Classroom Activity Chapter 18 Number 1 29 March 2017

1. Balance the following oxidation-reduction (redox) reactions using the smallest whole number coefficients. All ionics are aqueous and acidic.

$8H^+ + 2NO_3^- + 3Cu(s) \rightarrow 2NO(g) + 3Cu^{2+} + 4H_2O$

+5 -2 0 +2 -2 +2

3e⁻ red 2e⁻ ox LCM=6

8+ 2- 6+ 6+

$14H^+ + Cr_2O_7^{2-} + 6Cl^- \rightarrow 2Cr^{3+} + 3Cl_2(g) + 7H_2O$

+6 -1 +3 0

3e red per Cr 1e⁻ oxid per Cl

6e sub tot 2e sub tot LCM=6

14+, 2-, 6- 6+ 6+

$3H_2O + 3S_2O_3^{2-} + 4IO_3^- \rightarrow 6SO_4^{2-} + 4I^- + 6H^+$

+2 -2 +5 -2 +6 -2 -1

4e⁻ ox per S 6e⁻ red LCM=24

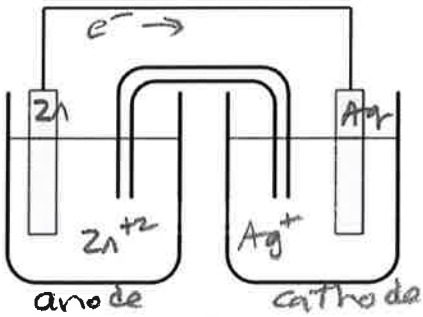
8e⁻ tot

6- 4- ⇒ 10- 12- 4- 6+ ⇒ 10-

0 | 0
9 | 24
12
21

2a. Sketch labels on the Galvanic cell shown below, with the zinc anode on the left. Labels should include all four constituents of the reaction. Indicate electron flow with an arrow.

$Ag^+(aq) + Zn(s) \rightarrow Ag(s) + Zn^{2+}(aq)$ (unbalanced)



2b. As the reaction proceeds, do you expect...

i. the mass of the anode electrode to increase? No

ii. the mass of the cathode electrode to increase? Yes

iii. $[Ag^+]$ to increase or decrease? No

iv. $[Zn^{2+}]$ to increase or decrease? Yes

2c. Does oxidation occurs at the anode or cathode?

2d. Balancing the reaction.

$2Ag^+ + Zn \rightarrow 2Ag + Zn^{+2}$

2e. Write the reaction in cell notation shorthand.

$Zn | Zn^{+2} || Ag^+ | Ag$

2f. Suppose the mass of the silver electrode was 2.00 g and the zinc electrode was 3.00 g and both solutions were initially 250 mL 1.00 M. After some time, the mass of the zinc electrode was found to be 1.20 g. What is the estimated mass of the silver electrode? What is $[Ag^+]$? What is $[Zn^{2+}]$?

Zn 65,38

$\Delta m_{Zn} = 3,00 - 1,20 = 1,80g$

$\Rightarrow 0,0275 mol\ Zn \Omega 0,055 mol\ Ag$

$2Ag^+ + Zn \rightarrow 2Ag + Zn^{+2}$

$0,0551 mol\ Ag * 107,9 = 5,94 g\ Ag$

$+ 2,00$

$7,94 g\ Ag$

$n = MV$

$[Ag^+] = \frac{0,25 mol - 0,0551 mol}{0,250 L} = 0,78 mol/L$

$[Zn^{+2}] = \frac{0,25 mol + 0,0275}{0,25} = 1,11 M$

Questions in final exam format:

3. Based on the balanced chemical equation shown below, determine the molarity of a solution containing Fe^{2+}, if 40.00 mL of the Fe^{2+} solution is required to completely react with 30.00 mL of a 0.125 M potassium bromate, $KBrO_3$, solution.

$6 Fe^{2+} + BrO_3^- + 6 H^+ \rightarrow 6 Fe^{3+} + Br^- + 3 H_2O$

A. 0.0156 M B. 0.0938 M

C. 0.562 M D. 1.00 M

$n = MV$

$= ,125 * ,030$

$= 0,00375 mol$

$\Rightarrow 2,25 \times 10^{-2} mol\ Fe^{+2}$

4. During an electrochemical reaction, electrons move through the external circuit toward the ____ and positive ions in the cell move toward the ____.

