

Laboratory Chemical Disposal

- General guidelines
- Chemical disposal procedures
- Biological disposal procedures

The Basics of Laboratory Chemical Disposal

Before You Undertake Any Disposal Procedure—Please Read this Narrative!

Chemical disposal is a normal part of teaching high school science. If you have a hands-on science program, if your students are actively involved in performing experiments and demonstrations, then you will generate some leftover chemicals, solutions, and chemical byproducts that will require proper disposal. Advance planning and preparation will help you minimize the amount of hazardous waste generated and reduce the time and resources needed to dispose of excess nonhazardous chemicals or chemical byproducts.

Every school should have a *Chemical Hygiene Plan* that outlines appropriate policies and procedures for the disposing of laboratory chemical byproducts and correctly identifying hazardous waste requiring licensed disposal. The first step in any laboratory waste policy should attack the problem at its source—where and when waste is generated. Careful planning, tailoring lab activities to science standards, adopting microscale lab techniques, and substituting safer chemicals will help you reduce the amount of waste generated. (See the article "17 Steps to Minimize Chemical Disposal" on page 1190.)

Laboratory chemical disposal requires specific knowledge and procedures. Knowing the type of sewer system your school has and understanding any federal, state, and local regulations that may apply are important steps in laboratory chemical disposal. Before you choose a disposal method, it is absolutely essential that you review your plans with regulatory officials. Do not assume that because we publish a set of disposal methods, these methods are "approved" or have the "blessing" of regulatory officials—NOT SO! In publishing laboratory waste disposal methods, we assume that:

- ▶ You will consult with local regulatory officials before proceeding
- ▶ You will act responsibly with respect to all regulations
- ▶ The quantity of material involved is very small (i.e., laboratory quantities)
- ▶ Only competent science teachers will attempt the methods

DO NOT USE THESE METHODS if the methods do not meet local regulations, if the quantity of material is not small, or if you are not comfortable with a disposal procedure.

Advance knowledge, preparation, and planning will also allow you to dispose of laboratory chemicals safely and promptly without straining your school's resources. There are three main categories of laboratory waste generated in high school science programs:

- ▶ Biological waste (preserved materials, "live" material remains, culture products)
- ▶ Chemical waste (unused testing solutions, reaction products, stains and indicators)
- ▶ Hazardous waste requiring licensed disposal.

Biological Waste from Life Science Experiments

High school life science experiments will sometimes produce hazardous biological waste. Special attention should be paid to all microbiological culture products since they may contain harmful organisms. Preserved materials, deceased living materials, and all "sharps" also deserve special attention prior to disposal. To assist with handling biological wastes, Flinn Scientific has developed a biological waste disposal procedure. Please review pages 1215–1216 for a thorough discussion and detailed procedures for the safe disposal of biological waste materials.

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Chemical Byproducts from Laboratory Experiments

Before performing any activity in a high school science laboratory, review the properties of the chemicals required and any products that may be generated. If the reactants or products present unique hazards or will require specialized disposal (e.g., flammable organic solvents), consider modifying the experiment or finding a different experiment that will teach the same concept. Flinn Scientific maintains an extensive library of tested laboratory activities for every principle and concept taught in high school chemistry. Please call (1-800-452-1261) or e-mail us (flinn@flinnsci.com) for suggestions of safe laboratory activities.

Most of the chemicals used or generated in middle school science activities may be easily disposed of using one of a dozen simple disposal methods. Other chemicals, in particular heavy metals and flammable organic compounds, require licensed disposal procedures. Please review the *Suggested Chemical Disposal Methods* listed on pages 1193–1216 for descriptions of the methods, materials, and procedures required for disposal of routine chemical byproducts or excess and leftover chemicals in the high school chemistry laboratory.

The catalog entry for every chemical listed in the *Chemicals* section of this *Flinn Scientific Catalog/Reference Manual* specifies a Flinn Suggested Disposal Method number in the product description. Simply look up the product in the alphabetical section of the chemical listings and determine the disposal number. Then refer to this Suggested Disposal Method in this *Reference* section.

For best results, incorporate treatment of leftover chemicals and reaction byproducts into any laboratory activity involving chemicals. Collect all solutions or similar products in a centrally located container. For example, if students are working with acidic solutions having a pH <3, have them pour their products into one beaker placed in the hood or other central location. The acid solution may then be neutralized with base according to *Flinn Suggested Disposal Method #24b* at the end of the lab period. Making disposal a routine part of every lab activity teaches students that concern for the environment is everyone's responsibility and that scientists working in the lab also take this responsibility seriously.

Note: For hazardous waste containing heavy metals (e.g., Cr, Hg, Pb), we recommend collecting the material in a labeled plastic waste container and contracting with a licensed waste disposal firm once a year for disposal.

Inventory Management and Laboratory Chemical Disposal

Managing the chemical inventory in the school is an important part of reducing the amount of laboratory waste and the impact of hazardous waste disposal on the school's budget and resources. Chemicals, supplies, and equipment tend to accumulate over time. The school's *Chemical Hygiene Plan* should include regular inventory audits and clean-ups (weeding out) of the science storerooms. Any comprehensive clean-up will likely generate some types of nonroutine laboratory waste—disposal of this material usually requires more extensive planning and preparation. If a school administrator or inspector has decided that the storeroom must be cleaned out and all hazardous chemicals removed, please ask for and allow enough time to examine

Continued on next page.

The Basics of Laboratory Chemical Disposal, continued

all disposal options. Hurried solutions to waste disposal problems are almost always expensive and frequently poorly done.

The first step in any large-scale cleanup and disposal project is determining what items will require disposal. Prepare an inventory of all chemicals, supplies, and equipment and identify what you want to keep. Materials that are broken, unusable, or no longer part of the curriculum should be disposed. This is particularly important for laboratory chemicals and preserved materials, which often have limited shelf-lives or life spans. The chemical inventory should include the full name of each chemical, whether it is a solid or a liquid, the quantity printed on the bottle's label, and the number of bottles of each size. In the case of chemical "unknowns," list each bottle as an unknown and estimate the volume of the bottle. (The size of the bottle is often more important than the quantity of material, because the whole bottle must be removed and shipped to a disposal facility.)

Most supplies and equipment that are no longer needed may be disposed of with the school trash. To reduce the possibility that students will discover and play with any discarded laboratory supplies, double or triple bag the items in dark trash bags and place the bags directly into the school's dumpster.

The properties of all chemicals requiring disposal must be researched prior to disposal. Determine which chemicals may be disposed of in the trash or down the drain by looking at the Flinn Suggested Chemical Disposal Method number listed on the label or in the *Flinn Scientific Catalog/Reference Manual*. Contact local authorities to verify that these chemicals can be disposed of locally.

Chemicals that must be disposed of using special methods or by a licensed hazardous waste disposal firm require special attention. The following options may help you in your planning:

Option A — Contact a chemistry teacher or science chair at other local high schools or districts. You may be able to share materials with another school. Your district or a neighboring district may have an on-going chemical disposal program or may be able to provide advice on local disposal firms.

Option B — Contact the state department of education. Many states have a state science supervisor who may be able to advise you about existing disposal programs. Flinn Scientific maintains a current list of state science administrative personnel—please call or write us for the name and address of your state contact.

Option C — Contact an officer of the state science teachers' professional association. Use the experience of other teachers who have faced similar problems to help your school deal with its waste disposal issues.

Option D — Contact the chemistry department chair at a nearby college or university for advice. Most colleges and universities have on-going hazardous waste disposal programs and may be able to help.

Option E — Contact the state Environmental Protection Agency (EPA) and discuss the problem with an agency representative. The agency will be able to provide you with a list of licensed waste disposal firms and may have valuable suggestions about state disposal programs.

Option F — Contact the local section of the American Chemical Society (ACS). (Any area with chemical industries is likely to have a local ACS section.) Local ACS section officers may be able to give you the name of a contact person who can provide advice and recommendations regarding chemical disposal.

Option G — Contact a local company for assistance. Many commercial enterprises generate small volumes of hazardous wastes that must be disposed of on a regular basis. Adding small amounts of similar materials may not increase the company's costs for disposal. Enlist your students' participation to identify firms that may be willing to help. (Offer students extra credit for each firm they find.) The next step is to visit these firms. Make sure the list of chemicals needing disposal is up-to-date and neatly prepared. Ask to talk to the President (of a small firm) or the Plant Manager or Safety Director (of a larger

facility). Explain the school's disposal options, show them the chemical inventory, and ask if the company disposes of similar materials. If they do, ask if they could help the local school by including some of the school's chemicals the next time they dispose of chemicals.

Option H — Contract with a licensed hazardous waste disposal firm for removing the chemicals. Because this is an expensive option, it is important to choose a licensed and reputable firm. Remember that the school has cradle-to-grave responsibility for its chemicals—documented proof that the chemicals have been properly disposed is required.

- ▶ Ask for and check references to make sure the firm is reputable and reliable.
- ▶ Do not automatically choose the low bid!
- ▶ Request a certificate of disposal for the chemicals.

Chemical removal and laboratory waste disposal are serious issues facing every school. Examine options carefully and responsibly before acting—do not act in haste. If a laboratory waste disposal problem must be resolved immediately due to a complaint or citation, then disposal by a licensed waste disposal firm, although expensive, may be the only feasible option.

Flinn Suggested Laboratory Chemical Disposal Methods

Flinn Scientific has been publishing suggested laboratory chemical disposal methods for more than 25 years. Each chemical in the *Flinn Scientific Catalog/Reference Manual* has a disposal number under its name. The disposal number refers to one of the suggested disposal procedures listed in this section. As federal, state, and local regulations have changed, however, some of the disposal procedures are no longer allowed. Flinn has updated or deleted some disposal procedures that are deemed unacceptable. Before attempting any disposal procedures, it is essential that you check local regulations to determine if it is still allowed in your locale.

Before attempting any disposal procedure, the following safety rules must be followed:

- ▶ Never work alone—always have a laboratory partner
- ▶ Always wear appropriate personal safety equipment
- ▶ Perform all procedures in a laboratory environment with good ventilation

If you have any questions concerning laboratory chemical disposal methods, please call (1-800-452-1261) or e-mail (flinn@flinnsci.com) the Technical Services department at Flinn Scientific Inc.

Did You Know It Is Always Yours?



Hazardous waste chemicals from your school are yours **FOREVER!** Yes, your school as the generator is held responsible in perpetuity for hazardous waste. Even if you hire a firm to remove the material from your school it remains yours forever. With that in mind, always know and get references for a firm you hire to remove such materials. As one teacher belatedly said after a sad series of disposal events, "I should have known I was in trouble when they came in a rented truck."

Disposal Procedures

FLINN METHOD

#1a Organic Acid Halides and Acid Anhydrides

Products in this class readily react with water, amines, and alcohols. They are also generally corrosive and their vapors are lachrymators. Most organic acid halides can be decomposed to water-soluble products of low toxicity that can be flushed down the drain. Heat may be liberated during this process. The heat can be controlled by immersing the reaction vessel in a larger container of ice water.

Examples

Acetyl chloride, adipoyl chloride, and acetic anhydride

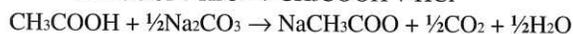
Materials Required

Chemical-resistant gloves
 Chemical-resistant apron
 Chemical splash goggles
 Fume hood or excellent ventilation
 Large glass or polyethylene container
 Saturated solution of sodium carbonate (200 g Na₂CO₃/L), enough for twofold molar excess
 Stirring rod
 Hydrochloric acid, HCl, 3 M
 pH indicator paper
 Ice-water bath (optional)

Chemical Concept

Organic acid halides are derived from organic acids by replacing the ionizable hydrogen atom of the acid with a halogen atom, usually chlorine. These substances react with water to form the original organic acid and hydrogen chloride, both of which will usually dissolve in excess water and form an acidic solution. This is the reason these compounds are corrosive and are lachrymators: their vapors react with the tears (mostly water) that bathe your eye and make them acidic. The disposal method involves two simultaneous steps. The saturated sodium carbonate solution contains both water and a base, sodium carbonate. The organic acid anhydride or halide reacts with the water, and the products of that reaction, which are acidic, immediately react with the sodium carbonate to form salts of the acids. These salts are innocuous and may be flushed down the drain. Gaseous carbon dioxide also forms, which will produce a fizzing as the reaction proceeds.

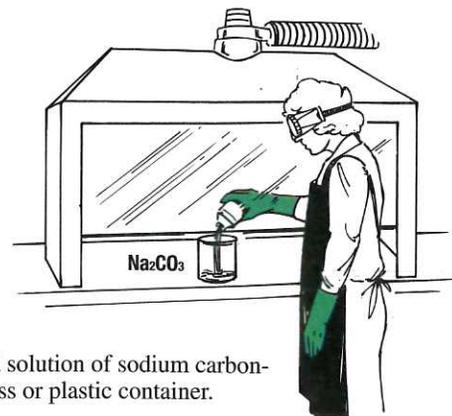
In the case of acetyl chloride, the reactions are as follows:



Note that one mole of sodium carbonate is required to fully neutralize one mole of the original acid halide or acid anhydride. There should be plenty of excess water in the saturated sodium carbonate solution to provide the initial reaction. To push the reaction to completion, a twofold molar excess of sodium carbonate is recommended. At 25 °C, a saturated sodium carbonate solution contains about 2 moles of sodium carbonate per liter of solution. Sodium hydroxide solution (2 M) can be substituted for saturated sodium carbonate in this procedure.

Both adipoyl chloride and sebacoyl chloride contain two chlorines per molecule. Therefore a fourfold molar excess of sodium carbonate solution should be used to neutralize these compounds.

Procedure



1

Place the saturated solution of sodium carbonate in the large glass or plastic container.



2

Slowly add a few milliliters or grams of the acid halide or anhydride to the container while constantly stirring. You can tell that the decomposition reaction is beginning if the material dissolves. The evolution of gaseous carbon dioxide should also be evident.

3

If a noticeable temperature rise is observed in the solution, place the container in the optional ice-water bath. This may occur with acetic anhydride.



4

Continue slow addition of the acid halide while stirring until all the compound has been consumed.

