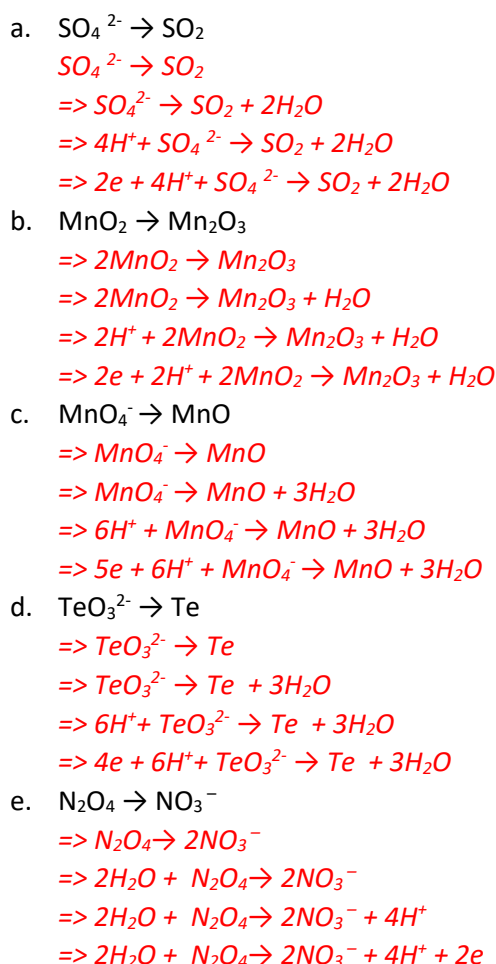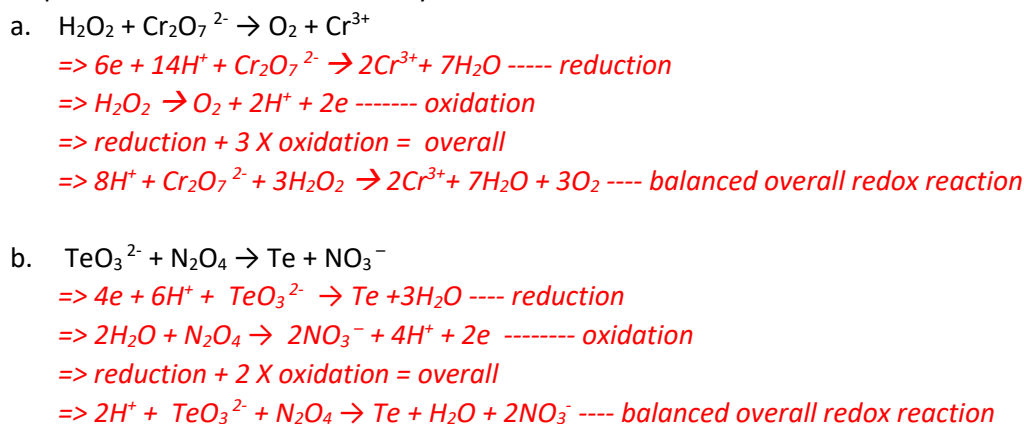Friday worksheet 2 – writing balanced redox half equations and overall equations.

1. Write the balanced half equations for the reactions below taking place in an acid solution. That means use H^+ when balancing for hydrogens. States not required

   a. $SO_4{}^{2-} \rightarrow SO_2$
      $SO_4{}^{2-} \rightarrow SO_2$
      => $SO_4{}^{2-} \rightarrow SO_2 + 2H_2O$
      => $4H^+ + SO_4{}^{2-} \rightarrow SO_2 + 2H_2O$
      => $2e + 4H^+ + SO_4{}^{2-} \rightarrow SO_2 + 2H_2O$

   b. $MnO_2 \rightarrow Mn_2O_3$
      => $2MnO_2 \rightarrow Mn_2O_3$
      => $2MnO_2 \rightarrow Mn_2O_3 + H_2O$
      => $2H^+ + 2MnO_2 \rightarrow Mn_2O_3 + H_2O$
      => $2e + 2H^+ + 2MnO_2 \rightarrow Mn_2O_3 + H_2O$

   c. $MnO_4{}^- \rightarrow MnO$
      => $MnO_4{}^- \rightarrow MnO$
      => $MnO_4{}^- \rightarrow MnO + 3H_2O$
      => $6H^+ + MnO_4{}^- \rightarrow MnO + 3H_2O$
      => $5e + 6H^+ + MnO_4{}^- \rightarrow MnO + 3H_2O$

