



Balancing Half Reactions

Once we've written the half-rxns we need to *balance the atoms & electrons* for each half-rxn.

Watch the video on [Balancing Half-Reactions](#) and then work through the examples and practice problems below.

Understand that most reactions occur in water. Therefore, H₂O molecules can take part in the reaction. In acidic medium we also have H⁺ ions.



[Balancing Half-Reactions](#)



[Full Redox Playlist](#)

We'll work in *acidic medium* when balancing all half rxns. This works for basic medium as well – we just need an extra step at the end of the entire process.

Balancing Half-Reactions

After you have written the half-reactions, the rest of the process is more straightforward (with a few exceptions). The steps are:

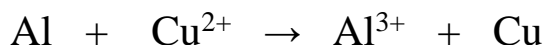
Balance each half-reactions for:

- atoms of interest.
- Oxygen (O) atoms by adding H₂O.
- Hydrogen (H) atoms by adding H⁺ ions.
- electrons (charge) by adding electrons.

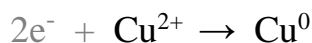
Remember, with Redox we must balance both the atoms and the electrons (charge)!

Example

Given the following equation, write the balanced half rxns.



Answer: For simple redox rxns we don't have any O or H atoms to balance. So we just add e⁻ to balance the charge.



Note, we we still need to make the e⁻ in each half rxn match (they don't right now). We'll balance the **overall** charge for the entire reaction in the next guide.

Balance each half-reactions for:

- atoms of interest.
- add H₂O to Balance O atoms.
- add H⁺ ions to balance H atoms.
- add electrons to balance charge

Key Idea

Half-reactions don't happen separately. They are two parts of the same chemical reaction.

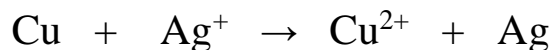


Watch [the video](#) for balancing the entire redox reaction.

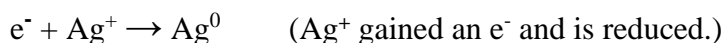
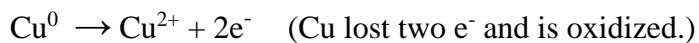


Practice #1 Scroll so the answer is hidden!

Given the following equation, write the balanced half rxns.



Answer:



Balance each half-reactions for:

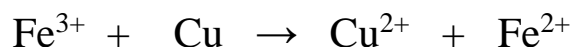
- atoms of interest.
- add H₂O to Balance O atoms.
- add H⁺ ions to balance H atoms.
- add electrons to balance charge

Loss of e⁻ is oxidation.

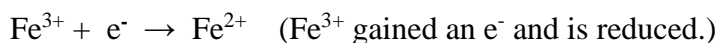
Gain of e⁻ is reduction.

Practice #2

Given the following equation, write the balanced half rxns. Label each half-rxn as oxidation or reduction.



Answer:



Balance each half-reactions for:

- atoms of interest.
- add H₂O to Balance O atoms.
- add H⁺ ions to balance H atoms.
- add electrons to balance charge

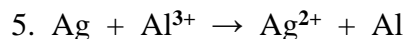
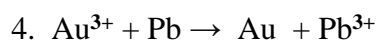
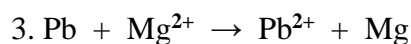
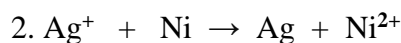
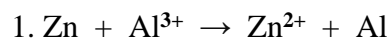
LEO the Lion
goes GER

Loses Electrons Oxidation

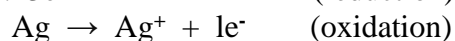
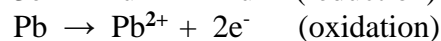
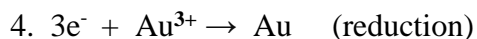
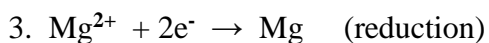
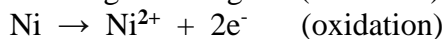
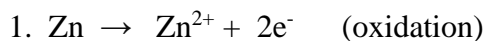
Gain Electrons Reduction

More Practice

Write the half rxns showing the e⁻ lost or gained, then label each half rxn as oxidation or reduction.



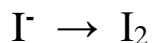
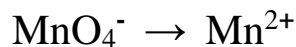
Answers (below)



Half-Reactions Involving the H and O

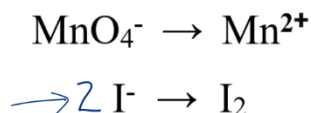
This is complicated at first but quickly becomes easier. It's almost always the same set of steps. But be careful, small mistakes can cause big problems later. Check your work at the end of this step!

