



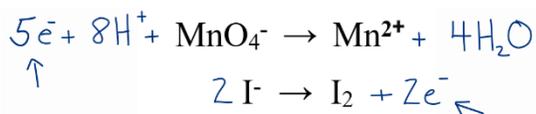
Combining Half Reactions

Video Workbook with Dr. B

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At this point we need to make the number of electrons in each half reaction match. Then we can combine the half-reactions.

For example, we have $5e^-$ in the first half-rxn and $2e^-$ in the second. They don't match!



They must match because they are the same electrons!

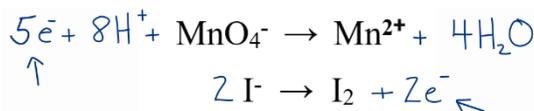
 [Balancing Half-Reactions](#)

 [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.

Simple Half-Rxns

Important: Electrons are neither created nor destroyed in a redox process. They are simply transferred from one species (substance) to another to maintain charge neutrality.

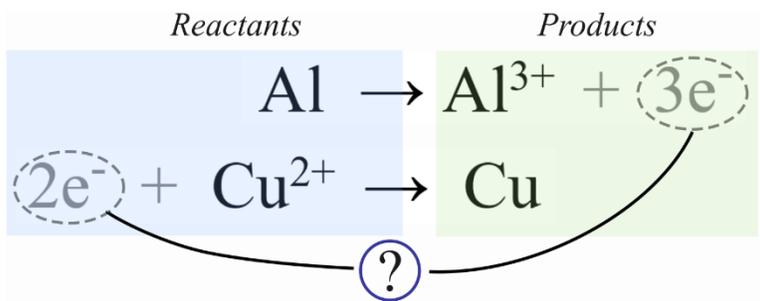


The arrows above show the electrons lost by Manganese (Mn) and gained by Iodine (I). But the numbers don't match! That is why they need to be balanced.

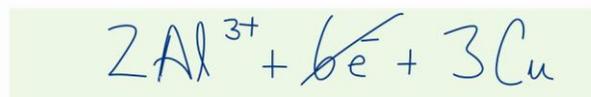
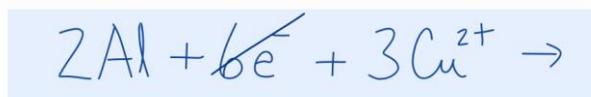
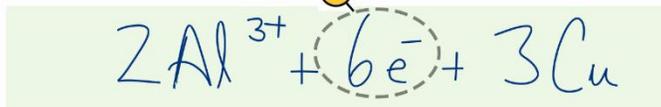
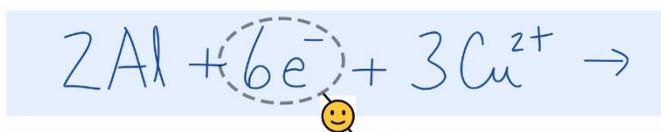
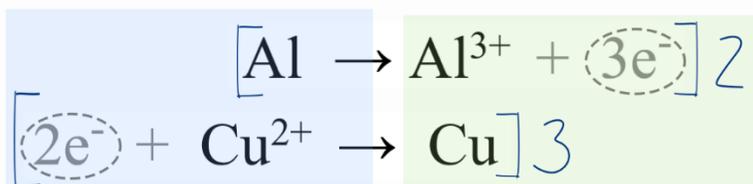
No matter how hard I try I cannot remove this whitespace here without destroying the rest of the document.



Example #1: Match the electrons in each half-rxn and combine the half-rxns.



Answer



Be sure to check to make sure the atoms are balanced and the charge is balanced for the entire equation.



Watch [the video](#) after doing the problem.

Everything is balanced except the number of electrons.
We're almost there.

We multiply the top by half-rxn by 2 and the bottom by 3.

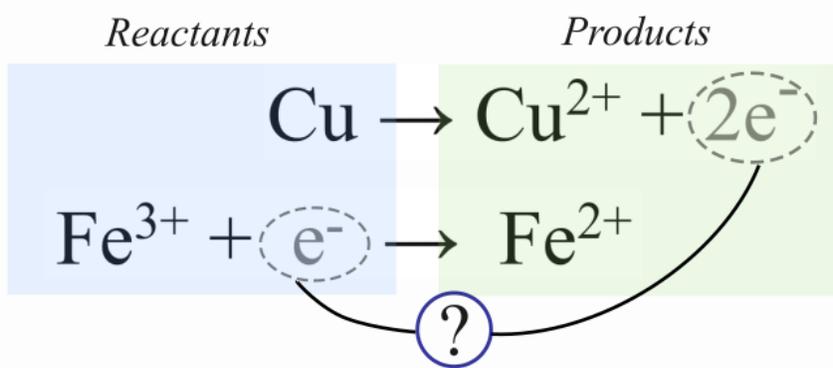
The ratios stay the same for each half-rxn.

