Chem 353
Take-Home Assignment 4 Answer Key

1. A steady-state voltammetric analysis of a 50.0-mL sample for the drug Librium yields a limiting current of 0.37 μA. After adding 2.00 mL of a 3.00 mM solution of Librium to the sample, the limiting current increases to 0.80 μA. What is the molar concentration of Librium in the sample?

   This is a standard addition; thus

$$\frac{0.37}{[\text{Librium}]} = \frac{0.80}{[\text{Librium}]\left(\frac{50}{52}\right) + (3.00)\left(\frac{2}{52}\right)}$$

   Solving gives [Librium] as 0.0962 mM. Note that you have to account for how the sample and the standard dilute each other when mixed together.

2. An amperometric sensor for glucose is calibrated by measuring the steady-state current when it is immersed in standard solutions of glucose. A typical set of calibration data is shown here.

[glucose] (mg/100 mL)	current (arb. units)
2.0	17.2
4.0	32.9
6.0	52.1
8.0	68.0
10.0	85.8

   A 2.00-mL sample is diluted to 10 mL in a volumetric flask and a steady-state current of 23.6 (arbitrary units) is measured. What is the concentration of glucose in the sample in mg/100 mL?

Linear regression gives the equation for the calibration curve as

$$i = -0.490 + 8.615(\text{mg glucose}/100\text{ mL})$$

   Substituting the current for the sample gives a glucose concentration of 2.796 mg/100 mL; thus

$$2.796 \text{ mg glucose}/100 \text{ mL} \times \frac{10.00 \text{ mL}}{2.00 \text{ mL}} = 14.0 \text{ mg glucose}/100 \text{ mL}$$

3. Zinc can serve as an internal standard when determining the concentration of thallium by anodic stripping voltammetry. A standard solution containing 5.00×10^{-5}M Zn^{2+} and 2.50×10^{-5} M Tl^{+} gives peak currents of 5.71 μA and 3.19 μA, respectively. A 8.713-g sample of an alloy known to be free of zinc was dissolved in acid, transferred to a 500-mL volumetric flask and diluted to volume. A 25.0-mL portion of this solution was mixed with 25.0 mL of a 5.00×10^{-4} M solution of Zn^{2+}. Analysis of this solution gave peak currents of 12.3 μA for Zn^{2+} and 20.2 μA for Tl^{+}. Report the percentage of thallium in the allow by mass.

This is an internal standardization; thus, for the standard we have

$$\frac{S_{Tl}}{S_{Zn}} = \frac{3.19}{5.71} = K\left(\frac{[Tl^+]}{[Zn^{2+}]}\right) = K\left(\frac{2.50 \times 10^{-5}}{5.00 \times 10^{-5}}\right)$$

which gives K as 1.117. For the sample, we have

$$\frac{20.2}{12.3} = 1.117 \times \frac{[Tl^+](25/50)}{(5.00 \times 10^{-4})(25/50)} = 1.117 \times \frac{[Tl^+]}{(5.00 \times 10^{-4})}$$

Solving gives $[Tl^+]$ as 7.35×10^{-4} M. This is the concentration of Tl^+ in the 500-mL sample; thus

$$\frac{(7.35 \times 10^{-4}\ \text{M}) \times 0.500\ \text{L} \times 204.38\ \text{g/mol}}{8.713\ \text{g}} \times 100 = 0.862\%\ \text{Tl}$$