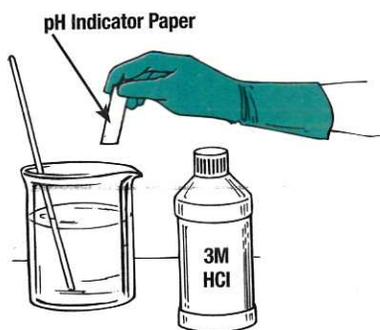
FLINN METHOD #1a continued on next page.



Please...Read the Narratives

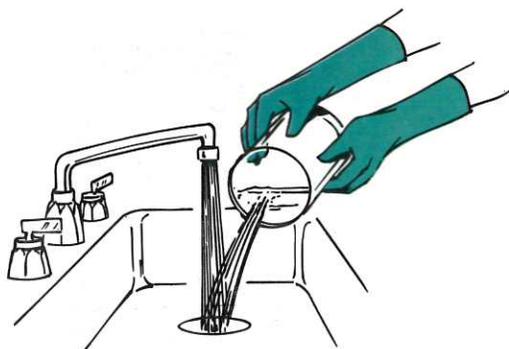
Important narratives precede these specific chemical disposal methods! Please read each narrative carefully! Do not use these procedures if you are not comfortable with the chemistry. Do not use these procedures without *first consulting with your local government regulatory officials*. These procedures may not be used in some jurisdictions. These procedures may be dangerous. Once again...read the narratives that precede these specific chemical disposal methods.

Flinn Method #1a, continued



5

When a clear solution has been obtained, cool it to room temperature and neutralize it to pH 7 with the 3 M hydrochloric acid.



6

Flush the neutral mixture down the drain with a 20-fold excess of water.

FLINN METHOD

#1b Water-Reactive Metal Halides

Products in this class are quite reactive with water and evolve heat during the reaction. Such reaction products are strongly acidic. Water-reactive metal halides must not be allowed to come into contact with wastes containing water. They can generally be decomposed to products suitable for flushing down the drain by reacting them with a large excess of cold water and neutralizing the resulting acidic solution.

Examples

Aluminum chloride (anhydrous) and tin (IV) chloride

Materials Required

Chemical-resistant gloves

Chemical-resistant apron

Chemical splash goggles

Fume hood or excellent ventilation

Large glass or polyethylene container, $\frac{3}{4}$ filled with ice/water slush

Stirring rod

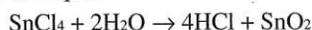
Sodium hydroxide solution, NaOH, 3 M or

saturated sodium carbonate solution, Na_2CO_3

pH indicator paper

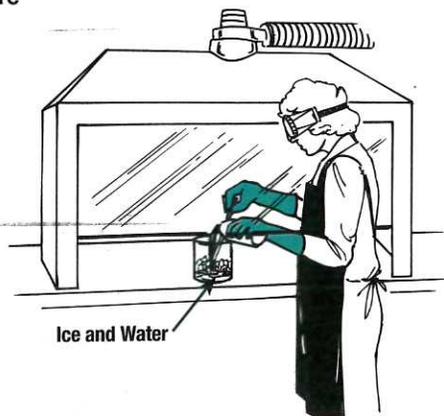
Chemical Concept

As described above, these substances react with water, and the products are acidic. For example:



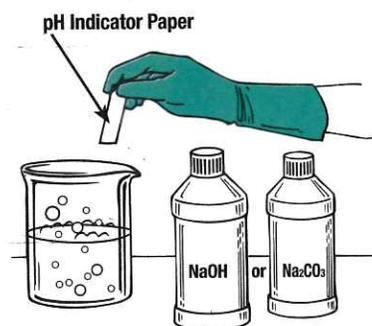
The HCl formed will dissolve in the excess water. It is neutralized with either sodium hydroxide (to form sodium chloride and water) or with sodium carbonate (to form sodium chloride, gaseous carbon dioxide and water).

Procedure



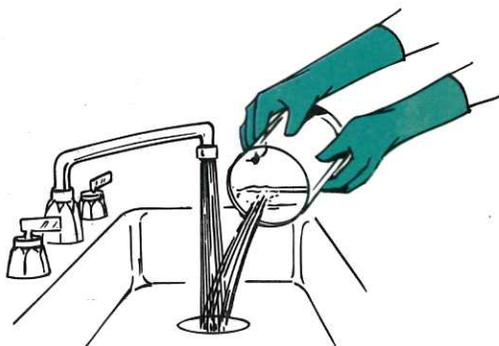
1

Prepare an ice/water slush in a large glass or polyethylene container. Slowly add the water-reactive metal halide directly to the ice/water slush with constant stirring. Aluminum chloride reacts vigorously with water. Be cautious to avoid localized overheating.



2

When all the compound has been added to the water, allow the mixture to come to room temperature and neutralize to pH 7 with sodium hydroxide or sodium carbonate solution. If you use sodium carbonate solution, expect some evolution of carbon dioxide gas during neutralization. A thick white precipitate of aluminum or stannic oxide will form.



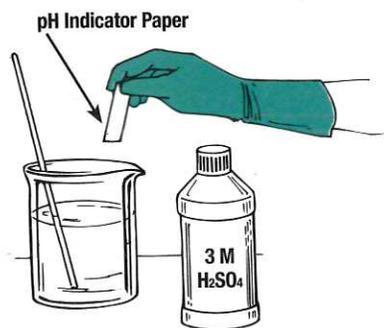
3

Let the mixture settle overnight and then decant the liquid to the drain with a 20-fold excess of water. The solid residue can be disposed of in the trash.

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Flinn Method #2, continued

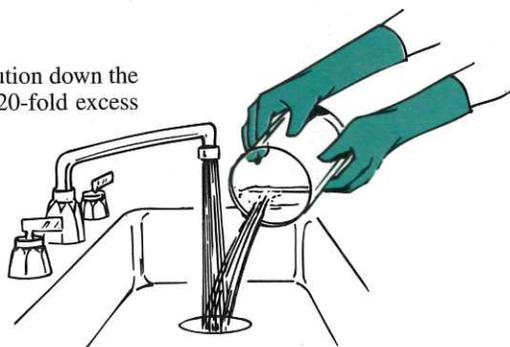


4

Allow the mixture to cool to room temperature and acidify to pH 7 with 3 M sulfuric acid. If only purple color remains, add 0.1 M sodium sulfite until mixture is brown.

5

Flush the solution down the drain with a 20-fold excess of water.



FLINN METHOD

#3 Alkali Metals and Alkaline Earth Metals

Materials in this class may be reactive with air and with liquids such as water, alcohol, and halogenated hydrocarbons. They should not be allowed to come into contact with wastes containing these liquids. The alkali metals are usually stored in a liquid hydrocarbon to keep them from air. The alkaline earth metals are usually covered with a thin coat of metal oxide which protects them from further oxidation. The best way to dispose of alkali metals is reaction with an alcohol (procedure A) while alkaline metals can be reacted with water or dilute acid (procedure B).

Examples

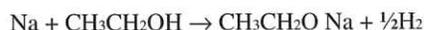
Alkali metals include lithium, sodium and potassium. Alkaline earth metals include magnesium and calcium.

Materials Required

- Chemical-resistant gloves
- Chemical-resistant apron
- Chemical splash goggles
- Fume hood
- Class D fire extinguisher or a large bucket of clean, dry sand
- Large glass beaker
- Magnetic stirrer and stir bar; or stir rod
- Knife to cut large pieces of metal (optional)
- pH indicator paper
- Ethyl alcohol, anhydrous (for sodium and lithium)
- tert-Butyl alcohol (for potassium)
- Hydrochloric acid, HCl, 1 M

Chemical Concept

Alkali metals are very reactive with water to produce a base (e.g., NaOH), hydrogen gas, and heat. They also react with alcohols in a more controlled manner to give similar products. The reaction is slower in alcohol due to the lower acid dissociation constant of alcohol relative to water.



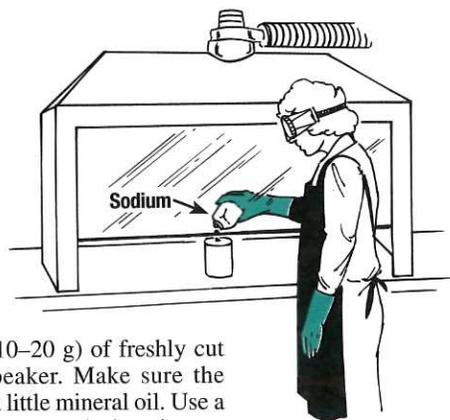
During this procedure, hydrogen gas is produced which is an explosion and fire hazard. The reaction also uses ethyl alcohol, an explosion and fire risk. The reaction needs to be carried out in a fume hood, behind a shield, and with proper safeguards.

Anhydrous ethyl alcohol contains very little water and is preferred in this procedure over 95% ethyl alcohol which contains water.

Potassium is the most difficult metal to dispose of safely due to its reactivity and tendency to form explosive peroxides. Even when stored under mineral oil or kerosene, a coating of yellow potassium superoxide (KO_2) is formed, on prolonged storage. Cutting or handling the yellow-coated potassium may result in a violent explosion. Do not attempt to cut yellow-coated potassium. Potassium should not be stored for any extended period of time.

Care must be taken in reacting alkali metals with alcohol. All the metals must be reacted with alcohol before water is added. Many laboratory accidents and fires have occurred by rushing this procedure and adding water too soon. The water will react with a small piece of metal generating substantial heat which auto ignites the flammable alcohol.

Calcium and magnesium are less reactive with water. Calcium is easily disposed of using a large amount of cold water and magnesium requires dilute acid to catalyze the reaction.

Procedure A:
For Sodium and Lithium Metal

1a

Place several pieces (10–20 g) of freshly cut metal in a 500-mL beaker. Make sure the metal is covered with a little mineral oil. Use a magnetic stirrer or stir rod to stir the mixture.

2a

Slowly add ethyl alcohol (at least 13 mL per g sodium, 30 mL per g lithium) to the metal at a rate to cause a reasonable hydrogen evolution. Do not add the ethyl alcohol too fast (causing excessive heat generation). Stir the reaction mixture until all the pieces of metal have dissolved.



3a

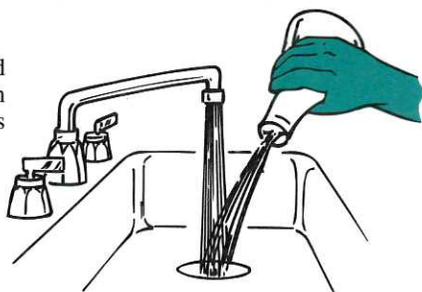
Only after all pieces of metal are gone, slowly add an equal volume of water to the reaction mixture. Neutralize with 1 M hydrochloric acid.



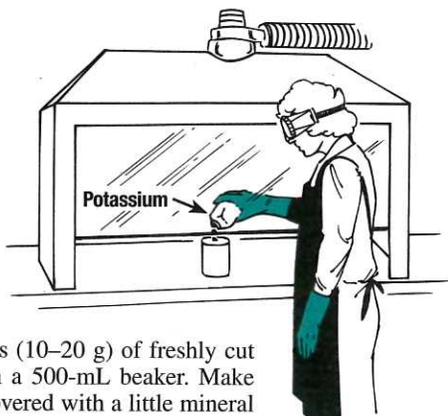
Flinn Method #3, continued

4a

Flush the neutralized mixture down the drain with a 20-fold excess of water.



Procedure B: For Potassium Metal



1b

Place several pieces (10–20 g) of freshly cut potassium metal in a 500-mL beaker. Make sure the metal is covered with a little mineral oil. Use a magnetic stirrer or stir rod to stir the mixture.



2b

Slowly add tert-butyl alcohol (at least 21 mL per g potassium) to the metal at a rate to cause a reasonable hydrogen evolution. Stir the reaction mixture until all the pieces of metal have dissolved. If the reaction is proceeding too slowly, add a few milliliters of dry, anhydrous ethyl alcohol.

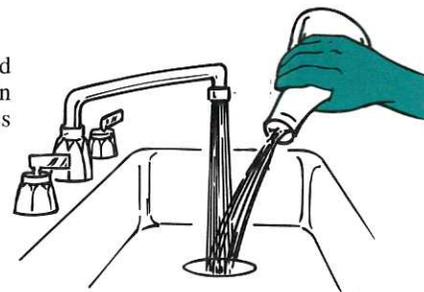


3b

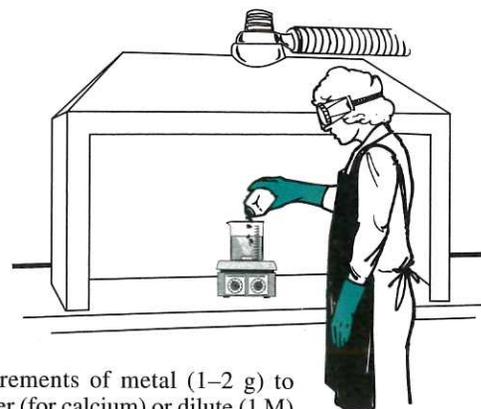
Only after all pieces of potassium are gone, slowly add an equal volume of water to the reaction mixture. Neutralize with 1 M hydrochloric acid.

4b

Flush the neutralized mixture down the drain with a 20-fold excess of water.



Procedure C: For Calcium and Magnesium Metal



1c

Add small increments of metal (1–2 g) to 1 L of cold water (for calcium) or dilute (1 M) hydrochloric acid (for magnesium). Stir the mixture until all the metal has dissolved.

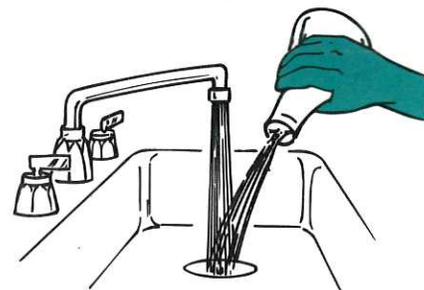


2c

Using pH indicator paper or a monitor, neutralize to pH 7 with 3 M sodium hydroxide or solid sodium carbonate.

3c

Flush the solution down the drain with a 20-fold excess of water.