Example #1: Balance the half-rxns.

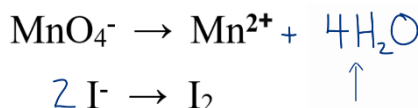


Answer:

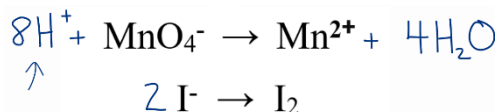
1. Balance the Iodine (I) atoms.
The Mn atoms are already balanced.



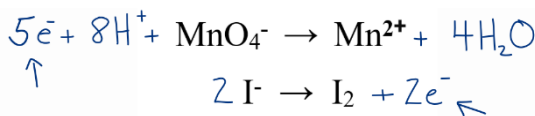
2. Add H₂O to balance the O atoms.



3. Balance the H atoms by adding H⁺.



4. Add e⁻ to balance charge. Note the total charge on each side must match.



Check your work. The number of atoms and overall charge for each half-rxn should be the same on both sides.

 [Watch the video solution.](#)

Steps

Balance each half-reaction for:

1. atoms of interest.
2. add H₂O to Balance O atoms.
3. add H⁺ ions to balance H atoms.
4. add electrons to balance charge

Don't worry about charge when balancing atoms.

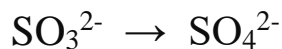
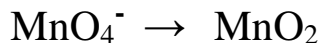
We can add H₂O because the rxn is taking place in water.

We can add H⁺ because the rxn is in acidic medium.

On the first half rxn we add 5e⁻ so the charge equals 2+ on each side (5e⁻ and 8H⁺ and 1- = 2+).

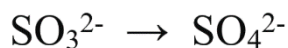
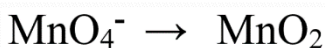
We add 2e⁻ on to the second half-rxn so the charge on each side is 2- .

Practice #1: Balance each half reaction.

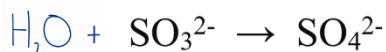


Answer (below)

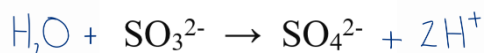
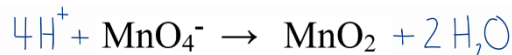
1. Mn and S atoms are already balanced.



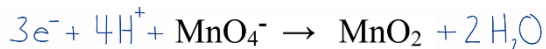
2. Add H₂O to balance the O atoms.



3. Balance the H atoms by adding H⁺.



4. Add e⁻ to balance charge.



 [Watch the video solution.](#)

Steps

Balance each half-reaction for:

1. atoms of interest.
2. add H₂O to Balance O atoms.
3. add H⁺ ions to balance H atoms.
4. add electrons to balance charge

For each half-rxn ask:

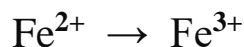
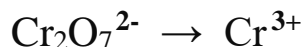
Do the main atoms balance?

Do the O atoms balance?

Do the H atoms balance?

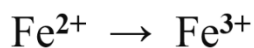
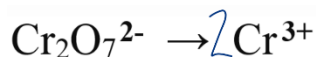
Does the charge balance?

Practice #2: Balance each half reaction.

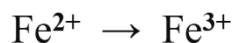


Answer

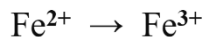
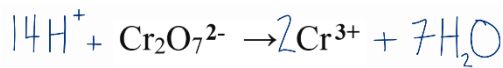
1. Balance the Cr atoms. The Fe atoms are already balanced.



2. Add H₂O to balance the O atoms.



3. Balance the H atoms by adding H⁺.

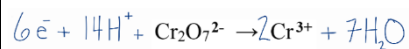
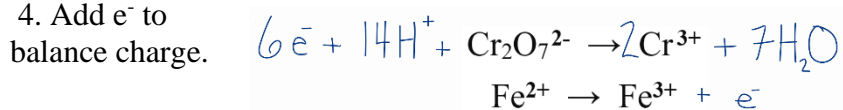


Steps

Balance each half-reaction for:

1. atoms of interest.
2. add H₂O to Balance O atoms.
3. add H⁺ ions to balance H atoms.
4. add electrons to balance charge

4. Add e^- to
balance charge.



On the right we have $2Cr^{3+}$. That gives us a total charge of **6+**.

