

experiment 6

Ten Test Tube Mystery

LECTURE AND LAB SKILLS EMPHASIZED

- Using solubility rules to test unknown samples.
- Recording detailed observations of chemical reactions.
- Using deductive reasoning to determine identity of solutions.
- Writing net ionic equations.
- Understanding precipitation reactions.

IN THE LAB

- Students will work in pairs.
- Parts must be completed in order.
- Record your procedure and original data in your lab notebook along with your calculations.





- Report data collected and subsequent calculations to www.chem21labs.com.
- *All equipment should be returned to the correct location after use.*

WASTE

- All solutions should be poured in the aqueous waste container.
- The well plate should be rinsed twice into the aqueous waste container with distilled water.

SAFETY

- Gloves and safety goggles are mandatory when anyone is performing an experiment in the lab.
- Wear long pants, closed-toed shoes, and shirts with sleeves. Clothing is expected to reduce the exposure of bare skin to potential chemical splashes.
- Always wash your hands before leaving the laboratory.

Additional information can be found at <http://genchemlab.wordpress.com/6-ten-test-tube/>

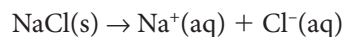
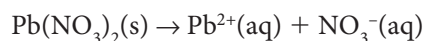
One of the most common problems chemists face is identifying unknown substances. **Qualitative chemical analysis** is the process of identifying the elements or groups of elements present in a given substance. In this case, you are not trying to determine how much of a substance is present (quantitative analysis), simply what the substance is.

Your company has been hired to assist an environmental agency. The agency recently found as part of their yearly inspections several containers that did not comply with standards of correctly labeling chemical supplies. In fact, these containers had no label at all. The environmental agency wants your team to determine the contents of the containers so they can dispose of the substances properly. You will need to submit your report of your findings and your reasoning behind your determination to Chem21.

Observing Chemical Reactions

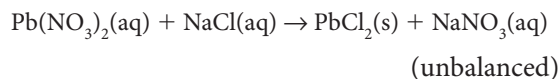
Solubility

Most ionic solids are soluble in water, while others form precipitates (solids) when two aqueous solutions are combined. For example, lead nitrate and sodium chloride are both soluble in water:



If these two solutions are combined, then $\text{PbCl}_2(\text{s})$ will precipitate (form a solid) from the combination of two solutions.

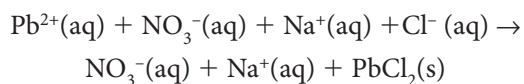
Molecular Equation



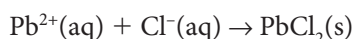


To better explain what is happening chemically, we can examine what's happening to the ions that formed when the two substances were mixed by writing the ionic equation and net ionic equations.

Ionic Equation



Net Ionic Equation



The formation of a solid in this reaction is a key observation that can be used to identify what the original substances are. Chemists look for clues to determine the identity of unknown substances by making observations of things like pH, color, viscosity, smell, and the result of mixing substances together.

For some of the solutions, the basic solubility rules (see Appendix D) will be sufficient to identify them. For others you will need additional information, which is included on the following page. You may notice that some of these facts conflict with the solubility rules you have learned. When solubility is introduced, it is usually an all or nothing thing—soluble or insoluble. The reality is that some soluble substances reach a point where they are no longer soluble and some insoluble species are actually slightly soluble.

The following facts give the information you need to identify each solution in these situations. While these are important for identifying the solutions in this experiment, you do not need to memorize these tips for the exam. However, you will be responsible for knowing the solubility rules.

1. Copper sulfate solutions are blue.
2. Acids will react with sodium sulfide to release a gas, hydrogen sulfide, which smells like rotten eggs.
3. If a base is mixed with NH_4Cl , the odor of ammonia (NH_3) is given off.

4. Ammonia vapor will turn damp litmus paper blue. **Do this test, if needed.** It may need to sit for a few minutes.
5. Silver nitrate will react with compounds containing halogens (Br, Cl, or I) to form white or yellowish precipitates.
6. BaCl_2 will react with H_2SO_4 and CuSO_4 to form a white precipitate, BaSO_4 .
7. CuSO_4 gives an orange-yellow precipitate when mixed with KI, but doesn't give a precipitate with NaBr.
8. A white cloudy precipitate, $\text{Ba}(\text{OH})_2$, forms when an excess of NaOH is added to BaCl_2 .
9. HCl will react with AgNO_3 to produce a white precipitate, AgCl.
10. AgCl forms a white precipitate while AgBr forms a creamy or light-yellow color precipitate.

Testing for Acidity

Both litmus paper and pH paper can be used to determine the acidity or basicity of a solution. These indicator papers contain chemicals which have different colors in the presence of an acid or base.

Litmus paper can be used to determine whether a solution is acidic or basic. Pale lavender strips of neutral litmus paper turn red when exposed to acid and blue when exposed to base. In neutral solutions, the color of the paper does not change.