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FLINN METHOD

#4a Picric Acid and Related Substances

Picric acid cannot be disposed of by untrained personnel. You must contact a commercial waste disposal service, the local bomb squad, or fire department. Chemical destruction of picric acid is not recommended, because it tends to be incomplete and the resulting residues usually have some explosive properties. Bouin's solution contains picric acid; treat it just as carefully as pure picric acid.

Examples

Picric acid, Bouin's solution

Materials Required

Chemical-resistant gloves

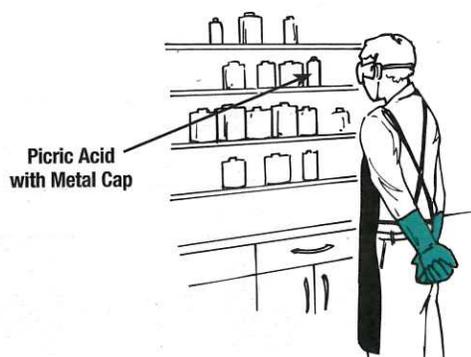
Chemical-resistant apron

Chemical splash goggles or full-face shield

Glass beaker with about 3 inches of water, large enough to contain picric acid container

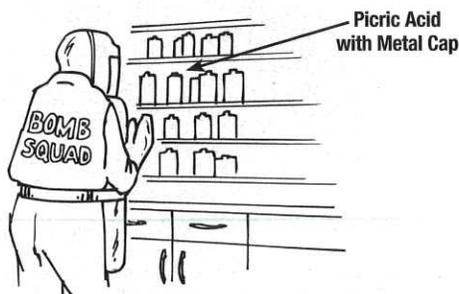
Chemical Concept

Picric acid is normally sold containing 10–15% water, and in this state it is relatively safe to handle. However, dry picric acid is very explosive. The explosion can be initiated by friction, shock, or sudden heating. Picric acid also reacts with metals to form explosive metal picrates which are highly sensitive to detonation. Do not attempt to dispose of picric acid by chemical means. This procedure merely provides a means to wet the picric acid to decrease its hazards.

Procedure

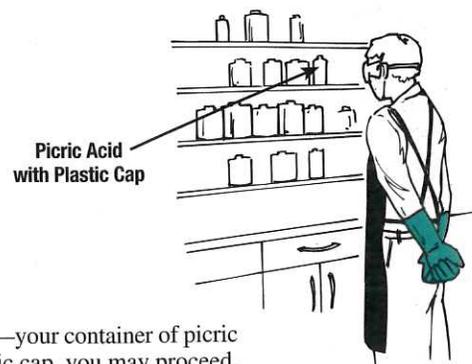
1

Without touching your container of picric acid, determine if it has a metal cap. If it does, do not touch the container at all.



2

A metal-capped container of picric acid should be handled only by a trained expert such as a member of a bomb squad. Call such an expert to remove the material from school premises as soon as possible. (Picric acid can form salts with the metal in the cap and these salts are more explosive than picric acid itself. The friction caused in attempting to remove the metal cap from a container of picric acid has been reported to cause detonation of minute amounts of metal picrate trapped in the threads of the cap.)

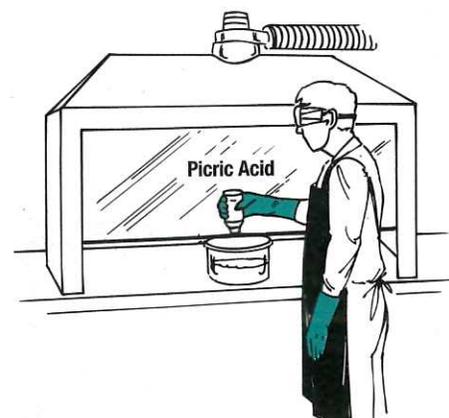


3

If—and only if—your container of picric acid has a plastic cap, you may proceed.



12:00 O'Clock

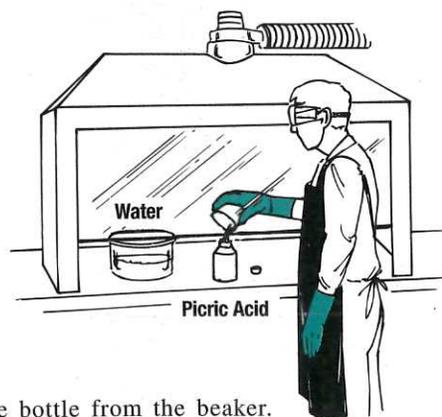


4

Immerse the plastic-capped container upside-down in the beaker of water. Allow it to stand for four hours to permit water to work its way up the threads between the cap and the bottle.



4:00 O'Clock



5

Remove the bottle from the beaker. Uncap it. Fill the bottle with water and replace the cap.



4:05 O'Clock



6

Re-invert the bottle. Allow it to stand for several days to thoroughly wet all the material inside.

7

Call a licensed hazardous waste disposal company, the local bomb squad, or fire department and have them remove the material from school premises.

FLINN METHOD

#4b Halogenated Hydrocarbons

Most halogenated hydrocarbons will require licensed hazardous waste disposal. The best route for disposal of nonvolatile halogenated hydrocarbons is through incineration. Use a licensed hazardous waste disposal company as described in Flinn Disposal Method #26c or #27j.

FLINN METHOD

#4c Organic Acids, Substituted

Substituted organic acids include amino acids and halogenated carboxylic acid (e.g., chloroacetic acid). Amino acids are water-soluble and usually have nutritive value. Amino acids are easily disposed of using Flinn Disposal Method #26a or #26b. Most water-soluble substituted carboxylic acids and their sodium, potassium, calcium or magnesium salts can be washed down the drain if local regulations permit. See Flinn Disposal Method #26b.

FLINN METHOD

#5 Amines, Aromatic

Aromatic amines are relatively toxic and flammable materials. Depending on the material, there are several disposal routes. Many common dyes and pigments contain aromatic amine groups and do not present any unusual problems for incineration or burial in a landfill. Please consult your local authorities and Flinn Disposal Method #26a.

Three common aromatic amines, pyridine, aniline, and diphenylamine, should be disposed of by a licensed hazardous waste company according to Flinn Disposal Method #26c.

FLINN METHOD

#6 Substances Precipitated by Calcium Ion

Substances in this class are of two different varieties: (a) soluble substances containing the fluoride ion, and (b) soluble substances containing the oxyanion of a toxic heavy metal (e.g., Mo, W) for which the calcium salt is quite insoluble. Fluoride ion is highly poisonous. Hydrofluoric acid is also a poison and insidious in its action on human flesh. It requires licensed hazardous waste disposal.

Examples

Sodium fluoride, sodium molybdate, sodium tungstate

Materials Required

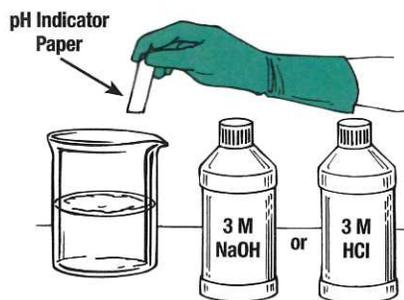
- Chemical-resistant gloves
- Chemical-resistant apron
- Chemical splash goggles
- Fume hood
- Calcium hydroxide (slaked lime) in threefold molar excess for HF disposal
- Calcium chloride solution, CaCl₂, 1 M, in threefold molar excess for other disposals
- Large plastic beaker or similar container (don't use glass for HF)
- Wood stirring stick
- Hydrochloric acid, HCl, 3 M or sodium hydroxide, NaOH, 3 M as necessary to adjust pH
- pH indicator paper
- Filtration apparatus

Procedure



1

Dissolve the soluble compound (metal salt) in the smallest amount of water possible.



2

Adjust the pH to 7 using pH indicator paper by adding 3 M sodium hydroxide or hydrochloric acid as necessary.



3



While stirring, add 1 M calcium chloride solution in a threefold molar excess to the neutral solution. Allow the resulting precipitate to stand about 15 minutes.



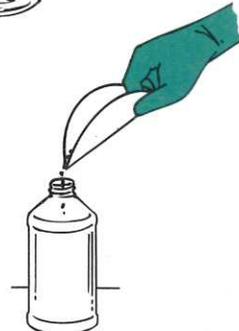
4

Filter or decant off the supernatant liquid. Flush the liquid down the drain with excess water.



5

Allow the solid to dry, place it in a plastic container, and send it to a landfill.



FLINN METHOD

#8 Azides and Azo- Compounds

Azides should NOT be drain-disposed. Drain disposal not only contaminates sewer water, but azides can also react with lead and copper in drain lines, solder joints and brass fittings. These metal azides remain resident in the sewer system, and are unstable and explosive. Drain systems have been destroyed by such explosions. In addition, azides are not biodegradable and kill the necessary bacteria present in the digestion system of wastewater treatment plants. Stocks of these materials should be kept low. These materials should be disposed of by a licensed hazardous waste disposal company as described in Flinn Disposal Method #26c.

FLINN METHOD

#9 Carbon Disulfide

Carbon disulfide is a highly volatile, highly toxic, and flammable solvent. Extreme care should be taken when handling and disposing of this material. This material should be disposed of by a licensed hazardous waste disposal company as described by Flinn Disposal Method #26c.

FLINN METHOD

#10 Bases, Strong and Weak, and Basic Anhydrides

Neutralizing acid and base solutions are very common disposal procedures and should present minimal problems. Two simple rules should be followed. First, the neutralization process should be mild. Any strong acids or bases should first be diluted to a concentration around 1 M or 10%. Second, the final product should be near neutral (pH 5–9) before discharge to the drain. In this procedure, bases are neutralized with dilute hydrochloric acid.

Examples

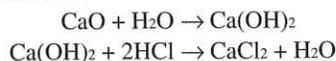
Ammonium hydroxide, calcium oxide, sodium hydroxide

Materials Required

Chemical-resistant gloves
Chemical-resistant apron
Chemical splash goggles
Efficient hood, if disposing of aqueous ammonia solution
Large glass beaker
Glass stirring rod
Ice/water slush (optional)
Hydrochloric acid, HCl, 3 M
pH indicator paper

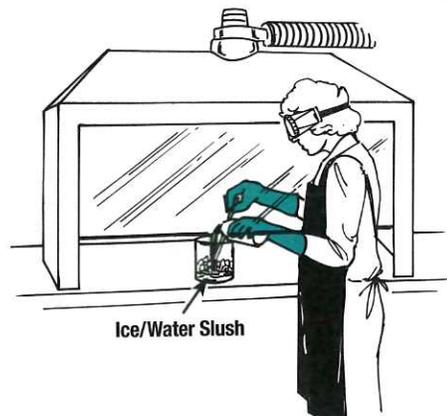
Chemical Concept

All bases react with acids in aqueous solution to form a salt and water. Basic anhydrides react with water to form bases, which are then neutralized with acid.



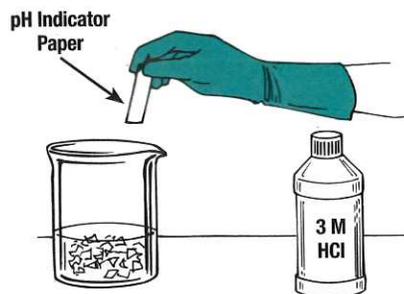
The soluble salts formed are innocuous, and can be flushed down the drain with water.

Procedure



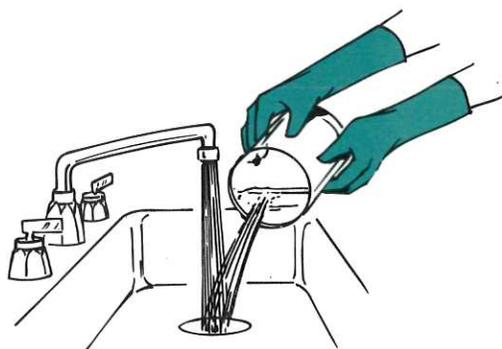
1

Prepare a dilute solution of (1 M or <10%) base by diluting the solution or dissolving the solid into water. Considerable heat may be involved when dissolving a solid base. It is wise to experiment with a small quantity to determine the heat generated, and if an ice/water slush is required.



2

When solution is complete, slowly add 3 M hydrochloric acid until the mixture is neutralized. Check with pH paper. More heat may be evolved in the neutralization process.



3

Flush the neutral mixture down the drain with a 20-fold excess of water.

FLINN METHOD

#11 Silver Compounds

Silver and silver compounds are expensive but often can be reclaimed for later use. Below, we present a silver recovery process.

Examples

Silver nitrate, silver chloride, silver oxide

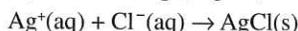
Materials Required

- Chemical-resistant gloves
- Chemical-resistant apron
- Chemical splash goggles
- Large glass beaker
- Glass stirring rod
- Sodium chloride, NaCl, 1 M
- Nitric acid, HNO₃, conc.
- Sodium hydroxide, NaOH, 6 M
- Sucrose
- Sodium hydroxide, NaOH, 2 M
- Filtration apparatus
- Magnetic stirrer/hot plate with stir bar

Chemical Concept

(Silver recovery process)

The first step (dissolving in nitric acid), puts the metals into solution as metal ions. The next step of adding sodium chloride causes the formation of a precipitate which is silver chloride. Since all metals (except platinum and gold) will dissolve in nitric acid, then any other metals present (in addition to silver) will also precipitate, e.g., lead as lead chloride. If your silver is still relatively pure and you wish to prepare AgCl, you want to stop after this step (step 2a).



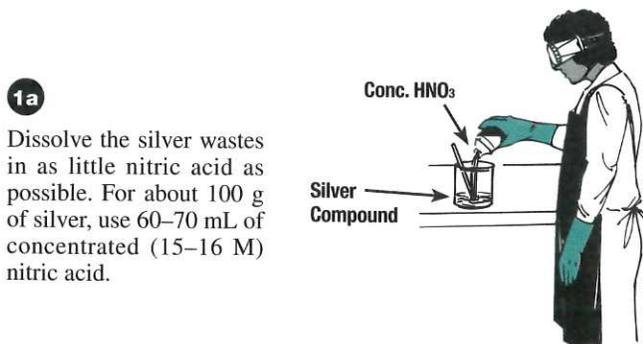
To produce silver metal, the silver chloride is dissolved in a strong base (NaOH) and heated. Sucrose is then added to this mixture. The disaccharide sucrose will hydrolyze in a strong base to the monosaccharides fructose and glucose. Fructose is an alpha-hydroxy ketose; glucose is an aldose. Both of these substances, i.e., fructose and glucose will reduce silver ion to silver metal. Silver will be formed as a heavy gray precipitate.

