

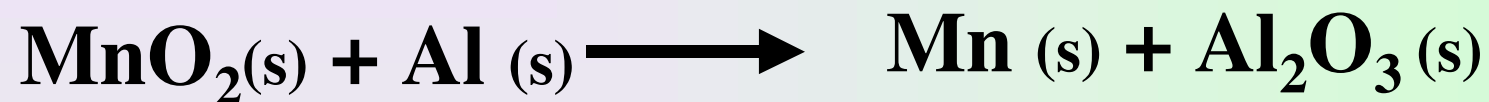
Balancing Oxidation-Reduction Equations

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

Balance the following equation for the reaction.



+4

-2

0

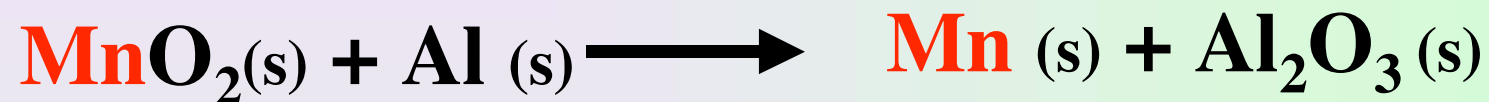
0

+3

-2

Example

Balance the following equation for the reaction.



+4

-2

0

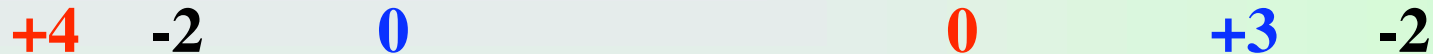
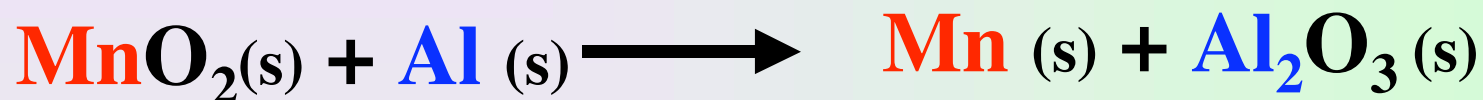
0

+3

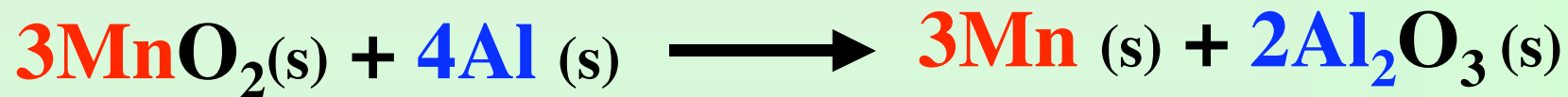
-2

Example

Balance the following equation for the reaction.



$$\text{increase} = 4(3) = \text{decrease} = 3(4)$$



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 H_2O and H by adding H^+**
- 5. Balance the charges by adding electrons.**
- 6. Add the half reactions**
- 7. Check to make sure atoms and charges are balanced**

Example

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

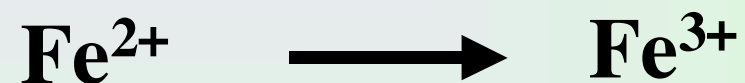


***All species are (aq)**

1. Write the unbalanced equation in ionic form.

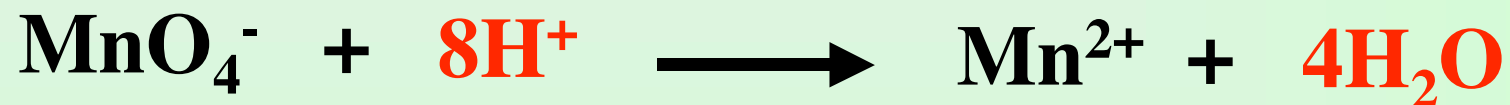
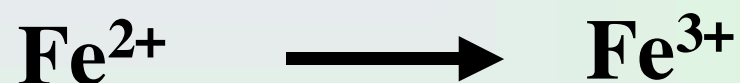


2. Separate the equation into two half-reactions



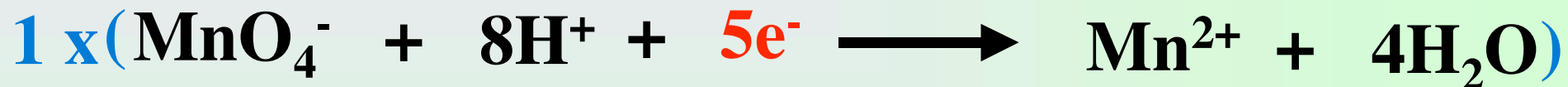
3. Balance each half reaction (except for O and H).

