d) Spontaneous vs. Non-Spontaneous

i) Definitions:

When an oxidizing and reducing agent are mixed there are two possible outcomes:

Spontaneous - The reactants will spontanteously start to react in a redox reaction

Non-Spontaneous - The reactants will not react or will only react in reverse.

ii) Predicting – Method A

Overall **E°cell** is positive (+), reaction is spontaneous

Overall **E°cell** is negative (-) , reaction is non-spontaneous

iii) Example: Will a redox reaction proceed if Ni^{+2} is mixed with $Sn_{(s)}$?

$Ni^{+2} + Sn_{(s)} \rightarrow Ni_{(s)} + Sn^{+2}$

$Ni^{+2} + 2e^- \rightarrow Ni_{(s)}$ $\quad E° = -0.26$ V

$Sn_{(s)} \rightarrow Sn^{+2} + 2e^-$ $\quad E° = +0.14$ V

E°cell = -0.12 V **NO! Non- spontaneous**

iv) Example: Will Mg^{+2} undergo oxidation, reduction or no reaction?

$Mg^{+2} + 2e^- \rightarrow Mg_{(s)}$ $\quad E° = -2.37$ V … non-spontaneous

NO reaction!

v) Example: Will $Mg_{(s)}$ undergo oxidation, reduction or no reaction?

$Mg_{(s)} \rightarrow Mg^{+2} + 2e^-$ $\quad E° = +2.37$ V … spontaneous

Thus, $Mg_{(s)}$ will undergo oxidation.

vi) Example: Which of Fe^{+3}, Al^{+3}, $Cl_{2(g)}$, or Au^{+3} will best oxidize $Pb_{(s)}$?

Compare to $Pb_{(s)} \rightarrow Pb^{+2} + 2e^-$ $\quad E° = +0.13$ V

$Fe^{+3} + e^- \rightarrow Fe^{+2}$ $\quad E° = +0.77$ V

$Al^{+3} + 3e^- \rightarrow Al_{(s)}$ $\quad E° = -1.66$ V

$Cl_{2(g)} + 2e^- \rightarrow 2Cl^-$ $\quad E° = +1.36$ V

$Au^{+3} + 3e^- \rightarrow Au_{(s)}$ $\quad E° = +1.50$ V … best oxidizing agent

vii) Predicting – Method B

If oxidizing agent is higher in table than reducing agent – Spontaneous

If both species are oxidizing agents – Non-spontaneous

If both species are reducing agents – Non- spontaneous

If reducing agent is higher in table than oxidizing agent – Non-spontaneous

Do Questions: #7-18 page 199-200