

# **Balancing Oxidation-Reduction Equations**

# **Oxidation States Method**

- 1. Assign the oxidation states of all atoms.**
- 2. Decide which element is oxidized and determine the increase oxidation state.**
- 3. Decide which element is reduced and determine the decrease oxidation state.**
- 4. Choose coefficients for the species containing the atom oxidized and the atom reduced such that the total increase in oxidation state equals the total decrease in oxidation state.**
- 5. Balance the rest of the equation by inspection.**

# Example

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**Balance the following equation for the reaction.**



+4

-2

0

0

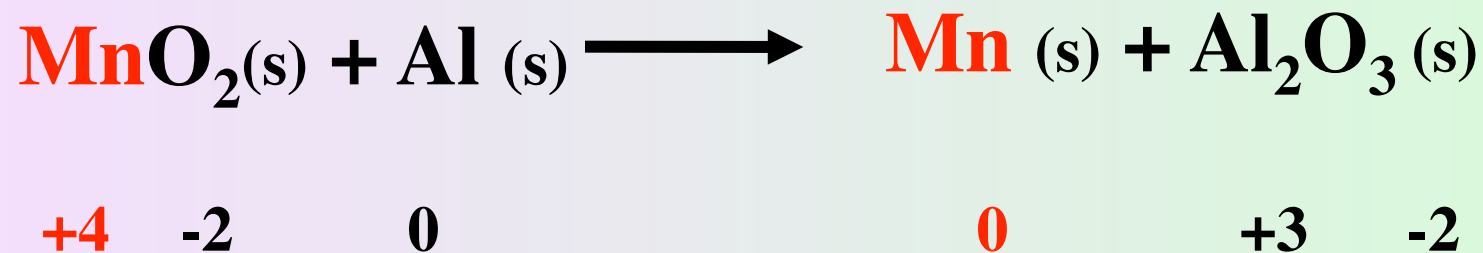
+3

-2

# Example

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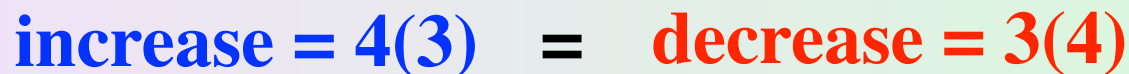
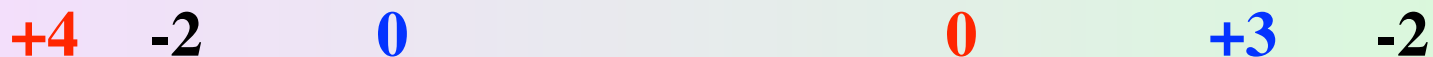
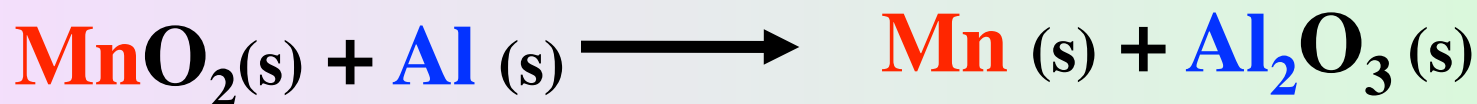
Balance the following equation for the reaction.



# Example

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Balance the following equation for the reaction.



## Half-Reaction Method in Acid

- 1. Write the unbalanced equation in ionic form.**
- 2. Separate the equation into two half-reactions.**
- 3. Balance each half reaction (except for O and H).**
- 4. In acid solution, balance O by adding  $\text{H}_2\text{O}$  and H by adding  $\text{H}^+$**
- 5. Balance the charges by adding electrons.**
- 6. Add the half reactions**
- 7. Check to make sure atoms and charges are balanced**

# Example

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**Balance the following equation for the reaction in acid solution. \***



