

IDENTIFYING UNKNOWN CHEMICALS IN SCIENCE LABS

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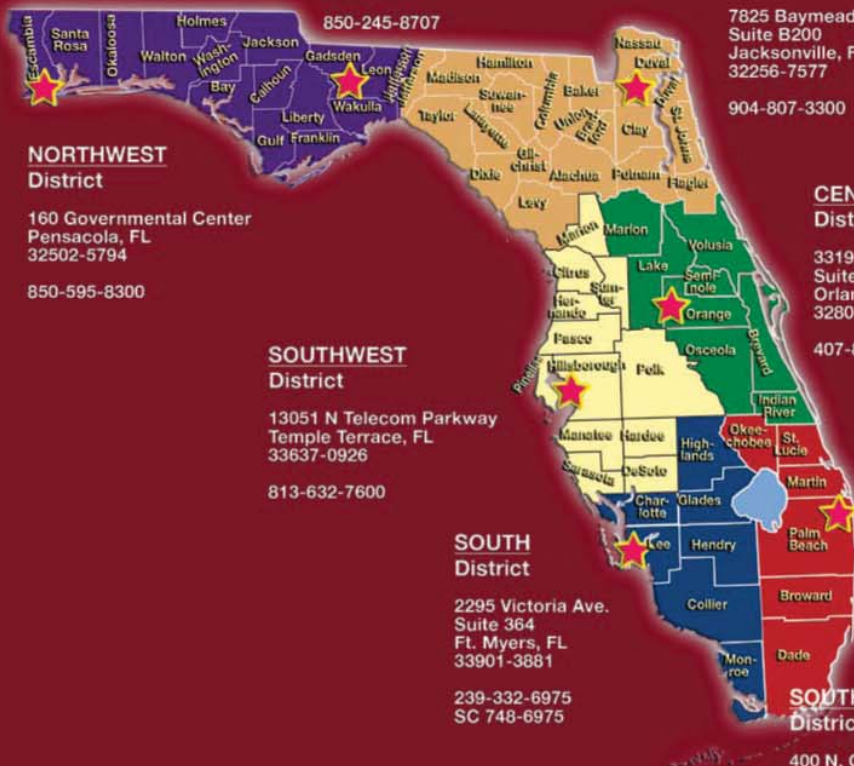
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When a chemical or solution has not been labeled, was improperly labeled, or its label has deteriorated, become obscured or illegible, it becomes an unknown. Fortunately, it is not necessary to know the exact identity of an unknown. It is usually sufficient to determine if an unknown is a hazardous material, and if it is, to assign it to an appropriate hazard class for safe transportation, treatment, and disposal. Many unknowns turn out to be perfectly harmless chemicals that could be disposed of as ordinary waste, or moderately hazardous chemicals that can be easily treated to render them non-hazardous. (The Flinn Chemical and Biological Catalog Reference Manual describes many examples in detail.)



You, the teacher, can often deduce the identity or at least the hazard class of unknowns. You know what chemicals are currently being used for experiments and demonstrations in your classes and may well have an idea of what chemicals were used in the past. Inventories, even out of date ones, are useful for suggesting what an unknown might be. Any information can provide hints.



Physical characteristics, such as color, type of crystal and density can suggest what an unknown might be. For example, a bright blue crystal suggests copper sulfate; a very heavy crystal might be a lead salt; a yellow solution could be a chromate, iron, or iodine. Simple tests can confirm these possibilities.



Hints From the Container: The type and condition of a chemical's container offer clues as to the identity of its contents. Chemicals are often sold in distinctive containers. For example, clear glass bottles with color-coded caps suggest acids or ammonium hydroxide, brown bottles suggest organic solvents, steel cans with screw tops often contain ethyl ether, and so on. Even the size of the container can provide a hint as to its contents; large containers generally contain common reagents or solvents.



A plastic bottle that has swollen or even been split by pressure from its contents probably contains a material that has reacted with air or water, such as anhydrous calcium oxide.



Old containers of sodium or potassium hydroxide often have formed a "crown" of carbonate salts around their lids. Caps on bottles of hydrochloric acid and ammonium hydroxide will, if stored in proximity to one another, form a "wig" of ammonium chloride crystals.

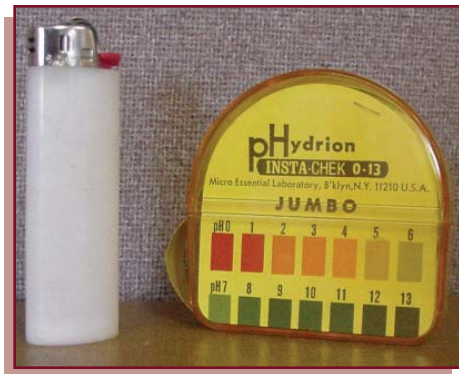
If a container has even a fragment of a label still on it, you may be able to glean enough information to identify its contents or at least narrow the possibilities. Perhaps the partial label indicates part of a name, molecular weight, boiling or melting point, warning statements, or even the antidote; all these are valuable clues.



