Name: KEY
Mod:_______ Date:__________

Chemistry II Practice Test
Electrochemistry – Chapter 17

Key Vocabulary

Anode –
Cathode –
concentration cell –
electrolytic cell –
galvanic cell –
ion-selective electrode –
oxidation –
reduction –
potential difference –
salt bridge –
work –
electromotive force (emf) –
Coulomb –
Faraday –
Electroplating –
Amperes –

1. Calculate the cell potential of a standardized galvanic cell with the two half reactions shown here. Also, write the line notation and the balanced redox equation. Finally, calculate the theoretical maximum work of this cell and the actual work if the cell is 65% efficient.

$(PbO_2 + 4H^+ + 2e^- \rightarrow Pb^{2+} + 2H_2O) \times -1$ $\mathcal{E}^\circ = 1.46$

$(Co^{3+} + e^- \rightarrow Co^{2+}) \times 2$ $\mathcal{E}^\circ = 1.82$

$Pb^{2+} + 2H_2O \rightarrow PbO_2 + 4H^+ + 2e^-$

$2Co^{3+} + 2e^- \rightarrow 2Co^{2+}$

$\mathcal{E}^\circ_{cell} = 0.36V$

$Pb^{2+} + 2H_2O + 2Co^{3+} \rightarrow PbO_2 + 4H^+ + 2Co^{2+}$ eqn.

$Pt | Pb^{2+}, PbO_2, H^+ || Co^{3+}, Co^{2+} | Pt$

$-W = q\mathcal{E}^\circ = nF\mathcal{E} = (2\ mole)(96485\ C/mole)(0.36\ J/C)$

$W_{max} = -69469.2\ J$ $W_{act} = 0.65(-69469.2\ J) = 45154.98\ J$

$W_{max} = -69\ kJ$ $W_{act} = -45\ kJ$

2. Calculate the cell potential of a standardized galvanic cell with the two half reactions shown here. Also, write the line notation and the balanced redox equation. Finally, calculate the theoretical maximum work of this cell and the actual work if the cell is 42% efficient. $3Co^{3+} + NO + 2H_2O \rightarrow 3Co^{2+} + NO_3^- + 4H^+$

$-1\,(NO_3^- + 4H^+ + 3e^- \rightarrow NO + 2H_2O)$ $\mathcal{E}^\circ = 0.96$

$3\,(Co^{3+} + e^- \rightarrow Co^{2+})$ $\mathcal{E}^\circ = 1.82$

$\mathcal{E}^\circ_{cell} = 0.86\,V$

$Pt, NO_{(g)} \,|\, NO_3^-, H^+ \,||\, Co^{3+}, Co^{2+} \,|\, Pt$

$-W_{max} = nF\mathcal{E} = (3\,mole)(96485\,C/mole)(0.86\,J/C) = 248931.3\,J$

$\times\ 0.42$ = $104551.146\,J$

$W_{max} = -249\,kJ,\ W_{act} = -105\,kJ$

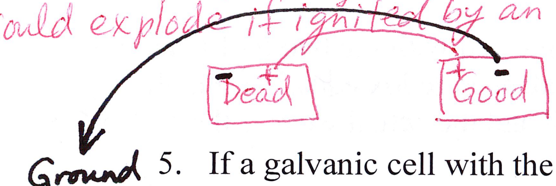
3. How does a hydrogen fuel cell work? (Include what is input and output and what happens at both the cathode and the anode during charging and discharging.)

	In	Out	@ cathode	@ anode
While "charging"	H_2O, elect.	H_2 & O_2	$H_2 \leftarrow H_2O$	$H_2O \rightarrow O_2$
While "discharging"	H_2 & O_2	H_2O, elect.	$O_2 \rightarrow H_2O$	$H_2O \leftarrow H_2$

A P.E.M. allows protons to pass through, but e^- can't so they flow through a wire around the PEM.

4. When a lead storage battery is recharged by the alternator in a car, not only are the active components of the battery restored, but electrolysis of water that is in the battery also produces which **TWO** byproducts ? In light of your answer, what is the SAFE way to connect jumper cables between a good battery and a drained battery? What hazard is there to connecting them the UNSAFE way? (2 points per correct answer)

Electrolysis of water in the dead battery produces H_2 & O_2 which could explode if ignited by an arc when the cables are disconnected.



5. If a galvanic cell with the line notation shown below is allowed to run until the concentration of ions in the cathode compartment has changed by 0.35 M, what is the new cell potential? (6 points) 0.175 M

$Zn \,|\, Zn^{2+}\ (1.0\ M) \,||\, Cu^+\ (1.0\ M) \,|\, Cu$

(1.175 M, 0.65 M; −0.76, 0.52)

$\mathcal{E}^\circ = 0.52 - (-0.76) = 1.28\,V$

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

$\mathcal{E} = \mathcal{E}^\circ - \frac{0.0591}{2}\log\left(\frac{(1.175)}{(0.65)^2}\right)$

$= 1.28\,V - (0.02955)(0.444211533) = 1.27\,V$

6. What mass of nickel can be electroplated from a solution of Ni^{2+} by running a current of 10.0 amps through the electrolytic cell for 25.0 minutes? ***If*** the solution volume and concentration were 50.0 mL and 0.75 M respectively, would 10.0 amps for 25.0 minutes plate out all of the available nickel? How long (in hours, minutes and seconds) would it take to electroplate 0.75 kg of nickel using the same current? (Assuming the solution contains enough nickel.)

$q = t \cdot A = (25.0\,min \times \frac{60\,sec}{1\,min}) \cdot (10.0\,\frac{C}{s}) = \frac{15000\,C}{96485\,C/mole^-} = 0.15546458\,mol\,e^- \times \frac{1\,Ni}{2\,e^-}$

$= 0.07773229\,mol\,Ni \times \frac{58.69\,g}{1\,mol} = 4.5621081\,g$ (4.56 g, Assuming enough Ni^{2+} in solution.)

$0.75\,M \cdot 0.050\,L = 0.0375\,mol \times \frac{58.69\,g}{1\,mol} = 2.20\,g$ - Yes, more than enough

$0.75\,kg \rightarrow 750\,g \times \frac{1\,mol}{58.69\,g} \times \frac{2e^-}{1\,Ni} \times \frac{96485\,C}{mole} = \frac{2465965.241\,C}{10.0\,C/s} = 246596.5241\,s$ (68 h 29 min 57 s) (Ignoring SF's)