- \rightarrow \text{MnO}_2$ a 3 electron process

Note the change in oxidation number means a different equivalent weight for the MnO_4^- depending on the reaction.

So we need to add an additional step in balancing redox reactions:

- Rules for acid solution: balance O by adding H_2O , then balance H by adding H^+

Rules for basic solution: for each O, add two OH^- to side needing O and one H_2O to other side
for each H, add one H_2O to side needing H and one OH^- to other side

Example 2. Balancing redox reactions in acid.

a	$\text{Fe}^{++} + \text{MnO}_4^-$	$\rightarrow \text{Mn}^{++} + \text{Fe}^{+++}$	Write out unbalanced equation
b	$\text{Fe}^{++} + \text{MnO}_4^-$	$\rightarrow \text{Mn}^{++} + \text{Fe}^{+++}$	Assign oxidation numbers
c	$\text{Fe}^{++} + \text{MnO}_4^-$	$\rightarrow \text{Mn}^{++} + \text{Fe}^{+++}$	Draw brackets connecting redox atoms
d	$\text{Fe}^{++} + \text{MnO}_4^-$	$\rightarrow \text{Mn}^{++} + \text{Fe}^{+++}$	Find common factor, assign stoichiometry
e	$\text{Fe}^{++} + \text{MnO}_4^-$	$\rightarrow \text{Mn}^{++} + \text{Fe}^{+++}$	Acidic solution balance of O atoms
	$\text{Fe}^{++} + \text{MnO}_4^-$	$\rightarrow \text{Mn}^{++} + \text{Fe}^{+++}$	Acidic solution balance of H atoms

Example 3. Balancing redox in a basic solution

a.	$\text{Fe}^{++} + \text{MnO}_4^-$	$\rightarrow \text{MnO}_2 + \text{Fe}^{+++}$	Write out unbalanced equation
b.	$\text{Fe}^{++} + \text{MnO}_4^-$	$\rightarrow \text{MnO}_2 + \text{Fe}^{+++}$	Assign oxidation numbers
c.	$\text{Fe}^{++} + \text{MnO}_4^-$	$\rightarrow \text{MnO}_2 + \text{Fe}^{+++}$	Draw brackets connecting redox atoms
d.	$\text{Fe}^{++} + \text{MnO}_4^-$	$\rightarrow \text{MnO}_2 + \text{Fe}^{+++}$	Find common factor , assign stoichiometry
e.	$\text{Fe}^{++} + \text{MnO}_4^-$	$\rightarrow \text{MnO}_2 + \text{Fe}^{+++}$	Basic solution balance of O atoms
e.	$\text{Fe}^{++} + \text{MnO}_4^-$	$\rightarrow \text{MnO}_2 + \text{Fe}^{+++}$	Basic solution balance of H atoms

And as always, practice, practice, practice. There will be problems assigned on an upcoming worksheet. While you are doing them, remember that every balanced redox reaction you generate is an electrochemical cell that has the potential (a pun!!!!) to be a battery.