

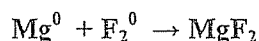
REDOX: REDUCTION-OXIDATION REACTIONS

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:



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 $\text{Pb}(\text{NO}_3)_2$	0.1 M $\text{Cu}(\text{NO}_3)_2$	0.1 M $\text{Zn}(\text{NO}_3)_2$

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 $\text{Cu}(\text{NO}_3)_2$. 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 $\text{Pb}(\text{NO}_3)_2$. 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 $\text{Zn}(\text{NO}_3)_2$. 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.

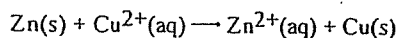
Questions:

- 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) $\text{AgNO}_3 + \text{Cu}$
- b) $\text{AgNO}_3 + \text{Pb}$
- c) $\text{AgNO}_3 + \text{Zn}$
- d) $\text{Cu}(\text{NO}_3)_2 + \text{Pb}$
- e) $\text{Cu}(\text{NO}_3)_2 + \text{Zn}$
- f) $\text{Pb}(\text{NO}_3)_2 + \text{Cu}$
- g) $\text{Pb}(\text{NO}_3)_2 + \text{Zn}$
- h) $\text{Zn}(\text{NO}_3)_2 + \text{Pb}$
- i) $\text{Zn}(\text{NO}_3)_2 + \text{Cu}$

- 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). $\text{Fe} + \text{CuCl}_2$ b). $\text{Al} + \text{NaOH}$ c). $\text{Ag} + \text{H}_2\text{SO}_4$ d). $\text{F}_2 + \text{CaCl}_2$

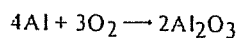
- 1) Given the balanced ionic equation:



Which equation represents the oxidation half-reaction?

- A) $\text{Zn}(s) \rightarrow \text{Zn}^{2+}(\text{aq}) + 2e^-$
- B) $\text{Cu}^{2+}(\text{aq}) \rightarrow \text{Cu}(s) + 2e^-$
- C) $\text{Zn}(s) + 2e^- \rightarrow \text{Zn}^{2+}(\text{aq})$
- D) $\text{Cu}^{2+}(\text{aq}) + 2e^- \rightarrow \text{Cu}(s)$

- 2) Given the reaction for the corrosion of aluminum:



Which half-reaction correctly represents the oxidation that occurs?

- A) $\text{Al} \rightarrow \text{Al}^{3+} + 3e^-$ C) $\text{O}_2 + 4e^- \rightarrow 2\text{O}^{2-}$
- B) $\text{Al} + 3e^- \rightarrow \text{Al}^{3+}$ D) $\text{O}_2 \rightarrow 2\text{O}^{2-} + 4e^-$

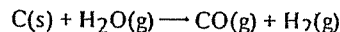
- 3) The transfer of which particle is required for a redox reaction to occur?

- A) electron C) proton
- B) neutron D) ion

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

- A) $\text{AgNO}_3 + \text{KI} \rightarrow \text{AgI} + \text{KNO}_3$
- B) $\text{Ba}(\text{OH})_2 + 2\text{HCl} \rightarrow \text{BaCl}_2 + 2\text{H}_2\text{O}$
- C) $2\text{KOH} + \text{H}_2\text{SO}_4 \rightarrow \text{K}_2\text{SO}_4 + 2\text{H}_2\text{O}$
- D) $\text{Cu} + 2\text{AgNO}_3 \rightarrow \text{Cu}(\text{NO}_3)_2 + 2\text{Ag}$

- 5) Given the equation:



Which species undergoes reduction?

- A) $\text{C}(s)$ C) C^{2+}
- B) $\text{H}_2(g)$ 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

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) $\text{Cu}(\text{NO}_3)_2$ & Pb			
b) $\text{Cu}(\text{NO}_3)_2$ & Zn			
3 a) $\text{Pb}(\text{NO}_3)_2$ & Cu			
b) $\text{Pb}(\text{NO}_3)_2$ & Zn			
4 a) $\text{Zn}(\text{NO}_3)_2$ & Pb			
b) $\text{Zn}(\text{NO}_3)_2$ & Cu			

Questions:

- 1 a) single replacement _____ \rightarrow
 half Rx 1 _____ \rightarrow half Rx 2 _____ \rightarrow
 type _____ type _____
- b) single replacement _____ \rightarrow
 half Rx 1 _____ \rightarrow half Rx 2 _____ \rightarrow
 type _____ type _____
- c) single replacement _____ \rightarrow
 half Rx 1 _____ \rightarrow half Rx 2 _____ \rightarrow

- 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) $\text{Fe} + \text{CuCl}_2 =$ _____ $E_0 =$ _____
 b) $\text{Ag} + \text{H}_2\text{SO}_4 =$ _____ $E_0 =$ _____
 c) $\text{Al} + \text{NaOH} =$ _____ $E_0 =$ _____
 d) $\text{F}_2 + \text{CaCl}_2 =$ _____ $E_0 =$ _____