



# Test Tube Mystery

## Topic

Observing chemical reactions, using logical deduction

## Introduction

Like detectives, chemists attempt to identify unknowns through a process of careful and creative analysis. This often requires observing reactions involving unknown substances and comparing them with the reactions of known substances. In this experiment you will try to identify ten different chemical compounds by reacting them with each other, observing the results, and then comparing the results with the known characteristics of some common chemicals.

## Time required

2 hours

## Materials

spotting plate  
 red and blue litmus paper  
 box containing 10 dropping bottles of solutions numbered in sequence from 1 to 10. The bottles contains a 0.1M solution of one of the following compounds:

	compound type
ammonium chloride ( $\text{NH}_4\text{Cl}$ )	salt
barium chloride ( $\text{BaCl}_2$ )	salt
copper sulfate ( $\text{CuSO}_4$ )	salt
hydrochloric acid ( $\text{HCl}$ )	acid
potassium iodide ( $\text{KI}$ )	salt
sodium bromide ( $\text{NaBr}$ )	salt
sodium hydroxide ( $\text{NaOH}$ )	base
sodium sulfide ( $\text{Na}_2\text{S}$ )	salt
sulphuric acid ( $\text{H}_2\text{SO}_4$ )	acid
silver nitrate ( $\text{AgNO}_3$ )	salt

safety glasses

lab apron

plastic gloves

## Safety note



**A teacher must supervise this experiment and should prepare the solutions in advance. All solutions should be treated as if they were poisonous and corrosive. Solutions of barium chloride and copper sulfate are harmful if swallowed. If you spill any solution on yourself, wash it off immediately with large amounts of water. Avoid inhaling fumes. Wear safety glasses, a lab apron and gloves. Clean up all residues. Dispose of all chemicals in the approved manner.**

## Procedure



Your goal is to identify which solution is in each bottle. You will work this out by testing each solution with litmus paper and by combining all possible pairs of the solutions (1 with 2, 1 with 3, etc). After describing each reaction in the data table and thinking carefully about the facts listed in the analysis section, you should be able to identify each solution.



1. Put two drops of solution 1 on the spotting plate. Do not poke the end of the dropping bottle into the liquid in the spotting plate. Screw the top back on the bottle tightly after you have used it.



2. Test solution 1 with red litmus paper and then with blue litmus paper. Write the result in the top box on the data table. If the solution turned red litmus paper blue, write R to B. If it turned blue litmus paper red, write B to R. If there was no reaction, write NLR. This stands for no litmus reaction.



DATA TABLE											
Number of solution	Name of solution	1									
1			2								
2				3							
3					4						
4						5					
5							6				
6								7			
7									8		
8										9	
9											10
10											


3. Wash and rinse the spotting plate.

4. Put two drops of solution 2 on the plate, test it with red and blue litmus paper, and note the results on the data table in the far right box of horizontal row 2.

5. Now, combine two drops of solution 1 with two drops of solution 2 on the plate. Observe the reaction and describe it in the box on the data table where vertical column 1 meets horizontal row 2. Write color PPT for the color of any precipitate and write NR for no reaction.

6. Continue in this way until you have filled in every box on the data table. This means you will have tested each individual solution with litmus paper and will have combined all possible pairs of solutions. Remember not to touch the top of any bottle to the plate, to wash and rinse the plate after each combination, and to screw the bottle caps on carefully after each use.

## Analysis

1. Compare the observations recorded on your data table with the following:
  - a. Acids turn blue litmus paper red.
  - b.  $\text{CuSO}_4$  solutions are blue.
  - c. Bases turn red litmus paper blue.
  -  d. Acids will react with  $\text{Na}_2\text{S}$  to release a gas, hydrogen sulphide ( $\text{H}_2\text{S}$ ), which smells like rotten eggs. *It is very poisonous, so be very careful.*
  - e. If a base is mixed with  $\text{NH}_4\text{Cl}$ , the odor of ammonia ( $\text{NH}_3$ ) is given off. Ammonia vapor turns damp red litmus paper blue.
  - f.  $\text{AgNO}_3$  will react with halogen-containing compounds – chlorides (Cl), bromides (Br), and iodides (I) – to form white or yellowish precipitates.
  - g.  $\text{BaCl}_2$  will react with  $\text{H}_2\text{SO}_4$  and  $\text{CuSO}_4$  to form a white precipitate,  $\text{BaSO}_4$ .
  - h.  $\text{CuSO}_4$  gives an orange-yellow precipitate when mixed with KI, but does not give a precipitate with NaBr.
  - i. A white cloudy precipitate,  $\text{Ba}(\text{OH})_2$ , forms when an excess of NaOH is added to  $\text{BaCl}_2$ .
  - j. HCl will react with  $\text{AgNO}_3$  to produce a white precipitate, AgCl.



You should be able to identify each solution using logical reasoning and the process of elimination. Write its name next to its number in the data table.



2. After you have identified all the solutions, write balanced equations for each of the reactions you performed.

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Using logical deduction, students should be able to identify all compounds used. The symbol equations for the reactions are as follows:

