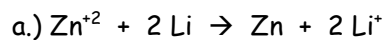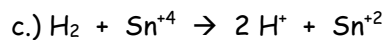# Oxidation Numbers and Spontaneity
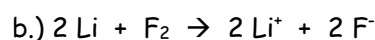
1.) In the following reactions, indicate which species are being oxidized and reduced, as well as label the oxidizing agent and the reducing agent.
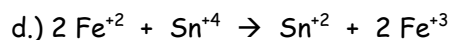
a.) $Zn^{+2} + 2\ Li \rightarrow Zn + 2\ Li^{+}$

Li oxidized and reducer, Zn^{+2} reduced and oxidizer

c.) $H_2 + Sn^{+4} \rightarrow 2\ H^{+} + Sn^{+2}$

H_2 oxidized and reducer, Sn^{+2} reduced and oxidizer

b.) $2\ Li + F_2 \rightarrow 2\ Li^{+} + 2\ F^{-}$

Li oxidized and reducer, F_2 reduced and oxidizer

d.) $2\ Fe^{+2} + Sn^{+4} \rightarrow Sn^{+2} + 2\ Fe^{+3}$

Fe^{+2} oxidized and reducer, Sn^{+2} reduced and oxidizer

2.) Calculate the oxidation number for **bold type** atom.

a.) $\mathbf{N}O_2^{-}$ +3

e.) $\mathbf{Al}(OH)_4^{-}$ +3

b.) $\mathbf{Cr}_2O_7^{-2}$ +6

f.) $\mathbf{N}_2O_3$ +3

c.) $\mathbf{N}_3^{-}$ $-\dfrac{1}{3}$

g.) $\mathbf{C}_3H_8$ $+\dfrac{8}{3}$

d.) $\mathbf{N}_2H_5^{+}$ -2

h.) $\mathbf{C}_2O_4^{-2}$ +3
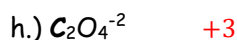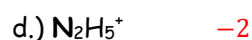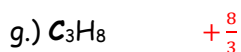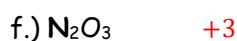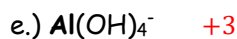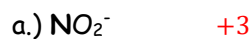
3.) Determine the oxidation number for the bold species for each reaction, and determine which species is being oxidized.

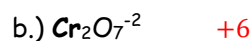a.) $\mathbf{Cl}O_2 + \mathbf{C} \rightarrow \mathbf{Cl}O_2^{-} + \mathbf{C}O_3^{-2}$

    +4   0   +3   +4   carbon ox

c.) $\mathbf{Mn}O_4^{-} + \mathbf{C}_2O_4^{-2} \rightarrow \mathbf{Mn}O_2 + \mathbf{C}O_2$

    +7   +3   +4   +4   carbon ox

b.) $\mathbf{Sn}^{+2} + \mathbf{Cl}^{-} + \mathbf{Br}O_3^{-} \rightarrow \mathbf{Sn}Cl_6^{-2} + \mathbf{Br}^{-}$

    +2   +5   +4   -1   tin ox

d.) $\mathbf{N}O_3^{-} + H_2\mathbf{Te} \rightarrow \mathbf{N}O + \mathbf{Te}O_4^{-2}$
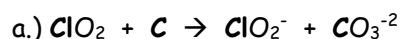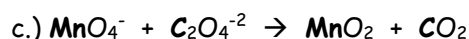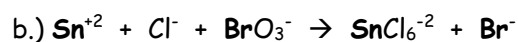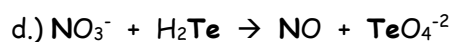
    +5   -2   +2   +6   tellurium ox

4a.) Which of Cl_2, ClO_4^{-}, Cl^{-}, ClO_3^{-}, or Cl_2O is the product when ClO_2^{-} is reduced? Cl_2, Cl^{-}, Cl_2O

b.) Which of NO_3^{-}, N_2, NO_2^{-}, N_2O, or N_2O_3 can be produced by the oxidation of NO? NO_3^{-}, NO_2^{-}, N_2O_3

