

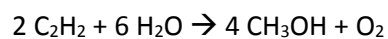
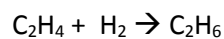
Electrochemistry

1. Consider the following reaction: $\text{FeSO}_4(\text{aq}) + \text{Al}(\text{s}) \rightarrow \text{Al}_2(\text{SO}_4)_3(\text{aq}) + \text{Fe}(\text{s})$
- Is this a redox reaction?
 - If so, write out the oxidation and reduction half reactions.
 - What is the oxidizing agent? How about the reducing agent?
 - Balance the reaction using the half reaction method.
 - Determine E^0 for each half reaction. Is this reaction spontaneous as written?
 - Sketch a galvanic cell composed of these reactants and products.
 - Using the standard shorthand method,
 - How many electrons are transferred from the reducing agent to the oxidizing agent?
 - Determine ΔG^0 for this reaction.
 - Determine ΔG at 25 °C if $[\text{FeSO}_4] = 250 \text{ mM}$ and $[\text{Al}_2(\text{SO}_4)_3] = 1 \text{ nM}$.

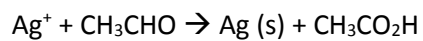
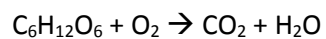
2. Determine the oxidation state of each atom in the following compounds:



3. Using only oxidation states, determine how many electrons are transferred from the reducing agent to the oxidizing agent.



4. Balance this reaction using the $\frac{1}{2}$ reaction approach.



Standard Reduction Potentials at 298K, 1M, 1atm

HALF-REACTION	E° (V)
$F_{2(g)} + 2 e^- \rightarrow 2 F^-_{(aq)}$	+2.87
$O_{3(g)} + 2 H^+_{(aq)} + 2 e^- \rightarrow O_{2(g)} + H_2O_{(l)}$	+2.07
$Co^{3+}_{(aq)} + e^- \rightarrow Co^{2+}_{(aq)}$	+1.82
$H_2O_{2(aq)} + 2 H^+_{(aq)} + 2 e^- \rightarrow 2 H_2O_{(l)}$	+1.77
$PbO_{2(s)} + 4 H^+_{(aq)} + SO_4^{2-}_{(aq)} + 2 e^- \rightarrow PbSO_{4(s)} + 2 H_2O_{(l)}$	+1.70
$Ce^{4+}_{(aq)} + e^- \rightarrow Ce^{3+}_{(aq)}$	+1.61
$MnO_4^-_{(aq)} + 8 H^+_{(aq)} + 5 e^- \rightarrow Mn^{2+}_{(aq)} + 4 H_2O_{(l)}$	+1.51
$Au^{3+}_{(aq)} + 3 e^- \rightarrow Au_{(s)}$	+1.50
$Cl_{2(g)} + 2 e^- \rightarrow 2 Cl^-_{(aq)}$	+1.36
$Cr_2O_7^{2-}_{(aq)} + 14 H^+_{(aq)} + 6 e^- \rightarrow 2 Cr^{3+}_{(aq)} + 7 H_2O_{(l)}$	+1.33
$MnO_{2(s)} + 4 H^+_{(aq)} + 2 e^- \rightarrow Mn^{2+}_{(aq)} + 2 H_2O_{(l)}$	+1.23
$O_{2(g)} + 4 H^+_{(aq)} + 4 e^- \rightarrow 2 H_2O_{(l)}$	+1.23
$Br_{2(l)} + 2 e^- \rightarrow 2 Br^-_{(aq)}$	+1.07
$NO_3^-_{(aq)} + 4 H^+_{(aq)} + 3 e^- \rightarrow NO_{(g)} + 2 H_2O_{(l)}$	+0.96
$2 Hg_2^{2+}_{(aq)} + 2 e^- \rightarrow Hg_{22}^{2+}_{(aq)}$	+0.92
$Hg_2^{2+} + 2 e^- \rightarrow 2 Hg_{(l)}$	+0.85
$Ag^+_{(aq)} + e^- \rightarrow Ag_{(s)}$	+0.80
$Fe^{3+}_{(aq)} + e^- \rightarrow Fe^{2+}_{(aq)}$	+0.77
$O_{2(g)} + 2 H^+_{(aq)} + 2 e^- \rightarrow H_2O_{2(aq)}$	+0.68
$MnO_4^-_{(aq)} + 2 H_2O_{(l)} + 3 e^- \rightarrow MnO_{2(s)} + 4 OH^-_{(aq)}$	+0.59
$I_{2(s)} + 2 e^- \rightarrow 2 I^-_{(aq)}$	+0.53
$O_{2(g)} + 2 H_2O + 4 e^- \rightarrow 4 OH^-_{(aq)}$	+0.40
$Cu^{2+}_{(aq)} + 2 e^- \rightarrow Cu_{(s)}$	+0.34
$AgCl_{(s)} + e^- \rightarrow Ag_{(s)} + Cl^-_{(aq)}$	+0.22
$SO_4^{2-}_{(aq)} + 4 H^+_{(aq)} + 2 e^- \rightarrow SO_{2(g)} + 2 H_2O_{(l)}$	+0.20
$Cu^{2+}_{(aq)} + e^- \rightarrow Cu^+_{(aq)}$	+0.15
$Sn^{4+}_{(aq)} + 2 e^- \rightarrow Sn^{2+}_{(aq)}$	+0.13
$2 H^+_{(aq)} + 2 e^- \rightarrow H_{2(g)}$	0.00
$Pb^{2+}_{(aq)} + 2 e^- \rightarrow Pb_{(s)}$	-0.13
$Sn^{2+}_{(aq)} + 2 e^- \rightarrow Sn_{(s)}$	-0.14
$Ni^{2+}_{(aq)} + 2 e^- \rightarrow Ni_{(s)}$	-0.25
$Co^{2+}_{(aq)} + 2 e^- \rightarrow Co_{(s)}$	-0.28
$PbSO_{4(s)} + 2 e^- \rightarrow Pb_{(s)} + SO_4^{2-}_{(aq)}$	-0.31
$Cd^{2+}_{(aq)} + 2 e^- \rightarrow Cd_{(s)}$	-0.40
$Fe^{2+}_{(aq)} + 2 e^- \rightarrow Fe_{(s)}$	-0.44
$Cr^{3+}_{(aq)} + 3 e^- \rightarrow Cr_{(s)}$	-0.74
$Zn^{2+}_{(aq)} + 2 e^- \rightarrow Zn_{(s)}$	-0.76
$2 H_2O_{(l)} + 2 e^- \rightarrow H_{2(g)} + 2 OH^-_{(aq)}$	-0.83
$Mn^{2+}_{(aq)} + 2 e^- \rightarrow Mn_{(s)}$	-1.18
$Al^{3+}_{(aq)} + 3 e^- \rightarrow Al_{(s)}$	-1.66
$Be^{2+}_{(aq)} + 2 e^- \rightarrow Be_{(s)}$	-1.85
$Mg^{2+}_{(aq)} + 2 e^- \rightarrow Mg_{(s)}$	-2.37
$Na^+_{(aq)} + e^- \rightarrow Na_{(s)}$	-2.71
$Ca^{2+}_{(aq)} + 2 e^- \rightarrow Ca_{(s)}$	-2.87
$Sr^{2+}_{(aq)} + 2 e^- \rightarrow Sr_{(s)}$	-2.89
$Ba^{2+}_{(aq)} + 2 e^- \rightarrow Ba_{(s)}$	-2.90
$K^+_{(aq)} + e^- \rightarrow K_{(s)}$	-2.93
$Li^+_{(aq)} + e^- \rightarrow Li_{(s)}$	-3.05