Key Concept Sequences

The following experiments have been tried and tested over a 6 year lab sequence for undergraduate chemistry majors. They are arranged in a historical and conceptual sequence allowing students to acquire a background understanding of chemistry.

Concept Sequence 1:

Sampling statistics control the **overall** analytical procedure beginning with in field sampling both in randomizing individual samples and in collecting a sufficient data base of information to derive meaningful information. Sampling statistics also control the **limit of detection**, a figure of merit used to select an instrument for use in analysis. By increasing the number of instrumental measurements using computer based collection of information, the standard deviation of the measurement goes down, and, therefore, so does the limit of detection.

Students are asked to make a running set of comparisons of the instrumental methods throughout the semester, so they need to be able to determine the **limit of detection** on each instrument and understand what factors come into play. **Experiments 1 and 2** set the student up to properly understand statistics and to use computer spread sheets, as well as some simple digital and electronic filtering to reduce noise.

Concept Sequence 2:

The final analysis is dependent upon the weakest link. Often that weak link is the analyst's understanding of the chemistry that precedes the instrumentation. One recurring theme in lead analysis is the need to control the pH in order to avoid lead hydroxide formation. Students are asked to build on the spread sheet skills in producing an alpha plot for lead hydroxides and to compare that data to measured free lead vs pH (**ISE, experiment 8).** Chemistry continues to be introduced in the form of chelation and phase separation in the UV-Vis Dithizone experiment. If the pH is not properly controlled the experiment can not work. The chemistry in this experiment also depends upon selectivity in chelation and on phase separation, concepts that reappear in the IR, NMR, and Chromatographic experiments.

Concept Sequence 3:

Lead exists in a variety of isotopes. The NMR and MS labs exploit the fingerprint pattern of lead.

Concept Sequence 4:

Ethics is implicitly and explicitly built into this lab. **Explicit** ethical issues to be explored include "professional" ethical issues relating to professional relationships within the work groups, honesty, integrity (Lab 1: a good lab book; Lab 23: digestion and designing internal quality control). We also explore how statistics (Lab 1) informs public policy in a different manner than it does analytical measurements. We directly explore (last lab) how a scientific disagreement should be carried out. **Implicit** ethic issues concern ownership of data between unequal collaborators (community groups and scientists), the extent to which scientists have a moral obligation to impart scientific knowledge to the general public, and the obligation that scientists have to not participate in scare science and/or to "use" community groups as mere learning tools.