5.) Which of the below chemicals can be oxidized, reduced, both or neither.

a.) $Se_{(s)}$ neither (needs H^{+})   b.) $Hg_{(l)}$ oxidized   c.) Sn^{+4} reduced

d.) Co^{+2} reduced   e.) I^{-} oxidized   f.) Fe^{+2} both   g.) $Cr_2O_7^{-2}$ (acidic)   reduced
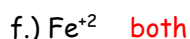
6.) Predict whether the following reactions will occur or not and write out the reaction if it occurs.

    a.) Zn^{+2} and $Li_{(s)}$ b.) $Ag_{(s)}$ and I^- c.) Sn^{+4} and $Au_{(s)}$ d.) Sn^{+2} and $Co_{(s)}$ e.) Al^{+3} and $Ni_{(s)}$

    a.) $Zn^{+2} + Li_{(s)} \rightarrow Zn + Li^+$ b.) No.   c.) No.   d.) $Sn^{+2} + Co_{(s)} \rightarrow Sn + Co^{+2}$ e.) No.

7.) Which of the reactants below will react, and if they will write the products.

    a.) $Zn_{(s)} + H_{2\,(g)}$ b.) $Mn_{(s)} + H^+$

      No, both want to be oxidized. $2\,H^+ + Mn_{(s)} \rightarrow H_2 + Mn^{+2}$

    c.) $Fe^{+2} + Cr_2O_7^{-2}$ (acidic)   d.) $MnO_{2\,(s)}$ and $H^+ + I^-$

      $6\,Fe^{+2} + Cr_2O_7^{-2} + 14\,H^+ \rightarrow 6\,Fe^{+3} + 2\,Cr^{+3} + 7\,H_2O$ $MnO_2 + 4\,H^+ + 2\,I^- \rightarrow Mn^{+2} + I_2 + 2\,H_2O$

8a.) Which of the following will act as an oxidizer when mixed with Co?   Cr, I_2, Al, and Fe^{+3} I_2, Fe^{+3}

    b.) Which of the following will act as a reducer when mixed with Ag^+? H_2, Cl_2, Hg^{+2}, and H_2O_2 H_2, H_2O_2

    c.) Which substance(s) can be oxidized by I_2 but not by acidic SO_4^{-2}?   Cu, S, and H_2SO_3

    d.) Which substance(s) can be reduced by I^- but not by Fe^{+2}? MnO_4^-, O_2 (acidified), and Fe^{+3}

9.) If an electrochemical cell is made by joining the two half reactions of $1\,M$ $Sn(NO_3)_2$ with a tin electrode and $1\,M$ $Fe(NO_3)_2$ with an iron electrode. Over time what happens to the Sn^{+2} and the Fe^{+2}?

   <u>Answer</u> – Sn^{2+} decreases (deposited on cathode as Sn), while Fe^{+2} increases (Fe dissolves into solution as

        Fe^{+2})

10.) Using the information given on the following four half-reactions, and knowing that F^{+2} reacts with $D_{(s)}$, $E_{(s)}$, and $G_{(s)}$, no reaction occurs between D^{+2} and any of the metals, and G^{+2} only reacts with $D_{(s)}$, arrange the four half-reactions in decreasing strength as oxidizing agents.

        $D^{+2} + 2\,e^- \leftrightarrow D_{(s)}$ weakest (4) $F^{+2} + 2\,e^- \leftrightarrow F_{(s)}$

        $E^{+2} + 2\,e^- \leftrightarrow E_{(s)}$ second (2) $E^{+2} + 2\,e^- \leftrightarrow E_{(s)}$

        $F^{+2} + 2\,e^- \leftrightarrow F_{(s)}$ strongest (1) $G^{+2} + 2\,e^- \leftrightarrow G_{(s)}$

        $G^{+2} + 2\,e^- \leftrightarrow G_{(s)}$ third (3) $D^{+2} + 2\,e^- \leftrightarrow D_{(s)}$