4. In acid solution, balance O by adding H₂O and H by adding H⁺



5. Balance the charges by adding electrons.

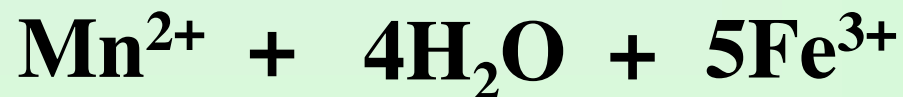
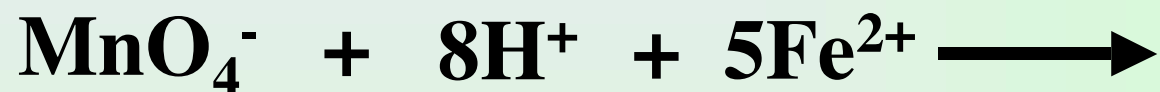
You need the same number of electrons on both sides of the equation.



5. Balance the charges by adding electrons.



6. Add the half reactions



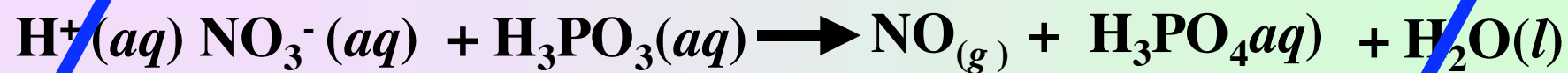
This is the balanced equation

Example

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



1. Write the unbalanced equation in ionic form.

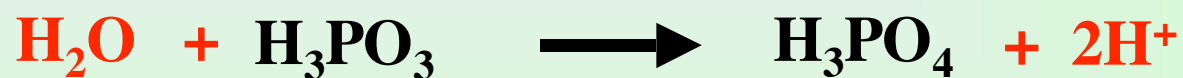
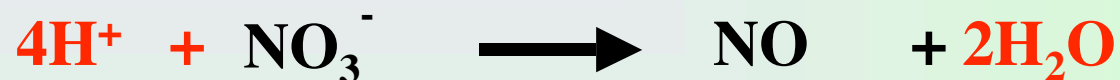


2. Separate the equation into two half-reactions



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

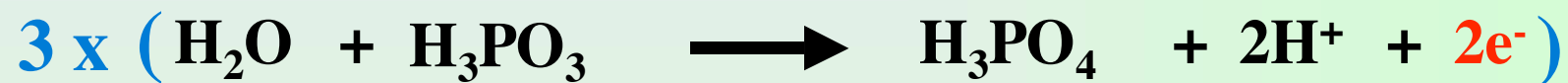
4. In acid solution, balance O by adding H₂O and H by adding H⁺



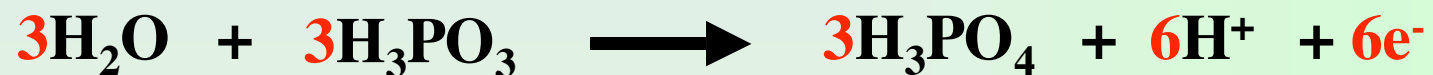
5. Balance the charges by adding electrons.



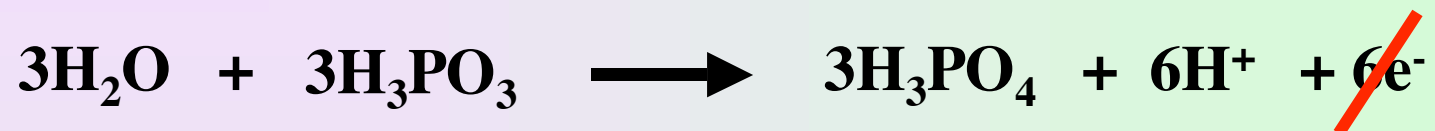
5. Balance the charges by adding electrons.



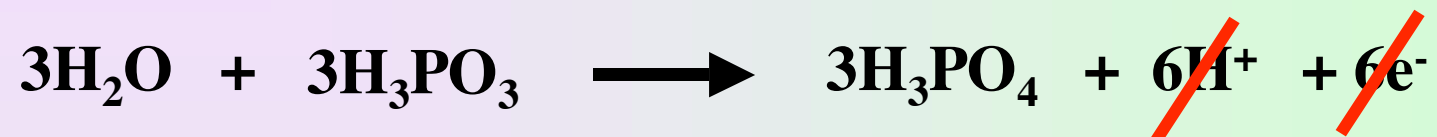
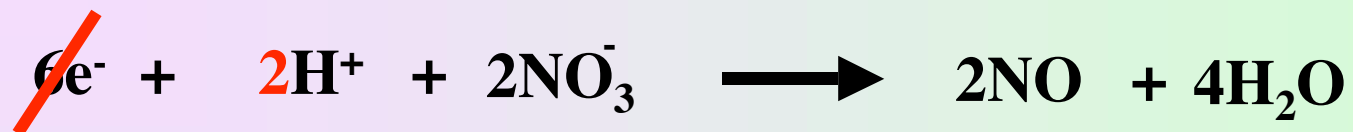
5. Balance the charges by adding electrons.



