

EIGHT BOTTLES

An Introduction to Scientific Investigations

Problem solving is not restricted to scientific investigations but is a life long process that involves every aspect of human endeavor. Although every investigator, being human, approaches each problem with some preconceived ideas, facts are gathered by accurately observing the behavior of a system of interest. Conclusions are based solely on the observed data.

The approach used by scientists is referred to as the *Scientific Method*.

First, the behavior of matter is observed.

Second, the results or data are arranged in an orderly fashion.

Third, the observed data is correlated to form a hypothesis.

Fourth, new experiments are designed to test the hypothesis.

There is nothing unique about the order of activity to this method other than it provides a logical way to determine cause and effect for natural phenomena. An inherent part of the scientific method is the element of creativity, allowing the development of completely new concepts. This experiment is designed to allow you to use some of the elements of scientific investigation mentioned here.

Eight bottles, labeled A through H, containing eight different solutions have been prepared for your examination. When mixed together, in pairs, several of these solutions will undergo a chemical reaction. A chemical reaction can be observed by one or more of the following changes:

1. The formation or disappearance of a **precipitate**, a solid product formed from the mixture of two aqueous solutions. A precipitate often gives a cloudy appearance due to very small solid particles evenly distributed throughout the solution.
2. A color change.
3. The formation of a gas, indicated by bubbles, a process known as **effervescence**.
A change in the odor of the solution also indicates that a gas has been produced.

No change (or No Reaction) is also an observation that must be noted.

By carefully observing any changes that occur (or do not occur) it should be possible for you to obtain enough data to determine the identity of an unknown solution.

PROCEDURE

Obtain a tray with dropper bottles containing solutions labeled A-H. In each dimple of a spot plate, combine 3 drops each of various combinations of two solutions. [i.e.: three drops of A and three drops of B; then three drops of A and three drops of C; etc.] Mix with a clean stirring rod, and record your observations (*color change or precipitate formation along with the color of the precipitate*) in the data table provided. If you detect no change, simply write NR for no reaction.

[Note: To prevent cross contamination, it is important to clean the stir rod between each mixture. You can simply wipe it with a damp paper towel or swish it around in a beaker of water and wipe off between mixtures.]

*Be sure to record your results for each reaction combination in the **two** corresponding boxes on your answer sheet. [i.e. When you mix solutions A and B, record the results under A vs B and B vs A.] When the spot plate is full, simply rinse it off into the waste bottle with distilled water and continue experimenting.

Unknowns: Before obtaining your two unknown solutions, show your instructor your completed data sheet for approval. When you choose two unknowns, they must be at least 10 numbers apart. Record their ID #s on your data sheet. Experiment with your unknown by mixing three drops with the contents of each of the bottles labeled A-H. [Be sure to use a clean eye dropper for each unknown to avoid cross contamination.] Remember to mix only two solutions at a time. Record your observations on the data sheet. Determine what letter bottle (A-H) your unknown is. It is not necessary to determine the chemical makeup of the unknown, only the corresponding bottle letter. If you are unhappy with your results, you may repeat the appropriate steps or choose a different unknown.

Clean up: When you are satisfied with your results, please clean your lab area. Anything you took from a lab drawer should be placed in the drawer where you found it for future labs. Anything you took from the lab cart should be neatly placed back on the cart. *If the lab room and cart are left in a disorderly fashion, ALL students from that lab section will lose points from their lab grade.* Please remember that the sink is NOT a garbage can!

Before next weeks lab, complete the backside of the lab report. The lab report is due at the BEGINNING of the lab period one week from completion. Late labs (any time after the first two minutes of lab) will have points deducted. Labs may be turned in up to one week late for partial credit. After one week, labs are worth ZERO. Two ZERO grades on lab reports will lead to a ZERO for your lab grade and a recommended withdrawal from the course.

If you are absent the week of a lab, you must call your instructor that day and leave a message explaining when you plan to make up the lab. Failure to leave a message will result in your lab being considered late and points deducted. Most labs require the full two hour lab period so you will need to come to another lab section to makeup your missed lab. You have one week to make up the missed lab. Please consult your MHCC schedule guide for days and times of chemistry labs. If you make up a lab, be certain to have that instructor clearly sign and date your lab data page.

Unknown # _____ Bottle ID (A-H) _____

Unknown # _____ Bottle ID (A-H) _____

POST LAB QUESTIONS:

1. Briefly explain how you determined what bottle letter your unknown corresponded to.
2. Briefly explain why you only mixed two solutions at a time and not three or more.
3. How would you detect the evolution of a gas upon mixing the solutions?
4. Which of the A-H "solution(s)" could be distilled water? How do you know?
5. True or False Safety questions (please read page 1 of lab packet "*Laboratory Safety & Etiquette*")
 - _____ a) If unsure how to dispose of chemicals, just flush down the drain with a lot of water.
 - _____ b) It is okay to drink your double mocha latte in lab, especially after a late night studying.
 - _____ c) Always point the open end of a heated test tube toward the top student in the class.
 - _____ d) Bare feet and open toed shoes are permitted in lab on really hot days.
 - _____ e) Obtain a pair of department safety goggles and wear them only when you feel like it.
 - _____ g) Leftover chemicals should be returned to the original bottle to save on costs.
 - _____ h) Leave dirty glassware for the next lab (or instructor) to clean.
 - _____ i) When diluting an acid, pour the acid slowly into water. Never pour water into acid.
 - _____ j) If you finish early and are curious about some possible chemical reactions, it is okay to carry out unauthorized experiments as long as you wear your goggles.