Thermochem Review

① $Q = mc\Delta t$

$Q = 7.35g \times 4.19 J/g^\circ C \times (98 - 21)$

$Q = 2371.33 J = 2.371 kJ$

② $Q = (237g)(4.19 J/g^\circ C)(37 - 4)$

$Q = 32769.99 = 32.77 kJ$

③ $\Delta H = nHm$

$\Delta H = 2.50g \times$

} omit - too difficult. Also don't know heat capacity of Hg in

④ $m_{Pb} c \Delta t = mc\Delta t_{H_2O}$

$1000g \times 0.160 J/g^\circ C \times (35.2 - 100) = -m(4.19 J/g^\circ C) \times (35.2 - 26.5)$

$m = 284.42 g$

⑤ $mc\Delta t = -mc\Delta t$

$(1.0g)(0.385 J/g^\circ C)\Delta t = (50.0g)(4.19 J/g^\circ C)\Delta t$

$(0.385 J/^\circ C)\Delta t = (209.5 J/^\circ C)\Delta t$

$(0.385 J/^\circ C)(t_f - 100^\circ C) = -(209.5 J/^\circ C)(t_f - 26.5^\circ C)$

$0.385 t_f - 38.5 J = -209.5 J/^\circ C\, t_f + 5551.75$

$0.385 t_f + 209.5 t_f = 5590.25 J$

$209.885 t_f = 5590.25$

$t_f = 26.6348^\circ C$

⑥ $C_8H_8O_3$

$nHm = -mc\Delta t$

$\left(1.013g \times \frac{1 mol}{152.16 g}\right) Hm = -(1.17 kg)\left(4.19 \frac{kJ}{kg^\circ C}\right)(30.09^\circ C - 24.89^\circ C)$

$Hm = -3829.0786 kJ/mol$

⑦ $nHm = -mc\Delta t$

$\left(1.176g \times \frac{1 mol}{122.12 g}\right)\left(-3226 \frac{kJ}{mol}\right) = -(1kg)\, C\, (4.96^\circ C)$

$C = 6.26 kJ/kg^\circ C$

(8) $AgNO_3 + NaCl \rightarrow NaNO_3 + AgCl$

100mL 100mL

1M 1M

* no need to calc limiting reagent b/c they are the same

$nH_m = -mc\Delta t$

$\left(\frac{1\,mol}{L} \times 1L\right) H_m = -(200g)\left(\frac{4.19\,J}{g\,°C}\right)(30.2 - 22.4°C)$

$H_m = -6536.4\,J/mol = -6.5364\,kJ/mol$

(9) $HCl + NaOH \rightarrow NaCl + H_2O$

100mL 50mL

1.02M 1.988M

* NaOH is L.R.

$*g\,H_2O$ from HCl $= \frac{1.02\,mol}{L} \times 0.10L \times \frac{1\,H_2O}{1\,HCl} \times \frac{18.02g}{1mol} = 1.838\,g$

$*g\,H_2O$ from NaOH $= \frac{1.988\,mol}{L} \times 0.050\,L \times \frac{1\,H_2O}{1\,NaOH} \times \frac{18.02g}{1mol} = 1.791$

$mc\Delta t = -mc\Delta t$

$nH_m = -mc\Delta t$

$\left(\frac{1.988\,mol}{L} \times 0.050\,L\right) H_m = -(0.150\,kg)\left(\frac{4.19\,kJ}{kg\,°C}\right)(33.69 - 24.52)$

$H_m = -57.98\,kJ/mol$

(10) $C_{12}H_{22}O_{11} + O_2 \rightarrow 12CO_2 + 11H_2O$

$-2226.1 \quad \emptyset \quad -393.5 \quad -241.8$

$\Delta H_{rxn} = (11 \times -241.8 * 12 \times -393.5) - (-2226.1)$

$\Delta H_{rxn} = -5155.7\,kJ/mol$

$\Delta H = nH_m$

$\Delta H = (1.0 \times 10^3\,kJ) = n(-5155.7\,kJ/mol)$

$n = 0.19396\,mol \times 342.34\,g/mol = 66.400\,g$ Sucrose

(11) $HCl + NaOH \rightarrow NaCl + H_2O(l)$

$-92.3 \quad -425.8 \quad -127 \quad -285.8$

$\Delta H = (-285.8 + -127) - (-92.3 + -425.8)$

$\Delta H = 105.3 \text{ kJ/mol}$

$\Delta H = Q = nHm$

$\Delta H = \left(0.1045 \frac{\text{mol}}{\text{L}} \times 0.025 \text{ L}\right)\left(105.3 \frac{\text{kJ}}{\text{mol}}\right)$

