How to measure arsenic

The importance of chemical analysis. Many research projects as well as activities that ensure our health and welfare depend on the ability to make reliable measurements of the chemical composition of relevant materials. In general, chemists refer to the overall processes involved in obtaining this information as an analytical method. An analytical method will consist of several parts: (1) obtaining a sample that is representative of the material to be analysed, (2) converting (by several chemical processes) the sample into a form suitable for measurement, (3) making the measurement with a chemical instrument, (4) calibrating the instrument response in terms of the concentration of the analyte (the target chemical species), (5) calculating the concentration of the analyte and (6) estimating the uncertainty in this number (assigning a ± term).

Often it is the performance of the instrument that governs both the sample pretreatment needed (i.e. step 2) and the quality of the result. Chemists refer to step 3 of the method as the use of an instrumental technique. These techniques are divided into broad groups on the basis of the nature of the phenomenon that is exploited to get the chemical information. So there are a bunch of electrochemical techniques (based on measuring electrical phenomena such as voltage, current and resistance), a bunch of spectroscopic techniques (based on the interaction of electromagnetic radiation with the sample material such as absorption, emission or fluorescence), and many others including the measurement of the volume of reagent solution needed to react with a sample component (volumetric or titrimetric techniques) and the mass of a pure chemical derivative of the target species (gravimetric techniques).

The next stage in getting involved in the arsenic project, is to learn something about the scope and limitations of the instrumental techniques that are used to measure arsenic (analytical chemists would say “that are used for the determination of arsenic”). I have chosen eight spectroscopic techniques, (including one in which the final reaction product is examined by eye—the field test kit, and one for which two versions are to be explained--visible absorption spectrometry), one separation techniques (GC) for which we normally assume that the species separated are detected as an integral part of the separation process (as the separation unit and detection unit are both part of the same instrument) and one electrochemical topic. Although, I did not select this topic this time, dissolving solid samples is an integral part of many methods, as many instrumental techniques require that the analyte be in solution. This list of topics is not comprehensive; however, it represents the majority of methods in current use.

The report on the technique should include the following sections: (1) explanation of the basic concept (i.e. the phenomenon that forms the basis for the measurement), (2) what is measured that is proportional to the amount of arsenic in the sample, (3) what the lowest concentration of arsenic in the material that is measured might be, (4) what interference effects might be encountered, (5) how the instrument is calibrated, (6) an estimate of the capital cost of the instrument, (7) whether the technique is suitable for measurements “in the field", (8) whether the technique is suitable for use by middle school students in their classroom, (9) whether the technique is suitable for use by rural communities in Bangladesh or Maine and (10) whether the technique is available on the UMass campus and, if so, just exactly where.

Each group should produce one paper and submit this electronically to Professor Tyson by midnight on March 16th. The target length is about 500 words excluding diagrams and references. The target audience is the other new members of the research group.

You should illustrate your basic explanations with one or two diagrams (with references) and you should include at least two links to sources of further information that can be accessed via the web. Break the text into paragraphs and consider the use of sub-headings to help the reader. Try to avoid the passive voice. It is quite acceptable to use the names of persons or organizations.

Copying and pasting diagrams or pictures from other sources is fine; but **you must** acknowledge the creator and indicate from where the picture or diagram came, **even if this is another website**. Copying and pasting long pieces of text from other sources is not considered good scientific writing, even if you put quotation marks around the text and give a reference to where you got the material. **However, if you don’t put quotations marks and give information about the source, you have committed plagiarism, which is considered to be a serious act of academic dishonesty and for which most organizations, including UMass, have zero tolerance.**

You should try to present the information from the different sources in your own words at a level appropriate for your readers. This is a skill that professional scientists and engineers need to be successful, and the way to be good at it is to practice a lot. So this is another chance to practice it.

A collaborative piece of writing can be tricky to organize. It helps if everyone is able to use the same Word processing software (Microsoft Word?) and is familiar with the “track changes” (Tools menu) and “insert comment” (Insert menu) features. Both features are accessible from the Reviewing Toolbar (select from the View menu). Be careful if your material is viewed on both PC and Macintosh computers as not every font and formatting crosses the platforms without change.