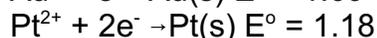


Chem 332
Analytical Chemistry
Exam III

Show all work for partial credit

I want you to design a really expensive battery that we will sell to the very rich. Make a galvanic cell using the following two half reactions :



1. A (15 points) Make a diagram of this cell showing:

Electron flow, anode, cathode, + pole, - pole, pole where oxidation occurs, pole where reduction occurs, salt bridge, electrode material, and solution in the two cells

Sorry making a diagram is difficult on a computer - so look at figure 14-3 of your text.

Make the following changes

The metal of the left hand electrode would be Platinum (Pt)

The solution in the left hand reservoir would contain Pt^{2+}

The metal of the right hand electrode would be Gold (Au)

and the solution in the right hand reservoir would contain Au^+

Oxidation goes on in the left hand electrode

Reduction goes on in the right hand electrode

1B. (5) points Make a line diagram of the complete cell



1C. (5) points What is the potential of this cell if $[\text{Au}^+] = 7 \mu\text{M}$ and $[\text{Pt}^{2+}] = 5 \mu\text{M}$

Using the Nernst equations for the $\frac{1}{2}$ reactions:

$$E_R = 1.69 - \frac{.059}{1} \log \frac{1}{[\text{Au}^+]} = 1.69 - .059 \log \frac{1}{7 \times 10^{-6}} = 1.386$$

$$E_L = 1.18 - \frac{.059}{2} \log \frac{1}{[\text{Pt}^{2+}]} = 1.18 - .0295 \log \frac{1}{5 \times 10^{-6}} = 1.024$$

$$E = E_R - E_L = 1.386 - 1.024 = .362$$

2. (15 points) Describe the construction and give potential values for two different reference electrodes.

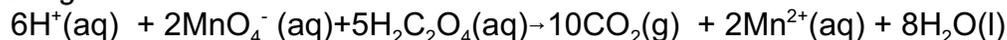
For questions like this a diagram is worth many words of explanation.

Hydrogen electrode - Diagram similar to the left cell of Figure 14-6.
Potential value 0.00

Silver-Silver chloride electrode - Diagram similar to figure 14-9.
Potential .222V if 1M KCl, .197 if saturated KCl.

Calomel electrode - Diagram similar to figure 14-10
Potential .268 if 1M KCl, .241 if saturated KCl.

For your assignment you calculated the titration curve for $H_2C_2O_4$ being titrated with MnO_4^- using the net reaction:



and the $\frac{1}{2}$ reactions:



3A. (5 points) Use the E° of these reactions to calculate the ΔG of this reaction.

This equation was given in the class notes, not the text.

$$\Delta G = -nFE^\circ$$

$$n = 10$$

$$E^\circ = E_R - E_L = 1.507 - (-0.432) = 1.939$$

$$= -10(9.649 \times 10^4)1.939$$

$$= -1871 \text{ kJ}$$

Alternatively you might remember $\Delta G = -RT \ln K$

$$-8.314(298) \ln X, \text{ where } X \text{ is the answer to 3B}$$

$$= -8.314(298) \ln(10^{328})$$

$$= -8.314(298)755$$

$$= -1.87 \times 10^6 \text{ J} = -1870 \text{ kJ}$$

3B. (5 points) Use the E° of these reactions to calculate the K for this reaction.

$$K = 10^{nE^\circ/0.05916}$$

$$= 10^{10(1.939)/0.05916} = 10^{328} \text{ Which will make most calculators overflow and error}$$

4. (5 points) What is a junction potential, describe a system in which a junction potential can arise.

A junction potential is a potential that arises whenever ions move at different speeds, so that a charge difference builds up between the different concentrations of ions. This kind of potential can build up on any surface or membrane that preferentially allows one ion to pass but not its counter ion, or it can occur even without a membrane when NaCl diffuses into water, when the smaller, more mobile Cl^- moves faster than the larger, slower Na^+ ion.

5. (15 points) Discuss how three different types of ion selective electrodes are constructed.

Again diagrams are difficult to make on a computer so I will refer you to figures 15-7 (Glass electrode), 15-12 (Solid state ion-selective) 15-14 (liquid-based Ion selective), or figure 15-17 (Compound electrode)

With each electrode I would expect a short discussion on how a barrier is made that selectively passes one particular ion.

6. (15 points) We use Beer's law in chemistry and biology often. Discuss the ways or experimental artifacts that can make Beer's law fail.

1. Concentrations > .01M
2. Precipitation causing particles in solution to scatter light.
3. Luminescence of material
4. Light inducing chemical reactions
5. Dirty cuvetts
6. Mismatched cuvetts

7 (15 points) An absorbance reading >1 cannot be trusted on an inexpensive 'Spec 20' spectrophotometer. Convert an absorbance of 1 to a transmittance reading. Use this reading to speculate why an inexpensive spectrophotometer does not work well when the transmittance is this low.

$$\begin{aligned}A &= -\log(T) \\1 &= -\log(T) \\-1 &= \log(T) \\10^{-1} &= T \\T &= .1\end{aligned}$$

$T=.1$ means that only .1 or 10% of the original light is getting to the detector. The first explanation I would try is that the detector is not very accurate at this low of a light intensity.