$\Delta H = 0.275 \text{ kJ}$

(12) $6C + \frac{13}{2}N_2 + 1O_2 + \frac{1}{2}N_2 \rightarrow C_6H_{13}O_2N + 637.3 \text{ kJ}$

$12C + 13N_2 + 2O_2 + 1N_2 \rightarrow 2C_6H_{13}O_2N + 1274.6 \text{ kJ}$

(13) $\underset{-103.8}{C_3H_8} + \underset{\emptyset}{5O_2} \rightarrow \underset{-393.5}{3CO_2} + \underset{-241.8}{4H_2O(g)} + 2043.9 \text{ kJ}$

$\underset{-125.7}{C_4H_{10}} + \underset{\emptyset}{\frac{13}{2}O_2} \rightarrow \underset{-393.5}{4CO_2} + \underset{-241.8}{5H_2O(g)} + 2657.3 \text{ kJ}$

$\Delta Hrxn = \Sigma(nH)_p - \Sigma(nH)_R$

(14) $2C_6H_6 + 15O_2 \rightarrow 12CO_2 + 6H_2O + 6535 \text{ kJ}$

$\Delta Hrxn = \Sigma(nH)_p - \Sigma(nH)_R$

$\Sigma(nH)_R = (12 \times -393.5 + 6 \times -285.8) - (-6535)$

$2 \text{ mol } C_6H_6 \quad Hm = 98.2 \text{ kJ}$

$Hm = 49.1 \text{ kJ/mol}$

(15) $\underset{-641.3}{1MgCl_2} + \underset{-425.8}{2NaOH} \rightarrow \underset{-411.2}{2NaCl} + \underset{-924.5}{1Mg(OH)_2}$

$\Delta Hrxn = -254 \text{ kJ}$

(16) $C_3H_4 + 2H_2 \rightarrow C_3H_8$

$2H_2 + \frac{2}{2}O_2 \rightarrow 2H_2O(l)$ $\Delta H = -285.8 \times 2$

$C_3H_4 + 4O_2 \rightarrow 3CO_2 + 2H_2O(l)$ $\Delta H = -1937\ kJ$

$3CO_2 + 4H_2O \rightarrow 5O_2 + C_3H_8$ $\Delta H = +2219.1\ kJ$

$\Delta H_{rxn} = -289.5\ kJ$

Electrochem Review

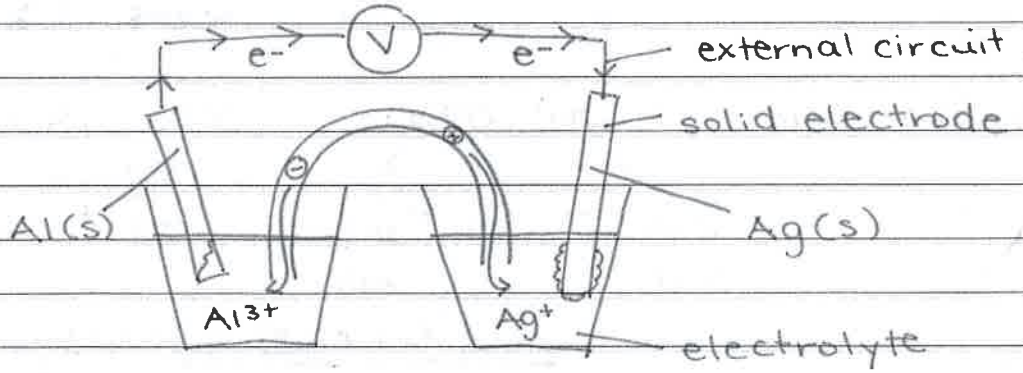
(1) Sc / Ag cell $Sc\,|\,Sc^{3+}\,||\,Ag^+\,|\,Ag$

$(Ag^+ + 1e^- \rightarrow Ag(s)) \times 3$

$Sc \rightarrow Sc^{3+} + 3e^-$

$3Ag^+(aq) + Sc \rightarrow 3Ag + Sc^{3+}$

(2)



Anode (−) $Al(s) \rightarrow Al^{3+} + 3e^-$ OXIDATION

Cathode (+) $Ag^+ + 1e^- \rightarrow Ag(s)$ REDUCTION

(3) Fe^{2+}, Cl^-, $Cl_2(g)$

Fe^{2+} ↑ SRA; Cl_2 ↑ SOA

$E°cell = +1.36 - 0.77 = 0.59\ V$

④ $KI(aq)$

$K^+ \quad I^- \quad H_2O$

OA SRA SOA RA

$2H_2O + 2e^- \rightarrow H_2 + 2OH^-$

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

$2H_2O + 2I^- \rightarrow I_2 + H_2 + 2OH^-$

$\Delta E°cell = -0.83 - 0.54$

$= -1.37\ V.$

⑤ $AgNO_3(aq) + Ag(s)$ Silver plated platinum.

