# REDOX: REDUCTION-OXIDATION REACTIONS

**Introduction:**

Reactions involving the exchange or transfer of electrons between substances are called Reduction-Oxidation Reactions or REDOX reactions. The substance that loses the electrons is oxidized whereas the substance that gains electrons is reduced. This can be remembered using the following phrase:

*LEO the lion goes GER* (LEO = lose electrons oxidized, GER = gain electrons reduced)

In a redox reaction, the substance that gets oxidized is called the reducing agent. The substance that gets reduced is the oxidizing agent. REDOX reactions are made up of two half-reactions: oxidation and reduction. For example:

$$Mg^0 + F_2^0 \rightarrow MgF_2$$

**Oxidation:** $Mg^0 \rightarrow Mg^{2+} + 2e$ **Reduction:** $F_2^0 + 2e \rightarrow 2\,F^{1-}$

In these reactions the electrons lost by the magnesium are gained by the fluorine. In any REDOX reaction the number of lost electrons equals the number of gained electrons.

REDOX reactions that occur spontaneously will have an overall positive electrode potential ($E^0$). If the overall $E^0$ is negative, the reaction will not occur spontaneously. To calculate the voltages, a *Table of Standard Electrode Potentials* would be referred to.

**Purpose:**

1) To observe different combinations of metals and aqueous solutions and decide if a redox reaction has occurred.
2) To determine the relative strengths of the metals as reducing agents (tendency to lose electrons) and the metallic ions as oxidizing agents (tendency to gain electrons).

**Materials:**

| | | | |
|---|---|---|---|
| 1 spot plate | pipettes | safety goggles | zinc, copper, lead |
| 0.1 M $AgNO_3$ | 0.1 M $Pb(NO_3)_2$ | 0.1 M $Cu(NO_3)_2$ | 0.1 M $Zn(NO_3)_2$ |

**Procedure:**

1) Fill 3 clean dry wells 1/3 the way full with 0.1 M $AgNO_3$. Add 1 piece of copper to the first well, lead to the second well and zinc to the third well.

2) Fill 2 clean dry wells 1/3 the way full with 0.1 M $Cu(NO_3)_2$. Add 1 piece of lead to the first well and 1 piece of zinc to the second well.

3) Fill 2 clean dry wells 1/3 the way full with 0.1 M $Pb(NO_3)_2$. Add 1 piece of copper to the first well and 1 piece of zinc to the second well.

4) Fill 2 clean dry wells 1/3 the way full with 0.1 M $Zn(NO_3)_2$. Add 1 piece of lead to the first well and 1 piece of copper to the second well.

5) Record observations. Decide if a reaction has taken place.

6) Pour solutions down the drain and place the used metals in the appropriate containers in the fume hood.

**Questions:**

1) Write and balance the single replacement reactions for each reaction that has occurred the REDOX way. Under that equation write the half reaction and identify which is oxidation and which is reduction. **Remember:** In order for a reaction to proceed, the element cutting in must be **above** the element it is replacing on Table J.

   a) $AgNO_3$ + Cu

   b) $AgNO_3$ + Pb

   c) $AgNO_3$ + Zn

   d) $Cu(NO_3)_2$ + Pb

   e) $Cu(NO_3)_2$ + Zn

   f) $Pb(NO_3)_2$ + Cu

   g) $Pb(NO_3)_2$ + Zn

   h) $Zn(NO_3)_2$ + Pb

   i) $Zn(NO_3)_2$ + Cu

2) List the relative order of metal activities from most reactive to least reactive.

3) According to the *Activity Series Table*, which metal will replace $Fe^{2+}$ but not $Zn^{2+}$?

4) Define oxidation, reduction, oxidizing agent and reducing agent.

5) Indicate whether or not the following reactions would occur by writing spontaneous (will occur) or not spontaneous (won't occur):
   a). Fe + $CuCl_2$  b). Al + NaOH  c). Ag + $H_2SO_4$  d). $F_2$ + $CaCl_2$

1) Given the balanced ionic equation:

$$Zn(s) + Cu^{2+}(aq) \longrightarrow Zn^{2+}(aq) + Cu(s)$$

Which equation represents the oxidation half-reaction?

