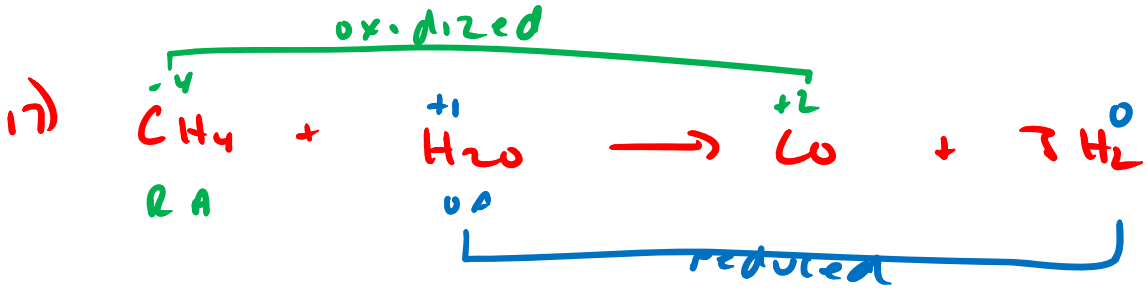
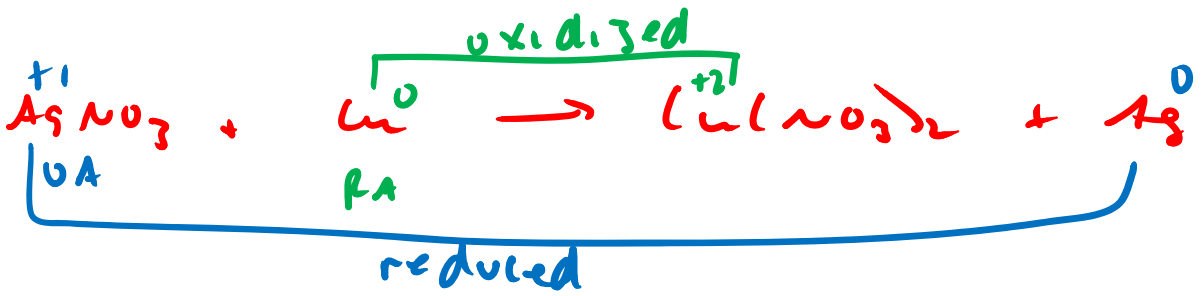
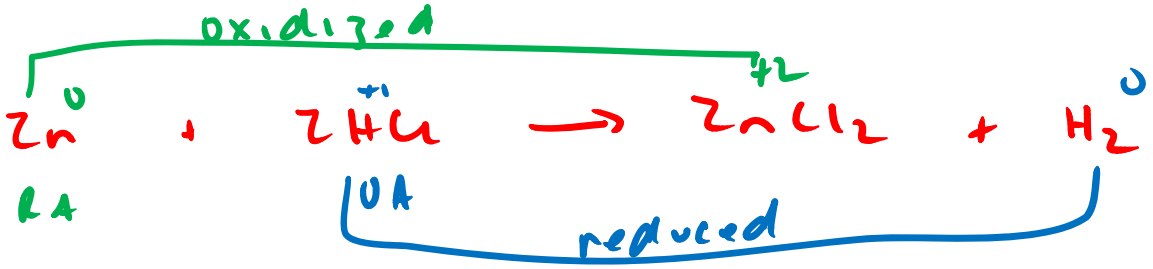
15) oxidation - loss of electrons
increase in ox. #

reduction - gain of electrons
decrease in ox #

17)







$2H^+ + 2(NO_3)^{-2} \rightarrow (N_2O_5)^{-2} + H_2O$

not redox

18) · Electrochemistry is the study of the interaction of chemical + electrical energy

- redox reactions involve transfer of electrons

- in a galvanic cell, a spontaneous redox reaction occurs that produces an electric current

- in an electrolytic cell, electricity is used to force a non spontaneous redox reaction to occur

2.) $\overset{0}{Mg} + 2\overset{+1}{H}Cl \rightarrow \overset{+2}{Mg}Cl_2 + \overset{0}{H_2}$

* two electrons are transferred

- we would need to use a galvanic cell to separate the two half reactions in order to control the flow of electrons through a wire to produce a voltage

29 a) $3I^- \rightarrow I_3^- + 2e^-$

$2e^- + 2H^+ + ClO^- \rightarrow Cl^- + H_2O$

$3I^- + 2H^+ + ClO^- \rightarrow I_3^- + Cl^- + H_2O$

b) $(^{15}5H_2O + {}^{3}As_2O_3 \rightarrow {}^{6}2H_3AsO_4 + {}^{12}4H^+)\,3$

$(^{12}12e^- + {}^{16}4H^+ + {}^{4}NO_3^- \rightarrow {}^{4}NO + {}^{6}2H_2O)\,4$

