

# APPENDIX I: CHEMICAL WASTE TREATMENT AND DISPOSAL

## Notes

These treatments should only be carried out by staff who have knowledge of the chemistry involved and are experienced in working with chemicals. In all other cases, the chemicals in their original form should be disposed of through a qualified waste broker.

These processes can reduce disposal costs and environmental impact, especially for larger quantities. Since schools may still have chemicals on-site that are no longer used or are not recommended for use in schools (e.g., heavy metals such as lead), treatment processes for these substances have been included. Their inclusion, however, does not imply appropriateness for school use. Hazardous waste treatment includes evaporation of aqueous solutions and various chemical treatments.

## Evaporation of Aqueous Solutions

When solutions contain chemicals not suitable for recovery, the volume of hazardous materials can be greatly reduced by allowing the solution to evaporate under a fume hood or in another well ventilated area. Transfer the solution to a wide-mouthed container, such as an evaporating basin or large beaker for maximum evaporation surface, and allow it to stand until a sludge remains. This sludge can be appropriately labelled for off-site disposal at such time as the volume of sludge sediment required dictates.

## Chemical Treatment

Disposal of hazardous wastes is regulated by municipal by-laws (see [Chapter 1](#)). If your municipality does not allow the disposal of acids, bases, or heavy metal salts directly into sewer systems, a qualified waste broker should be contacted to remove the waste. Alternatively, the following treatments may be used by staff who have knowledge of the chemistry involved and are experienced in working with chemicals.

A number of substances can be chemically converted into an insoluble or less toxic form that may, in many cases, be disposed of by means other than a chemical waste facility. Appropriate personal protective equipment, including eye protection, gloves, and laboratory coat, should be worn when performing the reactions.

## Neutralization of Acids and Bases

Waste quantities of acids, such as hydrochloric acid, sulfuric acid, nitric acid, and acetic acid, and bases such as sodium and potassium hydroxides, can be neutralized and washed into the drain. First, carefully add the concentrated acids or bases to 20 times their volume of water so that their concentration is reduced below 5%. This should be done in an ice bath under a fume hood using an adequately sized container (e.g., 100mL of concentrated waste will require 2 L of water). Caution: never add water to concentrated acid. Add 5% sodium hydroxide solution or solid sodium carbonate (soda ash) to the dilute solutions of waste acid until the pH is between 6 and 8. Waste dilute solutions of base can be treated with waste dilute solutions of acid or with 5% hydrochloric acid solutions. The neutralized solutions can be washed down the drain.

## Precipitation of Heavy Metal Salts

There are experiments both in Grade 11 and Grade 12 Chemistry that may require small amounts of heavy metals, such as silver, copper, iron, cobalt, manganese, chromium, nickel, or tin.

An alternative to the evaporation of dilute aqueous solutions of heavy metal salts is to precipitate the metals as an insoluble salt that can be removed by filtration or by allowing the solid to settle and decanting the liquid. The residue can then be disposed of according to relevant guidelines. Specific directions for precipitating lead ions from solution as their silicate are described, as are the modifications needed to use this method for other heavy metal ions. The formation of the silicate can be summarized by the following generalized equation:



Add a 0.01 molar solution of a soluble lead salt (e.g., 0.166 g of lead II nitrate in 50 mL of water) to a 0.03 mol/L solution of sodium metasilicate (0.392g  $\text{Na}_2\text{SiO}_3 \cdot 9\text{H}_2\text{O}$  in 50mL of water). Stir well. Adjust the pH to about 7 by the addition of about 15 mL of 2 mol/L aqueous sulfuric acid. Collect the precipitate by filtration or allow the mixture to stand until the solid has settled to the bottom of the container and the liquid can be poured off. Allow the solid to dry, and then package and label for disposal.