$Ag(s) + Ag^+ \rightarrow Ag^+ + Ag(s) \quad E°cell = 0.00V.$

⑥ $ne = \frac{It}{F}$

$Cu^{2+} + 2e^- \rightarrow Cu(s)$

$\#mol\ e^- = 12.39\ g\ Cu \times \frac{1\ mol}{63.55\ g} \times \frac{2e^-}{1\ Cu} = 0.387\ mol\ e^-$

$I = \frac{ne\,F}{t}$

$I = \frac{(0.387\ moles\ e^-)(9.65 \times 10^4)}{(19800s)}$

$I = 1.886\ A$

⑦ $PV = nRT$

$n = \frac{PV}{RT}$

$CuSO_4(aq)$

$Cu^{2+} \quad SO_4^{2-} \quad H_2O$

SOA SRA

$2H_2O \rightarrow O_2 + 4H^+ + 4e^-$

$n = \frac{(738\ mmHg)(2.62\ L)}{(62.364\ \frac{L\,mmHg}{mol\,K})(299.35\ K)}$

$n = 0.10357\ mols\ O_2 \times \frac{4e^-}{1\ O_2} = 0.41429\ moles\ e^-$

$ne = \frac{It}{F} \qquad t = \frac{ne\,F}{I} \qquad t = \frac{(0.414)(9.65 \times 10^4)}{2.13\ A}$

$t = 18769.47517\ s = 5.214\ hrs$

⑧ a) $CuSO_4(aq) + Fe(s)$

Oxidation SRA $Fe(s) \rightarrow Fe^{2+} + 2e^-$ $E°cell = 0.34 - (-0.45)$

Reduction SOA $Cu^{2+} + 2e^- \rightarrow Cu(s)$ $= 0.79V$

$Fe(s) + Cu^{2+} \rightarrow Fe^{2+} + Cu$ SPONT!

b) $NaBr + Cl_2$

Reduction SOA $Cl_2 + 2e^- \rightarrow 2Cl^-$

Oxidation SRA $2Br^- \longrightarrow Br_2 + 2e^-$ SPONT!

$Cl_2 + 2Br^- \rightarrow Br_2 + 2Cl^-$ $E°cell = 1.36 - 1.07$

$= 0.29V$

c) $NaCl + Br_2$

Reduction SOA $Br_2 + 2e^- \rightarrow 2Br^-$ NON SPONT!

Oxidation SRA $2Cl^- \longrightarrow Cl_2 + 2e^-$ * chloride anomoly *

$Br_2 + 2Cl^- \rightarrow Cl_2 + 2Br^-$ $Ecell = 1.07 - 1.36$

$= -0.29V$

d) $Fe_2(SO_4)_3 + Al$

Reduction SOA $(Fe^{3+} + 1e^- \rightarrow Fe^{2+}) \times 3$ $E°cell = 0.77V - (-1.66)$

Oxidation SRA $Al \longrightarrow Al^{3+} + 3e^-$ $= 2.43V$

$3Fe^{3+} + 1Al \rightarrow 3Fe^{2+} + Al^{3+}$ SPONT!

⑨ $Fe(s) + H_2O + O_2$ (regular corrosion)

SRA $Fe(s) \rightarrow Fe^{2+} + 2e^-$

SOA $O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$

$2Fe(s) + O_2 + 2H_2O \rightarrow 2Fe^{2+} + 4OH^-$

$E°cell = 0.40V - (-0.45) = 0.85V$

$Fe(s) + H^+ + O_2$ (acid rain)

SRA $Fe(s) \rightarrow Fe^{2+} + 2e^-$

SOA $O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$

$2Fe(s) + O_2 + 4H^+ \rightarrow 2Fe^{2+} + 2H_2O$

$E°cell = 1.23V - 0.45 = 1.68V$

Acid Rain ↑ spontaneity of rust.

Sacrificial Anode - Oxidizes instead

Galvanization - Coats and is stronger R.A.

Painting - Coats metal so $O_2 + H_2O + H^+$ can't get at it

Alloys (ie// stainless steel)