LECTURE 25

1. Determine the oxidation number of the underlined element in each of the following compounds or ions:

(a) $\underline{H}Cl$ **+1**
(b) $N\underline{H}_4^+$ **+1**
(c) $Na\underline{H}$ **-1**
(d) $NaAl\underline{H}_4$ **-1**
(e) $\underline{Fe}Cl_4^{2-}$ **+2**
(f) $\underline{I}Cl_3$ **+3**
(g) $\underline{S}O_4^{2-}$ **+6**
(h) $\underline{Cu}(OH)_2$ **+2**

2. Hydrogen peroxide (H_2O_2) is a harmful and reactive byproduct of metabolism. To prevent H_2O_2 from causing oxidative damage to cells, the enzyme catalase catalyzes the conversion of H_2O_2 to much less reactive molecules, oxygen and water.

$$2H_2O_2 \rightarrow 2H_2O + O_2$$

Using oxidation numbers, determine if H_2O_2 is reduced and/or oxidized in this reaction.

H_2O_2 is both reduced and oxidized

3. Using half-reactions, balance the following equations in **acidic** solution. Determine which atom or compound is the oxidizing agent and which is the reducing agent in each reaction.

(a) $Cr_2O_7^{-2}\ (aq) + C_2H_6O\ (aq) \rightarrow Cr^{+3}\ (aq) + C_2H_4O\ (aq)$
$Cr_2O_7^{-2}\ (aq) + 6\ e^- + 14\ H_3O^+\ (aq) \rightarrow 2\ Cr^{+3}\ (aq) + 21\ H_2O\ (aq)$
$C_2H_6O\ (aq) + 2\ H_2O\ (l) \rightarrow C_2H_4O\ (aq) + 2\ e^- + 2\ H_3O^+\ (aq)$
$Cr_2O_7^{-2}\ (aq) + 3\ C_2H_6O\ (aq) + 8\ H_3O^+\ (aq) \rightarrow 2\ Cr^{+3}\ (aq) + 3\ C_2H_4O\ (aq) + 15\ H_2O\ (l)$
$Cr_2O_7^{-2}\ (aq)$ is the oxidizing agent, $C_2H_6O\ (l)$ is the reducing agent

(b) $MnO_4^-\ (aq) + H_2O_2\ (aq) \rightarrow Mn^{2+}\ (aq) + O_2\ (g)$
$MnO_4^-\ (aq) + 5\ e^- + 8\ H_3O^+\ (aq) \rightarrow Mn^{2+}\ (aq) + 12\ H_2O\ (l)$
$H_2O_2\ (aq) + 2\ H_2O\ (l) \rightarrow O_2\ (g) + 2\ e^- + 2\ H_3O^+\ (aq)$
$2\ MnO_4^-\ (aq) + 5\ H_2O_2\ (aq) + 6\ H_3O^+\ (aq) \rightarrow 2\ Mn^{2+}\ (aq) + 5\ O_2\ (g) + 14\ H_2O\ (l)$
$MnO_4^-\ (aq)$ is the oxidizing agent, $H_2O_2\ (aq)$ is the reducing agent

4. Using half-reactions, balance the following equations in **basic** solution. Determine which atom or compound is the oxidizing agent and which is the reducing agent in each reaction.

(a) $CO_2\ (g) + F_2\ (g) \rightarrow FO_3^-\ (aq) + C_2O_4^{-2}\ (aq)$
$2\ CO_2\ (g) + 2\ e^- \rightarrow C_2O_4^{-2}\ (aq)$
$F_2\ (g) + 12\ OH^-\ (aq) \rightarrow 2\ FO_3^-\ (aq) + 10\ e^- + 6\ H_2O\ (l)$
$10\ CO_2\ (g) + F_2\ (g) + 12\ OH^-\ (aq) \rightarrow 5\ C_2O_4^{-2}\ (aq) + 2\ FO_3^-\ (aq) + 6\ H_2O\ (l)$

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CO_2 *(g)* is the oxidizing agent, F_2 *(g)* is the reducing agent

(b) $Cr(OH)_3$ *(aq)* + Br_2 *(l)* → CrO_4^{-2} *(aq)* + Br^- *(aq)*
$Cr(OH)_3$ *(aq)* + 5 OH^- *(aq)* → CrO_4^{-2} *(aq)* + 3 e^- + 4 H_2O *(l)*
Br_2 *(l)* + 2 e^- → 2 Br^- *(aq)*
2 $Cr(OH)_3$ *(aq)* + 3 Br_2 *(l)* + 10 OH^- *(aq)* → 2 CrO_4^{-2} *(aq)* + 6 Br^- *(aq)* + 8 H_2O *(l)*
Br_2 *(l)* is the oxidizing agent, $Cr(OH)_3$ *(aq)* is the reducing agent

5. In some alkaline batteries, a solid zinc electrode in a basic solution is oxidized to ZnO while solid manganese (IV) oxide is reduced to solid manganese (III) oxide.

(a) Write the half-reactions for both the anode and cathode of the cell, as well as the overall reaction.

(b) Calculate the mass in kg of ZnO(s) formed if 1.0 x 10^4 A are passed through the cell for 12 hours.

(a) Anode: Zn *(s)* + $2OH^-$ *(aq)* → ZnO *(s)* + H_2O *(l)* + $2e^-$
Cathode: $2MnO_2$ *(s)* + H_2O *(l)* + $2e^-$ → Mn_2O_3 *(s)* + $2OH^-$ *(aq)*
Overall: Zn *(s)* + $2MnO_2$ *(s)* → ZnO *(s)* + Mn_2O_3 *(s)*
(b) 180 kg

6. A jeweler is investigating a novel method for electroplating tungsten onto base metal. The jeweler passes a 30.0 A current through a solution for 1.00 hours and 100. g of tungsten is deposited on the ring. What is the oxidation number of tungsten in the solution?

2, W^{2+}

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