The last step has the precipitate being redissolved in nitric acid. Silver oxide is precipitated upon addition of sodium hydroxide. The substance should be quite pure since other cations and anions would have stayed in solution during the prior processes.

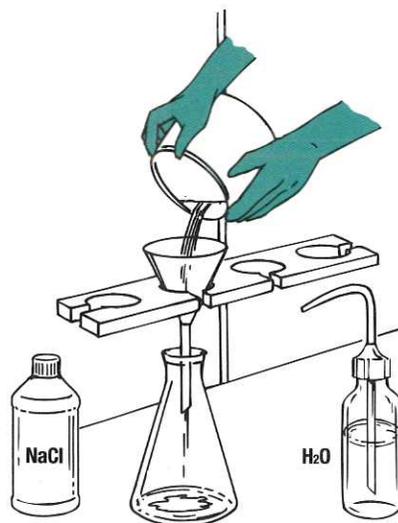
(Disposal method)

The silver is precipitated as silver chloride using sodium chloride. Although silver chloride is not as insoluble as silver sulfide, it is insoluble enough so that any silver ion that may leach from silver chloride in a landfill will be of such small concentration as to produce no hazard, and would probably react to form silver oxide in any case.

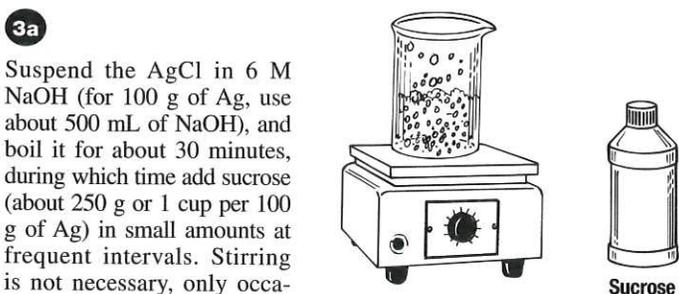
Procedure A:
A Silver Recovery Process



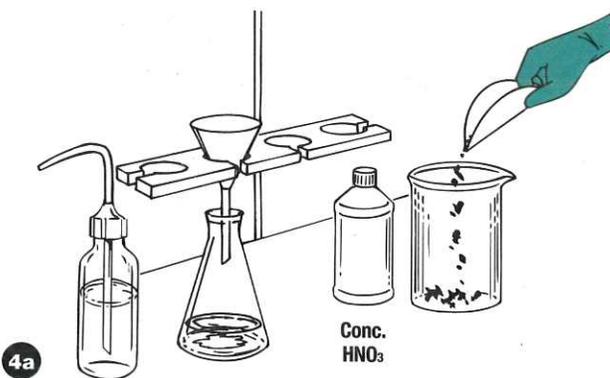
1a
Dissolve the silver wastes in as little nitric acid as possible. For about 100 g of silver, use 60–70 mL of concentrated (15–16 M) nitric acid.



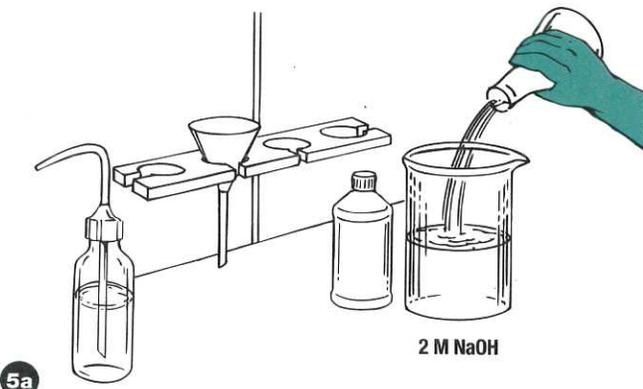
2a
Add sodium chloride (about 60 g per 100 g of Ag) to precipitate silver chloride. Filter and wash the precipitate. (This step is necessary to rid the silver of any copper contaminant.)



3a
Suspend the AgCl in 6 M NaOH (for 100 g of Ag, use about 500 mL of NaOH), and boil it for about 30 minutes, during which time add sucrose (about 250 g or 1 cup per 100 g of Ag) in small amounts at frequent intervals. Stirring is not necessary, only occasional swirling. At first there is considerable frothing, and then the solution becomes dark brown. Finally a heavy, gray precipitate forms.

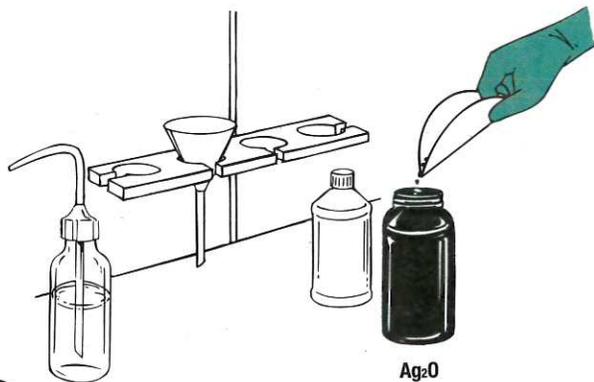


4a
Filter and wash this precipitate, then dissolve the precipitate in as little nitric acid as possible. For about 100 g of Ag, use 60–70 mL of concentrated HNO₃.



5a
Filter and pour the filtrate into 2 M NaOH to precipitate brown Ag₂O. (For 100 g of Ag, use about 500 mL of 2 M NaOH.)

Flinn Method #11, continued



6a

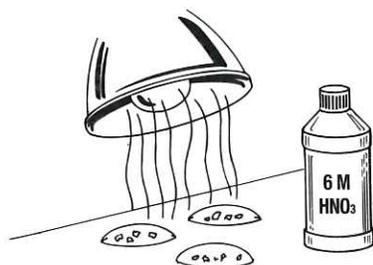
Filter, wash, dry, and store the Ag_2O . It can be converted to silver nitrate or silver chloride at a later date.

7a

If you would like to convert the silver oxide to silver nitrate, dissolve the silver oxide in 6 M HNO_3 and dry the product on either a steam mantle or under heat lamps.

If you wish to convert the silver oxide to silver chloride dissolve the silver oxide in 6 M HNO_3 , add 10% molar excess of sodium chloride. Collect the filtrate, wash with water and dry.

This process requires the use of quite a bit of nitric acid and sodium hydroxide. It is nevertheless a relatively simple process and surely a money saver. If you do not wish to attempt the above reclamation procedure, you may dispose of soluble silver compounds by the next procedure.



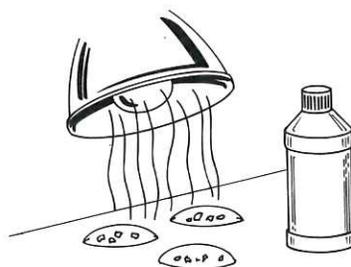
3b

Decant or filter the resulting precipitate of silver chloride.



4b

Allow the precipitate to dry and dispose of it in a landfill approved for such wastes.



5b

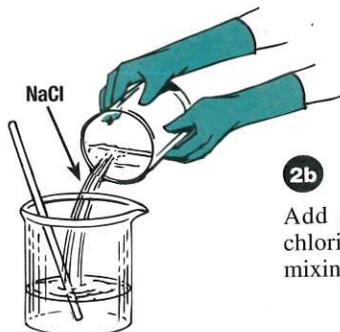
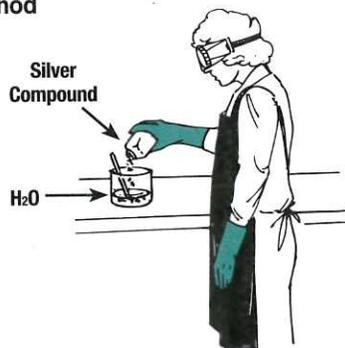
Flush the supernatant liquid down the drain with a 20-fold excess of water.



Procedure B: Disposal Method

1b

Dissolve the silver salt in water in the beaker.



2b

Add a 50% molar excess of sodium chloride solution and stir for complete mixing.

FLINN METHOD

#12a Oxidizing Agents

Strong oxidizing agents such as chlorates, permanganates, and chromates are hazardous when in contact with combustible materials. They should *never* be thrown away with general refuse as they may cause fires or form explosive mixtures.

Examples

Bromine, iodine, sodium chlorate, potassium permanganate, sodium chromate

Materials Required

Chemical-resistant gloves

Chemical-resistant apron

Chemical splash goggles

Sodium thiosulfate solution, $\text{Na}_2\text{S}_2\text{O}_3$, 4%

Sulfuric acid, H_2SO_4 , 1 M

Large glass beaker

Glass stirring rod

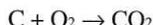
pH indicator paper

Sodium hydroxide solution, NaOH , 1 M

Flinn Method #12a, continued

Chemical Concept

Oxidizing agents by definition oxidize other substances; that is, they readily react with substances in low oxidation states to raise them to higher oxidation states. Thus oxygen, as an oxidizing agent, reacts with carbon to produce carbon dioxide.



The example above is a chemical representation of the burning of charcoal.

The oxidation state of both carbon and oxygen in their elemental form is zero. When the reaction is complete, the carbon has been oxidized from zero to plus 4 (+4), while the oxygen has been reduced from zero to negative 2 (-2). The complementary processes of oxidation and reduction are often accompanied by the evolution of considerable heat.

It is for this reason that we recommend that oxidizing agents be chemically changed before disposal, so that there is no possibility of a discarded oxidizing agent inadvertently reacting at some later time with some chemically combustible material and producing a lot of heat, which could lead to combustion. (This is why you don't store oily rags; under some conditions these rags, and their associated oil, can undergo oxidation from oxygen in the air, heat up and burst into flames).

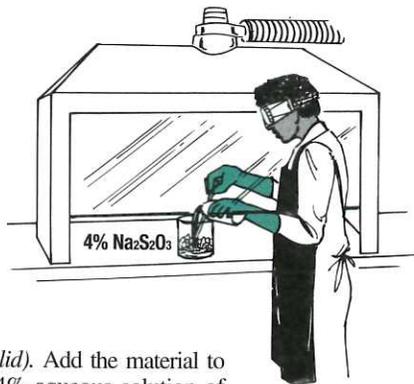
We recommend that oxidizing agents be safely reacted with a substance that is inexpensive and will destroy the oxidizing power before disposal. Such a substance is sodium thiosulfate. This reaction proceeds best in mildly basic, neutral, weakly acidic solutions. (Too much acid will react with the sodium thiosulfate directly, precipitating elemental sulfur from the mixture.) In the example below, thiosulfate ions react with the bromate ions to produce nonhazardous sulfate and bromide ions. Any excess acid is neutralized with base before flushing down the drain.



Procedure

1

This method is for small quantities of laboratory oxidizing agents only. It is best to experiment with a small portion of the amount you wish to destroy before undertaking the entire amount. See note on next page for iodine (solid). Add the material to a twofold excess of a 4% aqueous solution of sodium thiosulfate (hypo) with continuous stirring.

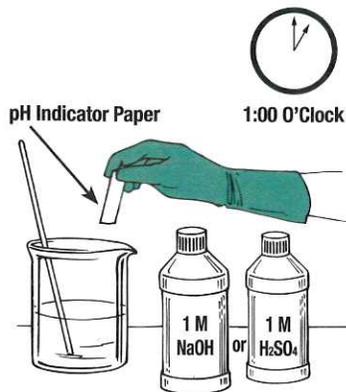


12:00 O'Clock



2

Allow the mixture to stand for about one hour for the redox reaction to proceed to completion. There may be a temperature rise during the reaction.



3

Check the pH of the mixture using pH paper. Neutralize the solution with dilute sodium hydroxide solution or sulfuric acid solution, if needed.

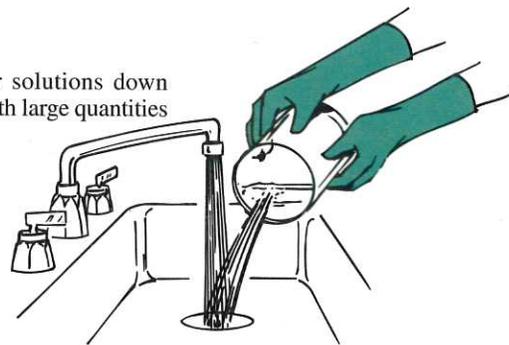
4

The residues from the above procedure must undergo further treatment if they contain chromium or manganese. The products from the reduction of chromates, dichromates, and permanganates are insoluble manganese dioxide or chromium hydroxide. These materials can be removed by filtration and must be treated by Flinn Disposal Method #27f before final disposal. Do not dump chromium salts down the drain.



5

Flush other solutions down the drain with large quantities of water.



Note: When disposing of solid iodine, which is only slightly soluble in water, place the iodine crystals in the 4% aqueous solution of sodium thiosulfate, and add a small amount of sodium carbonate (0.1 g) and stir until the iodine is consumed. Then check with pH paper, and go ahead with the remainder of the procedure (step 3).

Please...Read the Narratives

Important narratives precede these specific chemical disposal methods! Please read each narrative carefully! Do not use these procedures if you are not comfortable with the chemistry. Do not use these procedures without first consulting with your local government regulatory officials. These procedures may not be used in some jurisdictions. These procedures may be dangerous. Once again...read the narratives that precede these specific chemical disposal methods.

FLINN METHOD

#12b Reducing Agents

Strong reducing agents will react vigorously with oxidizing agents to produce heat and possibly fire. Some reducing agents may cause a fire when in contact with moist combustible materials. A simple oxidation reaction will render reducing agents safe for disposal.