A) $Zn(s) \longrightarrow Zn^{2+}(aq) + 2e^-$

B) $Cu^{2+}(aq) \longrightarrow Cu(s) + 2e^-$

C) $Zn(s) + 2e^- \longrightarrow Zn^{2+}(aq)$

D) $Cu^{2+}(aq) + 2e^- \longrightarrow Cu(s)$

2) Given the reaction for the corrosion of aluminum:

$$4Al + 3O_2 \longrightarrow 2Al_2O_3$$

Which half-reaction correctly represents the oxidation that occurs?

A) $Al \longrightarrow Al^{3+} + 3e^-$

B) $Al + 3e^- \longrightarrow Al^{3+}$

C) $O_2 + 4e^- \longrightarrow 2O^{2-}$

D) $O_2 \longrightarrow 2O^{2-} + 4e^-$

3) The transfer of which particle is required for a redox reaction to occur?

A) electron

B) neutron

C) proton

D) ion

4) Which reaction is an example of an oxidation-reduction reaction?

A) $AgNO_3 + KI \longrightarrow AgI + KNO_3$

B) $Ba(OH)_2 + 2HCl \longrightarrow BaCl_2 + 2H_2O$

C) $2KOH + H_2SO_4 \longrightarrow K_2SO_4 + 2H_2O$

D) $Cu + 2AgNO_3 \longrightarrow Cu(NO_3)_2 + 2Ag$

5) Given the equation:

$$C(s) + H_2O(g) \longrightarrow CO(g) + H_2(g)$$

Which species undergoes reduction?

A) C(s)

B) $H_2(g)$

C) $C^{2+}$

D) $H^+$

6) When a neutral atom undergoes oxidation, the atom's oxidation state

A) increases as it loses electrons

B) increases as it gains electrons

C) decreases as it gains electrons

D) decreases as it loses electrons

Chemistry Lab 20a  Redox: Oxidation-Reduction Reactions  Name _____
Period _____
Date _____

Purpose _____

Procedures:

| Reactants | Color of solution | Color of metal | Reaction indication |
|---|---|---|---|
| 1 a) $AgNO_3$ & Cu | | | |
| b) $AgNO_3$ & Pb | | | |
| c) $AgNO_3$ & Zn | | | |
| 2 a) $Cu(NO_3)_2$ & Pb | | | |
| b) $Cu(NO_3)_2$ & Zn | | | |
| 3 a) $Pb(NO_3)_2$ & Cu | | | |
| b) $Pb(NO_3)_2$ & Zn | | | |
| 4 a) $Zn(NO_3)_2$ & Pb | | | |
| b) $Zn(NO_3)_2$ & Cu | | | |

Questions:

1 a) single replacement _____ → _____

half Rx 1 _____ → _____  half Rx 2 _____ → _____

type _____  type _____

b) single replacement _____ → _____

half Rx 1 _____ → _____  half Rx 2 _____ → _____

type _____  type _____

c) single replacement _____ → _____

half Rx 1 _____ → _____  half Rx 2 _____ → _____

type type

2 a) single replacement _____ →

half Rx 1 _____ → half Rx 2 _____ →

type _____ type _____

b) single replacement _____ →

half Rx 1 _____ → half Rx 2 _____ →

type _____ type _____

3 a) single replacement _____ →

half Rx 1 _____ → half Rx 2 _____ →

type _____ type _____

b) single replacement _____ →

half Rx 1 _____ → half Rx 2 _____ →

type _____ type _____

4 a) single replacement _____ _____ →

half Rx 1 _____ → half Rx 2 _____ →

type _____ type _____

b) single replacement _____ →

half Rx 1 _____ → half Rx 2 _____ →

type _____ type _____

2. List of relative activities from most to least. _____ _____ _____ _____

3. _____

4. Oxidation _____

Reduction _____

Oxidizing agent _____

Reducing agent _____

5. a) $Fe + CuCl_2$ = _____ $E_0$ = _____ _____

b) $Ag + H_2SO_4$ = _____ $E_0$ = _____ _____

c) $Al + NaOH$ = _____ $E_0$ = _____ _____

d) $F_2 + CaCl_2$ = _____ $E_0$ = _____ _____