(Chem 1H) Ch. 18 Notes – REDOX REACTIONS
NOTE: Vocabulary terms are in **boldface and underlined**. Supporting details are in *italics.*

I.   Oxidation and Reduction
   A. Electron transfer and redox reactions
      1) Oxidation and reduction occur together

"LEO GER" = $\underline{L}$oss of $\underline{E}$lectrons is $\underline{O}$xidation. $\underline{G}$ain of $\underline{E}$lectrons is $\underline{R}$eduction.

OIL RIG = $\underline{O}$xidation is $\underline{L}$oss. $\underline{R}$eduction is $\underline{G}$ain.

---

   a) **oxidation** – *complete or partial loss of electrons* $Cl^- \rightarrow Cl + e^-$
   b) **reduction** – *complete or partial gain of electrons* $Ag^+ + e^- \rightarrow Ag$
   c) redox equations can involve monatomic cations and anions, molecular compounds, and polyatomic ions
   d) example equations with ions

- -

EXAMPLE 1)   Show work to identify what is oxidized and what is reduced in the following equation:
                magnesium + copper(II) oxide $\rightarrow$?

(activity series – p. 3 chapter 8 notes) $Mg + CuO \rightarrow MgO + Cu$

                                                  0   +2 -2   +2 -2   0

Mg $0 \rightarrow +2$ (oxidized) Cu $+2 \rightarrow 0$ (reduced)   O is unchanged.

- -

EXAMPLE 2)   Show work to identify what is oxidized and what is reduced in the following equation:
   sodium + chlorine $\rightarrow$?

$Na + Cl_2 \rightarrow NaCl$

Na $0 \rightarrow +1$ (oxidized) Cl $0 \rightarrow -1$ (reduced)

- -

      2) **oxidation numbers** – the basics (more on p. 3)
         a) ionic = charges
         b) uncombined solitary elements = 0
         c) uncombined allotropes of elements: C_{60} , S_8 , $Se_8 = 0$
      3) oxidizing and reducing agents
         a) **oxidizing agent**— *a substance that oxidizes another substance, becoming reduced in the process by accepting electron(s)*
         b) **reducing agent**— *a substance that reduces another substance, becoming oxidized in the process by releasing electron(s)*
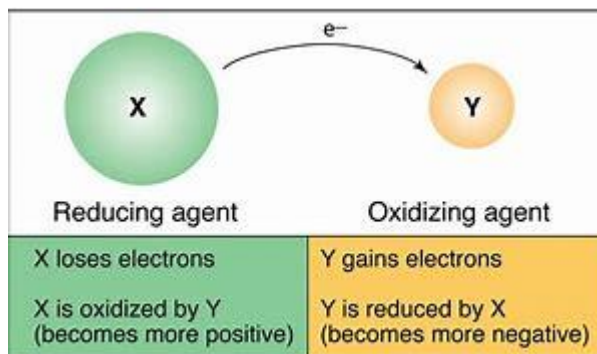
From ku.edu

B. Redox and electronegativity – redox equations with molecular compounds
   1) in redox equations with molecular compounds, no ions are formed and no electrons are transferred
   2) use *electronegativity differences* to identify what is oxidized or reduced
   3) periodic trend: electronegativity increases toward fluorine
      a) low electronegativity = lose e⁻ easily = oxidized = reducing agents
      b) high electronegativity = gain e⁻ easily = reduced = oxidizing agents
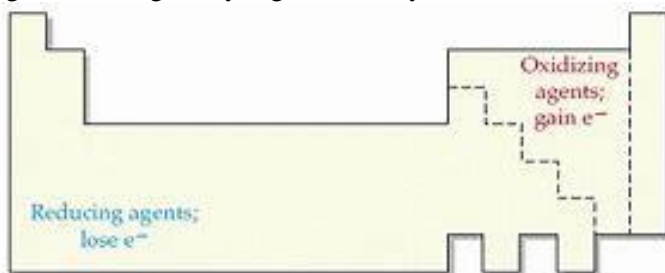
(From tdmu)

<table>
<tr><td colspan="2" align="center">Δ EN VALUES</td></tr>
<tr><td>0.0</td><td>nonpolar covalent</td></tr>
<tr><td>0.01 – 0.40</td><td>(mostly) covalent</td></tr>
<tr><td>0.40 – 1.70</td><td>polar covalent</td></tr>
<tr><td>> 1.70</td><td>(mostly) ionic</td></tr>
</table>

H 2.20																		He n.a.
Li 0.98	Be 1.57											B 2.04	C 2.55	N 3.04	O 3.44	F 3.98	Ne n.a.
Na 0.93	Mg 1.31											Al 1.61	Si 1.90	P 2.19	S 2.58	Cl 3.16	Ar n.a.
K 0.82	Ca 1.00	Sc 1.36	Ti 1.54	V 1.63	Cr 1.66	Mn 1.55	Fe 1.83	Co 1.88	Ni 1.91	Cu 1.90	Zn 1.65	Ga 1.81	Ge 2.01	As 2.18	Se 2.55	Br 2.96	Kr 3.00
Rb 0.82	Sr 0.95	Y 1.22	Zr 1.33	Nb 1.60	Mo 2.16	Tc 1.90	Ru 2.20	Rh 2.28	Pd 2.20	Ag 1.93	Cd 1.69	In 1.78	Sn 1.96	Sb 2.05	Te 2.10	I 2.66	Xe 2.60
Cs 0.79	Ba 0.89	La 1.10	Hf 1.30	Ta 1.50	W 2.36	Re 1.90	Os 2.20	Ir 2.20	Pt 2.28	Au 2.54	Hg 2.00	Tl 1.62	Pb 2.33	Bi 2.02	Po 2.00	At 2.20	Rn n.a.
Fr 0.70	Ra 0.89	Ac 1.10	Rf n.a.	Db n.a.	Sg n.a.	Bh n.a.	Hs n.a.	Mt n.a.	Ds n.a.	Rg n.a.	Uub n.a.	—	Uuq n.a.	—	—	—	—

EXAMPLE 3) Show work to identify what is oxidized and what is reduced in the following equation:
water → hydrogen + oxygen

$$H_2O \rightarrow H_2 + O_2$$

electronegativities: H = 2.20 and O = 3.44. Lower EN = oxidized (H). Higher EN = reduced (O).

C. Determining **oxidation numbers**
   1) uncombined solitary elements, "Super Seven," allotropes (such as C_{60}, S_8, Se_8) = 0
   2) monatomic ion = charge
   3) in a molecule or polyatomic ion, the most electronegative element is assigned its usual charge as if it were an independent ion
   4) F is always -1 when bonded to a different element
   5) O is always -2 , except in the *peroxide ion $(O_2)^{-2}$* it is -1
   6) H is +1 unless it is -1 in a metal *hydride* (such as KH, potassium hydride)
   7) Group 1 (IA), Group 2 (IIA), and Al = ionic charges
   8) the total of all oxidation numbers in a neutral compound = 0
   9) the total of all oxidation numbers in a polyatomic ion = the charge for the ion
   10) examples

EXAMPLE 4) What is the oxidation number of arsenic in the arsenate ion?

$(AsO_4)^{-3}$ $x + [(-2)x4] = -3$ $x - 8 = -3$ $x = +5$

EXAMPLE 5) What is the oxidation number of carbon in sodium cyanide?

NaCN $(+1) + x + (-3) = 0$ $x - 2 = 0$ $x = +2$

II.   Balancing Redox Equations – covered in AP Chemistry, for those who take it
   A. The oxidation-number method
   B. Balancing net ionic redox equations
   C. Balancing redox equations using half-reactions