Examples

Potassium nitrite, sodium sulfite, sodium thiosulfate

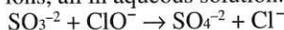
Materials Required

Chemical-resistant gloves
Chemical-resistant apron
Chemical splash goggles or full-face shield
Sodium carbonate, Na_2CO_3
Sodium hypochlorite solution (bleach)
Ammonium hydroxide, NH_4OH (proc. B)
Hydrochloric acid, HCl , 3 M (proc. B)
Hydrochloric acid, HCl , 1 M
Sodium hydroxide, NaOH , 1 M
Large glass beaker
Glass stirring rod
pH indicator paper

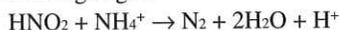
Chemical Concept

Reducing agents by definition reduce other substances; that is, they readily change the oxidation state of a substance from a high value to a lower value. They are the opposite of oxidizing agents. (See the discussion on oxidizing agents under Chemical Concept in Flinn Disposal Method #12a Oxidizing Agents.) In the example involving carbon reacting with oxygen, the oxygen was the oxidizing agent because it oxidized the carbon. On the other hand, in this same reaction, carbon is the reducing agent, because it changed the oxidation state of oxygen from zero to negative 2 (-2). In the process considerable heat is produced.

We recommend that reducing agents be safely reacted with a substance that will destroy the reducing power before they are disposed of. One such substance is bleach or sodium hypochlorite. This works best in a weakly basic solution, and a cheap base is sodium carbonate. So first, dissolve the reducing agent in water, then make it basic with sodium carbonate, and finally react it with the hypochlorite ion. After the material is oxidized, the pH is adjusted to neutral and the resulting mixture which contains innocuous ions is flushed down the drain. In the example below, sulfite ion reacts with hypochlorite ion to produce sulfate and chloride ions, all in aqueous solution.



Nitrites are a unique class of compounds in that the nitrogen is in an intermediate oxidation state (+3). It can be either oxidized to the +5 state (NO_3^-) or reduced to a lower state (NO or N_2). Nitrites are easily destroyed by adding 50% excess ammonia and acidifying to pH 1. The resulting product is nitrogen gas.



Note: The astute teacher may realize from the above discussions of oxidizing and reducing agents that the way to dispose of these substances is to react a substance from one class with a substance from another class. Think through the chemistry, and if you feel comfortable with it, try this "shortcut" of two processes compressed into one. You will also save costs of the other chemicals required. Always use small quantities when trying a new reaction, and be sure you know what products you will get and any potential hazards associated with them.

Procedure A: Sulfites, Thiosulfates**1a**

In the large beaker, dissolve an equal amount of sodium carbonate and reducing agent in distilled water.



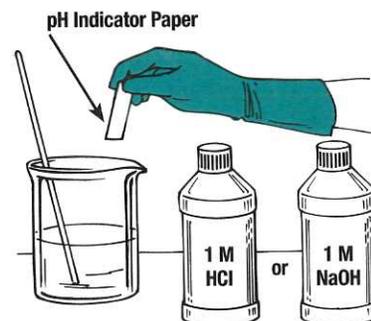
8:00 O'Clock

**2a**

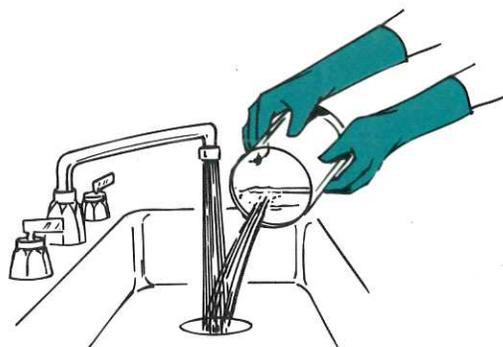
Slowly add a 25% molar excess of bleach to this mixture, with continuous stirring. The reaction may be vigorous and produce heat, so use caution. Allow the completed mixture to stand for several hours.



12:00 O'Clock

**3a**

Check the mixture with pH indicator paper and neutralize as necessary. Use sodium hydroxide solution if acidic, or hydrochloric acid solution if basic.

**4a**

Flush the neutral solution down the drain with a 20-fold excess of water.



Flinn Method #12b, continued

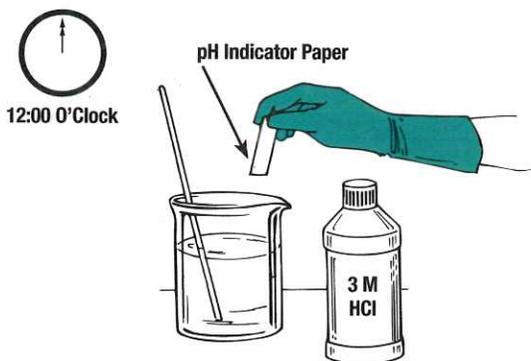
Procedure B: Nitrites



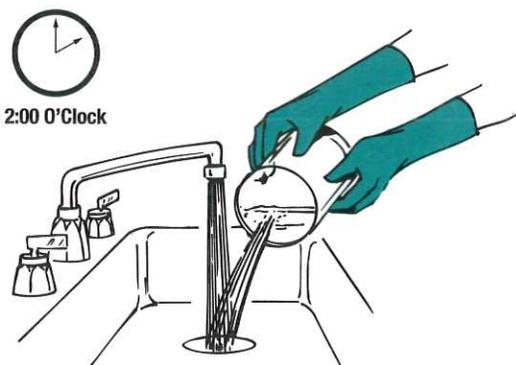
1b
Dissolve the inorganic nitrite salt in distilled water.



2b
Add 50% molar excess ammonium hydroxide solution.



3b
Using pH indicator paper to measure, acidify the solution to pH 1 with 3 M hydrochloric acid. Stir for two hours.



4b
Check the pH of the solution, neutralize if necessary. Wash the solution down the drain with excess water.

FLINN METHOD #13 Organic Sulfides, Mercaptans and Thioamides

Many organic sulfides and mercaptans are very toxic and should not be drain disposed. Because of their toxicity, they should only be disposed of by a licensed hazardous waste disposal company as described in Flinn Disposal Method #26c.

FLINN METHOD #14 Cyanides

All cyanides should be removed by licensed hazardous waste disposal professionals. Cyanides are severe and rapid-acting poisons, being quickly absorbed into the body via the respiratory system, skin, eyes and mouth. The cyano-complexes of iron are less hazardous. The following method is recommended only for cyano-complexes of iron that Flinn sells, and for small quantities, 100 g or less.

Examples

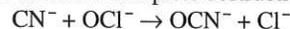
Potassium ferrocyanide, potassium ferricyanide

Materials Required

- Chemical-resistant gloves
- Chemical-resistant apron
- Chemical splash goggles
- Efficient hood
- Large glass beaker
- Glass stirring rod
- Sodium hydroxide solution, NaOH, 3 M (twofold molar excess)
- pH indicator paper
- Ice bath (optional)
- Sodium hypochlorite solution (bleach)
- Calcium hypochlorite solution, Ca(OCl)₂, 30%

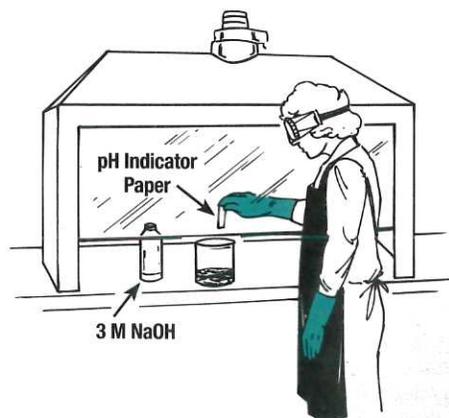
Chemical Concept

Ferro and ferricyanides are much less toxic and volatile than cyanide salts and are oxidized to cyanates by hypochlorite. A 50% molar excess of bleach is required to assure complete destruction.



Commercial bleach (5.25% sodium hypochlorite) or a 30% calcium hypochlorite solution can be used for this procedure. If larger quantities of cyano-complexes are being destroyed, a 30% calcium hypochlorite solution is more efficient.

Procedure



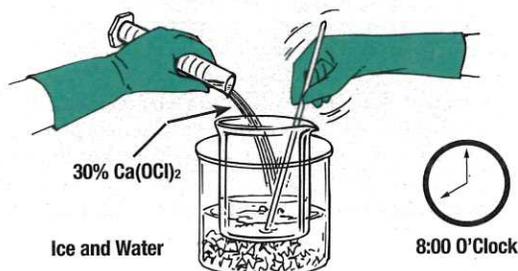
1
This procedure must be done in a fume hood. Fill a large beaker 1/2 full of water, and using pH indicator paper, make it basic (at least pH 12) with 3 M sodium hydroxide solution.

Flinn Method #14, continued



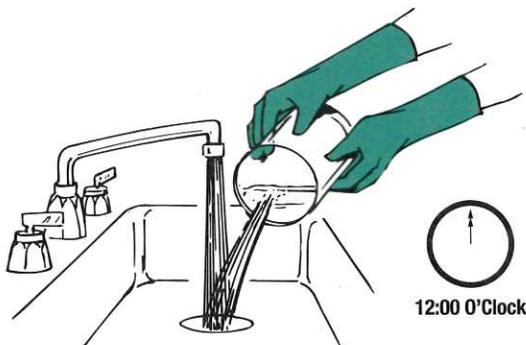
2

Dissolve the cyano-complex in the water.



3

While stirring, slowly add the sodium hypochlorite solution (about 100 mL per g CN) or 30% calcium hypochlorite solution (20 mL per g CN). Heat may be evolved; maintain the temperature below 50 °C by using an ice bath if necessary. Once the addition of hypochlorite is completed (use a twofold molar excess), allow the mixture to stand for several hours.



4

Flush the mixture down the drain with a 20-fold excess of water.

FLINN METHOD
#15 Ethers

Bottles of ethers that have been opened and are more than a year old may contain hazardous quantities of explosive peroxides. These bottles should not be opened and should be disposed of by the appropriate authorities.

Please...Read the Narratives

Important narratives precede these specific chemical disposal methods! Please read each narrative carefully! Do not use these procedures if you are not comfortable with the chemistry. Do not use these procedures without *first consulting with your local government regulatory officials*. These procedures may not be used in some jurisdictions. These procedures may be dangerous. Once again...read the narratives that precede these specific chemical disposal methods.

FLINN METHOD

#16 Hydrazines and Their Salts

Hydrazines contain a nitrogen–nitrogen single bond and as a result are very reactive. Many hydrazines are also toxic and/or carcinogenic. Phenyl hydrazine is the only chemical in this class that is routinely found in high school science laboratories and is less reactive and less toxic than many lower molecular weight hydrazines. It should still be disposed of by a licensed hazardous waste disposal company according to Flinn Disposal Method #26c.

FLINN METHOD

#18a Volatile Alcohols, Ketones, Esters

Many low-molecular weight, oxygen-containing organic compounds are volatile; soluble in water, and biodegradable. Aqueous solutions and extracts or small amounts of volatile alcohols, ketones, and esters—see the examples below—may be disposed in small quantities down the drain (sanitary sewer only) with excess water. Please check all federal, state, and local regulations that may apply before proceeding. See Flinn Suggested Disposal Method #26b for more information on drain disposal.

Examples

Acetone, isopropyl alcohol, ethyl acetate

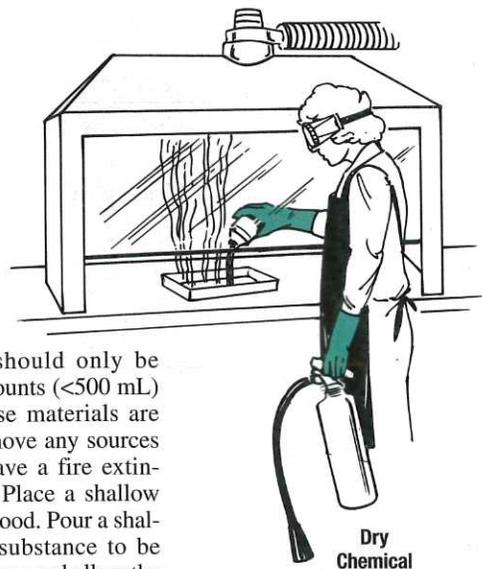
Materials Required

Chemical-resistant gloves
Chemical-resistant apron
Chemical splash goggles
Shallow metal or glass pan
Efficient fume hood, or site for outdoor evaporation
Dry chemical (ABC) fire extinguisher (optional)

Chemical Concept

No concept statement judged necessary for this procedure.

Procedure



This procedure should only be used for small amounts (<500 mL) of materials. These materials are flammable, so remove any sources of ignition and have a fire extinguisher available. Place a shallow pan in your fume hood. Pour a shallow layer of the substance to be disposed of in the pan and allow the natural air movement in the hood to evaporate the material. If you do not have a hood, the evaporation may be done outdoors, but it is required that the process be attended at all times.

If neither of the above options is appropriate, the materials should be disposed of by a licensed hazardous waste disposal company.

FLINN METHOD

#18b Hydrocarbons and NonVolatile
Ketones, Esters, Alcohols

Non-volatile organic compounds do not readily evaporate and are not easily converted into less toxic materials. The only disposal procedures available are disposal by a licensed hazardous waste company.

FLINN METHOD

#20 Organic Amides

Organic amides can be hydrolyzed back to the corresponding carboxylic acid and amine by refluxing in concentrated hydrochloric acid. This procedure is hazardous and frequently results in materials that are still not easily disposed. The best disposal procedures available to schools are disposal by a licensed hazardous waste disposal company.

FLINN METHOD

#22a Peroxides, Inorganic

Inorganic peroxides are strong oxidizing agents. When in contact or mixed with organic or combustible materials, fires or explosions are possible. Do not throw these materials in the trash.

Examples

Hydrogen peroxide, sodium peroxide

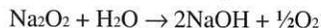
Materials Required

Chemical-resistant gloves
Chemical-resistant apron
Chemical splash goggles
Large beaker, $\frac{3}{4}$ full of water
Plastic spoon (optional)
Glass stirring rod
pH indicator paper
Sodium metabisulfite, $\text{Na}_2\text{S}_2\text{O}_5$, 1 M
Hydrochloric acid, HCl , 3 M

Chemical Concept

Hydrogen peroxide is destroyed by reducing with sodium metabisulfite or diluting it with water to less than 3% and flushing it down the drain.

Sodium peroxide reacts violently with water to form oxygen gas and sodium hydroxide. Because of this reaction, sodium peroxide is stored in sealed containers to avoid reaction with moisture in the air. With fresh sodium peroxide the reaction with water is quite exothermic, but if used from a previously opened container, it may be less vigorous. Old sodium peroxide may have already slowly converted itself to sodium hydroxide. Test the materials for reactivity by adding a small amount (0.1 g) to water. Evolution of oxygen indicates an active peroxide which should be reduced prior to disposal.