   d. $TeO_3{}^{2-} \rightarrow Te$
      => $TeO_3{}^{2-} \rightarrow Te$
      => $TeO_3{}^{2-} \rightarrow Te + 3H_2O$
      => $6H^+ + TeO_3{}^{2-} \rightarrow Te + 3H_2O$
      => $4e + 6H^+ + TeO_3{}^{2-} \rightarrow Te + 3H_2O$

   e. $N_2O_4 \rightarrow NO_3{}^-$
      => $N_2O_4 \rightarrow 2NO_3{}^-$
      => $2H_2O + N_2O_4 \rightarrow 2NO_3{}^-$
      => $2H_2O + N_2O_4 \rightarrow 2NO_3{}^- + 4H^+$
      => $2H_2O + N_2O_4 \rightarrow 2NO_3{}^- + 4H^+ + 2e$

2. Balance the following **unbalanced** redox reactions taking place in acidic solutions, by first writing the balanced reduction and oxidation half equations and then the overall balanced equation by first adding the two half reactions and cancelling for electrons. States not required. The first one is done for you

   a. $H_2O_2 + Cr_2O_7{}^{2-} \rightarrow O_2 + Cr^{3+}$
      => $6e + 14H^+ + Cr_2O_7{}^{2-} \rightarrow 2Cr^{3+} + 7H_2O$ ----- reduction
      => $H_2O_2 \rightarrow O_2 + 2H^+ + 2e$ ------- oxidation
      => reduction + 3 X oxidation = overall
      => $8H^+ + Cr_2O_7{}^{2-} + 3H_2O_2 \rightarrow 2Cr^{3+} + 7H_2O + 3O_2$ ---- balanced overall redox reaction

   b. $TeO_3{}^{2-} + N_2O_4 \rightarrow Te + NO_3{}^-$
      => $4e + 6H^+ + TeO_3{}^{2-} \rightarrow Te + 3H_2O$ ---- reduction
      => $2H_2O + N_2O_4 \rightarrow 2NO_3{}^- + 4H^+ + 2e$ -------- oxidation
      => reduction + 2 X oxidation = overall
      => $2H^+ + TeO_3{}^{2-} + N_2O_4 \rightarrow Te + H_2O + 2NO_3{}^-$ ---- balanced overall redox reaction

c. $ReO_4^- + IO^- \rightarrow IO_3^- + Re$

=> $7e + 8H^+ + ReO_4^- + \rightarrow Re + 4H_2O$ ------- reduction
=> $2H_2O + IO^- \rightarrow IO_3^- + 4H^+ + 4e$ ------- oxidation
=> 4 X reduction + 7 X oxidation = overall
=> $4ReO_4^- + 4H^+ + 7IO^- \rightarrow 4Re + 7IO_3^- + 2H_2O$ ---- balanced overall redox reaction

d. $PbO_2 + I_2 \rightarrow Pb^{2+} + IO_3^-$

=> $PbO_2 + 4H^+ + 2e \rightarrow Pb^{2+} + 2H_2O$ ------- reduction
=> $6H_2O + I_2 \rightarrow 2IO_3^- + 12H^+ + 10e$ ------- oxidation
=> 5 X reduction + oxidation = overall
=> $5PbO_2 + 8H^+ + I_2 \rightarrow 5Pb^{2+} + 4H_2O + 2IO_3^-$ ---- balanced overall redox reaction

e. $As \rightarrow H_2AsO^{4-} + AsH_3$

In this As is acting as both an oxidant and as a reductant
=> $As + 4H_2O \rightarrow H_2AsO_4^{4-} + 6H^+ + 2e$ ------- oxidation
=> $As + 3H^+ + 3e \rightarrow AsH_3$ ------ reduction
=> 3 X oxidation + 2 X reduction = overall
=> $5As + 12H_2O \rightarrow 3H_2AsO_4^{4-} + 2AsH_3 + 12H^+$---- balanced overall redox reaction

3. For each of the balanced overall reactions you have given for question 2. above identify the oxidant and the reductant. Note- the oxidant takes part in the reduction reaction while the reductant takes part in the oxidation reaction. The first one is done for you.

a.   *$Cr_2O_7^{2-}$ ----- oxidant, H_2O_2 -----reductant*
b.   *TeO_3^{2-} ----- oxidant, N_2O_4 -----reductant*
c.   *ReO_4^- ----- oxidant, IO^- -----reductant*
d.   *PbO_2 ----- oxidant, I_2 -----reductant*
e.   *As ----- oxidant, As -----reductant*