This gives $6e^-$ in each half reaction. They now match and we can add them together.

When adding the half-rxns together, make sure you keep the reactants together and the products together.

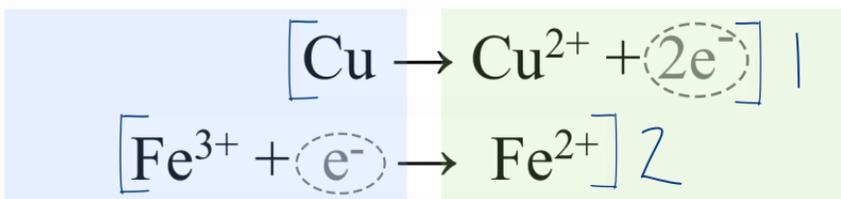
Cancel like terms and you're done.

Practice #1: Match the electrons in each half-rxn and combine the half-rxns.

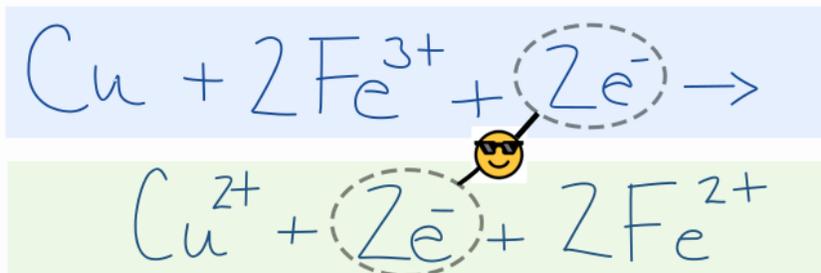


Everything is balanced except the number of electrons.
We're almost there.

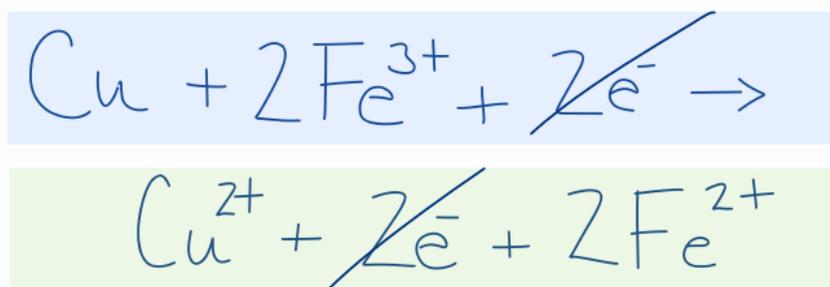
Answer



We multiply the top by half rxn by 1 and the bottom by 1.



This gives $2e^-$ in each half reaction. They now match and we can add them together.



When adding the half-rxns together, make sure you keep the reactants together and the products together.

Cancel like terms and you're done.

It is a bit tricky to check that the charge balances in this problem.

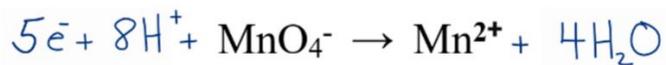
- In the reactants we have 2Fe^{3+} so the total charge is $6+$
- In the products we have Cu^{2+} and 2Fe^{2+} . So the charge is $2+$ and $4+$ for a total of $6+$.

Always check to be sure the **number of atoms** and the **charge balance**.

The number of Cu and Fe atoms are the same on both sides (don't worry about charge when counting atoms).

Half-Reactions involving H and O

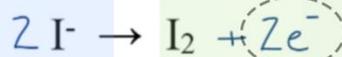
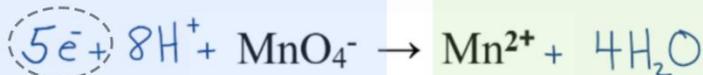
Example #1: Match the electrons in each half-rxn and combine the half-rxns.



