

Table of chemicals

Substance	Hazard	Guidance			
		Suitability	Comments		
<i>Acetaldehyde</i>					see Ethanal
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<i>Acetic acid, glacial</i>					see Ethanoic acid
<i>Acetic anhydride</i>					see Ethanoic anhydride
<i>Acetone</i>					see Propanone
<i>Acetonitrile</i>					see Ethanenitrile
<i>Acetophenone</i>					see Phenylethanone
<i>Acetyl chloride</i>					see Ethanoyl chloride
<i>Acetylene</i>					see Ethyne
<i>Acetylsalicylic acid (Aspirin)</i>					see Ethanoyl 2-hydroxybenzenecarboxylic acid
<i>Acrylamide</i>					see Propenamide
<i>Adipic acid</i>					see Hexanedioic acid
<i>Adipoyl chloride</i>					see Hexanedioyl dichloride
<i>Allyl bromide</i>					see 3-bromoprop-1-ene
Aluminium powder (pyrophoric)	F	Teacher/Technician			Should not be mixed with oxides of lead or copper. For use in the Thermit Reaction and action on iodine consult the relevant entries in <i>HazChemMan CD2 (SSERC)</i> and <i>Hazcards (CLEAPSS)</i> . On small scale
Aluminium powder (fine)	F-	Y9	N10	S2	
Aluminium bromide (anhydrous)	C	Y12	N13	S5	(FC) Use a fume cupboard for investigations of reaction with water as large volumes of toxic gas could be produced. Reaction with water violent. There can be a long induction period with the reaction especially if the sample is old.
Aluminium chloride (anhydrous)	C	Y12	N13	S5	
4-aminobenzenesulfonic acid (Sulphanilic acid)	Xn, Sen	Y12	N13	S6	As precursor for the preparation of Methyl Orange. If used as part of the spot test for nitrites avoid the use of naphthols as the other reagent by replacing with naphthylethylenediamine (or NED) hydrochloride.
4-aminobiphenyl	Carc 1	Banned			Prohibited by COSHH
Aminobutanes & aliphatic amino compounds aqueous solutions	F-, Xi C	Y12	N13	S5	FC
Ammonia gas	T, F-	Y7	N8	S2	See <i>Topic 4.3 in Topics in Safety</i> for details of safe smelling of gases.
Ammonia solution > 25% ammonia (0.880) (> 15M) 10% to 25% (6M to 15M) 5% to 10% (3M to 6M)	C, N C Xi	Y12 Y9 Y7	N13 N10 N8	S5 S5 S2	FC FC (FC) Beware evolution of ammonia gas when opening bottle, particularly on a hot day.
Ammoniacal silver nitrate solution (Tollen's Reagent)	E	Y12	N13	S5	Always prepare a fresh solution and use at once, do not store. Heat the mixture on a water bath only. Do not allow to boil dry as the solid produced is explosive. Any silver mirror produced should be rinsed from the tube using dilute nitric acid. Immediately dispose of excess solution, but do not add to silver residues.

Ammonium chlorate(VII) (perchlorate)	O	Not generally recommended	Not recommended for use in schools.		
Ammonium chloride	Xn	Y7	N8	S1	Fumes given off when heated are irritating to the eyes.
Ammonium dichromate(VI) solid & solutions > 7% (> 0.3M)	E, T+, N, Carc 2(inhal), Sen	Y12	N13	S5	Never heat with reducing agents such as magnesium or other metals. For the 'volcano experiment' contain in some safe way; (see entry in <i>HazChemMan CD2 (SSERC)</i> .) If the solid is heated in a test tube the reaction should be carried out in a fume cupboard with a very loose fitting glass wool plug in the end of the tube to prevent the escape of chromium(III) oxide dust. Solutions can be handled in open laboratory as long as no aerosol is created.
0.5 to 7% (0.02 to 0.3M)	T, Carc 2(inhal), Sen	Y9	N10	S3	
0.1 to 0.5% (0.004 to 0.02M)	T, Carc 2(inhal)	Y9	N10	S2	
Ammonium ethanedioate (oxalate)	Xn	Y12	N13	S5	
Ammonium metavanadate	T	Y12	N13	S5	Avoid raising dust. Students to use solutions only.
Ammonium molybdate	Xn	Y9	N10	S3	Use only as phosphate testing reagent. The solution of the reagent may contain concentrated nitric acid and this should be considered as the main hazard. If the solution is used with younger students it should be only under strict supervision.
Ammonium nickel sulfate, solutions >25%	Xn, Carc 3, N, Sen Xn, Sen	Y11 Y9	N12 N10	S5 S4	(FC) Causes sensitisation by skin contact. Avoid raising dust or creating aerosol as it may be a carcinogen by inhalation route only. For nickel plating, teacher or technician to prepare solution. Carry out in well ventilated lab or in fume cupboard.
solutions >1%	Sen				
Ammonium nitrate(V)	O	Y12 Y9	N13 N10	S6 S5	Solubility of salts or heat of solutions.
Ammonium nitrate(III) (nitrite)	E, O, T, N	Teacher/Technician			This material should not be heated or ground. Even concentrated solutions are not safe. To make nitrogen use a solution of sodium nitrite and ammonium chloride (either 5g of each in 100 cm ³ water or mix equal small volumes of 1M solutions of each salt); heat gently and remove heat source immediately the reaction has started.
<i>Ammonium oxalate</i>					see Ammonium ethanedioate
<i>Ammonium perchlorate</i>					see Ammonium chlorate(VII)
Ammonium peroxodisulfate (persulphate)	O, Xn, Sen	Y12	N13	S6	Sensitiser. Fire or explosion hazard if mixed with metals, non-metals, cloth, paper or wood. Decomposes slowly and pressure may build up in container.
Ammonium polysulfide solution (Ammonium sulfide solution)	C, N	Y12	N13	S6	FC Reacts with acid to give toxic hydrogen sulfide gas. Dilute solution twentyfold in fume cupboard for general use as precipitant.
Ammonium thiocyanate	Xn	Y9	N10	S3	Do not react with conc. sulfuric acid or dilute acid with boiling; a very noxious gas is evolved. Do not heat the solid. Use only in solution as a test for iron(III). Do not heat the result of the test to dryness.
<i>Amyl acetate</i>					see Pentyl ethanoate
<i>Amyl alcohols</i>					see Pentan-1-ol and pentan-2-ol

<i>iso-amyl alcohol</i>			see	3-methylbutanol
<i>iso-amyl acetate</i>			see	3-methylbutyl ethanoate
<i>Anhydron</i>			see	Magnesium chlorate(VII)
<i>Aniline</i>			see	Phenylamine
<i>Anilinium salts</i>			see	Phenylammonium salts
<i>Anisole</i>			see	Methoxybenzene
Anthracene	Xn	Not generally recommended		Keep exhibition sample only.
Antimony	Xn, N	Not generally recommended		If antimony electrodes are made by casting, do so in fume cupboard and apply minimum heat to melt metal.
Antimony compounds	Xn, N	(Y12) (N13) (S6)		
Aqua Regia	C, O	Teacher/Technician		Make and use at once in a fume cupboard. DO NOT STOPPER. Do not store.
Arsenic	T	Not generally recommended		Keep as exhibition sample only.
Arsenic compounds	T, Carc 1	Not generally recommended		Not recommended for use in schools. They will form highly toxic arsine in contact with acids and reducing agents, eg zinc. Some alloys or sulfide ore samples of other metals collected from the field for analysis may contain arsenic.
Asbestos - all forms	T, Carc 1	Banned	FC	Banned in schools by the Asbestos (Prohibitions) Regulations 1992. Alternative is Superwool
Azo dyes, solid		Teacher/Technician Y12 N13 S6		Preparation of solutions of indicators, stains, etc. Do not try to isolate the solid dye. Synthesis of dyes. 'Methyl Orange' and sulfonated azo dyes which are water soluble are generally safe. Many others are recognised carcinogens; see <i>HazChemMan CD2 (SSERC)</i> and <i>Hazcards (CLEAPSS)</i> .
Barium metal	F, C	Teacher/Technician		Handle with care: it is very difficult to cut.
Barium chloride, solid	T	Y12 N13 S6		
solutions > 25% (1M)	T	Y10 N13 S5		
>3% to 25% (>0.1M to 1M)	Xn	(Y7) (N8) (S2)		For identifying sulfates use 0.2 or 0.1M solution and dilute hydrochloric acid. Alternatively use barium nitrate solution and 0.5M nitric acid
Barium chromate(VI)	T, N	Not generally recommended		Not recommended for school use as a solid. If a precipitate is formed in a reaction it should not be isolated and dried as it is carcinogenic by inhalation.
Barium hydroxide	Xn, Xi	Y12 N13 (S4)		
Barium nitrate(V)	O, Xn	Y12 N13 (S2)		The thermal stability of barium nitrate is such that it does not decompose to give nitrogen dioxide and oxygen and cannot be used in place of lead nitrate as a source of a mixture of gases for separation of the nitrogen dioxide
Barium peroxide	O, Xn	Y12 N13 S5		Vigorous reaction with water to give corrosive solution. The reaction with metal powders and organic compounds is explosive.
Barium, salts in general		Y12 N13 S6		Note that the chloride is classed as Toxic.
as solids	Xn			
solutions < 25% (approx M)		(Y7) (N8) S2		

