# INDEPENDENT INQUIRY EXPERIMENTS (#7.2)

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## Purpose

- To give you added experience in the scientific method by involving you in the experimental design, as well as data collection and analysis you have previously experienced.
- To provide experience in presenting scientific research before a "peer" group, and defending your thesis by extemporaneous response to questions.

## Background

Each of the suggested projects will involve using the MicroLab interface to perform and analyze some aspect of marketplace products or some fundamental chemical relationship. OR, **if students decide to do a project of their own origin, the project will need to be approved by your instructor**. In either instance, you will need to decide what data to collect and how to report it. For this project, you will not be given detailed instructions as you were for the regular labs.

## Format

Students will be guided on how to accomplish the following:

1. Select a project least two (2) weeks before the experiment is scheduled to begin.
2. Follow the generalized protocol of what is commonly called the **Scientific Method**, by following these steps:
   a. Observation of initial phenomena
   b. Search the literature and conducting preliminary experiments to obtain additional information.
   c. Formulate one or more hypotheses to explain the observation in terms of the literature of known information and the additional information gained through the preliminary experiments.
   d. Devising experiments to test the hypotheses in terms of the known facts.
   e. Accepting or rejecting the original hypotheses in light of the experiments undertaken.
3. At the Instructor's discretion, students might want to review the concepts contained in **Organizing the Research and It's Report** and perform a **Research Design Analysis (RDA)** of your project, obtained from the CD, to determine an overall purpose for the project chosen, then to determine appropriate subpurposes that will divide the overall project into smaller problems that lead to a solution of the problem.
4. Lastly, they will need to design a set of experiments for each of these subpurposes that will provide the information necessary to solve the problem.
5. If the instructor desires, they will formulate an **RDA** sheet after the format given in **Organizing the Research Report**, and complete the **Independent Projects Experiment Form** attached herewith, listing all of the information required there.
6. Bring both of these to a prelab conference with your instructor at least one (1) week before the date the experiments are to be carried out in the lab. If your instructor passes you on the RDA and the Experiment Form, you may then take the form to the storeroom to request the necessary equipment and supplies. **CAUTION: Please follow these instructions, or you may not be able to start your experiments on the day they are scheduled to begin.**
7. Determine how you will program the MicroLab to collect the necessary data in the computer.
8. Carry out the experiments to collect the necessary data. **NO UNAUTHORIZED EXPERIMENTS MAY B E CONDUCTED, UPON PENALTY OF AN "F" !**
9. Analyze the collected data in terms of the aspects requested in the brief set of instructions you will be given after you have chosen your project.
10. Write a report of all of your work, again following the format given in **Organizing the Research and It's Report**, and roughly sketched out below as well. **It is expected that you will have several references to published literature, e.g., textbooks, etc, in this written report!**

As part of this project, students may be required to give a brief oral presentation to the whole lab class on their final results, with a possible time limit set by your instructor. Partner(s) should participate equally in this report, and might

be judged on how well they meet the time limit, and how equally each participates, as well as how they show their application of the scientific method to their problem. They should be encouraged to practice this report several times before the presentation, which will be the last lab period of the semester. Two of the most common complaints about recent graduates is "Why can't they explain themselves verbally?", and, "Why can't they write a simple report?". These requirements are here to build a little practice with these skills into your science courses. **Students might be encouraged to do a "Power Point" type of presentation, and to apply the principles discussed in "Organizing the Research and it's Report".**

As determined by the instructor, these projects might be worth more than a normal lab

**WRITTEN REPORTS:** At the instructor's option, students may be asked to submit the written report in the format given in"Organizing the Research and It's Report". Grammar, spelling and neatness SHOULD count ! ! **Each student should submit their own written report of their experiment.**

### Individual Project Descriptions

1. Acid-Base Properties of Antacids: Students will titrate three different commercial antacids and compare their relative abilities to neutralize acid. The presence of aluminum in an antacid formulation poses some special problems in analysis, which they will look at but will not have to solve completely.
2. Acid-Base Properties of Buffered Aspirin: Students will titrate three different brands of aspirin and buffered aspirin with both acid and base to determine their acidity and buffering capacity.
3. Acid-Base Properties of Some Common Household Products and Foods: Students will test the pH of a number of common household products, and titrate liquid toilet bowl cleaners to determine their acid content.
4. Thermometric Determination of Ammonia in Household Cleaners: Students will determine concentrations of ammonia in several household cleaners using two different methods to detect the endpoint of the reaction.
5. Determination of Phosphoric Acid Content in Colas: Students will titrate two different colas to determine the content of phosphoric acid. This one requires some preparation because the carbonate has to be removed first.
6. Measuring Caloric Content of Snack Foods: Students will "burn" a variety of snack foods to determine their "heat content" obtaining a measure of their caloric content.
7. Molar Enthalpies of Acid/Base Reactions: Students will react three different acids with both NaOH and KOH to determine the molar enthalpies of reaction and compare them with the theoretical enthalpies obtained by thermodynamic calculations.
8. Molar Enthalpies of Solution: Students will measure the amount of heat involved in the dissolution of three different salts and try to determine the origin of the energy changes.
9. Determination of a Mixture of Copper and Cobalt by Colorimetry: Using **the *MicroLab* Colorimeter Experiment**, Students will obtain the visible spectra of a $Cu^{2+}$ and $Co^{3+}$ solutions, Choose the appropriate wavelengths for quantitative analysis of each compound, construct standard curves for each, then determine the concentration of an unknown containing both ions.
10. Identity of Group I Carbonate Samples: Students will be given samples of $Li_2CO_3$, $Na_2CO_3$ and $K_2CO_3$ to identify by measuring $CO_2$ evolution by HCl addition. This has some interesting techniques.
11. Factors Affecting Freezing Point Depression in Water: Students will explore the various factors which cause a decrease in the freezing point of water.
12. Penetrating Ability of Beta and Gamma Radiation: Students could use various thicknesses of cards, aluminum and lead to determine the penetrating ability of these radiations.
13. Quantitative Determination of Vitamin C in Fruits and Vegetables: Students will use N-bromosuccinimide as the titrant to analyze the vitamin C content of various fruits and vegetables.
14. Colorimetric Determination of Phosphorous in Plant Food: Students will determine the phosphorous content of three different plant foods by colorimetric analysis using a commercial analysis kit with the ***MicroLab* Colorimeter Experiment**.
15. Any other experiment that Students are interested in exploring, as long as it meets the safety needs and is of interest to students in their further studies.

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