While litmus paper indicates only whether a solution is acidic, basic, or neutral; pH paper indicates the approximate pH of the solution. The pH strips are tan and change from red to orange to green to blue as the value of the pH changes from acid ($\text{pH} = 1$) to basic ($\text{pH} = 12$). A color chart is included on the tube for comparison.

The correct way to use pH or litmus paper is shown in Figure 6.1. Dip a clean, dry stirring rod into the solution to be tested and then touch the paper with the stirring rod. Do **not** dip the paper into your solution. Since it only takes a drop to test the solution, tear the paper strips in half before using them.

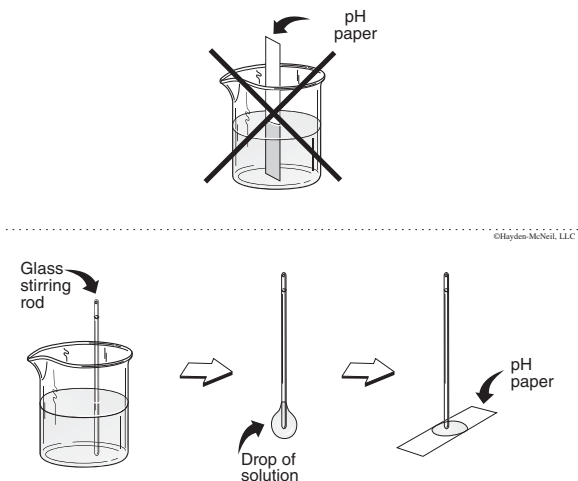


Figure 6.1. Testing the pH of a solution.

The solutions being tested include the following:

Name	Type
ammonium chloride, NH_4Cl	salt
barium chloride, BaCl_2	salt
copper sulfate, CuSO_4	salt
hydrochloric acid, HCl	acid
potassium iodide, KI	salt
silver nitrate, AgNO_3	salt
sodium bromide, NaBr	salt
sodium hydroxide, NaOH	base
sodium sulfide, Na_2S	salt
sulfuric acid, H_2SO_4	acid

Materials and Procedures

solutions A–J	test tube rack
96-well spot plate	Q-tips
24-well plate	litmus paper
ten semi-micro test tubes	pH paper
ten droppers	wash bottle

1. Obtain the 96- and 24-well plates and clean them thoroughly with Q-tips and soap. Rinse completely and dry.

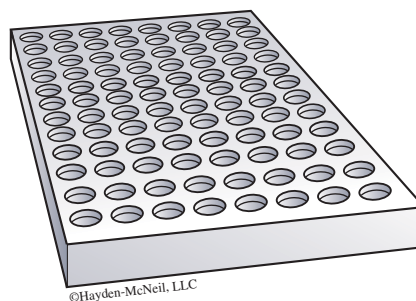


Figure 6.2. Well plate for microscale reactions.

2. The following table can give you a template for using the well plate and as a suggested data table for recording the results of the tests in your lab notebook. Record litmus paper tests in the last box in each row.
3. Use litmus paper to test each of the solutions by placing one drop of the solution on the litmus paper with a stirring rod. Do not put the litmus paper into the test tubes.
4. You will need to see how each solution reacts with every other solution. You must do this systematically since you will be doing many tests.
5. Using your semi-micro test tubes, obtain 1–2 mL of each of the solutions A–J ($\sim\frac{1}{2}$ full). Place one of the droppers in each test tube so that you have a dropper to use for each solution. Be careful not to mix up the droppers in the solutions.
6. For each test, place two drops of each solution into one of the well plates and record your observations. Only two of the original solutions should be combined at one time. Continue this until you have made all possible combinations of the ten solutions.



A										
B										
C										
D										
E										
F										
G										
H										
I										
J										
	A	B	C	D	E	F	G	H	I	J

Any key can be used to record your data as long as there is a legend included so that others can understand the results of the test. Some suggestions for the key:

No reaction = NR

Color of precipitate = color PPT (i.e., white PPT)

Data Analysis

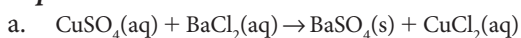
Make sure to show all of your calculations in your lab notebook as a record of how you completed your calculations. Don't forget to include your units and correct number of significant figures! Then, go onto Chem21 and report your results.

1. Identify each of the ten solutions.
2. Explain how you identified each solution. Each identification should have **at least two different** pieces of supporting evidence and/or reactions to make your case. The net ionic equation for the reaction must be shown separate from your two pieces of evidence:

Identification:

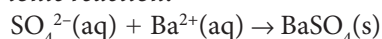
Solution Z is Number 3 (CuSO_4) in the unknown key.

Explanation:



b. Copper sulfate solutions are blue.

Net ionic reaction:



Please note that if I wrote "copper sulfate reacts with barium chloride to produce solid barium sulfate," this would be the **same** thing as given in part a of the example. For your explanations, you need two **different** pieces of evidence.

Any evidence must be based on data you collected and reported in your lab notebook and worksheet.



EXPERIMENT 6: TEN TEST TUBE MYSTERY