Barium sulfate	Low hazard	Y9	N10	S1	The dust of this material may present a hazard.
Benedict's Reagent	Xn, N	(Y7)	(N8)	(S2)	The mixtures must be heated on a water bath as test for reducing sugars. This is a much safer alternative to Fehling's solution.
<i>Benzaldehyde</i>					see Benzenecarbaldehyde
Benzene	F, T, Carc 1		Banned		<i>COSHH (Amendment) Regulations 1992</i> prohibited the use of benzene for educational purposes. Alternatives are available: see <i>Hazcards (CLEAPSS)</i> and <i>HazChemMan CD2 (SSERC)</i> .
Benzenecarbaldehyde (Benzaldehyde)	Xn	Y12	N13	S6	(FC) Small quantities may be used in a well ventilated laboratory.
Benzenecarbonitrile (Benzonitrile)	Xn	Y12	N13	S6	FC This compound provides a safer alternative to acetonitrile if the reactions of this class of compounds are investigated.
Benzene carbonyl chloride (Benzoyl chloride)	Xn	Y12	N13	S6	FC The substance is lachrymatory and irritates the lungs. Hydrogen chloride fumes are formed with water.
Benzene-1,4-diamine (p-phenylenediamine) (used in some photographic developers)	T, N, Sen	Y12 (Y9)	N13 (N10)	S6 (S3)	Toxic by inhalation of dust. A respiratory and skin sensitiser. An alternative locating agent for sugars in paper chromatography is by dipping in Fehling's or Benedict's reagents. Wear gloves and use tweezers. It may be preferable to buy solutions already made up.
Benzene-1,2-dicarboxylic anhydride (Phthalic anhydride)	Xn, Sen	Y12	N13	S6	A respiratory sensitiser; avoid contact and raising dust.
Benzene-1,2-diol (Catechol)	Xn	Y12	N13	S6	This material must not be reacted with concentrated nitric acid; may cause allergic skin reactions and dermatitis.
Benzene-1,3-diol (Resorcinol)	Xn, N	Y12	N13	S5	This material is generally used as a test reagent in ethanol, ethanoic acid or propanone. Treat as though the solvent were the hazard. This material must not be reacted with concentrated nitric acid.
Benzene-1,4-diol (Quinol, hydroquinone)	Xn, Carc 3, N, Sen	Y12 (Y9)	N13 (N10)	S6 (S3)	This material must not be reacted with concentrated nitric acid. As a developer solution in photography. Use gloves and tweezers.
Benzenesulfonic acid	C	Y12	N13	S6	
Benzene-1,2,3-triol (Pyrogallol)	Xn	(Y9)	(N10)	(S3)	For absorption of oxygen prepare solution as it is needed. A solution made up with sodium hydrogencarbonate is much safer than with sodium hydroxide.
Benzene-1,3,5-triol (Phoroglucinol)	Xi	Y12	N13	S6	
<i>Benzidine</i>					see Biphenyl-4,4'-diamine
<i>Benzoin</i>					see 2-hydroxy-1,2-diphenylethanone
<i>Benzonitrile</i>					see Benzenecarbonitrile
<i>Benzoyl chloride</i>					see Benzenecarbonyl chloride
<i>Benzoyl peroxide</i>					see di(benzenecarbonyl)peroxide
<i>Benzyl alcohol</i>					see Phenylmethanol
<i>Benzyl chloride</i>					see (Chloromethyl)benzene

Beryllium	T+, N, Carc 2(inhal), Sen	Not generally recommended	Keep as exhibition sample only and in a safe place.
Beryllium compounds	T+, N, Carc 2(inhal), Sen	Not generally recommended	Not recommended for use in schools.
Biological stains and powders	Most may be harmful. For full details see suppliers data sheet.	Teacher/Technician	These should be made up by staff. If large amounts of powder are involved the weighing is best carried out in a fume cupboard. If they are used in alcohol, solution they should be treated as alcohol from a safety point of view. Care needs to be exercised with old samples if their exact composition is not known. Treat as a hazard. Also consult <i>Handbook (CLEAPSS)</i> and <i>HazChemMan CD2 (SSERC)</i> .
Biphenyl-4,4'-diamine (Benzidine)	T, N, Carc 1	Banned	Prohibited by COSHH
Bis-(4-isocyanatophenyl)methane (Caradate 30)	Xn, Sen	Teacher/Technician	FC A sensitiser and suspect carcinogen.
Bismuth	Xi	Y12 N13 S6	Irritates eyes, skin and mucuous membranes, especially in powdery form.
Bismuth chloride	Xn	Y10 N11 S5	
Bismuth nitrate	O, Xn	Y12 N13 S5	
Biuret solution	C, Xi	(Y9) (N13) (S4)	The main hazard associated with the use of this reagent is that it contains either 1M or 2M sodium hydroxide and should be treated as such.
Bleaching powder	O, C, N	Y9 N10 S4	Useful as a safer source of chlorine. Old stock can become dangerous if traces of metals or rust are present. Reacts with acids to release TOXIC chlorine gas.
Bromates(V) potassium sodium	T, O, Carc 2 O, Xn	Y12 N13 S6 Y12 N13 S6	See chlorates for use of halogenates.
Bromine, liquid	T+, C, N	(Y12) (N13) (S6)	FC Use in a fume cupboard under very strict supervision. Suitable gloves and eye protection must be worn. Always have a solution of sodium thiosulfate available close by when this material is used. Do not react liquid bromine with concentrated ammonia solution or reactive metals. The reaction with sodium hydroxide is very exothermic.
Bromine water, saturated , (3.6%) 1 to 7% 0.1 to 1%	T, C, N T, C, N Xn, Xi	Y11 N12 S4 Y9 N10 S4	(FC) Teacher or technician to prepare saturated bromine water and dilute it tenfold for use by Y9, N10 and S4. The reaction with ethene is acceptable as little or no 1,2-dibromoethane is formed. Use on a small scale and do not attempt to isolate the product. Alternatively generate in situ on a test tube scale by adding acidified sodium chlorate(I) solution to 1M sodium or potassium bromide. This aqueous solution contains in addition to bromine, the extra ions: Na ⁺ or K ⁺ , Cl ⁻ , and possibly Br ⁻ .
Bromobenzene (Phenyl bromide)	F-, Xi, N	Y12 N13 S6	This is not a suitable compound for sodium fusion.
1-bromobutane (n-butyl bromide)	Xi, N	Y12 N13 (S6)	(FC) Do not distil dry. Steam distillation does not present any problems.
2-bromobutane (sec-butyl bromide)	F	Y12 N13 S6	(FC) Do not distil dry.
Bromoethane (Ethyl bromide)	F, Xn, Carc 3	Y12 N13 S6	(FC) Do not distil dry.

Bromomethane (Methyl bromide)	T, N	Teacher/Technician	FC	Use only in fume cupboard if it is necessary to use the compound at all !
2-bromo-2-methylpropane (<i>tert</i> -butyl bromide)	F, Xn	Y12 N13 S6	(FC)	Do not distil dry. For kinetic studies use dilute solution in ethanol/water. Once the reaction is over, a relatively harmless solution of 2-methylpropan-2-ol remains.
1-bromopropane (n-propyl bromide)	F-, Xn	(Y12) N13 S6	FC	Do not distil dry.
2-bromopropane (<i>iso</i> -propyl bromide)	F, T	(Y12) (N13) S6	FC	Do not distil dry.
3-bromoprop-1-ene (Allyl bromide)	T, F	(Y12) (N13) (S6)	FC	Use only in fume cupboard.
Butanal (Butyraldehyde)	F	Y11 N12 S5	(FC)	
Butane gas in cylinder	F+	Not generally recommended (Y10) (N11) (S3)		The keeping of large cylinders of butane is not recommended in schools other than as a temporary heat source or in a plumbed in supply from an external ventilated store. However gas cigarette lighters are useful source of the gas for experimentation purposes, provided they are used only under close supervision.
Butanoic acid (Butyric acid)	C	Y12 N13 S5		This material has a very unpleasant smell. If it is used to produce esters it is advisable to make the mixtures in a fume cupboard.
Butan-1-ol (n-butanol)	F-, Xn	Y10 N11 S5	(FC)	Heat only on a water bath.
Butan-2-ol (<i>sec</i> -butyl alcohol)	F-, Xi	Y10 N11 S5	(FC)	Heat only on a water bath.
<i>tert</i> -butanol			see	2-methylpropan-2-ol
Butanone (Methyl ethyl ketone or M.E.K.)	F, Xi	Y11 N12 S5	(FC)	Heat only on a water bath.
<i>cis</i>-butene-1,4-dioic acid (Maleic acid)	Xi	Y12 N13 S6		
<i>trans</i>-butene-1,4-dioic acid (Fumaric acid)	Xi	Y12 N13 S6		
<i>Butylamines</i>			see	Aminobutanes
<i>n-butyl bromide</i>			see	1-bromobutane
<i>2-butyl bromide</i>			see	2-bromobutane
<i>tert-butyl bromide</i>			see	2-bromo-2-methylpropane
<i>Butyl chloride</i>			see	Chlorobutane
<i>tert-butyl chloride</i>			see	2-chloro-2-methylpropane
<i>Butyl iodide</i>			see	Iodobutane
<i>Butyraldehyde</i>			see	Butanal
<i>Butyric acid</i>			see	Butanoic acid