$7H_2O + 4H^+ + 3As_2O_3 + 4NO_3^- \rightarrow 4NO + 6H_3AsO_4$

c) $(2Br^- \rightarrow Br_2 + 2e^-)\,5$

$(5e^- + 8H^+ + MnO_4^- \rightarrow Mn^{+2} + 4H_2O)\,2$

$16H^+ + 2MnO_4^- + 10Br^- \rightarrow 5Br_2 + 2Mn^{+2} + 8H_2O$

d) $(CH_3OH \rightarrow CH_2O + 2H^+ + 2e^-)\,3$

$6e^- + 14H^+ + Cr_2O_7^{-2} \rightarrow 2Cr^{+3} + 7H_2O$

$8H^+ + 3CH_3OH + Cr_2O_7^{-2} \rightarrow 2Cr^{+3} + 3CH_3O + 7H_2O$

a) $4H_2O + Al \rightarrow Al(OH)_4^- + 4H^+ + 3e^-$

$3e^- + 4H^+ + MnO_4^- \rightarrow MnO_2 + 2H_2O$

$2H_2O + Al + MnO_4^- \rightarrow Al(OH)_4^- + MnO_2$

b) $2e^- + Cl_2 \rightarrow 2Cl^-$

$2H_2O + Cl_2 \rightarrow 2OCl^- + 4H^+ + 2e^-$

$2H_2O + 2Cl_2 \rightarrow 2Cl^- + 2OCl^- + 4H^+$

$+4OH^-$ $= +4OH^-$

$4OH^- + 2Cl_2 \rightarrow 2Cl^- + 2OCl^- + 2H_2O$

$2OH^- + Cl_2 \rightarrow Cl^- + OCl^- + H_2O$

c) $6e^- + 7H^+ + NO_2^- \rightarrow NH_3 + 2H_2O$

$(4H_2O + 2Al \rightarrow 2AlO_2^- + 8H^+ + 6e^-)2$

$2H_2O + 2Al + NO_2^- \rightarrow H^+ + NH_3 + 2AlO_2^-$

$+OH^-$ $+OH^-$

$OH^- + H_2O + NO_2^- + 2Al \rightarrow NH_3 + 2AlO_2^-$

53) * good oxidizing agents are easily reduced

K^+ < H_2O < Cd^{+2} < I_2 < $AuCl_4^-$ < IO_3^-

-2.87 -0.83 -0.40 0.54 0.99 1.20

55) a) $2H^+ + 2e^- \rightarrow H_2$ $E^0 = 0.00$ V

$Cu \rightarrow Cu^{+2} + 2e^-$ $E^0 = 0.34$ V

$E^0_{cell} = E^0_{red} - E^0_{ox} = 0 - 0.34 = -0.34$ V

no

b) $Fe^{+3} + e^- \rightarrow Fe^{+2}$ $E^0 = 0.77$

$2I^- \rightarrow I_2 + 2e^-$ $E^0 = 0.54$

$E^0_{cell} = 0.77 - 0.54 = 0.23$ V yes

c) $H_2 \rightarrow 2H^+ + 2e^-$ $E^0 = 0.00$

$Ag^+ + e^- \rightarrow Ag$ $E^0 = 0.80$

$E^0_{cell} = 0.80 - 0.00 = 0.80$ V yes

$Na^+ + 1e^- \rightarrow Na \quad E^\circ = -2.71V$

$Cl_2 + 2e^- \rightarrow 2Cl^- \quad E^\circ = 1.36V$

$Ag^+ + 1e^- \rightarrow Ag \quad E^\circ = 0.80V$

$Zn^{+2} + 2e^- \rightarrow Zn \quad E^\circ = -0.76V$

$Pb^{+2} + 2e^- \rightarrow Pb \quad E^\circ = 0.13V$

a) Ag^+ is the best oxidizing agent

b) Zn is the best reducing agent

c) $SO_4^{-2} + 4H^+ + 2e^- \rightarrow H_2SO_3 + H_2O \quad E^\circ = 0.20V$

need a positive E°_{cell}

$E^\circ_{cell} = E^\circ_{red} - E^\circ_{ox}$

$\oplus = 0.20 - x$

Pb and Zn

d) $Al \rightarrow Al^{+3} + 3e^- \quad E^\circ = -1.66V$

$E^\circ_{cell} = E^\circ_{red} - E^\circ_{ox}$

$\oplus \quad -1.66$

Ag^+ and Zn^{+2}

5) a) $2Br^- \rightarrow Br_2 + 2e^-$ $E^\circ = 1.09\,V$

$2Cl^- \rightarrow Cl_2 + 2e^-$ $E^\circ = 1.36\,V$

$1.09V < E < 1.36$

$Cr_2O_7^{-2}$, O_2, MnO_2, IO_3^-

b) $Mn \rightarrow Mn^{+2} + 2e^-$ $E^\circ = 1.18\,V$

$Ni \rightarrow Ni^{+2} + 2e^-$ $E^\circ = 0.23\,V$

$-1.18 < E^\circ < -0.23$

$PbSO_4$, Cd^{+2}, Fe^{+2}, Cr^{+3}, Zn^{+2}, H_2O