Exam 2 * Chem 454 * March 6, 2019

Name_____

70 total points. Each question is worth 10 points. Ignore question 2.

1. A pH electrode was found to have a potential of 0.439 V in a pH 4.01 (0.050 M KHP) solution. A sample solution gave a potential of 0.344 V. What is the pH of that sample?
[1]

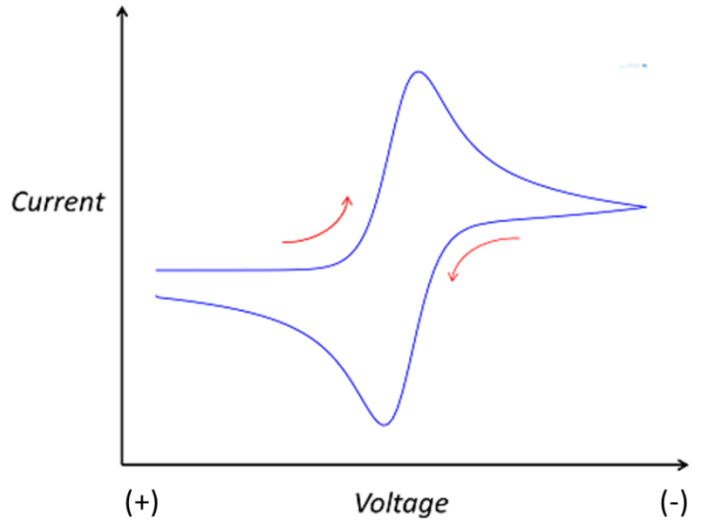
2. A Cl^- ISE responds to an unknown KCl solution with a potential of 667.7 mV. The volume of that solution is 10.00 mL. A spike of 0.100 mL of 2.52e-3 M KCl to that solution gave a response of 558.2 mV. What is the concentration of Cl^- in that unknown solution?
[2]

3. Sketch the configuration of a modern pH electrode.
[3]

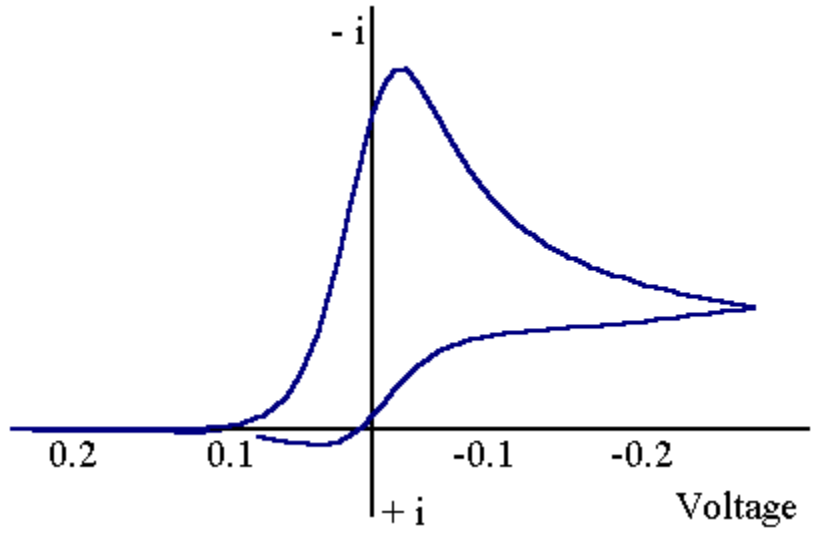
4. Explain the 3 electrodes needed for cyclic voltammetry. State the purpose of each electrode and why 3 electrodes are necessary.
[4]

5. In the figure below label the following: [5]

   a. Ox + e- → Red
   b. Capacitive Current.
   c. $i_{p,c}$
   d. $i_{p,a}$
   e. Red → Ox + e-
   f. E^0 and $E_{1/2}$