Cadmium	T	Y12	N13	S6	
Cadmium salts in general oxide, iodide & sulfate chloride sulfide	T, N, Carc 2 T, N, Carc 2(inhal) T+, N, Carc 2 T	TT	TT	(S6)	The electrolysis of molten cadmium salts is not recommended. Samples of cadmium salts are generally left overs from classical analysis. There is no point in buying new supplies of these toxic materials and the bulk of any stock should be disposed of. Very dilute solutions may be used by sixth year pupils, eg in preparation of photoresistive materials.
Caffeine	Xn	(Y12)	N13	S5	(FC) Trichloromethane has often been recommended for the extraction of caffeine from tea or coffee. Dichloromethane provides a safer alternative. The extraction should be carried out in a fume cupboard unless very small volumes are involved.
Calcium, metal	F	(Y8)	(N9)	(S2)	Reaction with water. The metal should not be reacted with sulfur or the hydroxides or carbonates of the alkali metals. Burning in air by the teacher using screens.
Calcium chlorate(I)	O, C, N	(Y9)	(N10)	(S4)	Reacts with dilute acids to give off toxic chlorine gas. Occasionally loosen stopper to release pressure as even carbon dioxide of the air reacts to slowly produce chlorine.
Calcium chloride , hydrated	Xi	Y9	N10	S1	
anhydrous	Xi	Y12	N13	S6	
Calcium dicarbide (Calcium carbide)	F	(Y12)	(N13)	(S6)	(FC) If the solid is to be used to generate ethyne, large lumps, not powder should be used and the gas produced treated with extreme care as the resulting mixture of ethyne and air is very explosive. The reaction between the dicarbide and solutions of silver or copper salts produces explosive acetylides. The reaction with chlorine can be best carried out under water by the teacher; (for details see entry in <i>HazChemMan CD2 (SSERC)</i> .)
Calcium hydroxide , solid	Xi	Y9	N10	S2	Although lime water is < 0.05M and strictly speaking is not even classed as being Irritant, the use of eye protection is advisable.
<i>Calcium hypochlorite(I)</i>					see Calcium chlorate(I)
Calcium oxide	C	(Y9)	(N10)	(S2)	
Calcium phosphide	F, T+, N	Not generally recommended			This material must be stored in a dry place and at the first sign of deterioration the screw cap should be replaced with a rubber stopper.
Camphor	Xi	(Y9)	(N10)	(S2)	
Caradate30					see Bis-(4-isocyanatophenyl)methane
Carbon dioxide solid cylinder, gas	Gas acts as asphyxiant	(Y12)	(N13)	(S6)	Always use tongs and thick gloves when handling the solid.
		(Y12)	(N13)	(S6)	
Carbon disulfide	F+, T	Not generally recommended			(FC) Not recommended for use in schools. The vapour can spread some distance and no heat sources of any type are safe in the same laboratory. Use dimethylbenzene for preparation of the allotropes of sulfur. 3-phenyl propenoate (ethyl cinnamate) can be used in 'hollow prism' experiments. The prism needs thorough cleaning after use with propanone.

Carbon monoxide, - cylinder	F, T	Not generally recommended			FC	When reducing metal oxides take the same precautions as when using hydrogen. Nickel and iron can form toxic, explosive carbonyls. Either avoid reducing the oxides of these metals or take precautions to ensure their decomposition; (see entry in <i>HazChemMan CD2 (SSERC)</i> .)
- preparation		(Y12)	(N13)	(S6)	FC	
- test tube preparation		(Y12)	(N13)	(S6)	FC	
<i>Carbon tetrachloride</i>					see	Tetrachloromethane
<i>Catechol</i>					see	Benzene-1,2-diol
Cement	C	(Y7)	(N8)	(S1)		Treat as alkaline. Wet cement can cause severe burns. The irritant dust also presents a hazard, especially if inhaled. Often contains some dichromate(VI).
<i>Chloral hydrate</i>					see	2,2,2-trichloroethanediol
Chlorates(I) (or hypochlorites) calcium sodium concentrated solns (> 10% chlorine) dilute solns (0.5 to 10% chlorine) Solid calcium chlorate (I) (bleaching powder)	O, C, N C C Xi O, C, N	Y9 Y9 (Y9) (Y7) Y9	N10 N10 (N10) (N8) N10	S5 S5 S5 (S1) S5		The solution must not be reacted with ammonium salts or methanol. Any pressure build-up during storage, due to formation of oxygen must be released on a regular basis. This decomposition is catalysed by transition metals. Do not acidify with concentrated acids if using the solution as a source of chlorine. Solutions of chlorine can be prepared by adding a few cm ³ of 1M hydrochloric acid to a few cm ³ diluted sodium chlorate(I) solution. (The commercial 14% solution should be diluted tenfold beforehand by the teacher or technician.)
Chlorates(V) (chlorates)	O, Xn	Y12	N13	S6		Avoid concentrated sulfuric acid as unstable chlorine dioxide will be formed which will give rise to a serious risk of explosion. Do not allow solutions to dry on wood, paper or clothing as these may ignite at a later time. Thermal decomposition with and without trace of MnO ₂ . Cleanliness is extremely important. Do not return unused chlorate(V) to jar and replace lid immediately to exclude dust. These compounds can react violently with reducing agents and should not be mixed with the following: (i) sulfur or sulfides (ii) ammonium salts (iii) phosphorus (iv) 2,4,6- trinitrophenol (picric acid) (v) fine metal powders such as aluminium and magnesium (vi) 3,4,5- trihydroxybenzoic acid (gallic acid.) (vii) fuels such as sugar and hydrocarbons. Use 0.05M solutions in redox reactions
		Teacher/Technician				
		Not generally recommended				
		ditto				
		ditto				
		ditto				
		ditto				
		ditto				
		ditto				
		Y12	N13	S6		

		Y12 N13 S6	Solutions of chlorates(V) produced, eg of potassium potassium or chlorate produced during determination of solubility/ temperature curves should not be allowed to dry out. The solid may be recovered by recrystallisation at the end of the measurement, but this should not be used for heating experiments.
Chlorates(VII) (perchlorates)	O, C	Not generally recommended (Y12) (Y12) (S6)	Not generally recommended for use in schools. Need for cleanliness. Do not return unused chlorate(VII) to jar and replace lid immediately to exclude dust. Do not allow solutions to dry on wood, paper or clothing as these may ignite at a later time. Use 0.05M solutions in redox reactions.
Chloric(VII) acid (Perchloric acid)	O, C	Not generally recommended	For hydrolysis of DNA, 6M hydrochloric acid is an effective alternative. For study of acid strengths of oxy-acids alternatives are sulfuric acid (H ₂ SO ₄) and sulfurous acid (H ₂ SO ₃) also the phosphoric(V) acid compared with phosphoric(III) acid (phosphorous acid.)
Chlorine - cylinder - preparation for use in "large scale" demonstration - preparation for use in "small scale" demonstration - small-scale preparation in test tubes	T	Not generally recommended Teacher/Technician (Y12) (N13) (S6) (Y9) (N10) (S1)	Not suitable for use in schools. Chlorine should not be reacted with fine metal powders such as aluminium, hydrocarbon gases or with ammonia or its compounds. Mixtures of hydrogen and chlorine gases in UV or sunlight are explosive over a range of compositions. FC There are many references to accidents involving the preparation of chlorine where concentrated sulfuric acid (used to dry the gas) and concentrated hydrochloric acid (used to prepare the gas) have been confused. Safer methods are available such as the action of acid on chlorate(I) solution. FC (FC) It may be possible to carry this out in a well ventilated laboratory. Students must be taught how to smell gases safely before they are asked to smell chlorine. (See Safeguards 4.3)
Chlorobenzene (Phenyl chloride)	F-, Xn, N	Y12 N13 S6	FC This substance explodes when heated with sodium and is unsuitable for sodium fusion.
<i>Chlorobenzidines & salts</i>			see 3,3'-dichlorobiphenyl-ylenediamine & salts
1-chlorobutane (Butyl chloride)	F	Y12 N13 S6	FC Do not distil dry.
Chloroethane (Ethyl chloride)	F+, Xn, Carc 3	Y12 N13 S6	FC Do not distil dry.
Chloroethanoic acid, <i>Dichloroethanoic acid</i> and <i>Trichloroethanoic acid</i>	T, N C, N C	(Y12) (N13)) (S6)	These materials should not be heated to dryness as they can decompose to give off toxic phosgene gas.
Chloroethene (Vinyl chloride monomer)	F+, T	Banned	Not actually banned, but to use it legally you would need all sorts of sealed systems and frequent monitoring. Thus for practical purposes it is banned in schools.
<i>Chloroform</i>			see Trichloromethane
Chloromethane (Methyl chloride)	F+, N, Carc 3	Not generally recommended	This and other low molecular mass haloalkanes are not recommended for use in schools.

