Redox in Basic Medium/Solution

Video Workbook with Dr. B

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The process is the same as we did with acidic solutions. *All we do is add one more step.*

You will usually be told if you need to balance in acidic or basic (also called alkaline) solution.

Full Redox Playlist

A basic solution usually has hydroxide ions (OH^-).

Balancing Redox in Basic Medium/Solution

Steps

1. Balance the redox reaction as you would with an acidic solution.
2. Then add OH^- to cancel out any H^+ ions.
3. Combine any OH^- and H^+ to form H_2O.
4. Cancel/combine any common terms (usually H_2O).

Note: Some teachers add the extra step earlier in the balancing process.

In most cases you will be told whether the reaction takes place in acidic or basic medium. If not, assume acidic conditions.

Sometimes basic solution/medium is called alkaline solution/medium.

Example: Balance the equation below in basic solution.

$$Pb(OH)_4^{2-} + ClO^- \rightarrow PbO_2 + Cl^- + OH^-$$

This is redox eq. we need to balance.

1. Balance in acidic medium to get:

$$Pb(OH)_4^{2-} + ClO^- + 2H^+ \rightarrow PbO_2 + Cl^- + 3H_2O$$

We followed the same process as before to get the balanced equation in acidic medium.

2. Add OH^- ions to cancel out the H^+ ions.

$$2OH^- + Pb(OH)_4^{2-} + ClO^- + 2H^+ \rightarrow PbO_2 + Cl^- + 3H_2O + 2OH^-$$

There are $2H^+$ ions in the reactants so we add $2OH^-$ ions **to each side** of the equation.

3. Combine OH^- and H^+ to form H_2O.

$$2OH^- + Pb(OH)_4^{2-} + ClO^- + 2H^+ \rightarrow PbO_2 + Cl^- + 3H_2O + 2OH^-$$

$$2H_2O + Pb(OH)_4^{2-} + ClO^- \rightarrow PbO_2 + Cl^- + 3H_2O + 2OH^-$$

When we have H^+ and OH^- on the same side of the equation we combine them to form H_2O.

4. Cancel out like terms to get the final balanced equation:

$$Pb(OH)_4^{2-} + ClO^- \rightarrow PbO_2 + Cl^- + H_2O + 2OH^-$$

There are $2H_2O$ in the reactants and $3H_2O$ in the products. We simplify this to $1H_2O$ in the products. We write this as just H_2O.

Practice: Balance the equation below in basic solution.

$$H_2O_2 + Cl_2O_7 \rightarrow O_2 + ClO_2^-$$

This is redox eq. we need to balance.

1. Balance in acidic medium to get:

$$4H_2O_2 + Cl_2O_7 \rightarrow 4O_2 + 2ClO_2^- + 2H^+ + 3H_2O$$

We followed the same process as before to get the balanced equation in acidic medium.

2. Add OH^- ions to cancel out the H^+ ions:

$$2OH^- + 4H_2O_2 + Cl_2O_7 \rightarrow 4O_2 + 2ClO_2^- + 2H^+ + 3H_2O + 2OH^-$$

There are $2H^+$ ions in the reactants so we add $2OH^-$ ions **to each side** of the equation.

3. Combine OH^- and H^+ to form H_2O.

$$2OH^- + 4H_2O_2 + Cl_2O_7 \rightarrow 4O_2 + 2ClO_2^- + 2H^+ + 3H_2O + 2OH^-$$

$$2OH^- + 4H_2O_2 + Cl_2O_7 \rightarrow 4O_2 + 2ClO_2^- + 3H_2O + 2H_2O$$

When we have H^+ and OH^- on the same side of the equation we combine them to form H_2O.

4. Combine like terms to get the final balanced equation:

$$2OH^- + 4H_2O_2 + Cl_2O_7 \rightarrow 4O_2 + 2ClO_2^- + 5H_2O$$

Here we have $3H_2O$ and $2H_2O$ in the products. We add them together to get $5H_2O$.

Practice Problems: Given the equation balanced under acidic conditions, *balance the following reactions in basic medium.*

1. Unbalanced Equation: $Co(OH)_3 + Sn \rightarrow Co(OH)_2 + HSnO_2^-$

   Balanced Under Acidic Conditions: $2Co(OH)_3 + Sn \rightarrow 2Co(OH)_2 + HSnO_2^- + H^+$

2. Unbalanced Equation: $ClO^- + Cr(OH)_4 \rightarrow CrO_4^{2-} + Cl^-$

   Balanced Under Acidic Conditions: $ClO^- + Cr(OH)_4 \rightarrow CrO_4^{2-} + Cl^- + 2H^+ + H_2O$

3. Unbalanced Equation: $Fe(OH)_2 + CrO_4^{2-} \rightarrow Fe_2O_3 + Cr(OH)_4^-$

   Balanced Under Acidic Conditions: $6Fe(OH)_2 + 2CrO_4^{2-} + 2H^+ \rightarrow 3Fe_2O_3 + 2Cr(OH)_4^- + 3H_2O$

4. Unbalanced Equation: $MnO_4^- + C_2O_4^{2-} \rightarrow MnO_2 + CO_2$

   Balanced Under Acidic Conditions: $2MnO_4^- + 3C_2O_4^{2-} + 8H^+ \rightarrow 6CO_2 + 2MnO_2 + 4H_2O$

5. Unbalanced Equation: $ClO_3^- + N_2H_4 \rightarrow NO + Cl^-$

   Balanced Under Acidic Conditions: $4ClO_3^- + 3N_2H_4 \rightarrow 6NO + 4Cl^- + 6H_2O$

Answers:

1. Balanced Under Basic Conditions: $2Co(OH)_3 + Sn + OH^- \rightarrow 2Co(OH)_2 + HSnO_2^- + H_2O$ (video solution)

2. Balanced Under Basic Conditions: $ClO^- + Cr(OH)_4 + 2OH^- \rightarrow CrO_4^{2-} + Cl^- + 3H_2O$

3. Balanced Under Basic Conditions: $6Fe(OH)_2 + 2CrO_4^{2-} \rightarrow 3Fe_2O_3 + 2Cr(OH)_4^- + 2OH^- + H_2O$ (video solution)

4. Balanced Under Basic Conditions: $2MnO_4^- + 3C_2O_4^{2-} + 4H_2O \rightarrow 6CO_2 + 2MnO_2 + 8OH^-$

5. Balanced Under Basic Conditions: $4ClO_3^- + 3N_2H_4 \rightarrow 6NO + 4Cl^- + 6H_2O$
   (There aren't any H^+ so you didn't need to add any OH^-).

Redox Guides

Report errors and suggestions to DrB@breslyn.org