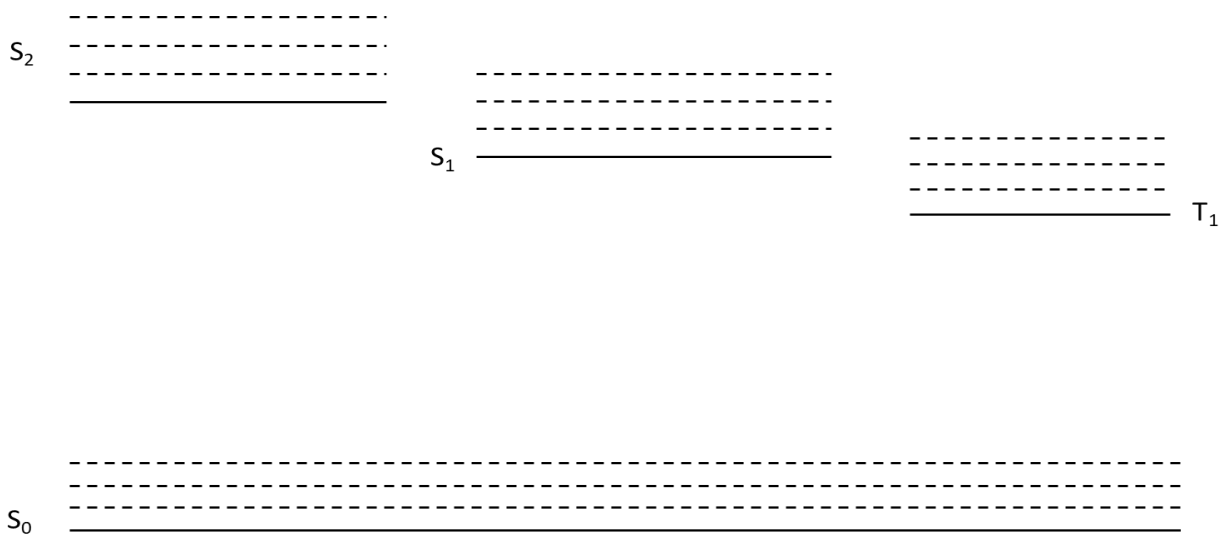
6. Explain why this cyclic voltammogram appears different than the one in question 5.
[6]



7. An anodic stripping voltammetric analysis was conducted for the analysis of Pb in soil extracts. The following standard addition analysis was conducted with a spike concentration of 100.0 ppb Pb^{2+}(aq) [7]

10.00 mL Aqueous Sample	100.1 µA
10.00 mL Aqueous Sample + 1.00 mL Spike	150.3 µA

8. Using the blank diagram below, illustrate the processes of absorption, vibrational relaxation, fluorescence, phosphorescence and internal conversion. [8]



Answers

[1] E = const – 0.0592pH, for the pH 4.01 solution: 0.439 V = const – 0.0592*4.01

Const = 0.676 for unknown: 0.344 = 0.676 – 0.0592*pH

pH = 5.61

[2] $E = const - 0.0592 \log [Cl^-]$

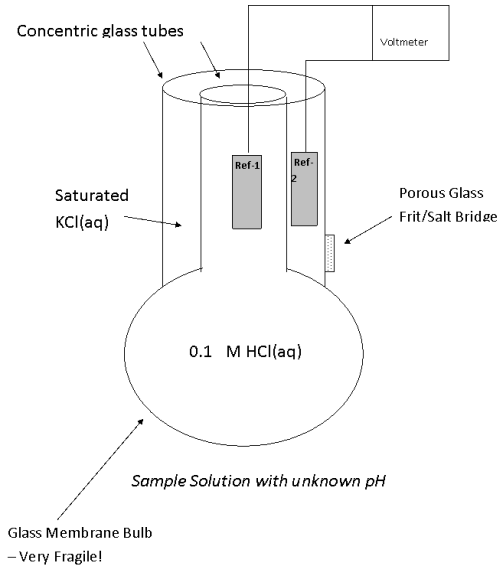
$0.6677 = const - 0.0592 \log x$

$-\{0.5582 = const - 0.0592 \log (x - (0.100/10.10)*2.52e\text{-}3)\}$

$0.1095 = 0.0592 \log (x - 2.50e\text{-}5) - \log x$

$X = 3.59e\text{-}7\ M$

[3] From the notes:

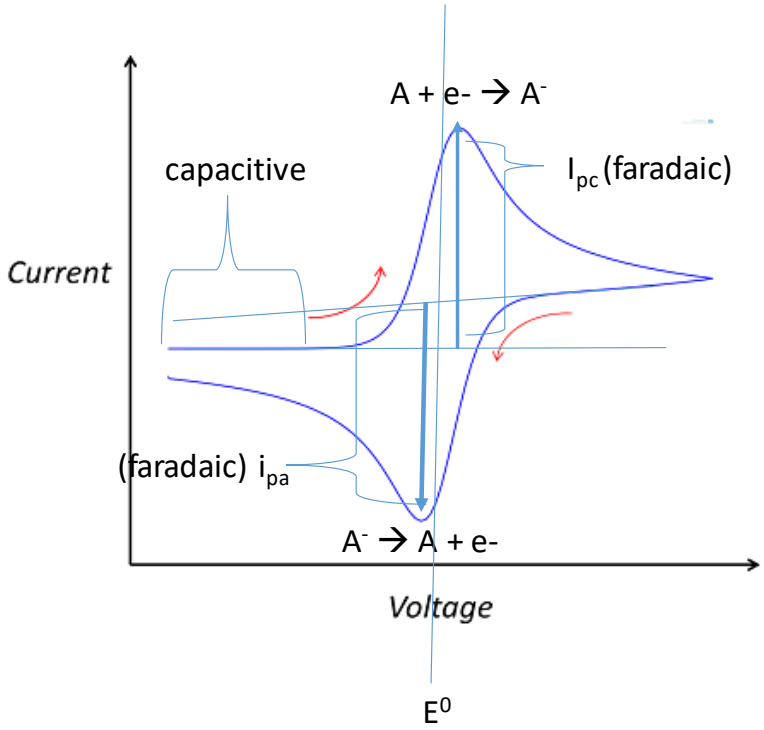


[4] Working electrode - This is where the reduction or oxidation electrochemical processes being investigated are taking place.

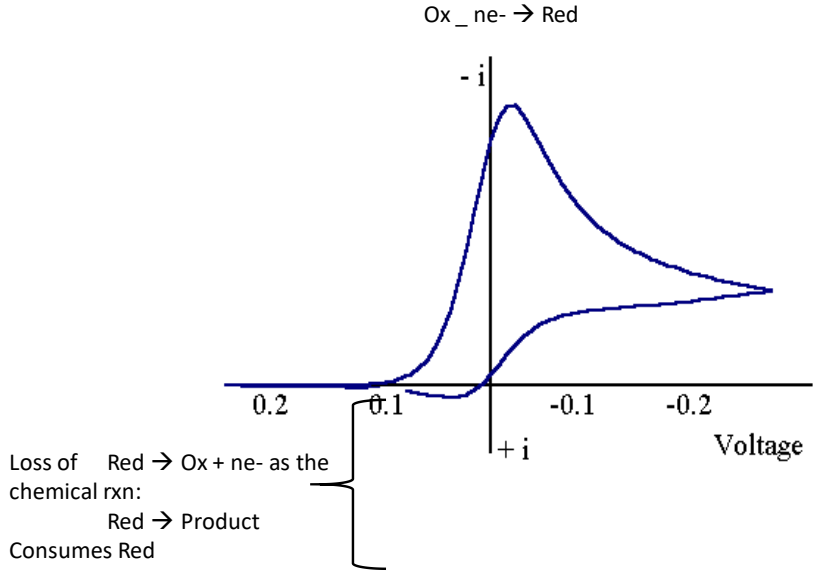
Reference electrode – This electrode provides a stable potential (e.g. Ag/AgCl) based on a chemical equilibrium that allows the working electrode to be compared to and controlled. As the potential is being measured no current is allowed to pass through the working electrode – reference electrode circuit.

Counter electrode – provides for the charge balance when the working electrode undergoes an oxidation or reduction. The current flow is the same but in a different direction relative to the working electrode, e.g. when the working electrode is undergoing a reduction, the counter electrode is undergoing an oxidation process. Current passes through the working – counter electrode circuit.

[5]



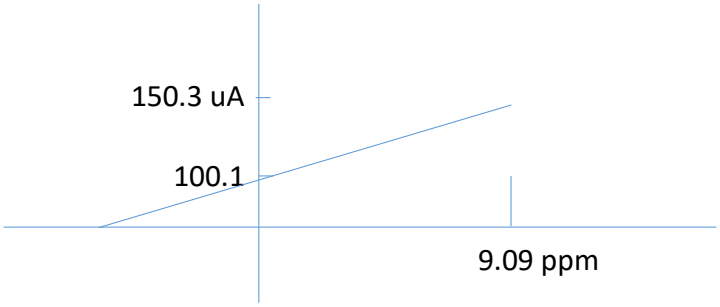
[6] This is an example of EC mechanism:



[7] Spike = 100.0 ppb Pb^{2+}(aq)

10.00 mL Aqueous Sample	100.1 µA
10.00 mL Aqueous Sample + 1.00 mL Spike	150.3 µA

Spike concentration = 100.0 ppb (1.00/11.00) = 9.09 ppb



Slope = (150.3 -100.1)/9.09 = 5.52 uA/ppm y-int = 100.1

Line is y = 5.52 (x) + 100.1 solve for x-int.

0 = 5.52 (x) + 100.1 x = 18.1 ppm

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