(Chloromethyl)benzene (Benzyl chloride or α -chlorotoluene)	T, Carc 2	Y12	(N13)	(S6)	This material has been safely used for sodium fusions in a fume cupboard.
2-chloro-2-methylpropane (<i>tert</i> -butyl chloride)	F	Y12	N13	S6	FC Do not distil dry.
<i>Chloroplatinic acid</i>					see Hexachloroplatinic(IV) acid
Chloropropanes (Propyl chlorides)	F, Xn	Y12	N13	S6	(FC) Very small quantities in a well ventilated laboratory are acceptable.
Chlorosulfonic acid	C	Y12	N13	(S6)	FC This substance has a violent reaction with water and therefore must be used with great care.
<i>α-chlorotoluene</i>					see (Chloromethyl)benzene
Chromates(VI) and dichromate(VI) (see also ammonium dichromate)					For preparations involving oxidation and titrations use manganate(VII) where possible. Use on as small a scale as is reasonable. Avoid creating dust - this is easy owing to the large crystals and avoid creating aerosols from solution, eg by vigorous gas evolution from electrolysis, etc.
Sodium and Potassium		Y12	N13	S6	Oxidation of alkanols - ensure all the solid has dissolved and add the acidified dichromate solution dropwise whilst mixing the contents of the flask thoroughly.
solid & solutions >7% (> 0.23M)	T+, N, Carc 2(inhal), Sen	Y12	N13	S5	Use on as small a scale as possible.
0.5% to 7% (0.017 to 0.23M)	T, Carc 2(inhal), Sen	Y10	N11	S3	Use on as small a scale as possible.
0.1% to 0.5% (0.003 to 0.017M)	T, Carc 2(inhal)	Y9	N10	S2	Chromate precipitates should not be isolated and dried in experiments.
Insoluble solids	T, Carc 2(inhal)	Not generally recommended			
' Chromic acid ' (cleaning mixture)	O, T, C, N Carc 1(inhal)	Not generally recommended			This mixture of concentrated sulfuric acid and potassium dichromate which has been traditionally used for cleaning glassware reacts violently with many organic compounds and residues. Under no circumstances should the material be stored. Commercial detergents are much safer.
Chromium(VI) oxide (Chromium trioxide)	O, T, C, N, Carc 1(inhal), Sen	(Y12)	(N13)	TT	This material reacts violently with materials such as alcohols, ketones, ethanoic acid and glycerol as well as assisting combustion of wood and fabric. If possible a safer alternative should be found. If chromium(VI) oxide is part of a 'preparation' for biological use, gloves and eye protection must be worn.
Chromium(VI) oxychloride (Chromyl chloride)	O, T, C, N Carc 1(inhal), Sen	(Y12)	(N13)	TT	This material should be prepared only in small quantities. Any excess material should be reacted carefully with dilute alkali solution.
Chromium(III) compounds	Xn, Xi	Y9	N10	S5	
<i>Chromium trioxide</i>					see Chromium(VI) oxide
<i>Chromyl chloride</i>					see Chromium(VI) oxychloride

Cobalt chloride						
solid	T, Carc 2(inhal), N, Sen					The material is a skin and respiratory sensitiser. It is easy to avoid creation of dust in the preparation of complexes and test tube reactions as the salt exists as large crystals. Handle as little as possible and where possible use tweezers. On the rare occasions when skin contact is needed in testing for moisture minimise the contact with skin and wash hands well afterwards. Teacher or technician to prepare test papers (filter paper dipped in 5% solution and dried). Cobalt thiocyanate is an alternative reagent.
solid & solution > 25% (> 1M)	T, Carc 2(inhal), N, Sen	Y12	N13	S6		
1 to 25% (0.04 to 1M)	T, Carc 2(inhal), Sen	(Y8)	(N9)	(S1)		
0.01 to 1% (0.0004 to 0.04M)	T, Carc 2(inhal)					
<i>Chromium trioxide</i>					see	Chromium(VI) oxide
Cigarette smoking machine		(Y9)	(N10)	(S1)		The tarry residues formed will be carcinogenic. Avoid skin contact.
Colchicine	T+	Not generally recommended				Not suitable for use in schools.
Copper salts, in general						There is a danger that the hazard of these materials can be underestimated because of their familiarity.
solid	Xn,	Y7	Y8	P7		
solution (> 1M) (< 0.01M)	Xn, N					
Copper(II) chloride						For electrolysis of solution, stop electrolysis as soon as litmus paper is bleached and first trace of chlorine is detected.
solid	Xn, N	Y12	N13	S6		
solution > 25% (> 1.5M)	Xn, N	Y9	N10	S4		
Copper(I) oxide	Xn	Y11	N12	S5		Preparation by reduction with alkaline glucose.
Copper(II) oxide	Xn	Y7	N8	S2		This material is not safe for reactions such as the Thermite or for reduction with reactive metals such as magnesium.
Crude oil	F,T Carc 1, owing to benzene content	Banned				Genuine crude oil is banned in schools, owing to its benzene content.
Crude oil, simulated	F	Y7	N8	S2	FC	There is an excellent recipe for a substitute in the entries for crude oil in <i>Hazcard (CLEAPSS)</i> and in <i>HazChemMan CD2 (SSERC)</i> . This can be safely distilled in small quantities by younger students under supervision or for demonstrations. However the tarry residues formed should be cleaned out carefully.
Cyanides		Not generally recommended				Not recommended for use in schools. Very small amounts of solutions of cyanides are sometimes used in advanced biological experiments or as a masking agent in analytical work in chemistry. It is safest if ready prepared solutions are bought in as and when they are needed and used only by staff.
solid	T+, N	Teacher/Technician				
solution > 7%	T+, N	Teacher/Technician				
1 to 7%	T, N	(Y12)	(N13)	(S6)		
0.1 to 1%	Xn	(Y12)	(N13)	(S6)		
Cyclohexane	F, Xn, N	Y10	N11	S3	(FC)	Small scale experiments on the reactions of saturated hydrocarbons can be carried out in a well ventilated laboratory.
Cyclohexanol	Xn	Y12	N11	S6	(FC)	If cyclohexene prepared by dehydration, DO NOT STORE as, unlike the commercial product, it does not contain peroxidation inhibitors.