A. anode, anode B. anode, cathode

C. cathode, anode D. cathode, cathode

6

$n = MV$

$2,25 \times 10^{-2} = M * 0,04$

5. What is the shorthand notation that represents the following galvanic cell reaction?

$Fe(s) + Cu(NO_3)_2(aq) \rightarrow Fe(NO_3)_2(aq) + Cu(s)$

A. $Fe(s) | Fe^{2+}(aq) || Cu^{2+}(aq) | Cu(s)$

B. $Cu(s) | Cu^{2+}(aq) || Fe^{2+}(aq) | Fe(s)$

C. $Fe(s) | NO_3^-(aq) || NO_3^-(aq) | Cu(s)$

D. $Cu(s) | Cu(NO_3)_2(aq) || Fe(NO_3)_2(aq) | Fe(s)$

Classroom Activity Chapter 18 Number 2 — 31 March 2017

1. Balance the following redox reaction in basic solution.

$2\,P(s) + 5\,SO_4^{2-} \rightarrow 2\,PO_4^{3-} + 5\,SO_3^{2-} + 6\,H^+$

$+3H_2O$

Now add one OH^- for every H^+:

$3H_2O + 2P + 5SO_3^{2-} + 6OH^- \rightarrow 2PO_4^{3-} + 5SO_3^{2-} + 6H_2O$

2. Consider the reaction:

Cd(s) | Cd^{2+}(aq) || Ni^{2+}(aq) | Ni(s)

2a. Write the half reaction for the anode and look up its E^o value.

$Cd \rightarrow Cd^{+2} + 2e^-$ $\quad E^\circ = +0,40$ V

2b. Write the half reaction for the cathode and look up its E^o value.

$Ni^{+2} + 2e \rightarrow Ni$ $\quad E^\circ = -0,26$ V

2c. Combine the two half reactions and determine the E^o value for the galvanic reaction.

$Cd + Ni^{+2} \rightarrow Cd^{+2} + Ni$ $\quad E^\circ = +0,14$ V

2d. Calculate ΔG^o_{rxn}

$\Delta G^\circ = -n F E^\circ$

$= -2 * 96,500 * (0,14)$

$= -27$ kJ

2e. Calculate E for

Cd(s) | Cd^{2+}(0.10 M) || Ni^{2+}(0.50 M) | Ni(s) $\quad n=2$

$E = E^\circ - \frac{0,0592}{n} \log Q$

$= 0,14 - \frac{0,0592}{2} \log \frac{(Cd^{+2})}{(Ni^{+2})}$ $\quad 0,10 / 0,50$

$= 0,12$ V

2g. Calculate ΔG under these conditions.

$\Delta G = -n F E$

$= -2 \cdot 96,5 \cdot 0,12$

$= -23$ kJ

2g. Calculate K_c from E^o and then from ΔG^o

$E^\circ = \frac{0,0592}{n} \log K$

$K_c = 5,4 \times 10^4$

$\Delta G^\circ = -RT \ln K$

$-27 = -0,008314 \cdot 298 \cdot \ln K$ $\quad K = 5,4 \times 10^4$

Questions in final exam format:

3. In a galvanic cell Pb(s) | Pb^{+2}(aq) || Ag^+ | Ag(s), which electrode will gain mass?

A. the anode, Pb(s) B. the cathode, Pb(s)
C. the anode, Ag(s) (D.) the cathode, Ag(s)

4. The standard cell potential for the dry cell battery (such as a AA or AAA, etc.) is 1.56 V. What is the standard free energy change for this cell?

$Zn(s) + 2\,MnO_2(s) + 2\,NH_4^+ \rightarrow 2\,NH_3 + Mn_2O_3(s) + Zn^{2+} + H_2O(l)$

A. +151 kJ B. -151 kJ $\quad \Delta G = -n F E$
(C.) -301 kJ D. -602 kJ

5. Doubling all the coefficients in the equation for the cell reaction…

A: doubles both E° and ΔG°.
B. doubles E°, but does not change ΔG°.
(C.) doubles ΔG°, but does not change E°.
D. does not change E° or ΔG°.

6. The standard potential for the following galvanic cell is +0.90 V:

$3\,Cu^{2+} + 2\,Ga(s) \rightleftharpoons 3\,Cu(s) + 2\,Ga^{3+}$

Given that the standard reduction potential for the Cu^{2+}/Cu half-cell is +0.34 V, what is the standard reduction potential for the Ga^{3+}/Ga half-cell?

A. -1.34 V (B.) 0.56 V
C. +0.56 V D) +1.36 V

Red ,34
Ox 0,56
Tot ,90

7. A galvanic cell consists of these half-cells. What is formed at the cathode and anode, respectively?

$Ag^+(aq) + e^- \rightarrow Ag(s)$ $\quad E^\circ = +0.80$ V cathode
$Cu^{2+}(aq) + 2\,e^- \rightarrow Cu(s)$ $\quad E^\circ = +0.34$ V anode

A. Ag(s) and Cu(s)
(B.) Ag(s) and Cu^{2+}
C. Cu(s) and Ag^+(aq)
D. Cu^{2+}(aq) and Cu(s)

$Cu \rightarrow Cu^{+2}$