UNIT 10: Redox & Electrochem STUDY GUIDE
REGENTS CHEMISTRY

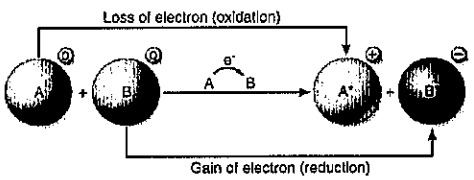
Name KEY

DUE DATE: *Friday 4/28 (day of exam)*

Vocabulary- Match the terms to the correct definitions.

P anode
N cathode
O electrode
Q electrolytic cell
A reduction
B oxidation
G reduction half reaction
H oxidation half reaction
C oxidation number/state
M voltaic cell
L salt bridge
D zero
F single replacement reaction
E double replacement reaction
I mass, energy, and charge
J Table J
K easily oxidized

A. Gain of electrons; oxidation goes down/reduces
B. Loss of electrons; oxidation number goes up
C. "charges" that can be assigned to atoms in elements, compounds, and ions
D. This is the oxidation state of any atom in a "free" element
E. This type of reaction is NEVER redox
F. This type of reaction is ALWAYS redox
G. Electrons are on the left hand side; i.e. $Fe^{3+} + 3\ e^- \rightarrow Fe$
H. Electrons are on the right hand side; i.e. $Fe \rightarrow Fe^{3+} + 3\ e^-$
I. These are ALWAYS conserved in a chemical change
J. Where to go to determine if a redox reaction will be spontaneous
K. Metals that are **higher up** on Table J are...
L. Required so that ions can flow to prevent charge build up in voltaic cells
M. Cells that spontaneously convert chemical energy into electrical energy
N. Electrode where reduction occurs RED CAT
O. Conductive surface where oxidation or reduction occurs
P. Electrode where oxidation occurs
Q. Cells that use electrical energy to force a nonspontaneous chemical reaction to occur

Topic	Practice Problems
Oxidation and Reduction *The "transfer" of electrons results in changes in oxidation number (charge) of an element.* Assigning oxidation states allows you to see which, if any, elements get... **Oxidized** (charge up) or **Reduced** (charge down)	1. Fill in the blanks to the left with either up or down. 2. What are the two memory devices to help remember what happens to electrons during oxidation and reduction? Write them below, and include what they actually mean! Oxidation Is Losing e⁻ Reduction Is Gaining LEO the lion says GER Losing electrons = Oxidation Gaining electrons = Reduction
Identifying Redox Reactions *In a redox reaction, electrons are transferred from one species to another, resulting in changes in oxidation #.* **Redox reactions** are changes in which one species is *oxidized* and another is *reduced* • ALL single **replacement** reactions are redox reactions. • Double replacement reactions are NEVER redox reactions. Example: $2CO + O_2 \rightarrow 2CO_2$ (+2 -2, 0, +4 -2; -2) These numbers are Oxidation States. Charge of C^{2+} goes up to C^{4+}: C^{2+} is oxidized Charge of O^0 goes down to O^{2-}: O^0 is reduced  	1. Fill in the blanks to the left by using the following words (some words may not be used): *Single* *Oxidized* *Double* *Transferred* *Reduced* *Oxidation states* 2. Assign oxidation states/numbers to each element in the following compounds: KOH (+1, +1, -2) Cu_2S (+1, -2) S_8 (0) AgBr (+1, -1) H_2SO_4 (+1, +6, -2, -2, -2) AgBr (+1, -1) Fe (0) CaS (+2, -2) SO_3 (+6, -2, -2) $Al(NO_3)_3$ (+3, +5, -2) NH_3 (-3, +1, +1, +1) Na (0) 3. Identify which species is being reduced and oxidized in the following reactions. $2Sr^{0} + O_2^{0} \rightarrow 2SrO^{+2-2}$ Species oxidized: Sr Species reduced: O_2 $Mg^{0} + 2HCl^{+1-1} \rightarrow MgCl_2^{+2-1} + H_2^{0}$ Species oxidized: Mg Species reduced: H^{+1} $2NaBr^{+1-1} + Cl_2^{0} \rightarrow 2NaCl^{+1-1} + Br_2^{0}$ Species oxidized: Br^{-1} Species reduced: Cl^{0}

Topic

Half-Reactions and Net Ionic Equations

Half-reactions show oxidation and reduction processes separately. Combining half-reactions gives a net ionic equation where the number of electrons lost is equal to the number of electrons gained

Example: An unbalanced redox reaction is shown.

$$Zn + Ag(NO_3) \rightarrow Ag + Zn(NO_3)_2$$

Oxidation half-reaction: Zn^0 is oxidized to Zn^{2+}

$$Zn^0 \rightarrow Zn^{2+} + 2e^-$$

Reduction half-reaction: Ag^+ is reduced to Ag^0

$$Ag^+ + 1\,e^- \rightarrow Ag^0$$

To make e^- lost = e^- gained (conservation of charge), the whole reduction half-reaction needs to be multiplied by 2. The equations can then be added to give a net ionic equation:

$$Zn^0 + 2Ag^+ \rightarrow 2Ag^0 + Zn^{2+}$$

Spontaneity and Metal Activity

Table J can be used to predict the reactivity of different elements.

