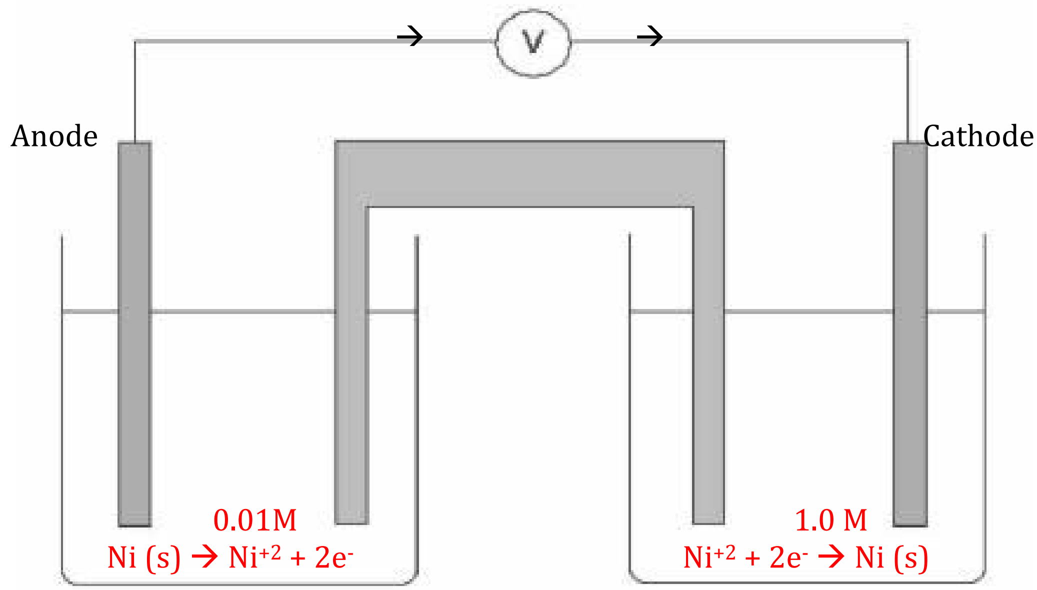
CH302 Exam 4
Vanden Bout/LaBrake
Spring 2013

Name:__________________________________
UTEID:__________________________________
Exam Version #_________________________

Your complete answer, including any calculations and work for partial credit, must be contained inside the boxes. Work outside of the boxes will not be graded. ***Tabular data (on the back of this page and front of the MC exam) contains relevant information.***

1. (15 points) Consider a nickel concentration cell. One compartment has a Ni^{+2} concentration of 0.01 M, while the other compartment has a Ni^{+2} concentration of 1.0 M. The two electrodes are made of solid nickel. When connected, current flow will be spontaneous in one direction.



a) (3 pt) Label the anode, cathode and salt bridge. (+1 each)
If anode and cathode are obviously not the pieces of metal, +1 total (1/2 each)

b) (1 pt) Label the direction of the flow of electrons. (+1)

c) (2 pt) Label the half reactions occurring at each electrode. (+1 each, +1 if switched) Do NOT need state symbols (s), (aq) for full credit
$Ni(s) \rightarrow Ni^{+2} + 2e^-$ $\qquad$ $Ni^{+2} + 2e^- \rightarrow Ni(s)$

d) (2 pt) Label the starting concentrations of the ion at each electrode. (+1 each)
Anode: $Ni(s) \rightarrow Ni^{+2} + 2e^-$ (0.01M)
Cathode: $Ni^{2+} + 2e^- \rightarrow Ni(s)$ (1.0M)
**If everything is flipped, then full credit as long as electrons flow from anode to cathode…

e) (4 pt) What is the cell potential for this nickel concentration cell?

$$E = E^o - \frac{0.05916}{n}\log Q$$

$$E = 0 - \frac{0.05916}{2}\log\left(\frac{0.01}{1}\right) = 0.05916V$$

+4 if perfect
Partial credit:

+1 for Nerst	-1 if set up is correct, but final answer is wrong (calculator error)
+1 for n = 2	
+1 for Q set up	-1 if answer is correct, but negative
+1 for E° = 0	

f) (1 pt) When will the cell potential reach zero?

