

Substitution of a More Hazardous Chemical by a Less Hazardous Chemical

It is important to minimize the use of hazardous chemicals and production of hazardous wastes in our K-12 schools. Using many of these chemicals can be exceedingly dangerous to the health of workers and students in a school laboratory setting. School science laboratories often do not meet OSHA standards either for the Laboratory Standard or Hazard Communication Standard. Teachers and students can be exposed to harmful odors and other associated hazards from chemicals. Many chemical storerooms do not possess a separate exhaust to the outside in addition to the fact that the school science department does not have a separate HVAC system. Additionally, it is expensive to remove waste chemicals from schools by hazardous waste companies. As a result, these harmful hazardous waste chemicals are left in the schools.

It is prudent practice to reduce the amounts of chemicals that are used in schools. It is essential that science inquiry be a vital part of the science laboratory experience in all sciences. Safety is not only for chemistry classes. All sciences use chemicals. All chemicals have associated hazardous that cannot be removed; however, the risks can be minimized by doing microscale chemistry, green chemistry or using less hazardous substitutes for more hazardous chemicals in the K-12 science laboratory. A list of possible substitutions follows:

Chemical Substitution List for Science IS...Inquiry Safely

Task	Hazardous Chemical	Substitute
Extraction solvents	Ethyl ether; Methyl-t-butyl ether (MTBE) ¹	Hexanes ¹
Oxidation of organic compounds	Chromate ion	Hypochlorite ion ¹
Qualitative test for heavy metals	Sulfide ion	Hydroxide ion ¹
Freezing point lowering	Benzene	Cyclohexane; Sodium chloride solution
Temperature	Mercury thermometers	Alcohol (red, blue, green) or Spirit-filled; Digital; Teflon [®] coated; Enviro-Safe TM ² ; Ever-Safe [®] ³ ; Oven thermometers
Pressure	Mercury barometers	Pressure probes; Non-mercury barometers
Preservation of biological specimens	Formaldehyde; Formalin	Ethanol or other preservatives, Formalernate ^{®3} ; Fisher-Free ^{®4} ; Fisher BioFresh ^{®4} ; CaroSafe TM ; Perfect Solution TM ⁵
Enthalpy of fusion	Acetamide; para-Dichlorobenzene	Stearic acid or Acetamide tubes; Paraffin wax ³
Melting point determination	para-Dicholorobenzene	Stearic acid; Cetyl alcohol; 1-Octadecanol; Palmitic acid; Lauric acid; 1-octyl Phenol; 4-(t-octyl) Phenol ³

Chemical Substitution List for Science IS...Inquiry Safely (cont'd.)

Heat transfer liquid for hot oil baths or melting point Thiele Tubes	Mineral oil*	Silicon oil (polymethylsiloxane) ³
Vapor Pressure / temperature	Carbon tetrachloride	Isopropyl alcohol ⁶
Water softening	Calgon	Sodium hexametaphosphate ³
Play Slime	Polyvinyl alcohol	Guar gum ³
Qualitative test for halide ions	Carbon tetrachloride	Cyclohexane, ¹ Hexane, Mineral oil ^{3**}
Qualitative test for heavy metals	Heavy metals Sulfide ion	Copper, cobalt, iron etc ⁶ Hydroxide ion
Solubility of Iodine or non-polar substances	Chloroform; Carbon tetrachloride; Benzene; Toluene; Xylenes; 1,1,1-Trichloroethane; 1,1,2-Trichlorotrifluoroethane & other halogenated solvents	Mineral Oil**; Hexanes; Non-halogenated solvents; Alcohols; Cyclohexanes ^{1,3}
Molar volume determination	Potassium chlorate & Manganese dioxide	Dry ice (see Flinn Chem Fax No. 1001 ³); Magnesium & Hydrochloric acid ³
Ignition of Thermite	Magnesium metal or other chemical igniters	Thermite ignition sticks ³
Anesthesia	Ethyl ether	Fly-Nap ^{® 5} ; Lull-A-Fly ^{® 3} ; Triethylamine
Highly reactive Group I metals	Potassium, sodium	Calcium, magnesium
Polymer	Chloroform; Carbon tetrachloride; 1,1,1-Trichloroethane	Isopropyl alcohol; Cyclohexane ^{1,3}
Histology	Xylene	Alcohols; Limonene based products ³
Acids and Bases	Regular acids / bases	Vinegar and sodium bicarbonate
Hydrogen sulfide	Sodium sulfide	Aitch-tu-ess cartridges ³
Metal alloy	Woods metal	Onion's Fusible Alloy ³
Volcano reaction	Ammonium dichromate	Vinegar and sodium hydrogen carbonate
Base spill neutralizer	Vinegar solution	Citric acid powder ³
Magnetism	Pure Iron filings	Flinn's Iron alloy filings ³
Alcohol use in lab	Methyl alcohol	Anhydrous ethyl alcohol ³
Polymer catalyst	Benzoyl peroxide	30 % Hydrogen peroxide; Lauroyl peroxide ³