More active **solid metals**...

- Are found at the top of Table J
- Are more likely to react by...
  - Losing electrons
  - Getting oxidized
- Will spontaneously replace less active metal ions in a single replacement rxn

Example: Zn + $Ag(NO_3)$ *will* react *spontaneosuly* because Zn is more active than Ag

Practice Problems

Write the oxidation and reduction reactions for each redox reaction. The first one is done for you. **If necessary, balance the equation by canceling out electrons.**

Fe^{2+} + Co ⇄ Co^{2+} + Fe

Oxidation: Co → Co^{2+} + $2e^-$

Reduction: Fe^{2+} + $2e^-$ → Fe

3 Ag^+ + Ni^0 ⇄ Ni^{3+} + 3 Ag^0

Oxidation: $Ni \rightarrow Ni^{3+} + 3e^-$

Reduction: $(Ag^+ + 1e^- \rightarrow Ag)\,3$

Cu^{2+} + Pb^0 ⇄ Pb^{2+} + Cu^0

Oxidation: $Pb \rightarrow Pb^{2+} + 2e^-$

Reduction: $Cu^{2+} + 2e^- \rightarrow Cu$

Circle the following redox reactions that will occur **spontaneously**.

$Cl_2(g) + 2NaBr(aq) \rightarrow Br_2(\ell) + 2NaCl(aq)$

$I_2(s) + 2NaF(aq) \rightarrow F_2(g) + 2NaI(aq)$

$Cu(s) + 2\,HCl(aq) \rightarrow CuCl_2(aq) + H_2(g)$

$Ba(s) + 2\,HCl(aq) \rightarrow BaCl_2(aq) + H_2(g)$

$Mg(s) + 2\,HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$

$Sn(s) + 2\,HCl(aq) \rightarrow SnCl_2(ag) + H_2(g)$

$Au^{3+} + Al(s) \rightarrow Au(s) + Al^{3+}$

$Fe^{2+} + Cu(s) \rightarrow Fe(s) + Cu^{2+}$

$Ni^{2+} + Pb(s) \rightarrow Ni(s) + Pb^{2+}$

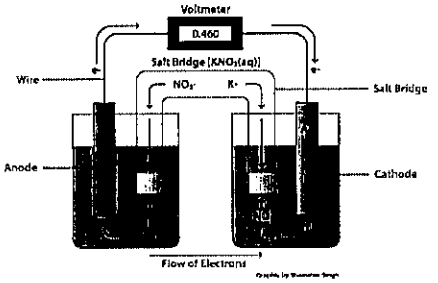
$Sr^{2+} + Sn(s) \rightarrow Sr(s) + Sn^{2+}$

Topic

Voltaic Cells

Electrochemical cells that spontaneously *convert* chemical *energy into* electrical *energy are called voltaic cells (used as batteries).*

AN OX and a BIG RED CAT



- Oxidation occurs at the Anode (mass lost) – more active metal is the anode!
- Reduction occurs at the Cathode (mass gained)
- e^- flow from the anode to the cathode

A Salt bridge allows for the migration of ions

Practice Problems

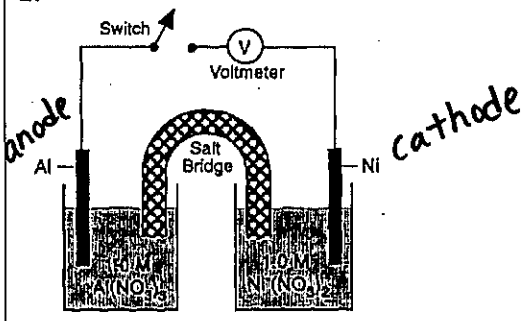
1. Fill in the blanks to the left by using the following words (some words may not be used):

Nonspontaneously *spontaneously* *salt bridge*

Chemical *electrical* *anode* *less*

Cathode *gained* *lost* *more*

2.



$2\,Al(s) + 3Ni^{2+}(aq) \rightarrow 2Al^{3+} + 3Ni(s)$

When the switch is closed, electrons flow from

(A) Al(s) to Ni(s)
B) Ni(s) to Al(s)
C) $Ni^{2+}(aq)$ to $Al^{3+}(aq)$
D) $Al^{3+}(aq)$ to $Ni^{2+}(aq)$

3.