**\*All species are (aq)**

**1. Write the unbalanced equation in ionic form.**



**2. Separate the equation into two half-reactions**





**3. Balance each half reaction (except for O and H).**

**4. In acid solution, balance O by adding H<sub>2</sub>O and H by adding H<sup>+</sup>**



## 5. Balance the charges by adding electrons.

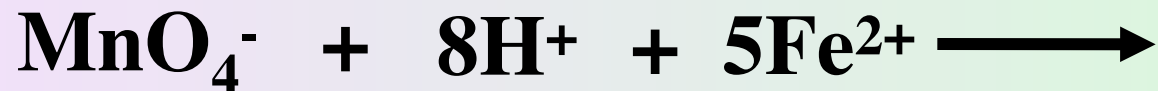
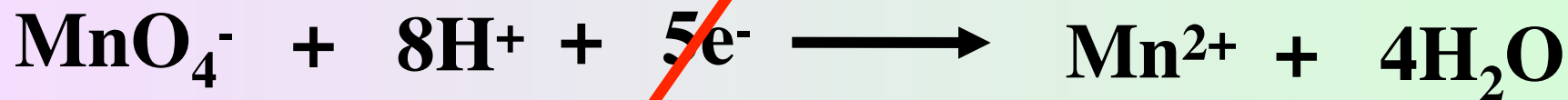
You need the same number of electrons on both sides of the equation.



**5. Balance the charges by adding electrons.**



## 6. Add the half reactions



**This is the balanced equation**

# Example

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**Balance the following equation for the reaction in acid solution. \***



**1. Write the unbalanced equation in ionic form.**



**2. Separate the equation into two half-reactions**

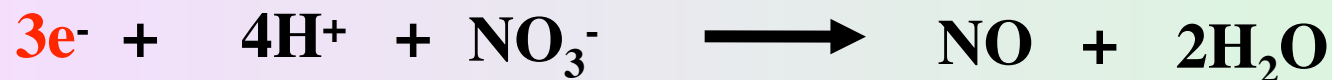


**3. Balance each half reaction (except for O and H).**

**4. In acid solution, balance O by adding H<sub>2</sub>O and H by adding H<sup>+</sup>**

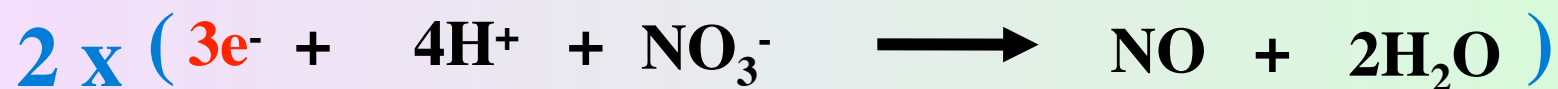


## 5. Balance the charges by adding electrons.

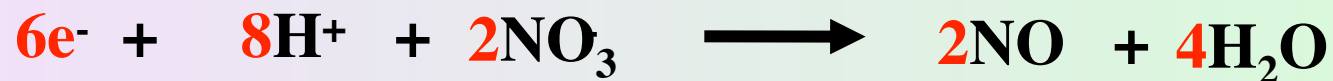




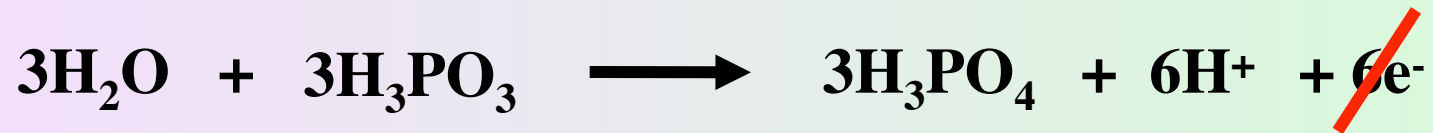
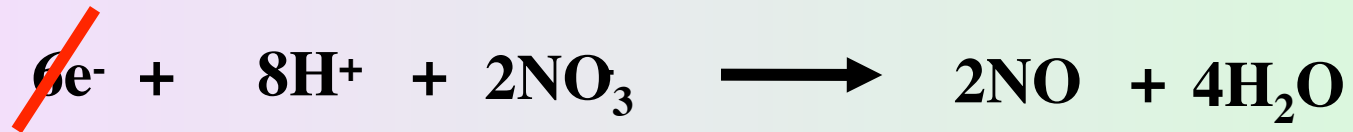
## 5. Balance the charges by adding electrons.



