Exam Review Questions: Electrochemistry

1. Consider a voltaic cell based on the following cell diagram:

$Pt \mid Pu^{3+}_{(aq)}, Pu^{4+}_{(aq)} \parallel Cl_{2(g)}, Cl^-_{(aq)} \mid Pt$

Given that the standard cell emf is 0.35V, and that the standard reduction potential of chlorine is 1.36V:
$1/2Cl_2 + e^- \rightarrow Cl^- \qquad E^o = 1.36V$
What is the value of the standard reduction potential $E^o_{Pu4+/Pu3+}$
$Pu^{4+} + e^- \rightarrow Pu^{3+}$

2. Which of the following substances can oxidize H_2O to $O_{2(g)}$ under standard state conditions (hint: You will need your standard reduction potential table)?
$2H_2O_{(l)} \rightarrow O_{2(g)} + 4H^+_{(aq)} + 4e^-$

MnO_4^-, $Cl_{2(g)}$, $Pb^{2+}_{(aq)}$, $Cl^-_{(aq)}$, $Ag^+_{(aq)}$

3. A metal object is to be gold-plated by an electrolytic procedure using aqueous $AuCl_3$ electrolyte and Au anode. Calculate the number of moles of gold deposited in 3.0min by a constant current of 10.A.

4. How many coulombs of electrical charge would be required to electroplate 35.0 grams of chromium by passing an electrical current through a solution containing $CrCl_3$?

5. For the reaction $2Cr^{2+} + Cl_{2(g)} \rightarrow 2Cr^{3+} + 2Cl^-$, the value of E^o_{cell} is 1.78V. Determine the value of E^o_{cell} for the related reaction $Cr^{3+} + Cl^- \rightarrow Cr^{2+} + \frac{1}{2} Cl_{2(g)}$.

6. An electrochemical cell is formed from aluminum and zinc and solutions containing their ions. Determine:
a. The oxidation half reaction
b. The reduction half reaction
c. The net ionic equation
d. The cell potential

7. Calculate the amount of time (in minutes) required to plate .750g of copper onto the surface of an object if a current of 525mA flows through an electrolytic circuit. Assume that the ion form of copper is Cu^{2+}. The molar mass of copper is 63.55g/mol.

Answers: (NOTE: There may be slight differences in cell potential depending on which reduction potential table is used.)

1.
$0.35V = (X_{ox}) + 1.36V$ $\quad X_{ox} = -1.01V$
$Pu_{(4+/3+)} = 1.01V$

2.
Look at the relative positions on the reduction potential table. Both chlorine gas and the permanganate ion have higher reduction potentials than $O_{2(g)} + 4H^{+}_{(aq)} + 4e^{-} \rightarrow 2H_2O_{(l)}$ and so will drive this reaction in the opposite direction.
Answer: MnO_4^- and $Cl_{2(g)}$

3. (10.0C/s)(3.0min)(60s/min)(1mol e^-/96,480C)(1mol Al/3mol e^-)
= **$6.2x10^{-3}$mol**

4.
$Cr^{3+} + 3e^- \rightarrow Cr$
35.0g Cr (1mol Cr / 52.00g Cr)(3mol e^- / 1mol Cr)(96,480C / 1mol e^-)
= $1.95x10^5$C

5. The change in coefficients don't affect the cell potential but the reaction is reversed = **-1.78V**

6.
a. **$Al \rightarrow Al^{3+} + 3e^-$**
b. **$Zn^{2+} + 2e^- \rightarrow Zn$**
c. **$2Al + 3Zn^{2+} \rightarrow 2Al^{3+} + 3Zn$**
d. $E^o_{cell} = 1.66 + (-0.76V) =$ **.900V**

7. .750g / 63.55g/mol = .0118mol Cu
.0118mol Cu (2mol e^- / 1mol Cu) = .0236mol e^-
.0236mol e^- (96,480C/mol e^-) = 2,277.26 C
2,277.26C (1s / .525C) = 4337.64 s
4337.64s (1min / 60s) = 72.294min = **72.3min**