Cyclohexanone	F-, Xn	Y12	N13	S5	(FC)
Cyclohexene	F, Xn	Y10	N13	S4	(FC) This material can be used on a small scale to compare saturated and unsaturated compounds but care needs to be exercised in the disposal of the liquid. Cyclohexene may form unstable peroxides on storing over a period. Test for presence of peroxides before distilling or evaporating.
DDT	T, N, Carc 3	Not generally recommended			
Decanedioyl dichloride (Sebacoyl chloride). Use in Nylon preparation.	C	Y12 (Y9)	N13	S6 (S4)	FC (FC) If nylon is to be produced the solvent cyclohexane is safer than the halogenated hydrocarbons. It forms the upper layer if the diaminohexane is used in water.
Devarda's alloy (Copper/aluminium/zinc powder mix)		Y9	N10	S5	Strongly exothermic reaction with sodium hydroxide as in test for nitrate.
<i>1,2-diaminoethane</i>					see Ethane-1,2-diamine
<i>1,6-diaminohexane</i>					see Hexane-1,6-diamine
Diazonium salts	E(if dry), T	Y12	N13	S6	Normally prepared in dilute solution immediately prior to use. Do not attempt to isolate the salts. When diazonium compounds are prepared it is important to check that the diazotisation of the aromatic amine is complete by adding extra nitrite solution and testing a sample with acidified KI solution. See entry for Phenylamine.
Di(benzenecarbonyl) peroxide (Benzoyl peroxide)	E, Xi	Not generally recommended			The substance is a sensitiser. Di(dodecanoyl)peroxide provides a much safer alternative catalyst for polymerisation.
1,2-dibromoethane (Ethylene dibromide)	T, N, Carc 2	Banned			Banned in schools as it is carcinogenic. However the reaction between bromine water and ethene does not present a risk as the amount of dibromide formed is very small. No attempt should be made to isolate the dibromide.
1,2-dibromopropane (Propylene dibromide)	F-, Xn	Y12	N13	S6	FC
1,4-dichlorobenzene	Xi, N	Y12	N13	S6	Use 1,4-dichlorobenzene for the pre-treatment of roots to arrest metaphase. See <i>Hazcards(CLEAPSS)</i> .
1,2- and 1,3-dichlorobenzene	Xn, N	Y12	N13	S6	
3,3'-dichlorobiphenyl-ylenediamine (Chlorobenzidine) & salts	T, N, Carc 2	Banned			Effectively banned in schools by government education departments (AM70 in England and Wales, SEED Circular 8/95 in Scotland and DENI Guidance in N.Ireland).
1,2-dichloroethane (Ethylenedichloride)	F, T, Carc 2	Not generally recommended			FC Not recommended for use in schools.
Dichloroethanoic acid (Dichloroacetic acid)	C, N	Y12	N13	S6	
Dichloromethane (Methylene dichloride)	Xn, Carc 3	(Y11)	(N12)	(S5)	(FC) It is very volatile; consider substituting solvent applications by butyl ethanoate where ease of evaporation is not required, eg extraction of caffeine. Recover and re-use.
Di(dodecanoyl) peroxide (Lauroyl peroxide)	O, Xn	(Y9)	(Y10)	S4	The reaction with methyl methacrylate to produce perspex is very exothermic if the concentration of the peroxide is >1%. Styrene provides a safer alternative. The solid should not be allowed to dry out or be heated even on its own.

Diethylamine liquid x 20 dilution (ca 0.6M)	F, C Xi	(Y12) (Y9)	(N13) (Y10)	S6 S5	FC	For most test tube reactions the 20 fold dilution works well.
<i>Diethyl ether</i>					see	Ethoxyethane
<i>Diethyl ketone</i>					see	Pentan-3-one
Diethyl sulfate	T+, Carc 2			Banned		Effectively banned in schools by government education departments (AM70 in England and Wales, SEED Circular 8/95 in Scotland and DENI Guidance in N.Ireland).
1,2-dihydroxybenzene					see	Benzene-1,2-diol , catechol
1,4-dihydroxybenzene					see	Benzene-1,4-diol , hydroquinone, quinol
Diiodine hexachloride (Iodine trichloride)	T, C	(Y12)	(N13)	(S6)	FC	Demonstration of reversible reaction.
3,3'-dimethylbiphenyl-4,4'-diamine (o-tolidine)	T, N, Carc 2			Banned		Effectively banned in schools by government education departments (AM 70 in England and Wales, SEED Circular 8/95 in Scotland and DENI Guidance in N.Ireland)
Dimethyldichlorosilane	F, Xi	Y12	N13	S6	FC	Harmful vapour and corrosive liquid. Usually sold as solution in Volasil 244 and formerly in 1,1,1-trichloroethane. Reacts violently with water and alkanols. Short shelf life once opened.
Dimethyl formamide	T	Y12	N13	S6	FC	
Dimethyl sulfate	T+, Carc 2, Sen			Banned		Effectively banned in schools by government education departments (AM70 in England and Wales, SEED Circular 8/95 in Scotland and DENI Guidance in N.Ireland).
Dinitrobenzene	T+, N	(Y12)	(N13)	(S6)		
<i>3,5-dinitrobenzoic acid</i>					see	3,5-dinitrobenzenecarboxylic acid
3,5-dinitrobenzenecarboxylic acid	Xn	Y12	N13	S6		
4,4'-dinitrobiphenyl		Not generally recommended				Known carcinogen. Effectively banned in schools by government education departments (AM70 in England and Wales, SEED Circular 8/95 in Scotland and DENI Guidance in N.Ireland)
2,4-dinitrobromobenzene	T	Not generally recommended				Sensitiser. Not suitable for use in schools.
2,4-dinitrochlorobenzene	T,	Not generally recommended				Sensitiser. Not suitable for use in schools.
2,4-dinitrofluorobenzene	T	Not generally recommended				Sensitiser. Not suitable for use in schools.
Dinitrogen oxide (Nitrous oxide) - cylinder - prepared for reactions	T	Not generally recommended Y12 N13 S6			(FC)	The gas is explosive if mixed with ammonia, carbon monoxide, hydrogen or hydrogen sulfide. This gas should not be prepared by the thermal decomposition of ammonium nitrate. Better alternatives are (i) ammonium sulfate/ potassium nitrate in solution and (ii) hydroxylamine hydrochloride/Iron(III) ammonium sulfate mixtures. Discontinue heating immediately the reaction starts.
Dinitrophenols , dilute solutions	T, N	(Y12)	(N13)	S5		It is possible that these compounds may be prepared by side reactions during the nitration of phenol. They should not be isolated and care needs to be taken when apparatus is being washed. The hazards associated with samples of the mixture produced for use in chromatographic analysis can be reduced if gloves are worn, the reaction carried out on a micro scale and the spotting tubes wrapped and discarded after use.

Dinitromethylbenzenes (Dinitrotoluene)		Y12	N13	S6	
2,4- isomer	T, N, Carc 2				
2,6- isomer	T, Carc 2				
2,4-dinitrophenylhydrazine	E, T	Y12	N13	S6	The solid should be kept damp at all times. Gloves need to be worn at all times when using this material. Brady's Reagent is corrosive, toxic and flammable.
<i>Dinitrotoluenes</i>					see Dinitromethylbenzenes
1,4-dioxane	F, Xn, Carc 3	(Y12)	N13	S6	Forms explosive peroxides. Test for these before distilling or evaporating.
Dipentene (Limonene)	Xi, N, Sen	Y9	N10	(S5)	Sensitiser.
Diphenylamine					Best advice is to buy purified material as impure samples may contain carcinogens. The toxic effects of the material are cumulative.
solid	T, N	Teacher/Technician			Reagent in concentrated sulfuric acid should be prepared by teacher. Care needs to be exercised in making the solution.
reagent solution	C	(Y12)	(N13)	(S6)	Reagent is corrosive.
Disulfur dichloride	T, C, N	Y12	N13	S6	FC Reacts violently with water producing a range of sulfur compounds. The use of a fume cupboard is essential.
Dodecylbenzenesulfonic acid (Nansa Acid)	Xn	Y9	N10	S4	Its viscosity makes transfer of the corrosive liquid very difficult.
Dye stuffs solid	(Some are sensitisers, e.g. Procion)	Teacher/Technician			FC The dust produced by some of these materials may cause problems. Solutions of most synthetic dyes should be prepared by the teacher in a working fume cupboard. Some dyes as solids are quite toxic and others, eg reactive dyes like Procion are respiratory sensitisers. See <i>Dyestuffs</i> entry in <i>HazChem Man CD2 (SSERC)</i> or <i>Hazcards (CLEAPSS)</i> .
solutions		Y9	N10	S2	Suitable dyes may be used. The dilute solutions prepared by teacher or technician are usually of lvery low concentration and hence of low risk. However it is generally wise to avoid contact with skin.
Engine oil	Xi	Y12	N13	S4	Use only fresh engine oil. Used engine oil will contain carcinogenic polycyclic aromatic hydrocarbons and must not be used.
Ethanal (Acetaldehyde)	F+, Xn, Carc 3	Y12	N13	S5	(FC) On account of its high volatility use the less volatile propanal or butanal, especially for those reactions which require heating- eg test with Fehling's. Use a water bath for heating. Small quantities of acid can cause the material to polymerise and it is best to keep small quantities for class use in separately labelled bottles.
Ethanal tetramer (Metaldehyde)	F-, Xn	(Y9)	(N10)	S5	This is a safe alternative to alcohol for steam engines. It yields a toxic vapour if heated and produces toxic fumes if blown out. The best method is to drop it in a metal tin and close the lid tightly.
Ethanal trimer (Paraldehyde)	F	Y12	N13	S6	(FC)
Ethanamide	Xn, Carc 3	Y12	N13	S6	(FC)
Ethane , cylinder	F+	Not generally recommended			Not suitable for use in schools

