Take-Home Assignment 1

The main focus of Chem 170 is the stoichiometric relationship between individual reactants and between reactants and products in a chemical reaction. Two additional topics from Chem 170 of importance, particularly when working in lab, are converting between different units for expressing concentration and dilutions. The three problems here provide a review of these two topics. Your neatly worked solutions to these problems are due at the beginning of our next lab session. Be prepared to share your work.

Erythrosin B (which we will abbreviate as EB) is a dye with a number of analytical uses, including as a stain for bacteria in soil, as a stain for nerve cells (in conjunction with the dye methylene blue), as a phosphorescent probe for studying the diffusion of membrane proteins, and as an acid-base indicator. The chemical formula for EB's sodium salt—its common, soluble form—is $C_{20}H_6O_5I_5Na_2$.

(1) When used as an acid-base indicator, EB is coated onto crystals of NaCl so that it easier to dispense. Consider a mixture of EB and NaCl that is 0.116 % w/w in EB. How much EB and how much NaCl are present in a 0.1000-g portion of the mixture.

Percent weight-to-weight (% w/w) gives the grams of analyte per 100.0 grams of the mixture; thus, for a mixture that is 0.116% w/w EB, there are 0.116 g of EB per 100.0 g of mixture, or, for a 0.1000-g portion of the mixture, we have

$$0.1000 \text{ g mixture} \times \frac{0.116 \text{ g EB}}{100.0 \text{ g mixture}} = 1.16 \times 10^{-4} \text{ g EB}$$

The amount of salt in the mixture is

$$0.1000 \text{ g mixture} - 1.16 \times 10^{-4} \text{ g EB} = 0.0999 \text{ g NaCl}$$

(2) Suppose you take a 0.2519-g sample of a 0.116% w/w EB mixture, transfer it to a 25-mL volumetric flask, and dilute to volume. What is the concentration of EB in the resulting solution? Report your answer in each of the following units: molarity, % w/v, and ppm, being careful to report each with an appropriate number of significant figures.

$$\frac{0.2519 \text{ g mixture}}{0.02500 \text{ L}} \times \frac{0.116 \text{ g EB}}{100.0 \text{ g mixture}} \times \frac{1 \text{ mol EB}}{1006.7 \text{ g EB}} = 1.16 \times 10^{-5} \text{ M}$$

$$\frac{0.2519 \text{ g mixture}}{25.00 \text{ mL}} \times \frac{0.116 \text{ g EB}}{100.0 \text{ g mixture}} \times 100 = 1.17 \times 10^{-3} \text{ \%w/v}$$

$$\frac{0.2519 \text{ g mixture}}{25.00 \text{ mL}} \times \frac{0.116 \text{ g EB}}{100.0 \text{ g mixture}} \times \frac{10^6 \text{ µg EB}}{\text{g EB}} = 11.7 \text{ ppm}$$

(c) Suppose you have a stock solution of 20.00 ppm EB. Explain how you can use common volumetric glassware to make a solution that is 1.280 ppm EB. The volumetric glassware available to you are volumetric pipets that dispense volumes of 1, 2, 3, 4, 5, 10, 25, 50, 100, 250, 500, and 1000 mL, and volumetric flasks that hold volumes of 5, 10, 25, 50, 100, 250, 500, and 1000 mL. There is no single answer to this question as many combinations of glassware and dilutions give the same result.

For a dilution, we know that $C_1V_1 = C_2V_2$ where C_1 and C_2 are the concentration of the original and the diluted solution, respectively, V_1 is the volume taken from the original solution, and V_2 is the volume of the diluted solution. Here we know C_1 and C_2 and, therefore, solve for the ratio V_2/V_1

$$\frac{V_2}{V_1} = \frac{20.00 \text{ ppm}}{1.280 \text{ ppm}} = 15.625$$

There are many ways to achieve this ratio, including diluting 16 mL (using 10-mL, 5-mL, and 1-mL volumetric pipets) to 250 mL or diluting 2 mL to 25 mL and then diluting 20 mL of this solution (using two aliquots from a 10-mL pipet) to 25 mL.