Procedure A: Water Dilution



1a

Hydrogen peroxide of any concentration may be disposed of by pouring it into a large beaker containing at least a tenfold excess of water. Stir constantly.

2a

When the mixture is uniform, flush it down the drain with large amounts of extra water.



3a

If you are dealing with sodium peroxide, first break up any lumps with a dry glass stirring rod or a plastic spoon.



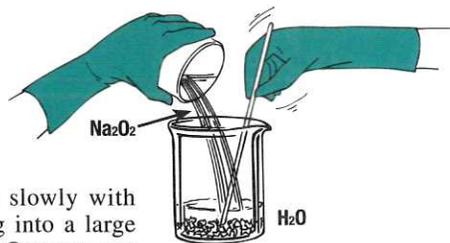
FLINN METHOD #22a continued on next page.

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Flinn Method #22a, continued

4a

Pour the material slowly with continuous stirring into a large beaker of water. Oxygen gas will evolve and the solution will become strongly basic. The final amount of sodium peroxide in the water should be no more than 5%. (If you have more sodium peroxide than will fit into this concentration in your beaker, do the procedure again until all the material is disposed of.)



pH Indicator Paper

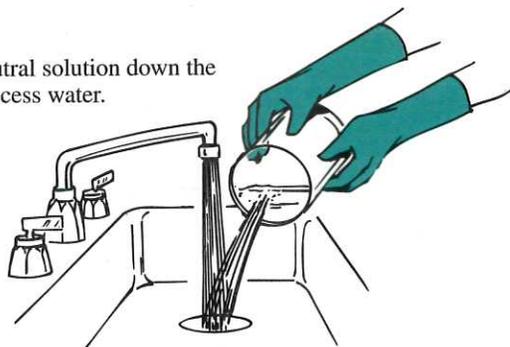


5a

Using pH indicator paper as a monitor, neutralize the solution with 3 M hydrochloric acid.

6a

Flush the neutral solution down the drain with excess water.



Procedure B: Reduction

1b

If you are dealing with sodium peroxide, break up any lumps with a dry glass stirring rod or a plastic spoon.



2b

1 M $\text{Na}_2\text{S}_2\text{O}_5$



Slowly add the sodium peroxide into a large beaker containing 1 M sodium metabisulfite (100 mL per g Na_2O_2) and stir continuously.

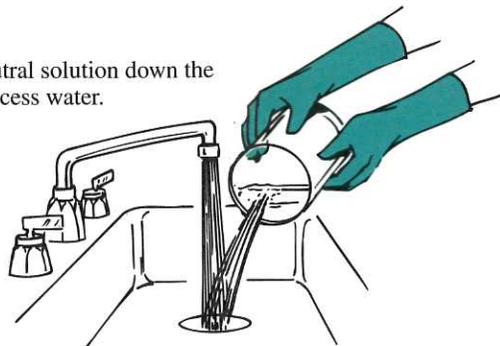
3b

Using pH indicator paper as a monitor, neutralize the solution with 3 M hydrochloric acid.



4b

Flush the neutral solution down the drain with excess water.



FLINN METHOD

#22b Peroxides, Organic

Organic peroxides are particularly dangerous materials that are highly flammable and explosive. Peroxides are sensitive to heat, shock, friction, or contact with combustible materials. These materials cannot be disposed of in a landfill.

Examples

Benzoyl peroxide and lauroyl peroxide

Materials Required

Chemical-resistant gloves

Chemical-resistant apron

Chemical splash goggles

Efficient hood

Sodium hydroxide solution, NaOH, 3 M—tenfold volume excess of the material to be destroyed, in a large glass beaker

Plastic spoon (optional)

Glass stirring rod

pH indicator paper

Hydrochloric acid solution, HCl, 6 M

FLINN METHOD #22b continued on next page.

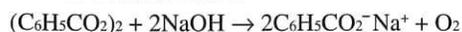
Please...Read the Narratives

Important narratives precede these specific chemical disposal methods! Please read each narrative carefully! Do not use these procedures if you are not comfortable with the chemistry. Do not use these procedures without *first consulting with your local government regulatory officials*. These procedures may not be used in some jurisdictions. These procedures may be dangerous. Once again...read the narratives that precede these specific chemical disposal methods.

Flinn Method #22b, continued

Chemical Concept

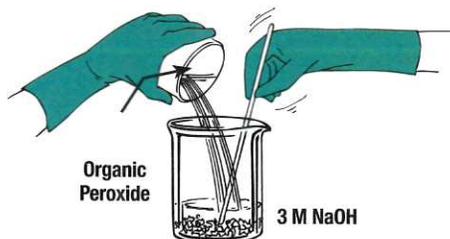
When reacted with base, benzoyl peroxide and lauroyl peroxide (the only substances we catalog for which this procedure is suggested) will cleave between the two joined oxygen atoms and form sodium benzoate or sodium laurate, which are soluble in water and innocuous. Use care not to go past the neutral point when adding acid to the aqueous solution. If the solution is acidic, some benzoic acid may precipitate out. This is not particularly harmful, but it would be better to flush the soluble sodium salt down the drain.



1

Procedure

Break up any lumps in the organic peroxide with a glass stirring rod or a plastic spoon.



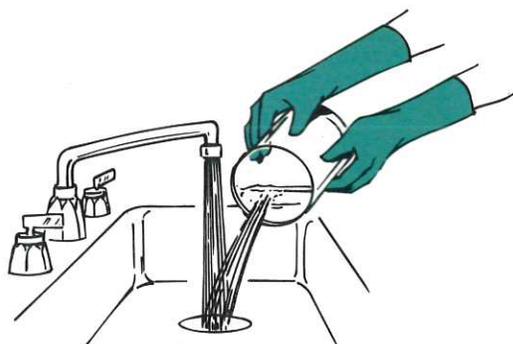
2

Pour the material into the 3 M sodium hydroxide solution. Allow to stand at least 24 hours, stirring frequently. Benzoyl peroxide has low water solubility, so frequent agitation is important to bring the decomposition reaction to completion.



3

Using pH indicator paper as a monitor, neutralize the solution with 6 M hydrochloric acid.



4

Flush the neutral solution down the drain with excess water.

FLINN METHOD

#23 Sulfides, Inorganic

Inorganic sulfides release highly toxic hydrogen sulfide gas on treatment with acid. These materials should not be disposed of in the trash or drain.

Examples

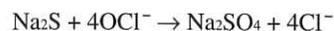
Sodium sulfide, ammonium sulfide.

Materials Required

- Chemical-resistant gloves
- Chemical-resistant apron
- Chemical splash goggles
- Efficient hood or excellent ventilation
- Large glass beaker
- Glass stirring rod
- Sodium hypochlorite solution, NaOCl, (laundry bleach)
- Sodium hydroxide solution, NaOH, 0.5 M

Chemical Concept

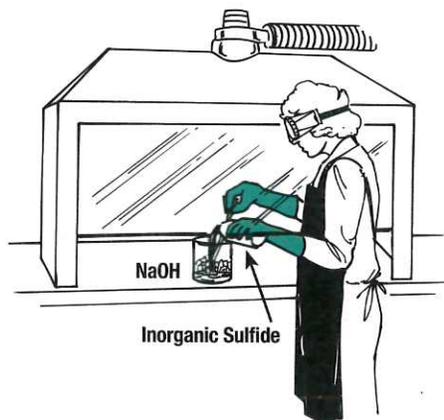
Inorganic sulfides are easily oxidized to sulfate using hypochlorites as an oxidizing agent.



A small amount of base is added to keep the solution basic. A basic solution is needed because inorganic sulfides react with acid to produce highly toxic hydrogen sulfide gas and the hypochlorite is more stable at a higher pH.

The products from the reaction are sulfate salts which are nonvolatile, odorless and have low toxicity. These materials can be flushed down the drain.

Procedure



1

This procedure must be performed in a fume hood. Dissolve the inorganic sulfide in 0.5 M NaOH solution. For ammonium sulfide, use 100 mL of NaOH solution for every 10 mL of sulfide solution.

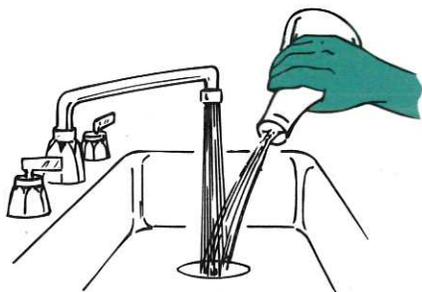


2

Slowly add sodium hypochlorite solution (bleach) to the inorganic sulfide. Add 200 mL bleach for each 10 mL of ammonium sulfide or 5 g of sodium sulfide.

Flinn Method #23, continued

Procedure



3

Allow the solution to sit overnight in the fume hood. Flush the entire solution down the drain with a 20-fold excess of water.

Note: This procedure is not intended for use with hydrogen sulfide gas. Gas cylinders are best if used completely, vented in an operating fume hood for several hours, then disposed of in the trash. Small lecture bottles cannot be reused.

FLINN METHOD

#24a Acids, Organic

Organic carboxylic acids can be disposed of by neutralization, solid waste disposal, and incineration. Water-soluble organic acids are best disposed of by reacting with a base to form water soluble sodium salts. Long alkyl chain carboxylic acids (e.g., lauric, decanoic) and their salts are insoluble in water, but small quantities pose little risk to the environment. These can be disposed of using Flinn Disposal Method #26a. All other organic acids are best disposed of using a licensed hazardous waste disposal company.

Use Neutralization Method for These Acids

Acetic acid

Acetic anhydride

(Use NaOH only; the decomposition may be slow)

Aceto-orcein solution

Barfoed's reagent

(Copper carbonate may be formed. Filter and landfill.)

Formic acid

Fumaric acid

Lactic acid

Malonic acid

Oxalic acid

Propionic acid

Succinic acid

Tartaric acid

Trichloroacetic acid

Materials Required

Chemical-resistant gloves

Chemical-resistant apron

Chemical splash goggles

Fume hood or excellent ventilation

Large glass beaker

Glass stirring rod

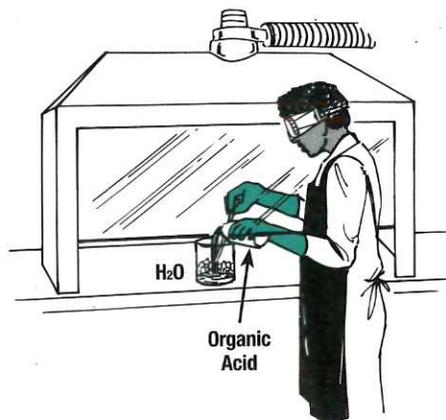
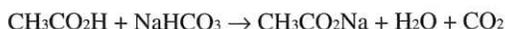
Sodium carbonate, Na₂CO₃, or sodium hydroxide solution,

NaOH, 3 M

pH indicator paper

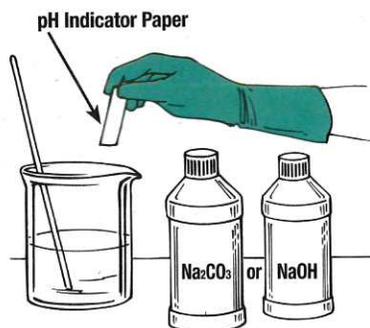
Chemical Concept

Organic acids that are water soluble readily react with bases to form soluble sodium salts. Some organic acids that have limited solubility in water may produce soluble sodium salts (e.g., benzoic acid) and are also disposed of by this method. Sodium hydroxide solutions or sodium bicarbonate are suitable bases. If sodium bicarbonate is used, carbon dioxide is also formed.



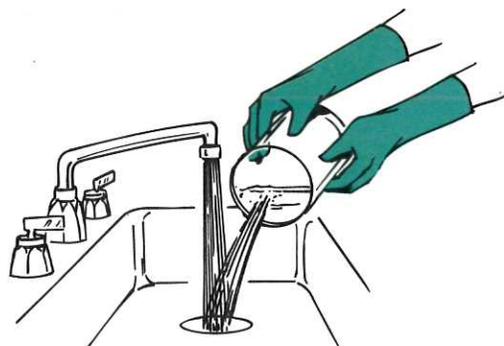
1

The organic acid may be diluted by adding it slowly to a 20-fold excess of water while stirring...



2

...neutralizing the resulting solution with sodium carbonate or sodium hydroxide solution, checking the pH with pH paper. Stir the solution until all solid organic acids have dissolved.



3

Rinse the solution down the drain with an excess of water.

FLINN METHOD

#24b Acids, Inorganic

Neutralizing acid and base solutions are very common disposal procedures and should present minimal problems. Two simple rules should be followed. First, the process should be mild. Any strong acids or bases should first be diluted to a concentration around 1 M or 10%. Remember, always add acid to water. Second, the final product should be near neutral (pH 5-9) before discharge to the drain. In this procedure, acids are neutralized with sodium carbonate.

Examples

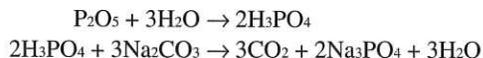
Hydrochloric acid, sulfuric acid, nitric acid

Materials Required

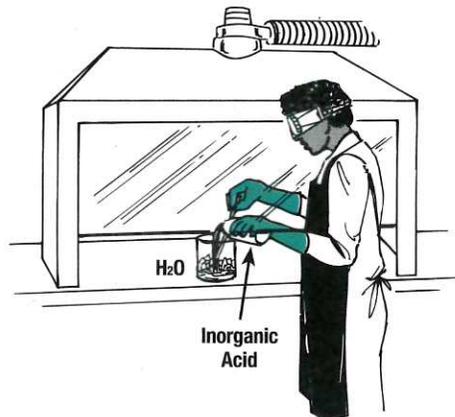
- Chemical-resistant gloves
- Chemical-resistant apron
- Chemical splash goggles
- Fume hood or excellent ventilation
- Large borosilicate glass beaker less than 1/2 full of water
- Glass stirring rod
- Sodium carbonate solution, Na₂CO₃, 1 M
- pH Indicator paper

Chemical Concept

This procedure is a standard neutralization of an acid with a carbonate. In the case of phosphorus pentoxide, which is an acid anhydride, reaction with water produces phosphoric acid. This reaction is highly exothermic. You may want to consider immersing your reaction vessel in an ice bath.



