

Problem Set 3 – Uncertainty and Statistics

Complete all problems on separate paper. Show all work for credit. Correct use of significant figures is required for full credit.

1. We can measure the concentration of an HCl solution by reaction with pure sodium carbonate: $2\text{H}^+ + \text{Na}_2\text{CO}_3 \rightarrow 2\text{Na}^+ + \text{H}_2\text{O} + \text{CO}_2$. A volume of 27.5 ± 0.04 mL of HCl solution was required for complete reaction with 0.9674 ± 0.0009 g of sodium carbonate (FM 104.988 ± 0.001). Find the formality of the HCl and its absolute uncertainty.
2. For the HCl from problem 1, determine the pH and its absolute uncertainty.
3. An atomic absorption method for the determination of copper in engine oil yielded copper contents of 8.35, 8.45, 8.23, 8.55, and 8.32 $\mu\text{g Cu/mL}$. Determine the sample mean, sample standard deviation and median for these data. Find the 95% confidence interval for these results. (You may use a calculator or computer to do the calculations but you should indicate how you found them (i.e. TI-83, Excel, etc.))
4. A titrimetric method for the determination of calcium in limestone was tested by analysis of a NIST limestone sample certified to contain 30.15 % CaO. The results of four analyses of the sample gave the following data: 30.27 %, 30.00 %, 30.28 %, 30.33 %. Use a Q-test to determine if a single point may be discarded at the 90 % confidence level. Use a Grubbs test to determine if a single point may be discarded at the 95 % confidence level. Do the data indicate the presence of systematic error at the 95 % confidence level?
5. A food company testing a new method for the analysis of the polyunsaturated fat content of various vegetable and animal oils obtained the results at the right for the old and new methods. Determine if the new and old analysis procedures are giving the same results at the 95% confidence level. (You may assume that the precision is approximately the same for these two methods. Feel free to use a spreadsheet to streamline calculations, just be sure you understand how do to the calculations by hand.)

Polyunsaturated Fat
(% w/w of Total Fat)

Sample Number	Old Method	New Method
1	4.3	4.1
2	36.3	35.0
3	5.2	4.9
4	63.7	60.9
5	17.4	16.0
6	8.2	6.7
7	48.2	45.7
8	30.6	25.8