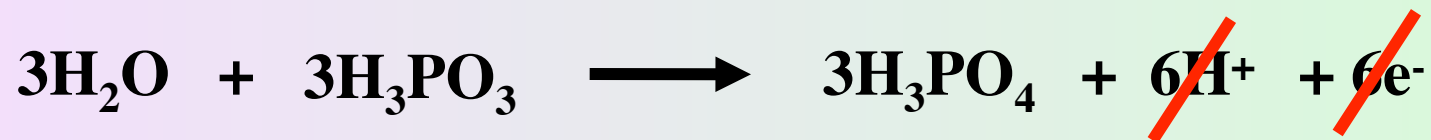
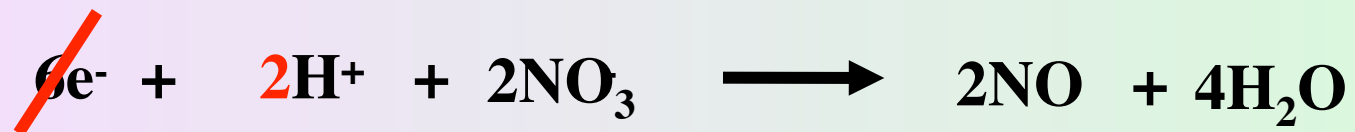
**5. Balance the charges by adding electrons.**



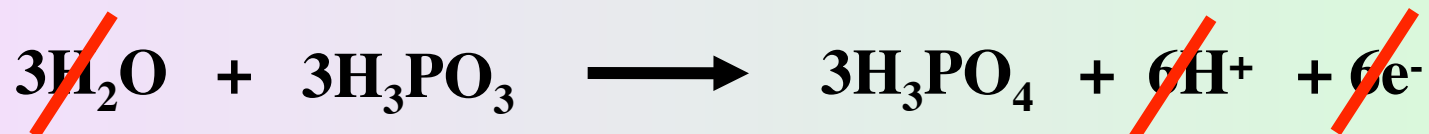
## 6. Add the half reactions



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**This is the balanced equation**

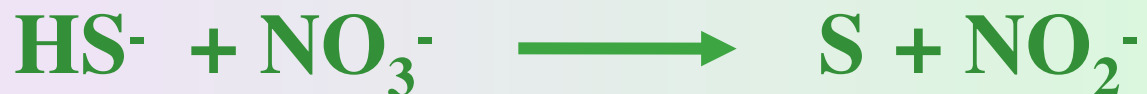
## Half-Reaction Method in Base

- 1. Use the half-reaction method as specified for acidic solutions to obtain the final balanced equation *as if  $H^+$  ions were present.***
- 2. Add the number of  $OH^-$  ions to both sides of the equation to turn the remaining  $H^+$  ions to  $H_2O$**
- 3. Eliminate waters that appear on both sides of the equation.**

# Example

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Balance the following equation for the reaction in basic solution. \*



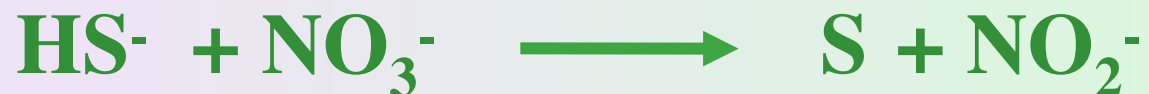
\*All species are (aq)