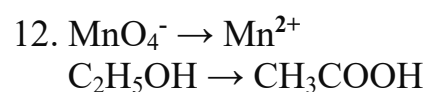
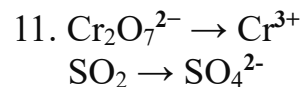
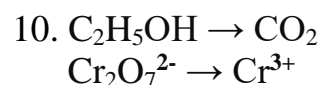
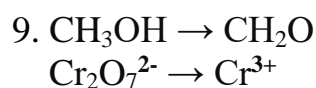
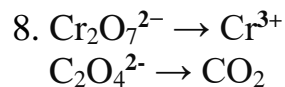
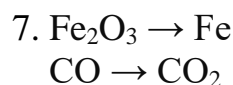
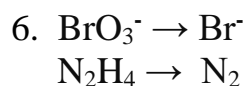
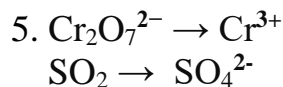
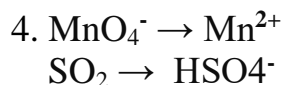
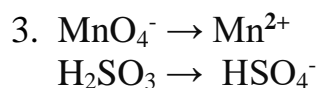
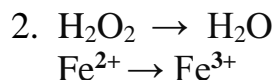
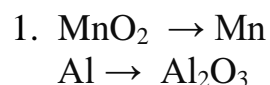
On the left we have $14H^+$ and $2-$ on the $Cr_2O_7^{2-}$ ion. We need to make that equal **6+**. Therefore we add $6e^-$ ($6e^-$ and $14H^+$ and $2-$ is equal to $6+$)

Check to make sure atoms and charge are balanced.

 [Watch the full video solution.](#)

More Practice: Balance the Half-Reactions and Check Your Work (answers below)

Remember, we'll make the electrons match and add the half-rxns together in the next guide.



Answers (below)

- | | |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>1. $4e^- + 4H^+ + MnO_2 \rightarrow Mn + 2H_2O$
 $3H_2O + Al \rightarrow Al_2O_3 + 6H^+ + 6e^-$
 Video Solution</p> | <p>7. $Fe_2O_3 + 6H^+ + 6e^- \rightarrow 2Fe + 3H_2O$
 $CO + H_2O \rightarrow CO_2 + 2H^+ + 2e^-$
 Video Solution</p> |
| <p>2. $H_2O_2 + 2H^+ + 2e^- \rightarrow 2H_2O$
 $Fe^{2+} \rightarrow Fe^{3+} + e^-$
 Video Solution</p> | <p>8. $Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$
 $C_2O_4^{2-} \rightarrow 2CO_2 + 2e^-$
 Video Solution</p> |
| <p>3. $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$
 $H_2SO_3 + H_2O \rightarrow HSO_4^- + 3H^+ + 2e^-$
 Video Solution</p> | <p>9. $CH_3OH \rightarrow CH_2O + 2H^+ + 2e^-$
 $Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$
 Video Solution</p> |
| <p>4. $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$
 $SO_2 + 2H_2O \rightarrow HSO_4^- + 3H^+ + 2e^-$
 Video Solution</p> | <p>10. $C_2H_5OH + 3H_2O \rightarrow 2CO_2 + 12H^+ + 12e^-$
 $Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$
 Video Solution</p> |
| <p>5. $Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$
 $SO_2 + 2H_2O \rightarrow SO_4^{2-} + 4H^+ + 2e^-$
 Video Solution</p> | <p>11. $Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$
 $SO_2 + 2H_2O \rightarrow SO_4^{2-} + 4H^+ + 2e^-$
 Video Solution</p> |
| <p>6. $N_2H_4 \rightarrow N_2 + 4H^+ + 4e^-$
 $BrO_3^- + 6H^+ + 6e^- \rightarrow Br^- + 3H_2O$
 Video Solution</p> | <p>12. $C_2H_5OH + H_2O \rightarrow C_2H_4O_2 + 4H^+ + 4e^-$
 $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$
 Video Solution</p> |

In the next section we'll get the electrons to be the same on each side and then add the half-rxns together. From there we cancel out like terms, and we're done. But we should check our work to make sure atoms and charge balances.

Redox Guides

[Introduction to Redox](#)

[Finding Oxidation Numbers](#)

[Writing Half Reactions](#)

[Key Terms: Oxidized, Reduced, Oxidizing Agent, Reducing Agent](#)

[Balancing Half Reactions](#) (this guide)

[Matching Electrons, Combining Half Reactions](#)

[Balancing Redox in Basic Medium](#)

[Practice, Practice, Practice](#)

Report errors and suggestions to DrB@breslyn.org