Procedure



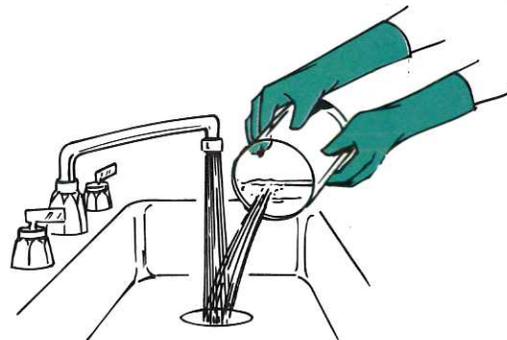
1

Dilute the acid by pouring it into a large beaker containing water. The final concentration of the acid should be 1 M or less.



2

Slowly add 1 M sodium carbonate solution to the diluted acid while stirring. Carbon dioxide gas will be evolved. As the acid is neutralized by the sodium carbonate, the rate of gas evolution will decrease. When further additions of sodium carbonate solution yield no gas evolution, the neutralization is complete.



3

Flush the neutral mixture down the drain with a 20-fold excess of water.

FLINN METHOD

#25 Carbides

Calcium carbide reacts with small quantities of water to generate acetylene, a highly flammable gas. Decomposition under controlled conditions will produce acetylene which can be vented to a fume hood for safe disposal.

Example

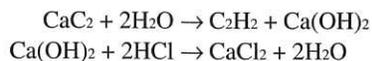
Calcium carbide

Materials Required

- Chemical-resistant gloves
- Chemical-resistant apron
- Chemical splash goggles
- Fume hood or outdoor site
- Large glass beaker 3/4 full of water
- Glass stirring rod
- Dry chemical (ABC) fire extinguisher
- Hydrochloric acid, HCl, 3 M
- pH indicator paper

Chemical Concept

Calcium carbide reacts with water to form acetylene gas and calcium hydroxide, which is not very soluble in water. The addition of hydrochloric acid to the suspension of calcium hydroxide will dissolve it, forming water and calcium chloride. This solution may be flushed down the drain.



FLINN METHOD #25 continued on next page.

Flinn Suggested Laboratory Chemical Disposal Methods

Flinn Scientific has been publishing suggested laboratory chemical disposal methods for more than 35 years. Each chemical in the *Flinn Scientific Catalog/Reference Manual* has a disposal number under its name. The disposal number refers to one of the suggested disposal procedures listed in this section. As federal, state, and local regulations have changed, however, some of the disposal procedures are no longer allowed. Flinn has updated or deleted some disposal procedures that are deemed unacceptable. Before attempting any disposal procedures, it is essential that you check local regulations to determine if it is still allowed in your locale.

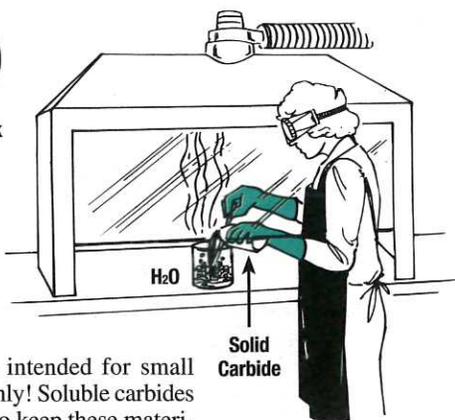
If you have any questions concerning laboratory waste disposal methods, please call (800-452-1261) or e-mail (flinn@flinnsci.com) the Technical Services department at Flinn Scientific Inc.

Flinn Method #25, continued

Procedure



8:00 O'Clock



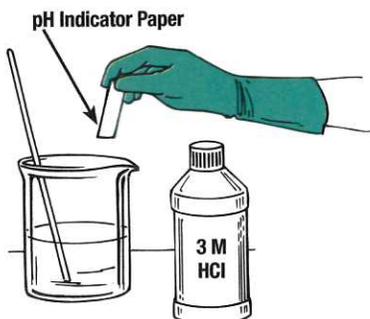
1

This technique is intended for small amounts (<10 g) only! Soluble carbides react with water, so keep these materials dry until ready for use or disposal.

Slowly put the carbide granules into the large beaker of water with stirring. Flammable acetylene gas will be given off. Allow the acetylene to dissipate in the air but avoid sources of possible ignition in the area. Allow the mixture to stand for several hours. The resulting solution will be strongly basic.

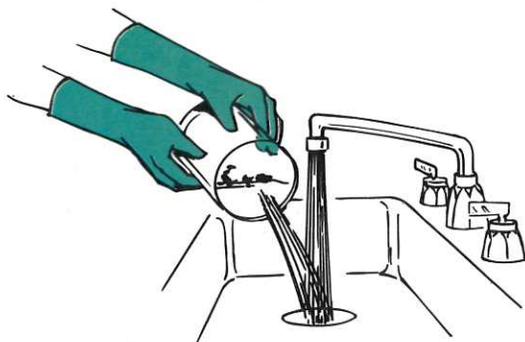


12:00 O'Clock



2

Using pH indicator paper, neutralize the solution with 3 M hydrochloric acid.



3

Decant the neutral solution and flush it down the drain with a 20-fold excess of water.



4

Dry any remaining precipitate, and package it for disposal in a landfill suitable for chemical wastes.

FLINN METHOD

#26a Solid Waste Disposal in Landfill

The majority of inorganic wastes are salts consisting of a cation and an anion. In planning the disposal of these materials, the hazards associated with the cation and anion must be determined separately. If either part presents a potential hazard, the substance should not be disposed of in a municipal landfill.

Cations that have a relatively low level of toxicity are: Al, Bi, Ca, Cu, Fe, Li, Mg, Mo(VI), K, Sc, Na, Sr, Ti, Zn, and Zr. Anions that have relatively low hazards are:

Bisulfite (HSO_3^-)	Cyanate (OCN^-)	Phosphate (PO_4^{3-})
Borate (BO_3^{3-})	Hydroxide (OH^-)	Sulfate (SO_4^{2-})
Bromide (Br^-)	Iodide (I^-)	Sulfite (SO_3^{2-})
Carbonates (CO_3^{2-})	Oxide (O_2^-)	Thiocyanate (SCN^-)
Chloride (Cl^-)		

This list of less hazardous cations and anions is presented only as a guideline. Your chemical judgment, volume of waste, and local regulations must also be considered. For example, sodium hydroxide contains an acceptable cation (Na) and anion (OH^-) but is in fact a toxic and corrosive material that should be treated before disposal.

Materials Required

Crumpled newspaper
Cardboard boxes
Heavy tape to seal boxes

Chemical Concept

No concept statement judged necessary for this procedure.

Procedure



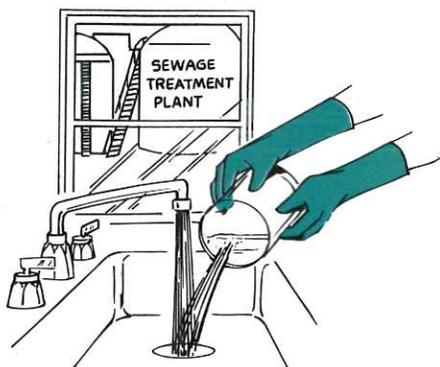
Bury these materials in a landfill site approved for the disposal of chemical and hazardous waste. Do not mix these materials by removing them from their separate containers as an unpredictable chemical reaction might occur. Rather, pack the separate containers into sturdy cardboard boxes, separating the glass containers from each other with crumpled newspapers to avoid inadvertent breakage. Seal the cardboard boxes with heavy tape.

This procedure is recommended for a wide array of materials, from aspirin to zinc. We use the term "landfill site approved for the disposal of chemical and hazardous waste" while full well realizing that many of these substances can go into the school trash. However, regulations about landfill use change with great frequency. Local regulations should be consulted about exactly what you can and cannot place in the landfill in your area. We cannot possibly keep track of all the changes in all the jurisdictions governing landfills, so you must determine what is permitted in your area. Please, we exhort you, do not assume that it is acceptable simply to dump materials into the school trash. Take the time to investigate. Some teachers have made this "investigation" a student/teacher project, and have learned a great deal in the process.

If you have made solutions of the water-soluble or alcohol-soluble materials classified for disposal under this procedure, we recommend that you dispose of these solutions by Flinn Disposal Method #26b.

FLINN METHOD

#26b Waste for Drain Disposal Without Pretreatment



If—and only if—your school drains are connected to a sanitary sewer system, with a water treatment plant operating on the effluent from your drains, you may use this procedure. These guidelines must be followed:

- Do not use this procedure if your drains empty into groundwater through a septic system—or into a storm sewer (see note below).
- These materials may be disposed of in quantities not to exceed 100 grams each day for each substance by rinsing them down the drain with a large excess of water.
- Do not put combinations of materials down the drain at one time.
- Completely dissolve each substance in water in a separate container. Rinse this solution down the drain with a tenfold excess of water. Then rinse the solution of a second substance down the drain with a tenfold excess of water. Repeat as necessary.

Local regulations may be more strict on drain disposal than the practices we recommend. You must determine what is permitted in your area. Sewer disposal in your community is regulated by an ordinance of your local water treatment facility. The regulations will spell out in considerable detail the allowable limits for various waste components. Because each water treatment facility is unique, you must contact the facility and get a copy of the ordinance. We also recommend meeting with representatives of the local treatment facility if a major laboratory cleanup and disposal is planned. A good working relationship with the treatment facility will make everyone more comfortable with the appropriate use of the sewer as a disposal method. For example, in some areas, compounds of aluminum, copper, and zinc are not permitted in sanitary sewers. In most cases, we recommend that you substitute Flinn Disposal Method #26a for this one. All the materials recommended for this procedure are water-soluble to the extent of at least 3%, and represent a very low toxicity hazard. In addition, the organic materials are readily bio-degradable.

Note: If your drain system does not empty into a wastewater treatment facility, do not put these substances down the drain. Rather, landfill the non-flammable substances and aqueous solutions according to Flinn Disposal Method #26a, and dispose of all others using a licensed hazardous waste disposal company according to Flinn Disposal Method #26c.

Please...Read the Narratives

Important narratives precede these specific chemical disposal methods! Please read each narrative carefully! Do not use these procedures if you are not comfortable with the chemistry. Do not use these procedures without *first consulting with your local government regulatory officials*. These procedures may not be used in some jurisdictions. These procedures may be dangerous. Once again...read the narratives that precede these specific chemical disposal methods.

FLINN METHOD

#26c Licensed Hazardous Waste Disposal

Many hazardous laboratory wastes are best disposed of using a licensed hazardous waste disposal company. Because this is an expensive option, it is important to choose a licensed and reputable firm. Please read the introduction on page 1188 for more information on choosing an acceptable disposal firm. Remember that the school has cradle-to-grave responsibility for its chemicals—documented proof that the chemicals have been properly disposed is required.

- ▶ Ask for and check references to make sure the firm is reputable and reliable.
- ▶ Do not automatically choose the low bid!
- ▶ Request a certificate of disposal for the chemicals.

FLINN METHOD

#27a Scrap Metals

These metals have commercial value as scrap. If you do not wish to retain them, try to sell them. Otherwise dispose of them by Flinn Disposal Method #26a.

FLINN METHOD

#27b Mercury Metal

Procedure

Mercury metal must not be disposed of by any means except to return it to a supplier for recycling. Mercury Waste Solutions, Inc. (1-800-741-3343) is a major mercury recycler and may be a disposal option. Under no circumstances should any other method of disposal be attempted. Metallic mercury is never buried, burned, placed down a drain or otherwise put into the environment. For disposal of mercury compounds, please see Flinn Disposal Methods #27d or #27f, depending on the compound.

FLINN METHOD

#27c Phosphorous, Red and White (Yellow)

Phosphorous is a highly reactive and very flammable material. Yellow (also called white) phosphorous is pyrophoric, a poison, and ignites spontaneously in air. Red phosphorous is not pyrophoric but is very flammable and can react explosively with strong oxidizing agents. Both chemicals must be handled and disposed of with utmost care by a licensed hazardous waste disposal company.

FLINN METHOD

#27d Antimony, Arsenic, Vanadium and Their Compounds: Cadmium and Other Heavy Metals as Elements

These heavy metals are very toxic and harmful to the environment. They should be disposed of properly by a licensed hazardous waste disposal company according to Flinn Disposal Method #26c.

FLINN METHOD

#27f Heavy Metals and Their Salts and Compounds

The heavy metal elements have limited reactivity and low solubility in water. These materials, while in metallic form are less hazardous. Examples include lead, antimony, cadmium, chromium, cobalt, and nickel metals.

Heavy metal salts are very soluble in water, extremely toxic, and accumulate in body tissues. Many states and municipalities have strict regulations on the disposal of these materials. These materials should be disposed of properly by a licensed hazardous waste disposal company according to Flinn Disposal Method #26c.

FLINN METHOD

#27h Barium Compounds

Soluble barium salts are extremely toxic and should not be flushed down the drain or buried in a landfill. Conversion to an insoluble barium sulfate is the best disposal route.

Examples

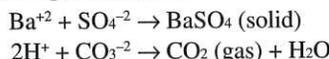
All barium salts, i.e., barium nitrate, barium hydroxide, barium chloride

Materials Required

Chemical-resistant gloves
Chemical-resistant apron
Chemical splash goggles
Large beaker
Glass stirring rod
Sulfuric acid, H₂SO₄, 3 M
Filtration apparatus (optional)
Wide-mouth plastic container with screw top
pH indicator paper
Sodium carbonate, Na₂CO₃

Chemical Concept

In contrast to the metal ions mentioned in #27f above, barium sulfide is rather soluble. However, barium sulfate is highly insoluble. This procedure produces barium sulfate in an acidic solution. Note that the only acid which will work in this procedure is sulfuric acid. The acid serves a double purpose in the case of barium hydroxide and barium peroxide, in that it neutralizes the hydroxide ion in addition to its primary purpose of furnishing sulfate ion to react with the barium ion. Once the precipitation is complete, the precipitate is separated from the supernatant liquid and any excess acid is neutralized with sodium carbonate. The solid barium sulfate is put in a landfill, and the neutralized supernatant liquid is flushed down the drain.