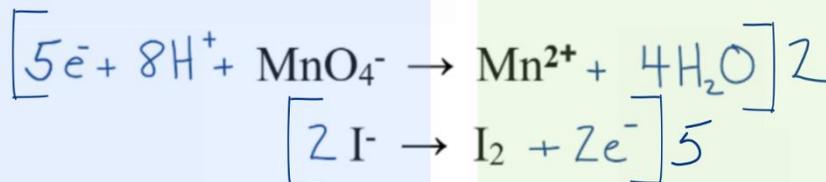
Answer

Reactants

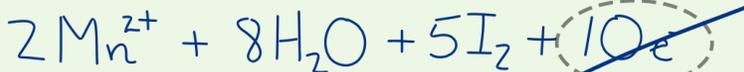
Products



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😊



Watch [the video](#) after doing the problem.

Everything is balanced except the number of electrons. *We're almost there.*

We multiply the top by half-rxn by 2 and the bottom by 5.

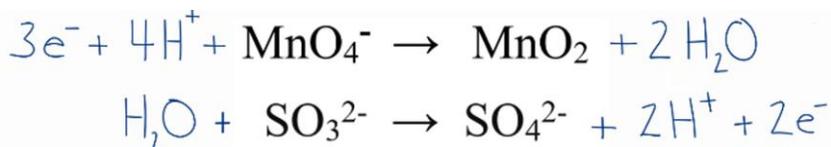
This gives $10e^-$ in each half reaction. They now match and we can add them together.

When adding the half-rxns together, make sure you keep the reactants together and the products together.

Cancel like terms.

Finally, check to make sure the atoms are balance and the charge is balanced for the entire equation.

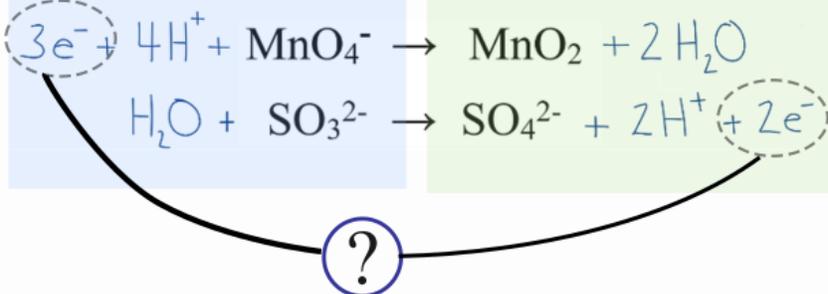
Practice #1 Match electrons and combine the half-rxns.



Answer

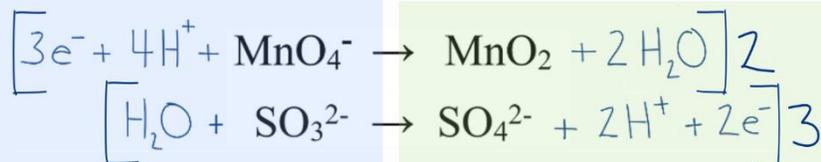
Reactants

Products

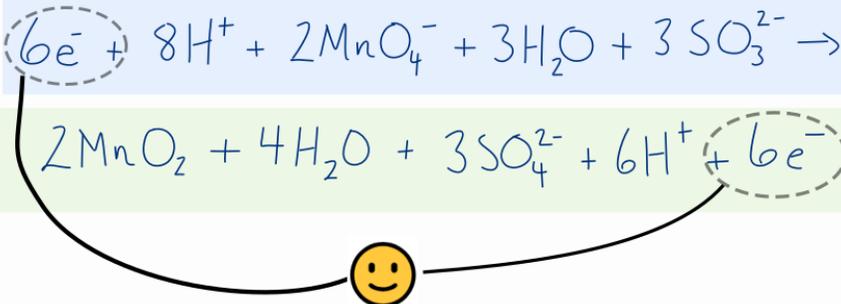


Watch [the video](#) for this reaction.

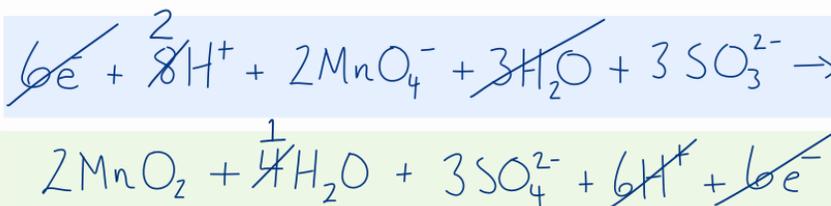
Everything is balanced except the number of electrons.



