Answer Key 12: Quality Assurance

1. (a) Determine the amount of cadmium per gram of dry clam weight. Express your final result as a weight percent.

The first step in determining the amount of cadmium is using the method of standard additions to plot the instrument response as a function of mass of cadmium standard. From this analysis, you should obtain the equation

$$y = 0.1896x + 0.080$$

Now solve for the x-intercept to obtain the mass of cadmium from the unknown sample in each standard addition solution. This is the amount present in the standard addition solution, so divide by the volume of the solution, 100 mL, to obtain the concentration in the standard addition solution. Only 5 mL of this solution came from the original unknown, so use the dilution equation to obtain the concentration in the original solution, which should give you 0.0844 μg/mL. This is the concentration of the original solution, so multiply by its volume to get the mass. This solution came from the preparation of 51.00 mg of the clam sample. Convert the mass of the homogenized clams to grams, and divide the mass of cadmium by it and multiply by 100% to obtain the weight percent, resulting in 0.0165%.

(b) Find the absolute uncertainty (standard deviation) of the measurement.

To determine the uncertainty in the weight percent, determine the standard deviation in the x-intercept (s_{x-int}), which is in turn used to determine the uncertainty in the x-intercept. This can obtained using the formula

$$s_{x-int} = \frac{s_y}{|m|}\sqrt{\frac{1}{n} + \frac{\overline{y}^2}{m^2 \sum (x_i - \overline{x})^2}}$$

where s_y is the standard deviation of the y values, m is the slope, n is the number of measurements, $\overline{y}$ is the mean value in y, x_i is an individual x value, and $\overline{x}$ is the mean of x values. In Excel, the LINEST function can be used to determine s_y. Highlight an array of two columns by five rows, type =LINEST(y-values, x-values, TRUE, TRUE) and press CTRL + SHIFT + ENTER. s_y is in the second column and third row. Input the rest of these values and you should obtain s_{x-int} of 0.01203. The relative uncertainty is the standard deviation of the x-intercept divided by the x-intercept, giving 0.0285. The absolute uncertainty is the relative uncertainty multiplied by the calculated weight percent, giving 0.00047%.

(c) Determine the 95% confidence interval of the measurement.

The 95% confidence interval is the product of the absolute uncertainty and the Student's t value determine from the table for $n - 2$ degrees of freedom. This t value is 3.182, giving a confidence interval of $\pm$0.00150%.

2. (a) What is the concentration of methyl benzoate in the plant stream?

Use the preliminary run to calculate the response factor F, using the equation

$$\frac{\text{area peak A}}{\text{concentration A}} = F \times \frac{\text{area peak B}}{\text{concentration B}}$$

to find $F = 0.950$. Then, use the same equation with the found value of F to calculate the concentration of methyl benzoate in the sample. Remember to account for the dilution of the sample when the standard solution was added to the analyte solution, but in this case they end up canceling out, giving 2.44 mg/mL.