

**Table 5.28.**

**SUBSTITUTION OF A MORE HAZARDOUS CHEMICAL BY A LESS HAZARDOUS CHEMICAL**

Task	Hazardous Chemical	Substitute
Extraction solvents	Ethyl ether; Methy-t-butyl ether (MTBE) <sup>1</sup>	Hexanes <sup>1</sup>
Oxidation of organic compounds	Chromate ion	Hypochlorite ion <sup>1</sup>
Qualitative test for heavy metals	Sulfide ion	Hydroxide ion <sup>1</sup>
Freezing point lowering	Benzene	Cyclohexane; Sodium chloride solution
Temperature	Mercury thermometers	Alcohol (red, blue, green) or Spirit-filled; Digital; Teflon <sup>®</sup> coated; Enviro-Safe <sup>™</sup> <sup>2</sup> ; Ever-Safe <sup>®</sup> <sup>3</sup> ; Oven thermometers
Pressure	Mercury barometers	Pressure probes; Non-mercury barometers
Preservation of biological specimens	Formaldehyde; Formalin	Ethanol or other preservatives; Formalterate <sup>®</sup> <sup>3</sup> ; Fisher-Free <sup>®</sup> <sup>4</sup> ; Fisher BioFresh <sup>®</sup> <sup>4</sup> ; CaroSafe <sup>™</sup> ; Perfect Solution <sup>™</sup> <sup>5</sup>
Enthalpy of fusion	Acetamide; para-Dichlorobenzene	Stearic acid or Acetamide tubes; Paraffin wax <sup>3</sup>
Melting point determination	para-Dichlorobenzene	Stearic acid; Cetyl alcohol; 1-Octadecanol; Palmitic acid; Lauric acid; 1-octyl Phenol; 4-(t-octyl) Phenol <sup>3</sup>
Heat transfer liquid for hot oil baths or melting point Thiele Tubes	Mineral oil	Silicon oil (Polymethylsilosane) <sup>3</sup>
Vapor pressure / temperature	Carbon tetrachloride	Isopropyl alcohol <sup>6</sup>
Water softening	Calgon	Sodium hexametaphosphate <sup>3</sup>
Play Slime	Polyvinyl alcohol	Guar gum <sup>3</sup>
Qualitative test for halide ions	Carbon tetrachloride	Cyclohexane; 1-Hexane; Mineral oil <sup>3</sup>
Qualitative test for heavy metals	Heavy metals; Sulfide ion	Copper; Cobalt; Iron etc <sup>6</sup> ; 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 <sup>1,3</sup>
Molar volume determination	Potassium chlorate; Manganese dioxide	Dry ice (see Flinn Chem Fax No. 10013); Magnesium; Hydrochloric acid <sup>3</sup>
Ignition of Thermite	Magnesium metal or other chemical igniters	Thermite ignition sticks <sup>3</sup>
Anesthesia	Ethyl ether	Fly-Nap <sup>®</sup> <sup>5</sup> ; Lull-A-Fly <sup>®</sup> <sup>3</sup> ; Triethylamine
Highly reactive Group I metals	Potassium; Sodium	Calcium; Magnesium

**Table 5.28. (cont'd)**

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Task	Hazardous Chemical	Substitute
Polymer	Chloroform; Carbon tetrachloride; 1,1,1-Trichloroethane	Isopropyl alcohol; Cyclohexane <sup>1,3</sup>
Histology	Xylene	Alcohols; Limonene based products <sup>3</sup>
Acids and Bases	Regular acids; Bases	Vinegar; Sodium bicarbonate
Hydrogen sulfide	Sodium sulfide	Aitch-tu-ess cartridges <sup>3</sup>
Metal alloy	Woods metal	Onion's Fusible Alloy <sup>3</sup>
Volcano reaction	Ammonium dichromate	Vinegar; Sodium hydrogen carbonate
Base spill neutralizer	Vinegar solution	Citric acid powder <sup>3</sup>
Magnetism	Pure Iron filings	Flinn's Iron alloy filings <sup>3</sup>
Alcohol use in lab	Methyl alcohol	Anhydrous ethyl alcohol <sup>3</sup>
Polymer catalyst	Benzoyl peroxide	30% Hydrogen peroxide; Lauroyl peroxide <sup>3</sup>
Diffusion properties	Bromine; Iodine	Bromine; Iodine diffusion tubes <sup>3</sup>
Cleaning	Chromex; Chromic acid	Detergents; Flinn-it™ Cleaner; RBS 35® Cleaner <sup>3</sup>
Cleaner	Sodium dichromate	Sodium hypochlorite <sup>1</sup>
Solvent; Cleaner	Toluene	Alcohols <sup>1</sup>
Mercury spills	Sulfur powder	Zinc dust; Mercon® Spill Control Kit <sup>3</sup>
Sulfur solvent	Carbon disulfide	5 mL Olive oil <sup>3</sup>
Insect killing jars	Metal cyanides	Ethanol; Ethyl acetate <sup>3</sup> or Freezing insects
Genetic taste test for bitter taste for PTC	Phenol thiourea; Phenol thiocarbamide solution or powder	PTC paper <sup>3</sup>
DNA Extraction	Chloroform	DNA extraction kits <sup>3,4,5</sup>
Azure B staining procedures	Azure B stain	Methylene blue stain <sup>3</sup>
Antibiotic solutions	Antibiotic solutions	Antibiotic test disks <sup>5</sup>
Chemical waste reduction	Large scale chemistry	Green chemistry; Microchemistry
Generation of Oxygen	Potassium chlorate; Manganese dioxide	Hydrogen peroxide; Manganese dioxide
Density determination	Methanol solutions	Sugar; Diet soda solutions

\*Silicon oil is a less hazardous chemical that can be substituted for mineral oil.

\*\*Mineral oil is much less hazardous than the alternative in these activities.

References:

<sup>1</sup>University of Missouri-Rolla, Material Substitutions. Waste Minimization Program, 2002, UMR Environmental Health and Safety Department.

<sup>2</sup>Foster, Barbara, Mercury Thermometer Replacements in Chemistry Laboratories. Journal of Chemical Education, Vol. 82, No. 2, February 2005.

<sup>3</sup>Flinn Chemical & Biological Catalog Reference Manual 2007. Flinn Scientific Company, Batavia, IL.

<sup>4</sup>Fisher Scientific 2007 Catalog. Fisher Scientific Division of Thermo Fisher, Hanover Park, IL.

<sup>5</sup>Carolina Biological Supply Catalog 2006. Carolina Biological Supply Company, Burlington, NC.

<sup>6</sup>Scholar® Chemistry Resource Manual, Developed with Charles A. Dana Center at the University of Texas at Austin. [www.scholarchemistry.com](http://www.scholarchemistry.com)