WARNING! While the crystals in the examples above are harmless, crystals around the cap or inside a bottle of certain solvents could be extremely dangerous peroxides. Do not open or even touch a container of one of these chemicals or of an unknown solvent if such crystals are visible.

Often unknowns are in volumetric or Erlenmeyer flasks or in beakers. Volumetric flasks usually contain standard solutions, commonly an acid, base or buffer. If the flask has been covered in aluminum foil, its contents are probably a light-sensitive compound, such as silver nitrate. Liquids in small dropper bottles are likely to be test solutions or indicators. Very often, some bottles are labeled while others are not; the appearance and characteristics of the contents of the labeled ones will help identify those that are unlabelled.





Tests: One can learn a good deal about a chemical simply by measuring its pH and determining if it is flammable. Often, this information is enough to know how to package and dispose of the unknown chemical.

pH: Hold a strip of broad-range pH paper over the mouth of an unknown liquid. Fumes from concentrated hydrochloric acid and concentrated nitric acid will cause the paper to turn red without even touching the liquid. Fumes from ammonium hydroxide, even fairly dilute solutions, will turn the paper green. If no color change occurs, wet the pH paper with the liquid. If the paper indicates an acidic solution, it could be an acid, an ester or a solution of an acidic salt. If the solution is basic, it could be a solution of a hydroxide, a basic salt or an amine. Any solution having a pH equal to or less than 2.0, or equal to or greater than 12.5 is a corrosive hazardous waste.

Flammability Test, Liquid: Using a lighter or Bunsen burner, try to light the wetted pH paper. If the material burns, observe how it burns. Light-weight alcohols burn with a nearly invisible flame; simple alkanes burn fairly cleanly, while aromatic compounds or those with double or triple bonds will produce a smoky flame. If the compound contains a significant amount of halogens, nitrogen or sulfur the pH paper will turn red due to the acidic products of combustion. All flammables should be handled as hazardous waste.

WARNING! Because many substances give off toxic fumes when heated, perform this test only in a functioning fume hood and use great care.

Flammability Test, Solid: This test can determine if a solid material is organic or inorganic. The burn test can be performed in a steel spoon or in a test tube. Place a small sample in the spoon or test tube and gently heat. Any organic material will burn if it gets hot enough, producing smoke and often the black residue of elemental carbon. Most inorganics will not burn; the exceptions are some metals (especially fine powders), hydrosulfites and sulfur. Burned metals will leave some residue (their oxides), white or colored (this can give you a clue as to the identity of the metal.) Sulfur will melt into a red-brown liquid that will then burn with a blue-purple flame.

Solubility Test: What solvent a substance will dissolve into gives hints as to its identity ("like dissolves like"). Some materials generate heat when they dissolve in water, others absorb heat from their surroundings and the solution becomes cold; this characteristic can help identify the substance. A material that is insoluble in water but soluble in acid is either a metal or a base. (Aluminum is one metal that will dissolve in a basic solution.) A material that is insoluble in water but soluble in a basic solution is an acidic compound.

Heavy Metal Test: Add a few drops of sodium or ammonium sulfide solution to the unknown solution. If a precipitate forms, there is a heavy metal present. Go to specific tests to determine which one it is.

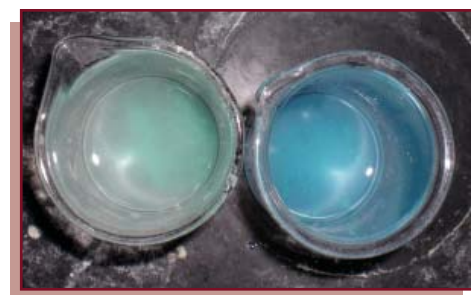
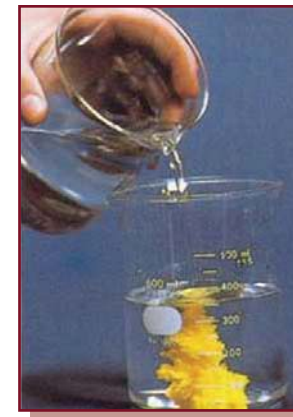
Arsenic: Arsenic will not form a precipitate with sulfide, because arsenic sulfide is fairly soluble in basic solution. But if the unknown solution turns yellow or orange upon the addition of sulfide, carefully lower the pH with dilute HCl. If arsenic is present, the yellow arsenic sulfide will precipitate out as a cruddy mass.

WARNING! Before you add acid to any unknown basic material, check to be sure that it's not cyanide!
(See cyanide test.)