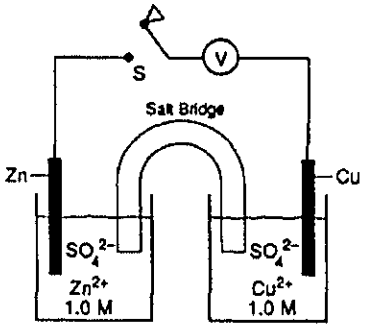
A standard zinc half-cell is connected to a standard copper half cell by means of a wire and a salt bridge. Which electronic equation represents the oxidation reaction that takes place?

(A) $Zn^0 - 2e^- \rightarrow Zn^{2+}$ best choice Zn vs Cu
B) $Zn^{2+} + 2e^- \rightarrow Zn^0$
C) $Cu^0 - 2e^- \rightarrow Cu^{2+}$
D) $Cu^{2+} + 2e^- \rightarrow Cu^0$

$Zn \rightarrow Zn^{2+} + 2e^-$

4.

Base your answer to the following question on the diagram below which represents a chemical cell at 298 K and 1 atmosphere.



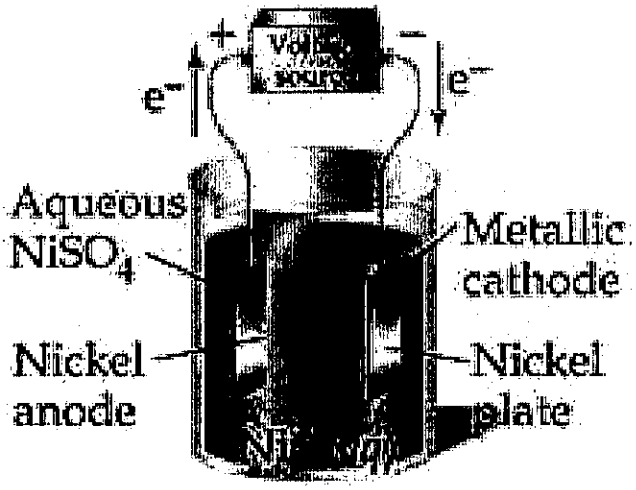
AN OX RED CAT

Which species represents the cathode?

A) Cu^{2+} B) Zn C) Zn^{2+} (D) Cu

Electrolytic Cells

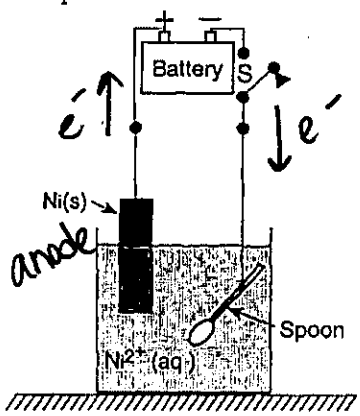
Electrochemical cells that use batteries to non-spontaneously convert electrical energy into chemical energy are called electrolytic cells.



AN OX and a **BIG RED CAT** still applies, but an external **power source** is needed to oxidize the *less* active metal (LOWER on Table J).

1.

The diagram below shows a spoon that will be electroplated with nickel metal.



What will occur when switch S is closed?

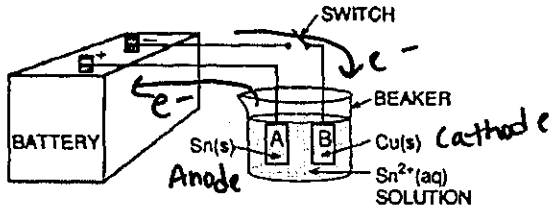
A) The spoon will lose mass, and the Ni(s) will be reduced.

B) The spoon will gain mass, and the Ni(s) will be oxidized.

C) The spoon will gain mass, and the Ni(s) will be reduced.

D) The spoon will lose mass, and the Ni(s) will be oxidized.

2.



. When the switch is closed, what will happen to the two electrodes?

A) *A* will dissolve and *B* will become coated with copper.

B) *B* will dissolve and *A* will become coated with copper.

C) *A* will dissolve and *B* will become coated with tin. $Sn^{2+} + 2e^- \rightarrow Sn$

D) *B* will dissolve and *A* will become coated with tin.

3. In the above electrolytic cell, which metal (Sn or Cu) is the anode and which is the cathode?

Anode: Sn Cathode: Cu

4. Write the oxidation and reduction ½ reactions occurring in the electrolytic cell in #2:

Reduction: $Sn^{2+} + 2e^- \rightarrow Sn$

Oxidation: $Sn \rightarrow Sn^{2+} + 2e^-$