Ethane-1,2-diamine (Ethylene diamine)	F-, C, Sen	Y12	N13	S6	FC	The substance is both a respiratory sensitiser and a skin contact sensitiser.
Ethanedioic acid and salts (Oxalic Acid)						Forms explosive mixtures with silver and mercury salts.
solid	Xn	Y12	N13	S6		
solution > 5% (> 0.4M)	Xn	Y9	N10	S3		
Ethanediol (Ethylene glycol)	Xn	Y12	N13	S5		
Ethanenitrile (Acetonitrile)	F, Xn	Not generally recommended			FC	Benzenecarbonitrile (benzonitrile) offers a much safer alternative for reactions of this class of compounds.
Ethanoic acid (Acetic acid)						
Glacial	C, F-	Y11	N13	S5	(FC)	A fume cupboard should be used if large volumes are involved e.g. in the preparation of dilute solutions. Gloves and eye protection are vital when handling the liquid. The liquid acid reacts violently with chromium(VI) oxide, manganate(VII), nitric acid and peroxides.
> 25% (> 4 M)	C	Y11	N13	S5		
"dilute" 10 to 25% (1.5 M to 4M)	Xi	(Y7)	N13	S1		
Ethanoic anhydride (Acetic anhydride)	F-, C	Y12	N13	S6	(FC)	Use a fume cupboard if large volumes are involved. The reaction with water is often delayed and can be hazardous with heat building up at the interface between the two liquids. This reaction is catalysed by acids such as ethanoic acid.. The reaction with ethanol can be very vigorous in the presence of acids. The liquid reacts violently with boric acid, chromium(VI) oxide, manganate(VII), nitric acid and peroxides.
> 25%	C					
1 to 25%	Xi					
Ethanol and Industrial Methylated Spirits	F	(Y7)	(N8)	(S1)	(FC)	Use a fume cupboard if large volumes are involved. All experiments involving heating, e.g. the extraction of chlorophyll, should be carried out on a water bath, in a beaker of water heated in a kettle or using an electric heater with a sealed element. Several serious accidents have occurred when this material has been used as the fuel for steam engines or in experiments where heats of combustion are being measured. The accidents tend to occur when material is being added to a burner that had been thought to be extinguished or when the liquid is being decanted too close to a bunsen burner. For steam engines, solid fuels should be used to replace the alcohol. For combustion reactions careful supervision must be in place at all times. The oxidation of ethanol with acidified dichromate(VI) is a very exothermic reaction. Potassium reacts violently with ethanol.
Ethanoyl chloride (Acetyl chloride)	F, C	Y12	N13	S6	FC	Violent reaction with water. The reaction with ethanol has a short induction period and can produce enough heat to eject the contents of the tube. The reactions with concentrated ammonia and with phenylamine are vigorous and produce copious amounts of white smoke. All reactions involving the acid chloride must be carried out in a fume cupboard and a safety screen is a wise precaution.
Ethanoyl hydroxybenzene-carboxylic acid (Aspirin, Acetylsalicylic acid)	Xn	Y12	N13	S6		

Ethene , cylinder	F+	Not generally recommended			Not suitable for use in schools.
Ethers (general)	F+, Xn	(Y12)	(N13)	(S6)	FC Under strict supervision with all students. See specific details under ethoxyethane. Ethers can be tested for peroxides by the addition of a small volume of acidified potassium iodide solution. The production of iodine suggests a peroxide build-up. Peroxides can be removed in several ways but these also remove added inhibitors. Methods include shaking with about half the volume of 1M iron(II) sulfate solution. If ethers are treated in this way they must be tested again for peroxides and used soon, not stored.
Ethidium bromide	Xi	Y12	N13	S6	
Ethoxyethane (Diethyl ether)	F+, Xn	(Y12)	(N13)	(S6)	FC Under strict supervision with all students. If ether is used as a solvent or in solvent extraction experiments all sources of ignition must be extinguished. Any pressure build-up in the separating funnel must be vented. Sodium used to dry ether must be disposed of with care. Ethers need to be tested for peroxide build-up in old stock at least once a year. This effect can be minimised by storing the ether in a dark bottle with the minimum of air space. Ethers can be tested for peroxides by the addition of a small volume of acidified potassium iodide solution. The production of iodine suggests a peroxide build-up. Peroxides can be removed in several ways but these also remove added inhibitors. Methods include shaking with about half the volume of 1M iron(II) sulfate solution. If ethers are treated in this way they must be tested again for peroxides and used at once not stored.
<i>Ethyl acetate</i>					see Ethyl ethanoate
Ethylamine	F+, Xi	Y12	N13	S6	(FC) Solutions diluted down to 1M can be used in a well ventilated laboratory for typical reactions of amines on a test tube scale.
Ethyl benzenecarboxylate (Ethyl benzoate)	Xi	Y9	N10	S4	(FC) Small quantities may be used in a well ventilated laboratory.
<i>Ethyl bromide</i>					see Bromoethane
<i>Ethyl chloride</i>					see Chloroethane
<i>Ethylene</i>					see Ethene
<i>Ethylenediamine</i>					see Ethane-1,2-diamine
<i>Ethylene dibromide</i>					see 1,2-dibromoethane
<i>Ethylene dichloride</i>					see 2-dichloroethane
<i>Ethylene glycol</i>					see Ethanediol
Ethyl ethanoate (acetate)	F, Xi	Y11	N12	S5	(FC) Use a fume cupboard if large volumes are involved. This material is an alternative to propanone in experiments involving the measurement of the strength of hydrogen bonds.
<i>Ethyl iodide</i>					see Iodoethane
<i>Ethyl formate</i>					see Ethyl methanoate
Ethyl methanoate (formate)	F, Xn	Y9	N10	S5	(FC) Use a fume cupboard if large volumes are involved.
Ethyl propanoate (propionate)	F	Y9	N10	S5	(FC) Use a fume cupboard if large volumes are involved.

Ethyne cylinder (Acetylene)	F+	Not generally recommended	Not suitable for use in school laboratories.
Fehling's Solution No 1	Xn, N	Y9 N10 S4	Treat as copper sulfate solution.
Fehling's Solution No 2	C	(Y11) (N12) (S4)	Younger students need very careful supervision with the reagent which is heated as it contains approx 2M sodium hydroxide. When reducing sugars are being tested the mixture must be heated on a water bath. Benedict's solution is a much safer alternative. However the latter is not reduced by alkanals; alternatives are (i) Sandell's reagent which contains approx 0.5 M sodium hydroxide or (ii) Benedict's solution fortified with an equal volume of 0.5M sodium hydroxide. Details of Sandell's reagent are in <i>HazChemMan CD2 (SSERC)</i> .
<i>Ferric chloride, anhydrous</i>			see Iron(III) chloride
<i>ferricyanides</i>			see Hexacyanoferrates(III)
<i>Ferric nitrate</i>			see Iron(III) nitrate
<i>Ferric sulphate</i>			see Iron(III) sulfate
<i>ferrocyanides</i>			see Hexacyanoferrates(II)
<i>Ferrous sulphate</i>			see Iron(II) sulfate
<i>Ferrous sulphide</i>			see Iron(II) sulfide
Fixatives, biological	Some may be harmful. For full details see suppliers' data sheets.	Teacher/Technician	(FC) These should be made up by staff. If large amounts of powder are involved the weighing is best carried out in a fume cupboard. If they are used in alcohol solution they should be treated as alcohol from a safety point of view. Care needs to be exercised with old samples especially if their exact compositions are not known. Treat as a hazard. See <i>Handbook (CLEAPSS)</i> or <i>HazChemMan CD2 (SSERC)</i> .
Fluorides solid solutions 3% to 25% (0.5 to 4M)	T Xn	Teacher/Technician Y12 N13 S6	
Fluorine	T+, C	Not generally recommended	Not suitable for use in schools.
<i>Formaldehyde</i>			see Methanal
<i>Formamide</i>			see Methanamide
<i>Formic acid</i>			see Methanoic acid
Fuchsin, basic solid solution in ethanol	Xn F	Teacher/Technician Y12 N13 (S5)	
Fumaric acid			see trans-butene-1,4-dioic acid
<i>Gallic acid</i>			see 3,4,5-trihydroxybenzenecarboxylic acid, 3,4,5-trihydroxybenzoic acid
Germanium(IV) chloride (Germanium tetrachloride)	C	Y12 N13 S6	FC Very reactive with water.
Heptane	F, Xn, N	Y7 N8 S2	(FC)