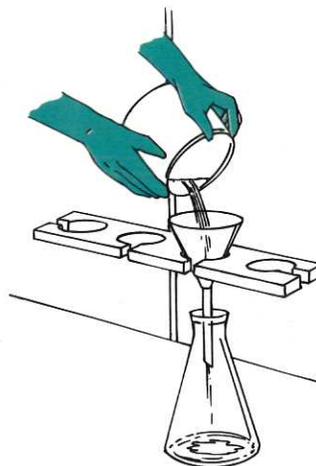


Procedure

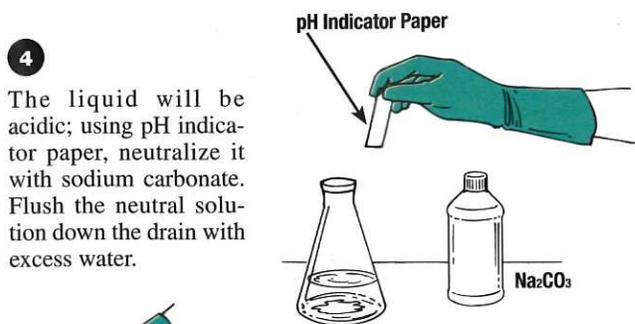
1 Dissolve the solid barium salt in a minimum amount of water. (Barium carbonate and barium peroxide are not soluble in water, so just suspend them in a tenfold excess of their weight in water.)



2 Add 3 M sulfuric acid to the solution while stirring until the precipitation of barium sulfate appears to be complete. Add at least a twofold molar excess of sulfuric acid.



3 Allow the precipitate to settle, and decant off the supernatant liquid or filter off the precipitate.



4 The liquid will be acidic; using pH indicator paper, neutralize it with sodium carbonate. Flush the neutral solution down the drain with excess water.



5 Allow the precipitate to dry, place it in a plastic bag and then in a plastic container, and bury the container in a landfill suitable for such waste.

FLINN METHOD

#27j Halogenated Solvents

Halogenated solvents should be disposed of properly by a licensed hazardous waste disposal by a licensed hazardous waste disposal company according to Flinn Disposal Method #26c.

REFERENCES

The disposal procedures listed in this section are obtained from the following reliable and highly regarded sources:

Lunn, G.; Sansone, E. B. *Destruction of Hazardous Chemicals in the Laboratory*, 2nd ed.; John Wiley & Sons: New York, 1984.

Laboratory Waste Disposal Manual; Manufacturing Chemists Association: Washington, D.C., 1975.

Armour, M. A., *Hazardous Laboratory Chemical Disposal Guide*, 2nd ed.; Lewis: New York, 1996.

Hazardous Chemicals, A Manual for Schools and Colleges; Oliver & Boyd: Edinburgh, 1980.

Prudent Practices in the Laboratory; National Academy: Washington, D.C., 1995.

Pitt, M. J.; Pitt, E. *Handbook of Laboratory Waste Disposal*; Ellis Horwood: Chichester, 1985.

Prudent Practices for Disposal of Chemicals from Laboratories; National Academy: Washington, D.C., 1983.

Biological Waste Disposal

Ecological studies have repeatedly demonstrated the intertwined nature of all elements of the ecosystem. A basic ecological principle simply states—"You can't do just one thing." So when we dispose of materials we are likely to do more than just dispose of the materials. When considering the disposal of any material (school or elsewhere) our goal must be to minimize the environmental impact of the disposal, i.e., come as close to doing "one thing" as possible. Common sense, a knowledge of the material, and a familiarity with local disposal regulations, procedures and policies must prevail. The general guidelines provided here are only intended to stimulate clear thinking about how to minimize our effects on the environment as we recycle earth's materials.

One important first step is to formulate a biological waste disposal policy. General guidelines and parameters should be written prior to conducting actual disposal procedures. Some suggestions that might help in formulating a general biology disposal policy:

- Contact your state department of education. Many states have a science supervisor who might be able to make suggestions on disposal of biohazards or advise you about existing programs already in operation.
- If you are located near a large university, biological research facility, hospital, or other biological institution, check with officials for possible cooperative activities. You may be able to piggyback your biohazard materials with their disposal procedures.
- You might form a cooperative with other schools in your area and have a unified disposal plan. There are often savings in bulk disposal.
- Your state equivalent of the Environmental Protection Agency (EPA) may have useful resources.
- Your state or national biology teacher associations have resources and guidelines that are very helpful.

When conducting any disposal procedures, be sure to provide personal protection for yourself and others around you. Always wear proper personal protection equipment (goggles, aprons, gloves, etc.). Conduct disposal procedures in proper areas for the materials (hoods, ventilated areas, appropriate sinks, etc.). Where appropriate, follow sterile procedures and cautions relative to potential pathogens.

We have arbitrarily divided waste materials into six categories for the sake of discussion and clarity. Some situations might involve a combination of several of the categories. Specific federal, state, and local regulations may apply to the disposal of biohazards from your lab. You must review your obligations and options with regulatory and school officials before developing a disposal procedure at your school.

Type I: Potentially harmful due to microorganism-type contamination

Type II: Potentially harmful due to dangerous chemical hazards

Type III: Preserved materials

Type IV: Living materials

Type V: Sharps and glass items

Type VI: Common garbage items

Type I Potentially Harmful Wastes Due to Microorganism-Type Contamination

Examples

Bacterial cultures, culture tubes, disposable loops, Petri dishes, blood typing materials, any body fluids, any unknown "growing" items, contaminated media products, disposable gloves used in dissections or when handling living materials, electrophoresis materials, any items which might harbor microorganisms.

★ HAZARDS

All laboratory wastes that may harbor any microorganisms must be assumed to be pathogenic and need to be treated before they are thrown in the trash. Biological culture media is specifically designed to foster the growth of microorganisms. These organisms will continue to grow even after disposal unless they are destroyed. Contaminating microorganisms may be growing along with known organisms. These organisms must be assumed to be harmful. Recent concerns about blood-borne pathogens and body fluid transmissions have heightened awareness for utilizing sterile techniques when doing any human physiology experiments or blood typing. For these reasons, all of these laboratory materials must be sterilized after use and before disposal.

Disposal Procedures

Materials that are potentially contaminated with microorganisms *must* first be sterilized before disposal. After sterilization, they can usually be disposed of by normal trash removal methods. Check with local authorities for rules and regulations that apply to your community. There are two methods for sterilizing wastes: Method IA—autoclaving and Method IB—chemical sterilization.

Method IA: Autoclaving

Materials can be autoclaved in an autoclave. If an autoclave is not available, a pressure cooker may be used. Biohazard bags should be used wherever possible and will make the sterilization of some biohazard materials easier, while also providing a convenient disposal container. Biohazard bags are made of a very durable plastic that can withstand the high temperature and pressure of autoclaving. An indicator patch on the bag turns dark when it has been autoclaved/steam processed. The dark patch provides quick external proof that the bag and its contents have been sterilized and that it should not be opened.

Objects to be autoclaved should be placed into a biohazard bag carefully without opening the containers (Petri dishes, test tubes, etc.). Highly dangerous materials should be handled only when wearing gloves, masks, and safety eyewear, and practicing other sterile precautions. Do not put any sharp objects (blood lancets, broken glass, dissecting instruments, etc.) into biohazard bags. The bag should then be tightly sealed by doubling over its end and sealing it shut with a twist tie. Do not overload or "stuff" the bag.

The bagged biohazard materials should now be autoclaved. The bagged biohazard materials should be autoclaved at 15 lbs. per square inch of pressure for 30 minutes at 121 °C. Follow directions for specific autoclaves or pressure cookers very carefully. Use insulated gloves when removing the bags from the autoclaving device. Bags containing glass or other breakable materials should be separated from other bags prior to disposal in the trash depending on your local practices.

Method IB: Chemical Sterilization

To sterilize, place culture or material in a 10% bleach solution for 24 hours. To prepare 10% bleach solution, dilute one part household bleach with nine parts water. Rinse the sterilized materials with water, and then dispose of them following appropriate procedures.

Type II Potentially Harmful Wastes Due to Dangerous Chemical Hazards

Examples

Solutions from electrophoresis or staining procedures, formaldehyde solutions, or other chemical solutions or solids.

★ HAZARDS

Chemical wastes may be corrosive, toxic, or flammable and should be handled accordingly. If the waste material is of unknown composition, assume the material is toxic, corrosive, and flammable and take all precautions when handling the material. Contact Flinn Scientific technical staff for advice on how to identify and dispose of unknown chemical wastes.

Continued on next page.

Biological Waste Disposal, continued**Disposal Procedure**

If the identity of the chemical waste is known, then consult the chemical waste disposal section of the *Flinn Scientific Catalog/ Reference Manual*. To find the proper disposal procedure, look up the chemical in the chemical section of the *Flinn Scientific Catalog/ Reference Manual*, and find the Flinn Suggested Disposal Procedure (e.g., Disposal: #26a) in the chemical listing. Then find the Flinn Suggested Disposal Procedure in the Chemical Disposal Procedures section of the reference manual. The disposal of chemical wastes is regulated by federal, state, and local ordinances; do not perform any disposal procedure without first consulting with your local government regulatory officials.

Type III Preserved Materials**Examples**

Preserved materials used in dissection activities such as fetal pigs, frogs, rats, etc., either before or after dissection. Museum mount display materials.

★ HAZARDS

Preserved materials are often fixed using formalin or formaldehyde. After the fixing process, the excess formaldehyde is usually removed and replaced with a nonformaldehyde preservative. The preservative solution and the preserved material both contain low levels of formaldehyde, a known carcinogen, and other chemicals. Many of these chemicals are also toxic by ingestion and inhalation.

Disposal Procedure

Do not perform this procedure if your school uses a septic system for waste water treatment. No chemicals should be placed down the drain unless your school is hooked up to a municipal water treatment facility. Prior to starting this procedure, check with your local water treatment facility for any rules or regulations concerning the disposal of formaldehyde solutions.

The first step in this disposal procedure is to rinse and wash away the preservative from the specimens. The room in which this process is undertaken should be well ventilated. Transfer the preserved specimens to a large plastic bucket or pail and place it in a large sink. Attach a length of tubing to the cold water outlet and, wearing gloves, force the exit end of the tubing into the very bottom of the bucket. If possible, use a water faucet equipped with a siphon breaker to eliminate the possibility of backflow.

Turn the water on slowly. You may want to start the water flowing before you force the tubing into the bucket to better gauge and control the water flow. A very slow, but steady, flow is desirable.

Allow the water to flow into the bottom of the bucket, forcing the preservative to overflow into the sink. Continue washing the specimens overnight or for a period of 10–12 hours to completely wash all preservative from the specimens.

After the wash cycle is complete, turn off the water, remove the tubing, and drain all the remaining water from the container. Let the specimens drain for an hour, and then double bag them in non-transparent plastic bags (black is preferred). Seal each bag completely and follow your local procedures for normal garbage disposal. Do not leave the specimens where students may find them, such as the trash can in the science laboratory.

Type IV Living Materials**Examples**

Carcasses of dead animals such as snakes, guinea pigs, fish, etc.

★ HAZARDS

Deceased living materials may contain diseases or pathogenic microorganisms that may spread to humans. Deceased animals should only be handled with gloves and disposed of as quickly as possible.

Disposal Procedure

Living animals, especially reptiles, amphibians, and insects should never be released to the environment unless first checking with local authorities. Introducing new species to your local environment may result in irreparable damage to local ecosystems.

Most areas prohibit the burial of dead animals and you should review the local county's sanitation regulations for information on disposal of dead animals. For advice, consult your local Humane Society office, the local animal shelter, highway department, or state natural resources department. A general disposal procedure is to wrap the deceased animal in newspaper, place it in a non-transparent plastic bag, and then throw it in the school's main trash container if this is allowed. Do not leave the animal where it may be discovered by students.

Microorganism cultures, such as protozoans, should be sterilized by Method IA or IB as outlined earlier and then flushed down the drain.

Very small dead fish can be simply flushed down the drain if the school is hooked up to a municipal water treatment facility.

Type V Sharps and Broken Glass**Examples**

Sharps and broken glass items. Needles, dissecting blades, glass tubing, and glass pipets.

★ HAZARDS

Any sharp metal or glass object has the potential to puncture or cut the skin and deliver pathogenic organisms directly into the bloodstream in addition to creating a wound. These materials must be placed inside a hard plastic or metal container to prevent any possible physical injury.

Disposal Procedure

Check with a local hospital, health clinic, or college for assistance in disposing of sharps. Hospitals and health clinics have rigorous programs to handle their sharps and may be willing to help a local school in safely disposing of sharps.

If outside help is not available, either purchase a sharps disposal container or obtain a hard plastic or metal container and add a large "sharps" label on the outside. If using a plastic container, make sure it is a hard plastic that is not flexible and cannot be easily squeezed. PET and PVC are usually better than LDPE or HDPE plastic containers. Ideally, the bottle should have a narrow neck to prevent any possibility of a student sticking their hand into the sharps container. Another option is to cut a small hole in the top of the lid to allow the sharps to be added but not easily removed.

When the sharps container is full, the container and sharps must be sterilized before disposal. Use either Method IA or IB for sterilizing biohazards. After sterilization, place a cap on the bottle, wrap the container in a heavy thickness of newspaper, place it in a nontransparent plastic bag, and dispose of it following local disposal procedures. Never place a sharps container in a recycling bin.

Type VI Common Garbage Wastes**Examples**

Paper products, plastic laboratory wastes that are not contaminated with chemicals or biological material.

★ HAZARDS

No hazards with these materials beyond that of normal garbage.

Disposal Procedure

If a material has been used to dispense a chemical solution, rinse thoroughly before placing it in the trash. Dispose of all other materials that do not have chemical or biological wastes in the normal trash following your school's normal trash procedures. A good practice is to place disposable laboratory items in a black plastic garbage bag and then thoroughly close the plastic bag before throwing it in the trash. This may prevent laboratory items from being discovered in the trash by students and used for personal experiments or practical jokes.