Chap. 21: Selected Problems

(33)

(a) $Al(s) + Cr^{3+}(aq) \rightarrow Al^{3+}(aq) + Cr(s)$

The two half rxns are

oxidation: $Al \rightleftarrows Al^{3+} + 3e^-$ ← ANODE ½ RXN

reduction: $Cr^{3+} + 3e^- \rightleftarrows Cr(s)$ ← CATHODE ½ RXN

Cell: $Al / Al^{3+}(aq) // Cr^{3+}(aq) / Cr$

$E^\circ_{cell} = E^\circ_{cath} - E^\circ_{an} = E^\circ_{Cr^{3+}/Cr} - E^\circ_{Al^{3+}/Al}$

$= -0.74V - (-1.66V) =$ **+0.92V**

(b) $Cu^{2+}(aq) + SO_2(s) + 2H_2O(l) \rightarrow Cu(s) + SO_4^{2-} + 4H^+(aq)$

oxidation $SO_2 + 2H_2O \rightarrow SO_4^{2-} + 4H^+ + 2e^-$ ← ANODE ½ RXN

reduction $Cu^{2+} + 2e^- \rightarrow Cu$ ← CATHODE ½ RXN

Cell: $Pt / SO_2(g); H_2SO_4(aq) // Cu^{2+}(aq) / Cu$

Since there is no metal in the anode ½ rxn have to use an inert metal as an electrode. Pt (platinum) is a common choice. The $H_2SO_4(aq)$ comes from the need to supply H^+'s and SO_4^{2-} for the ½ rxn equilibria

$E^\circ_{cell} = E^\circ_{cath} - E^\circ_{an} = E^\circ_{Cu^{2+}/Cu} - E^\circ_{SO_4^{2-}/SO_2}$

$= +0.34V - +0.20V =$ **+0.14V**

Chap. 21 : Selected Problems

(34)

(a) $Mn \mid Mn^{2+}(aq) \,||\, Cd^{2+}(aq) \mid Cd$

ANODE - ox. 1/2 rxn

CATHODE - red. 1/2 rxn

oxidation: $Mn \rightarrow Mn^{2+} + 2e^-$

reduction: $Cd^{2+} + 2e \rightarrow Cd$

$$Mn + Cd^{2+} \rightarrow Mn^{2+} + Cd$$

$E^\circ_{cell} = E^\circ_{CAT} - E^\circ_{AN} = E^\circ_{Cd^{2+}/Cd} - E^\circ_{Mn^{2+}/Me}$

$= -0.40V - (-1.18V) =$ **+0.78V**

(b) $Fe \mid Fe^{2+}(aq) \,||\, NO_3^-(aq) \mid NO(g) \mid Pt$

ANODE - ox 1/2 rxn

CATHODE - red 1/2 rxn

Pt again acts as an inert electrode - not involved in rxn

oxidation: $Fe \rightarrow Fe^{2+} + 2e^-$

reduction: $\overset{+5}{N}O_3^- \rightarrow \overset{+2}{N}O$ (unbalanced)

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

×3 → $3Fe \rightarrow 3Fe^{2+} + 6e^-$

×2 → $2NO_3^- + 8H^+ + 6e^- \rightarrow 2NO + 4H_2O$

$$3Fe + 2NO_3^- + 8H^+ \rightarrow 3Fe^{2+} + 2NO + 4H_2O$$

$E^\circ_{cell} = E^\circ_{NO_3^-/NO} - E^\circ_{Fe^{2+}/Fe} = 0.96 - (-0.44)$

$=$ **1.40 V**