Balancing Overall Equations from 1st Principles by Dissection WORKSHEET

1. Calculate the oxidation state/number of the underlined and bolded element in each of the following chemical species:

+4 $\underline{C}O_2$	+1 -1 $\underline{H}_2\underline{O}_2$	+7 $\underline{Mn}O_4^-$	+4 $\underline{S}O_2$	+5 $H\underline{Cl}O_3$	-1 $H\underline{Br}$
-1 $Na\underline{H}$	+2 $[\underline{Zn}(OH)_4]^{2-}$	-3 $\underline{N}H_3$	-2 $\underline{C}H_3OH$	4+ $H_2\underline{C}O_3$	5+ $\underline{N}O_3^-$
4+ $\underline{N}O_2$	3+ $\underline{Al}_2O_3$	6+ $Mg\underline{Cr}O_4$	-3 $\underline{N}H_4^+$	3- $\underline{C}_2H_6$	+6 $\underline{S}O_3$

2. Balance the following equation by establishing two half equations, balancing these by 1st principles, and combining them to give a fully balanced equation (show your intermediate equations):

+3
$C_2O_4^{2-}$

0 +1 -2
$C_6H_{12}O_6$

+1 +2 -3
HCN

(a) $H_2O_2 + NO \rightarrow NO_3^- + H_2O$

(b) $I_2 + H_2S \rightarrow I^- + S$

(c) $MnO_4^- + H_2C_2O_4 \rightarrow Mn^{2+} + CO_2$

(d) $Cu + SO_4^{2-} + H^+ \rightarrow Cu^{2+} + SO_2$

(e) $Cr_2O_7^{2-} + C_2H_5OH \rightarrow Cr^{3+} + CH_3CHO$

a) Reducción

$H_2O_2^{-1} \rightarrow H_2O^{-2}$

$2e^- + 2H^+ + H_2O_2 \rightarrow 2H_2O$

Oxidación

$\overset{+2}{N}O \rightarrow \overset{+5}{N}O_3^-$

$2H_2O + NO \rightarrow NO_3^- + 4H^+ + 3e^-$

So $3(2e^- + 2H^+ + H_2O_2 \rightarrow 2H_2O)$

$2(2H_2O + NO \rightarrow NO_3^- + 4H^+ + 3e^-)$

$6e^- + 6H^+ + 3H_2O_2 + 4H_2O + 2NO \rightarrow 6H_2O + 2NO_3^- + 8H^+ + 6e^-$

$3H_2O_2 + 2NO \rightarrow 2H_2O + 2NO_3^- + 2H^+$.

b) $I_2 \rightarrow I^-$

$I_2 + 2e^- \rightarrow 2I^-$

$\overset{-2}{H_2S} \rightarrow S^0$

$H_2S \rightarrow S + 2H^+ + 2e^-$

$2e^- + I_2 + H_2S \rightarrow 2I^- + S + 2H^+ + 2e^-$

$I_2 + H_2S \rightarrow 2I^- + S + 2H^+$

c) $MnO_4^- \rightarrow Mn^{2+}$

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

$\overset{+3}{H_2C_2O_4} \rightarrow \overset{+4}{CO_2}$

$5(H_2C_2O_4 \rightarrow 2CO_2 + 2H^+ + 2e^-$

$16H^+ + 2MnO_4^- + 5H_2C_2O_4 \rightarrow 2Mn^{2+} + 8H_2O + 10H^+ + 10CO_2$

$6H^+$

d) $\overset{6+}{SO_4^{2-}} \rightarrow \overset{+4}{SO_2}$

$2e^- + 4H^+ + SO_4^{2-} \rightarrow SO_2 + 2H_2O$

$Cu \rightarrow Cu^{2+}$

$Cu \rightarrow Cu^{2+} + 2e^-$

$4H^+ + SO_4^{2-} + Cu \rightarrow SO_2 + 2H_2O + Cu^{2+}$

e) $\overset{6+}{Cr_2O_7^{2-}} \rightarrow Cr^{3+}$

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

$\overset{-2}{C_2H_5OH} \rightarrow \overset{-1}{CH_3}\overset{-1}{CHO}$

$-4 \quad +5 \quad -2+1 \qquad +3 \quad +1 \quad -2$

$3(C_2H_5OH \rightarrow CH_3CHO + 2H^+ + 2e^-$

$6e^- + 14H^+ + Cr_2O_7^{2-} + 3C_2H_5OH \rightarrow 2Cr^{3+} + 7H_2O + 3CH_3CHO + 6H^+ + 6e^-$

$8H^+ + Cr_2O_7^{2-} + 3C_2H_5OH \rightarrow 2Cr^{3+} + 7H_2O + 3CH_3CHO$.