Hexachloroplatinic(IV) acid (Chloroplatinic acid)	T, Sen	Teacher/Technician	FC	Quite corrosive and a skin and respiratory sensitiser. Main use is platinising electrodes. Details in <i>HazChemMan CD2 (SSERC)</i> .
Hexacyanoferrates(II) (ferrocyanides) solid dilute solution		Y12 N13 S5 Y9 N10 S2		Forms explosive mixtures with nitrites and gives extremely toxic hydrogen cyanide if heated with acids. Do not heat the solid. Detection of iron(III) ions.
Hexacyanoferrates(III) (ferricyanides) solid dilute solution		Y12 N13 S5 Y9 N8 S2		May explode with ammonia, forms explosive mixtures with nitrites and gives extremely toxic hydrogen cyanide with acids. Do not heat the solid. Detection of iron(II) ions and as constituent of "Ferroxyl solution" used in corrosion tests.
Hexamethylenetetramine (Hexamine)	F, Xn	Y9 N10 S4		The preferred alternative to ethanol as a fuel for model steam engines; needs special burner.
Hexane	F, Xn, N	Y9 N10 S4	(FC)	Use a fume cupboard if large volumes are involved.
Hexane-1,6-diamine (Hexamethylenediamine) solid solution	C Xi	Y12 N13 S6 (Y9) N13 (S4)		Carry out 'Nylon Rope' trick in well ventilated laboratory. Prepare solution in water and use cyclohexane as solvent for the decane dioyl dichloride.
Hexanedioic acid (Adipic acid)	Xi	Y9 N10 S4		
Hexanedioyl dichloride (Adipoyl chloride) diluted solutions in cyclohexane		Y12 N13 S6 (Y9) (N10) (S4)	FC (FC)	The preferred solvents for the preparation of nylon are hexane or cyclohexane. On small scale.
Hexan-1-ol (n-hexanol)	F, Xn	Y9 N10 S3	(FC)	
Hexenes	F, Xn	Y9 N10 S4	(FC)	
Hydrazine, anhydrous	T, F-, N, Carc 2, Sen	Not generally recommended	FC	Only by teacher use with strictest precautions
Hydrazine salts	T, N, Carc 2, Sen	Not generally recommended	(FC)	Only use by teacher with strictest precautions. Hydrazine may be released on reaction with alkali.
Hydrides, (of reactive metals)	F, C	(Y12) (N13) (S5)		These materials give hydrogen with water and leave a corrosive solution.
Hydriodic acid > 25% 10 to 25%	C Xi	(Y9) (N10) S6		
Hydrobromic acid >40% 10 to 40%	C Xi	(Y9) (N10) S6		

Hydrochloric acid					Do not mix with methanal. Sulfuric acid can be used in place of hydrochloric acid in the preparation of urea/methanal polymer.
>25% (concentrated and > 7M)	C	(Y9)	(N10)	(S5)	
10% to 25% (2M to 7M)	Xi	(Y7)	(N8)	(S2)	Typical reactions of dilute acids.
< 5% (< 1M)		Y7	N8	S1	0.1M is adequate for simple investigation of pH of materials.
Hydrofluoric acid		Not generally recommended			Only handled by experienced teacher or by S6 with extremely close supervision.
Hydrofluoric acid etching demonstration	T, C	Teacher/Technician			FC Etching may be demonstrated on a small scale by teacher by placing a microscope slide on top of a test tube containing sodium fluoride and a drop of conc. sulfuric acid.
Hydrogen	F+				
- cylinder		Teacher/Technician			Further details in <i>HazChemMan CD2 (SSERC) or Handbook (CLEAPSS)</i> .
- prepared as needed on large scale		Teacher/Technician			Mixtures between 4% and 74% of hydrogen with air can explode. The ignition temperature is well below red heat and the reaction is catalysed by transition metals and their oxides.
- prepared on small scale		Y8	N9	S2	The use of sulfuric acid for drying the gas is best avoided. (Concentrated calcium chloride solution will do). When hydrogen is being prepared or used safety screens are essential, but eye protection is still necessary.
- reduction of metal oxides		Teacher/Technician			It is essential to ensure all the air has been displaced before lighting the excess. See entry on <i>Methane</i> in <i>HazChemMan CD2 (SSERC)</i> for method using hydrogen/methane mixture which ensures efficient displacement of the air.
Hydrogen chloride (gas)	T, C	(Y9)	(N10)	S3	(FC) Small scale preparation on test tube scale; teacher to add the few drops of sulfuric acid.
Hydrogen cyanide	F+, T+, N	Not generally recommended			Not suitable for use in schools.
Hydrogen peroxide					
> 60% (> 200 vol) (18M)	O, C	Teacher/Technician			Staff only. Reacts violently with propanone, ethanol, glycerol and other organic reducing agents. Finely divided metals cause violent decomposition.
20% to 60% (71 to 200 vol), (6 to 18M)	C	Y12	N13	(S6)	Causes burns.
5% to 20% (18 to 71 vol), (1.5 to 6M)	Xi	Y9	N10	S3	20 vol (6%; 1.7M) and less concentrated is suitable for most applications.
<5% (<18 vol)		Y7	Y8	S1	10 or even 5 volume is suitable for small scale oxygen preparation.
Hydrogen sulfide	F+, T+, N				
- cylinder		Not generally recommended			The gas can react violently with metal oxides, peroxides and soda lime.
- gas prepared as needed		Y12	N13	S6	Not suitable for use in schools.
- solution		Y12	N13	S6	FC Only small quantities of the gas should be made as needed and only in a fume cupboard. Use of mini-Kipps suitable.
					(FC) May be permissible for redox reactions and sulfide precipitations in well ventilated laboratory if solutions are dilute.
<i>Hydroquinone</i>					see Benzene-1,4-diol
Hydroxyammonium salts (Hydroxylamine salts)	Xn, N, Sen	Y12	N13	S6	Preparation of dinitrogen monoxide should be carried out in fume cupboard if amounts are other than small.
2-Hydroxybenzenecarboxylic acid (2-hydroxybenzoic acid, Salicylic acid)	Xn	Y11	N13	S5	A skin and eye irritant.

2-hydroxy-1,2-diphenylethanone (Benzoin)	Low hazard	Y12	N13	S6	
2-hydroxypropanoic acid (Lactic acid)	Xi	Y9	N13	S2	
<i>hypochlorites</i>					see Chlorates(I)
Indicator powders	Most may be harmful. For full details see suppliers data sheet.	Teacher/Technician			(FC) Indicator solutions should be made up by staff. If large amounts of powder are involved the weighing is best carried out in a fume cupboard. If the indicators are made up in alcohol solution they should be treated as alcohol from a safety point of view. Care needs to be exercised with old samples of indicators if their exact composition is not known. Treat these as a possible hazards. See <i>HazChemMan CD2 (SSERC)</i> and <i>Handbook (CLEAPSS)</i> .
Iodates(V)	O, Xn	Y12	N13	S6	
Iodic(V) acid	O, C	Teacher/Technician			
Iodine					
Reaction with aluminium powder		Teacher/Technician			Iodine's reaction with ethanal, ammonia, antimony and alkalis should be avoided as they are potentially explosive. The use of iodine to prepare iodoethane in schools from ethanol and phosphorus is not recommended.
solid	Xn, N	(Y7)	(N9)	(S2)	This reaction, catalysed by water, must be carried out in a fume cupboard. The induction period can be reduced if a dilute solution of detergent is used.
gas	Xn	(Y7)	(N9)	(S2)	(FC) Use under close supervision with younger students if the iodine is to be heated. All heating should be carried out in a fume cupboard. Use cyclohexane to demonstrate the 'colour' of iodine in solution.
solutions > 25%	Xn	Y7	Y8	S2	(FC) For change of state demonstrations use only a trace of iodine crystals and a long test tube with a loose plug of cotton wool in the mouth. Discontinue heating as soon as some iodine crystals have condensed near the mouth of the tube. Some non-aqueous solvents are highly flammable.
<i>Iodine trichloride</i>					see Diiodine hexachloride
Iodobenzene	Xn	Y12	N13	S6	(FC) There is some evidence that this material is explosive above 200°C. and samples should not be redistilled. The reaction between potassium iodide and benzene diazonium chloride solution can be carried out provided the normal precautions are taken for working with diazo compounds. (<i>See Phenylamine</i>)
Iodobutane	F-, Xi	Y12	N13	S6	(FC) This substance is a suspected carcinogen and is sensitive to light. Gloves should be worn.
Iodoethane (Ethyl iodide)	F-, Xi	Y12	N13	S6	(FC) This substance is a suspected carcinogen. and is sensitive to light. Gloves should be worn.
<i>Iodoform</i>					see Triiodomethane
Iodomethane (Methyl iodide)	T, Care 3	Y12	N13	S6	(FC) Gloves should be worn.
1-Iodopropane (n-Propyl iodide)	F-, Xn	Y12	N13	S6	(FC) This substance is a suspected carcinogen. and is sensitive to light. Gloves should be worn.