For dilute solutions of lead salts of unknown concentration, the sodium metasilicate solution should be added until there is no further precipitation. Adjust the pH to a level between 7 and 8 with the addition of 2 mol/L sulfuric

acid, and allow the solution to stand overnight before collecting the solid by filtration or by allowing it to settle and pouring off the liquid. Solutions of cadmium and antimony salts can be treated similarly. Several other heavy metal salts can also be precipitated in the same way as silicates. The quantities given for lead are also appropriate for 0.01 moles of these metals. The only modification necessary is a change in the pH at which the silicate is precipitated. This includes the Fe (II) & (III) ions, Zn(II), Al(III), Cu (II), Ni (II), Mn (II), and Co (II) ions, all of which can be precipitated without adjustment of the pH that results from the addition of the solutions of sodium metasilicate.

<b>pH of Precipitation of Metal Ions Using Sodium Silicate</b>		
Metal Ion	pH for maximum precipitation	Concentration of metal ion remaining in solution
Iron II	9.5–10.0	5 ppm
Iron III	10.0–10.5	2 ppm
Zinc II	8.5	< 0.5 ppm
Aluminum III	8.5	< 2 ppm
Copper II	10.5–11.0	0.03 ppm
Cobalt II	9.5–10.0	0.08 ppm
Manganese II	9.5–10.0	0.2 ppm
Nickel II	9.5–10.0	0.3 ppm

Similarly, solutions of unknown concentration can be treated with sodium metasilicate solution until there is no further precipitation. Adjust the pH to the required value by the addition of 2 mol/L sulfuric acid or 5% sodium hydroxide solution, and allow the mixture to stand overnight before collecting the solid by filtration or by allowing it to settle and pouring off the liquid. After standing in the air to dry, the metal silicates should be placed in a labelled container for disposal. The liquids can be washed into the drain.

## Reduction of Oxidizing Agents

Inclusion of this reduction process does not imply appropriateness for school use of some of the compounds identified here. The process is described, however, for the benefit of schools that may have these compounds on their shelves and are looking to discard them.

Solutions of compounds, such as potassium permanganate, sodium chlorate, sodium periodate, and sodium persulfate, should be reduced before being discarded into the drain to avoid uncontrolled reactions in the sewer system. The reduction can be accomplished by treatment with a freshly prepared 10% aqueous solution of sodium bisulfite or metabisulfite. Specific quantities and conditions for these reactions are detailed in the table below.

Oxidizing agent present in wastestream	Quantity and concentration of oxidizing agent in aqueous solution	Quantity of 10% aqueous sodium metabisulphite	Comments
Potassium permanganate	2L of 6%	1.3 L	Solution becomes colourless
Sodium chlorate	1L of 10%	1.8 L	50% excess reducing agent added
Sodium periodate	1L of 9.5%	1.7 L	Solution becomes pale yellow
Sodium persulphate	1L of 10%	0.5 L	10% excess reducing agent added

## Treatment of Iodine and Iodine Solutions

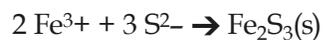
Under the fume hood, cautiously add 1 gram of solid iodine to a solution of sodium thiosulfate (2.5 g sodium thiosulfate in 60 mL of water) also containing 0.1g of sodium carbonate. Stir the mixture until the iodine has all dissolved and the solution is colourless. Check the pH and, if needed, add solid sodium carbonate to bring the pH of the solution to a level between 6 and 8. The solution can then be washed into the drain. The following is a summary of the reaction:



Solutions of iodine can be dealt with as follows: Stir a sodium thiosulfate solution (4 g in 100 mL of water) containing sodium carbonate (0.1 g) into the iodine solution. Continue stirring until the solution becomes colourless. If necessary, add sodium carbonate to bring the pH to a level between 6 and 8. Treat the liquid for sulfides.

## Treatment of Sulfides

Under a fume hood, place 1 mol/L FeCl<sub>3</sub> solution (three times the excess of solution to be disposed of) in a beaker, and then add disposal solution with continuous stirring. A precipitate will form. Neutralize with sodium carbonate, a reaction that will release CO<sub>2</sub> gas. A summary of the reaction can be given as follows:



Allow precipitate to settle and then either decant solution or filter. Flush neutral solution down the drain and dispose of the precipitate to an appropriate landfill. If flushing of iron is a sewer concern, then all the material may be evaporated to dryness and disposed of via solid waste disposal.