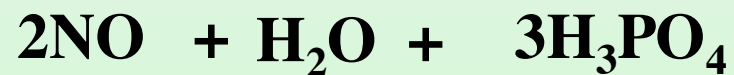
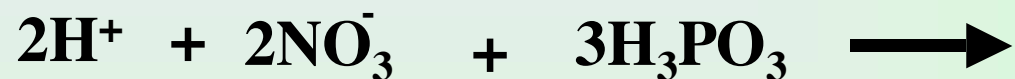
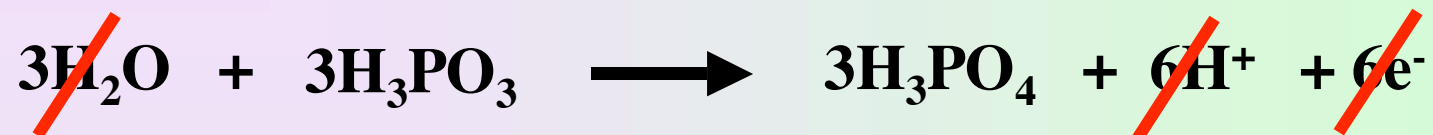
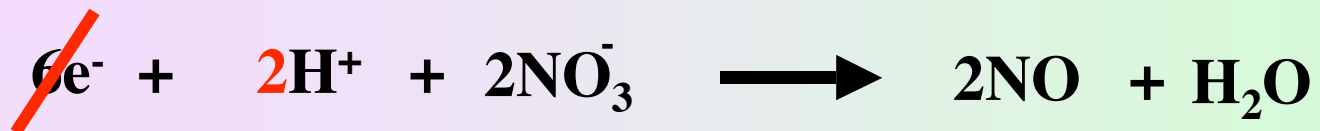
6. Add the half reactions



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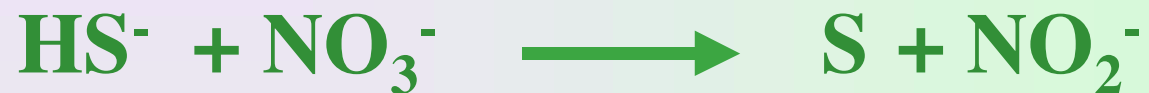
This is the balanced equation

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

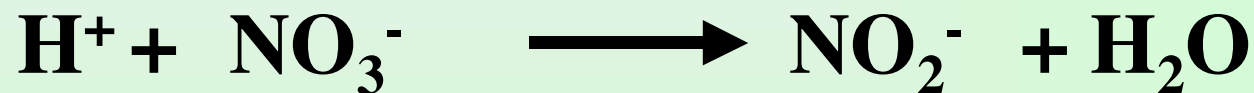
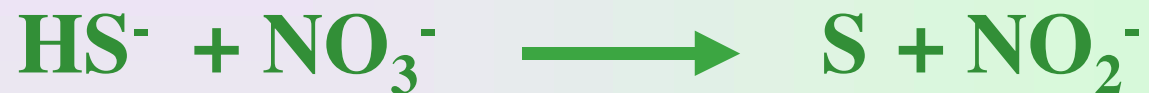
Balance the following equation for the reaction in basic solution. *



***All species are (aq)**

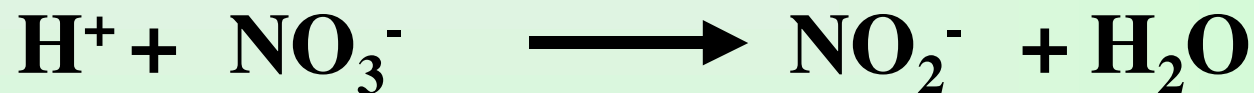
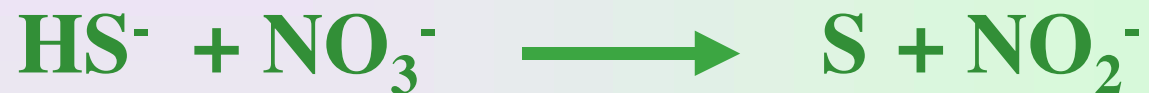
Example