We multiply the top by half-rxn by 2 and the bottom by 3.



This gives $6e^-$ in each half reaction. They now match and we can add them together.

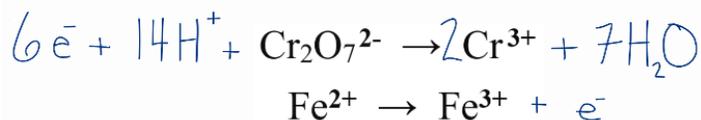


When adding the half-rxns together, make sure you keep the reactants together and the products together.

Cancel like terms and you're done.

Note: for this reaction we have $3H_2O$ in the reactions and $4H_2O$ in the products. We cancel out three on each side and are left with $1H_2O$ in the products.

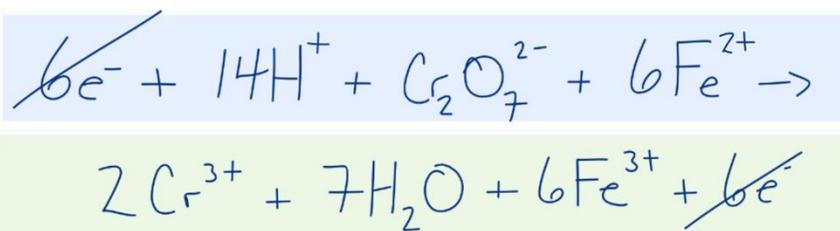
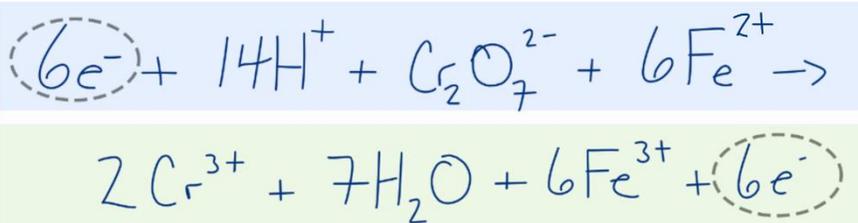
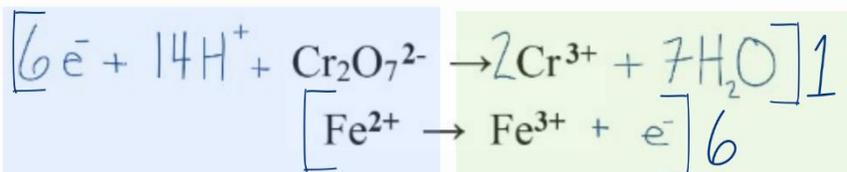
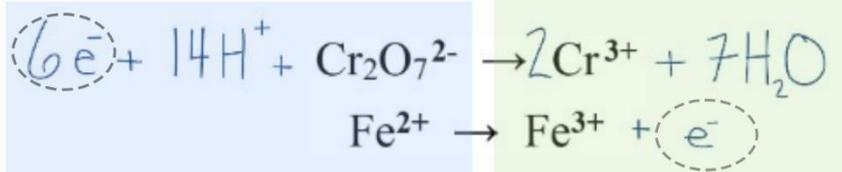
Practice #2: Match the electrons in each half-rxn and combine the half-rxns.



Answer:

Reactants

Products



Check that atoms and charge balance. If not, go back and check each step to find the problem.



Watch [the video](#) for this reaction.

Everything is balanced except the number of electrons.

We multiply the top by half-rxn by 1 and the bottom by 6.

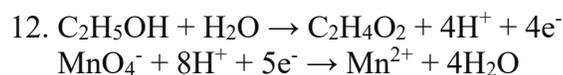
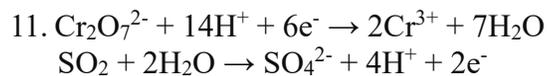
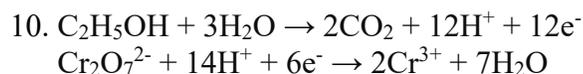
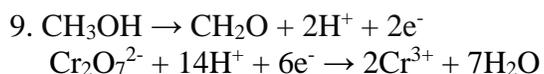
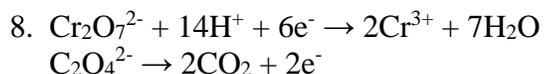
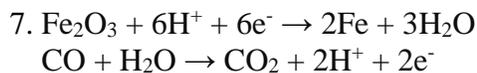
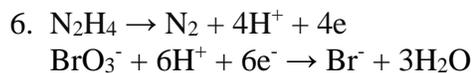
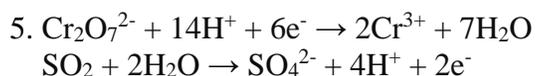
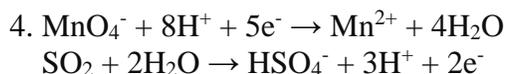
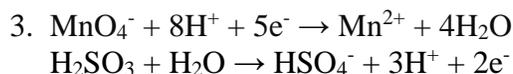
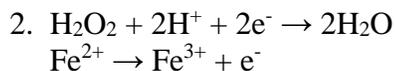
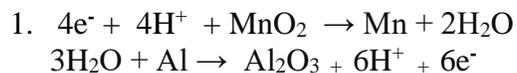
This gives $6e^-$ in each half reaction. They now match and we can add them together.

When adding the half-rxns together, make sure you keep the reactants together and the products together.

Cancel like terms and you're done.

More Practice

Balance the electrons, combine the half-rxns, and cancel out like terms.



Answers (below)

<p>1. $2\text{MnO}_4^- + 5\text{H}_2\text{SO}_3 + \text{H}^+ \rightarrow 2\text{Mn}^{2+} + 5\text{HSO}_4^- + 3\text{H}_2\text{O}$ Video Solution</p> <p>2. $\text{H}_2\text{O}_2 + 2\text{Fe}^{2+} + 2\text{H}^+ \rightarrow 2\text{Fe}^{3+} + 2\text{H}_2\text{O}$ Video Solution</p> <p>3. $2\text{MnO}_4^- + 5\text{H}_2\text{SO}_3 + \text{H}^+ \rightarrow 2\text{Mn}^{2+} + 5\text{HSO}_4^- + 3\text{H}_2\text{O}$ Video Solution</p> <p>4. $2\text{MnO}_4^- + 5\text{SO}_2 + 2\text{H}_2\text{O} + \text{H}^+ \rightarrow 2\text{Mn}^{2+} + 5\text{HSO}_4^-$ Video Solution</p> <p>5. $\text{Cr}_2\text{O}_7^{2-} + 3\text{SO}_2 + 2\text{H}^+ \rightarrow 2\text{Cr}^{3+} + 3\text{SO}_4^{2-} + \text{H}_2\text{O}$ Video Solution</p> <p>6. $2\text{BrO}_3^- + 3\text{N}_2\text{H}_4 \rightarrow 2\text{Br}^- + 3\text{N}_2 + 6\text{H}_2\text{O}$ Video Solution</p>	<p>7. $\text{Fe}_2\text{O}_3 + 3\text{CO} \rightarrow 2\text{Fe} + 3\text{CO}_2$ Video Solution</p> <p>8. $\text{Cr}_2\text{O}_7^{2-} + 3\text{C}_2\text{O}_4^{2-} + 14\text{H}^+ \rightarrow 2\text{Cr}^{3+} + 6\text{CO}_2 + 7\text{H}_2\text{O}$ Video Solution</p> <p>9. $3\text{CH}_3\text{OH} + \text{Cr}_2\text{O}_7^{2-} + 8\text{H}^+ \rightarrow 3\text{CH}_2\text{O} + 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$ Video Solution</p> <p>10. $\text{C}_2\text{H}_5\text{OH} + 2\text{Cr}_2\text{O}_7^{2-} + 16\text{H}^+ \rightarrow 4\text{Cr}^{3+} + 2\text{CO}_2 + 11\text{H}_2\text{O}$ Video Solution</p> <p>11. $\text{Cr}_2\text{O}_7^{2-} + 3\text{SO}_2 + 2\text{H}^+ \rightarrow 2\text{Cr}^{3+} + 3\text{SO}_4^{2-} + \text{H}_2\text{O}$ Video Solution</p> <p>12. $4\text{MnO}_4^- + 5\text{C}_2\text{H}_5\text{OH} + 12\text{H}^+ \rightarrow 4\text{Mn}^{2+} + 5\text{CH}_3\text{COOH} + 11\text{H}_2\text{O}$ Video Solution</p>
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Redox Guides

[Introduction to Redox](#)

[Finding Oxidation Numbers](#)

[Writing Half Reactions](#)

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

[Balancing Half Reactions](#)

Matching Electrons, Combining Half Reactions (this guide)

[Balancing Redox in Basic Medium](#)

[Practice, Practice, Practice](#)

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