When the concentrations are equal. When the cell reaches equilibrium.
Either correct

g) (2 pt) Which solution of Ni^{2+} ions has a lower free energy? Why?

The higher concentration has a lower free energy. Entropy! Vapor Pressure, more solute particles…

MANY potential correct answers.
+1 for "higher concentration"
+1 for "why" MUST mention entropy or something from thermodynamics for full credit

2. (10 points) You have a solution of 0.1 M ReI_3. Given that the price of rhenium is currently about $3500 per kilogram, you would like to recover the rhenium metal from the solution via electrolysis of the solution.

a) (2 pt) Write the balanced overall reaction for your electrolytic cell.

$2ReI_3 \rightarrow 2Re\ (s) + 3I_2\ (s)$
OR
$2Re^{+3} + 6I^- \rightarrow 2Re\ (s) + 3I_2\ (s)$

+2 if perfect
+1 if not balanced
+1 if balanced NOT to lowest common denominator
MANY potential WRONG answers. Keep a list.
Do NOT count off if they lack (s)
IF their equation is drastically different the entire back page will be graded based on their initial equation.

b) (2 pt) What is the standard potential for an electrolytic cell of this type?

$E° = E_{cathode} - E_{anode}$
$E° = 0.3 - 0.54 = -0.24$

+2 if all they have is the CORRECT number
LOOK BACK at (a) for partial credit
+1 for equation OR correctly identifying anode/cathode
No credit for -0.54 – 0.3 = 0.84
flipped one sign, AND subtracted
wrong anode/cathode

→

c) (3 pt) Given the starting concentrations of the ions, what is the minimum potential necessary to run your electrolytic cell?

$$E = E^{O} - \frac{0.0591}{n}\log Q$$

$$E = -0.24 - \frac{0.0591}{6}\log\left(\frac{1}{(0.1)^2(0.1)^6}\right) = -0.3188$$

At least 0.3188 V to run cell

+3 if perfect
-1 if did not flip the sign (should be POSITIVE)
Partial credit:
+1 for Nerst
+1 for n = 6
+1 for Q set up
+1 for -0.2304 (wrong sign, wrong Q)
+2 for +0.2304 (correct sign, wrong Q)
+1 for ΔG=-nFE, IF and ONLY IF n = 6

d) (3 pt) Assuming you run this cell at a current of 100 mAmps, how many hours will it take to collect 1 gram of rhenium?

1 g Re	1 mol	6 mol e^-	96485 C	1 sec	1 min	1 hr
	186.2 g Re	2 mol Re	1 mol e^-	0.1 C	60 sec	60 min

= 4.32 hrs

+3 if Perfect
LOOK BACK at their balanced equation!!
FULL CREDIT if they correctly used their incorrect ratio of Re to electrons
-1 if not in hours
-1 (+2) if set up is correct, but answer is wrong (calculator error)
-1 if incorrect Re:e^- ratio (based off of #2(a))
Partial Credit:
-1 if set up is correct and calculator was the error (+2)
+1 for correct Amps
+1 for correct ratio of Re to electrons

Standard Reduction Potentials:

Ni^{2+} (aq)+ 2e^- ↔ Ni(s) E°= 0.24 V

Re^{3+} (aq)+ + 3e^- ↔ Re(s) E°= 0.30 V

Pd^{2+} (aq)+ 2e^- ↔ Pd(s) E°= 0.915 V

Cl_2(g) + 2e^- ↔ 2 Cl^-(aq) E°= 1.36 V

Br_2(l) + 2e^- ↔ 2 Br^-(aq) E°= 1.1 V

I_2(s) + 2e^- ↔ 2 I^-(aq) E°= 0.54 V

2 H^+(aq) + 2e^- ↔ H_2(g) E°= 0 V