# Example

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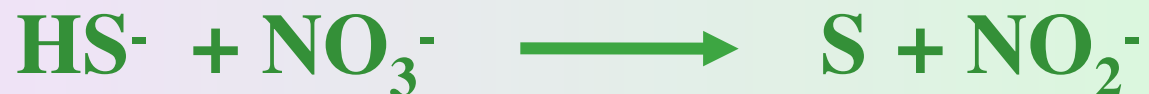
Balance the following equation for the reaction in basic solution. \*



# Example

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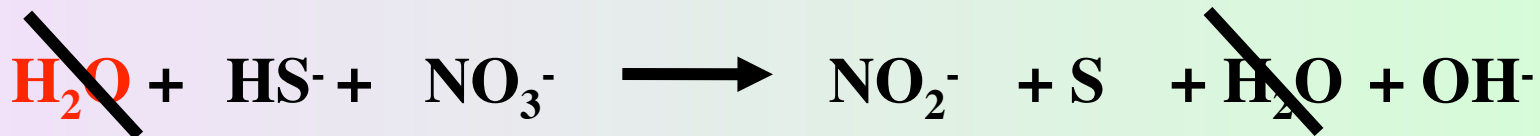
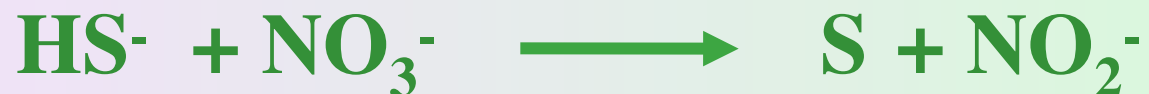
Balance the following equation for the reaction in basic solution. \*



# Example

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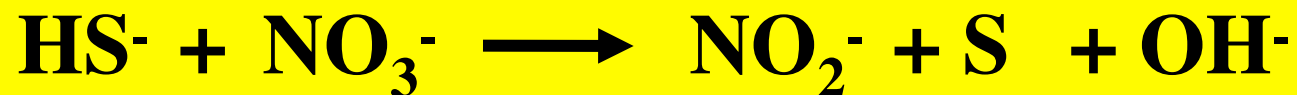
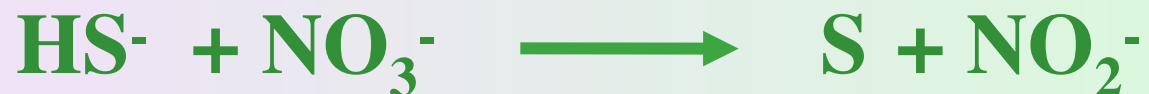
Balance the following equation for the reaction in basic solution. \*



# Example

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Balance the following equation for the reaction in basic solution. \*



# Example

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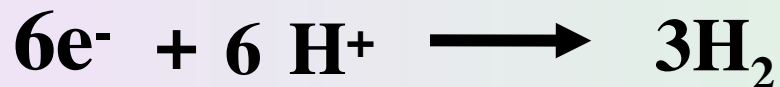
Balance the following equation for the reaction in acid solution. \*



# Example

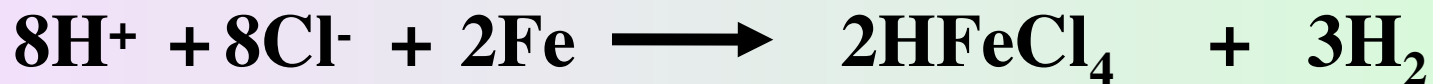
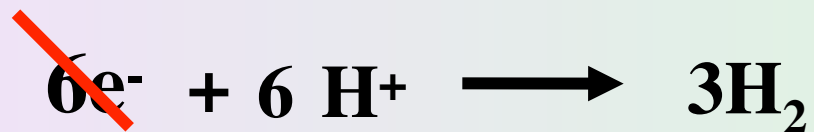
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Balance the following equation for the reaction in acid solution. \*



# Example

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or