Chromate: The chromate ion is yellow, the dichromate ion is orange. Both can be confirmed by the addition of sodium hydrosulfite. If a yellow or orange solution is strongly acidic, adjust the pH to slightly acidic before you add the hydrosulfite. The yellow Cr+6 ion will be reduced to the green Cr+3 ion. (Chromic acid that has been used for cleaning may have already turned green.) Chromate can also be detected by adding a few drops of lead nitrate to the unknown; a precipitate of yellow lead chromate confirms.



Lead: Lead in solution can be detected by adding the chloride or iodide ion. Lead forms a white precipitate with chloride and a yellow one with iodide. The presence of lead must be confirmed by adding chromate to another sample of the unknown; a brilliant yellow precipitate confirms lead.



Copper: The addition of a few drops of ammonium hydroxide to a solution of copper salts turns the solution a much deeper blue due to the formation of the complex copper-ammonium ion.

Iron: Fe(II) is greenish in solution. Its presence can be confirmed by the addition of potassium ferricyanide which will produce a brilliant blue precipitate. Fe(III) is yellow in solution. Its presence can be confirmed by the addition of potassium thiocyanate which will turn the iron solution a deep red color.



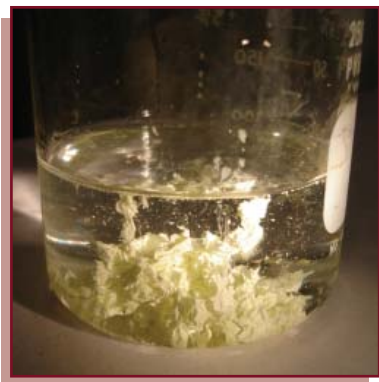
Silver: You can check for silver in solution with a bright copper penny. Cover the penny with the unknown, if silver is present it will plate out onto the penny, turning it black.

Cation Test: A common source of unknowns in school laboratories is the solutions of salts used in the laboratory experiment of flame spectroscopy to identify cations. The same technique used in this experiment can help identify unknowns.

Oxidizer: Wet a piece of potassium iodide-starch paper with HCl diluted 1:3 with water and immerse in or touch to the unknown. If it's an oxidizer the paper will turn blue-black. An alternate test is to mix the suspected oxidizer with flour or sugar in a steel spoon as described in the flammable test. If the unknown is an oxidizer the mixture will burn much more vigorously than flour or sugar by itself.

Reducing Agents: Reducing agents such as sodium hydrosulfite and formaldehyde will convert the yellow Cr+6 ion to the green Cr+3 ion. Add a slightly acidic solution of chromate or dichromate to the unknown and look for the color change.

Cyanide: Add table salt to the unknown solution to provide an excess of the chloride ion. Add a few drops of silver nitrate to the solution. If a white precipitate of silver chloride forms, no cyanide is present. If no precipitate forms, cyanide (or ammonia, but you've already checked for that) is present. This is because silver forms a complex, soluble ion with cyanide.



Iodine: Iodine dissolves somewhat in water to produce a brown solution, and readily dissolves in alcohol to produce a brilliant purple solution. Its presence can be confirmed by adding a pinch of flour to its aqueous solution; look for that blue-black complex.

Lecture Bottles: To identify an unlabeled cylinder of compressed gas, contact the manufacturer, if known. If not known, request the assistance of the Environmental Health and Safety Department of a university. Do not depend upon the color of the cylinder, as color-coding is not standardized.

These simple tests are a few examples of those available to identify or at least categorize unknown chemicals commonly found in school laboratories. More tests can be found in textbooks on qualitative analysis, and there is a wealth of information about identifying chemicals on the Internet. One example of a searchable database is www.cameochemicals.noaa.gov. And remember, the best solution to the problem of unknown chemicals in schools is having good labels!

Where can I get more information?

The **School Chemical Clean-Out Campaign (SC3)** can provide you with information on safe chemical management and how to conduct an inventory of your school's chemicals. The goal of **SC3** is to create a chemically safer school environment in which chemicals are purchased wisely, stored safely, handled by trained personnel, used responsibly, and disposed of properly. To accomplish this goal, **SC3** provides both classroom style and hands-on training seminars for teachers and other school staff.

For information, please call 850-245-8707.

You may also visit the **SC3** website at:
www.dep.state.fl.us/waste/categories/hazardous/pages/schoolchemicals.htm



This booklet was published by the
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This document was published to help science teachers identify unknown chemicals or solutions they may have found in classroom science laboratories in order to safely and properly dispose of those chemicals. It is not intended to determine the regulatory status of chemicals or compliance with local, state, and federal regulations. The information in this document should only be used by school staff trained to manage laboratory chemicals. The Department of Environmental Protection is not responsible for any accidents that may occur as a result of using the procedures described in this document.