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



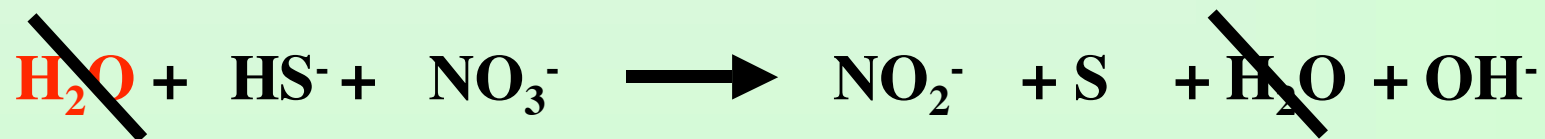
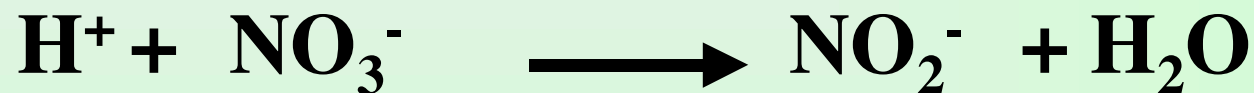
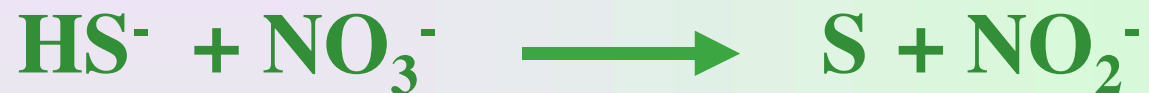
Example

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



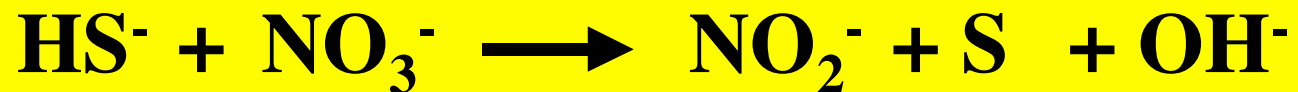
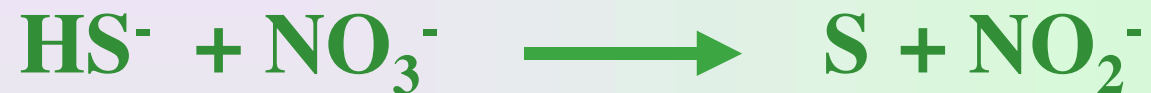
Example

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



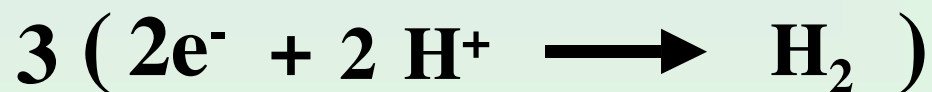
Example

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



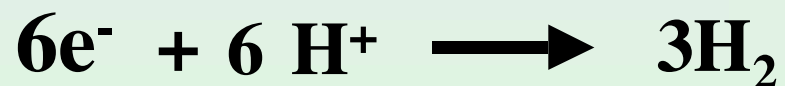
Example

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

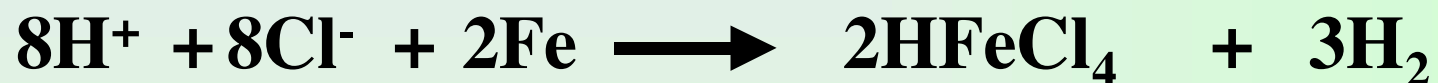
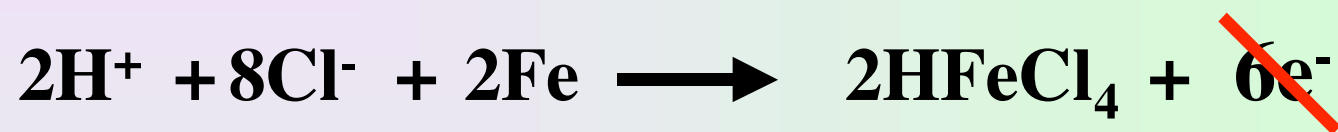
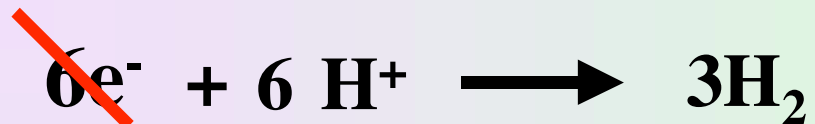


Example

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



Example



or