Iron(III) chloride , anhydrous solid	C	Y11	N13	S6	FC	Use fume cupboard for preparation from the elements. See <i>HazChemMan CD2 (SSERC)</i> for PCB etching.
hydrated solid	Xi	(Y7)	N13	(S3)		
solution (> 0.7M)	Xi	(Y7)	N13	S2		
Iron(III) nitrate	O, Xi	Y9	N10	S2	(FC)	Use fume cupboard, if more than a small amount is thermally decomposed.
Iron(II) sulfate	Xn	Y7	N8	S2		
Iron(III) sulfate	Xn	Y8	N9	S2		
Iron(II) sulfide		Y9	N10	(S2)	(FC)	Carry out reaction of iron and sulfur in a fume cupboard unless on a very small scale in a well ventilated laboratory.
<i>Kerosene</i>					see	Paraffin
<i>Lactic acid</i>					see	2-hydroxypropanoic acid
<i>Lauroyl peroxide</i>					see	Di(dodecanoyl)peroxide
Lead metal		Y8	N9	(S3)		Wash hands after handling.
Lead salts in general	T, N	(Y9)	(N10)	(S3)	(FC)	Avoid touching and wash hands well after working with them. Avoid inhaling aerosol of any lead salts, eg when dissolving a carbonate in dilute acids, cover with a watch glass or carry out in a fume cupboard.
solutions (> 0.02M)	T	Y9	N10	S3		
solutions (0.0002 to 0.02M)	Xn	Y7	N8	S2		
Lead(II) bromide	T, N	(Y9)	(N10)	(S5)		Use a fume cupboard if the molten solid is to be electrolysed and recycle residue.
Lead(II) carbonate	T, N	(Y9)	(N10)	S5		
Lead(II) chloride	T, N	(Y9)	(N10)	S5		
Lead(II) chromate (VI)	T, N, Carc 3	Not generally recommended				The solid is not recommended for use in schools. The production of a precipitate of lead chromate does not present a hazard provided it is not filtered off and dried.
Lead(II) ethanoate (acetate)						
solid	T, N, Carc 3	Y12	N13	(S5)		As a source of Pb ²⁺ ions use lead nitrate as a substitute. May use lead nitrate papers to test for sulfides.
solution (< 0.02M)	Xn	Y9	N10	S4		
Lead(II) methanoate (formate)	T, N	(Y9)	(N10)	S4		
Lead(II) nitrate					(FC)	If used to examine the effect of heat on nitrates as a class experiment very small quantities should be used and only in a well ventilated laboratory as the OES for nitrogen dioxide is low (5 ppm).
solid	O, T, N	(Y9)	(N10)	(S4)		
solutions (> 0.02M) (0.0001 to 0.02M)	T Xn	(Y9) (Y7)	(N8) (N8)	(S4) (S2)		
Lead oxides	T, N	(Y7)	(N8)	(S2)		Vigorous reaction with aluminium, magnesium powders and organic materials. When reducing lead oxides on charcoal blocks, moisten slightly to minimise the powder being blown off.

Lime water		Y9	N9	S1	Although the OH ⁻ concentration in a saturated solution is < 0.05M and therefore is strictly speaking not even classed as Irritant, the use of eye protection is advised.
<i>Limonene</i>					see Dipentene
Lithium	F, C	(Y9)	(N10)	S4	Reaction with water. On heating in air, lithium is known to sometimes explode (the reaction being accelerated by moisture). Heat on a metal deflagrating spoon, and NOT ON PORCELAIN. When the material does burn it is difficult to extinguish it; use powdered sodium chloride, or if the amount is small, simply allow it to burn out. Do not react lithium with mercury.
Lithium chloride	Xn	Y9	N10	S2	Use for flame tests.
Lithium hydroxide	C, Xn	Y12	N13	S6	
Lithium nitrate	O, Xn	(Y9)	(N10)	S5	(FC) Nitrogen dioxide is produced on heating (See note for <i>Lead (II) nitrate</i>).
Lithium tetrahydridoaluminate (Lithium aluminium hydride)	F	TT	TT	(S6)	FC This material should only be used in those schools equipped to cope with the problems involved in its use. The tetrahydridoaluminate can ignite with moisture and has to be used with the extremely flammable ethoxy ethane as solvent, whereas sodium tetrahydroborate (borohydride) can be used with ethanol or even with the much less flammable propan-2-ol.
Lotoxane		Y7	N8	S1	An alternative, safer solvent to chlorinated hydrocarbons for some, but not all applications. Composed of C11 to C13 paraffins it is irritating to skin; it has the advantage over some commonly used alternatives of not being flammable at room temperature.
Magnesium powder	F	(Y9)	(N10)	(S6)	When mixed with air the powder can form explosive mixtures. The dust should not be blown into a bunsen flame. Remove what is needed and replace the lid on the jar immediately. The reactions of magnesium with ammonium dichromate, silver nitrate, sulfur or halogenated hydrocarbons should not be carried out in schools. The reaction with alcohol is violent after a long induction period. Magnesium metal is not a suitable alternative for use in the Thermit reaction except as a fuse. The use of magnesium powder to reduce sand to silicon is very exothermic and can be explosive if the sand is not absolutely dry.
ribbon	F	(Y7)	(N8)	S2	If this material is burnt ensure students do not look directly at the flame.
turnings	F	(Y9)	(N8)	S2	The reaction with acids is very vigorous and careful supervision is needed.
Magnesium chlorate(VII) (Anhydrous)	O, Xi	Not generally recommended			Not suitable for use in schools.
Magnesium nitrate	O	(Y9)	(N10)	S2	Nitrogen dioxide is produced on heating (See note for <i>Lead (II) nitrate</i>).
<i>Magneson I</i>					see 4[(4-nitrophenyl)azo]benzene-1,3-diol
<i>Magneson II</i>					see 4[(4-nitrophenyl)azo]naphthalen-1-ol
<i>Maleic acid</i>					see cis-butenedioic acid

Manganese(IV) oxide (Manganese dioxide)	Xn	(Y7) (N8) (S2)	Its use as a catalyst in the thermal decomposition of potassium chlorate(V) to prepare oxygen has been the source of many accidents generally because one or other of the reactants was not pure. Oxygen is best generated from hydrogen peroxide solution using manganese(IV) oxide as a catalyst. Recover the oxide, wash and keep for re-use.
"Medicinal paraffin"			see Paraffin, liquid
Mercury	T, N	(Y12) (N13) (S6)	(FC) In a well ventilated room on a spillage tray. The major risk is for long term exposure to very small quantities of mercury vapour. For this reason the metal should not be left open to the air for very long and never heated except in a very efficient fume cupboard. Persons wearing gold rings should wear protective gloves! Mercury should not be reacted with ammonia, bromine or chlorine. FC If mercury is used as the electrode in the electrolysis of sodium chloride solution the amalgam formed must afterwards be totally reacted before the mercury is added to the stock of 'dirty' mercury saved for purification. This can be achieved by covering the material with dilute hydrochloric acid and leaving it standing for several days or by the addition of water and an iron nail. Hydrogen is slowly evolved. The reaction of air with aluminium initiated by treating the metal with mercury or its salts is very exothermic and difficult to stop. The foil is best left in water and disposed of with other unwanted chemicals. The use of a mercury bead in a short length of sealed capillary tube to investigate Charle's Law is safer than using concentrated sulfuric acid.
Mercury alkyls	T+, N	Not generally recommended	Not suitable for use in schools
Mercury, inorganic compounds in general			
solid & solution > 2% (approx. 0.1M)	T+, N	(Y12) (N13) (S6)	Cole's modification of the Millon's Reagent should be used rather than Millon's itself for protein tests. For a recipe for Cole's modification consult <i>HazChemMan CD2 (SSERC)</i> or <i>Hazcards (CLEAPSS)</i> .
solution 0.5 to 2% (0.02 to 0.1M)	T, N	(Y9) (N10) (S5)	
solution 0.1 to 0.5% (0.005 to 0.02M)	Xn		
Mercury(II) chloride , solid (Mercuric chloride)	T+, N	(Y12) (N13) (S5)	
Mercury(II) nitrate , solid (Mercuric nitrate)	T, N	(Y12) (N13) (S6)	FC Heating this solid produces mercury as well as nitrogen dioxide. It produces mercury fulminate with ethanol.
Mercury(II) oxide , solid (Mercuric oxide)	T, N	(Y12) (N13) (S6)	FC If heated, an efficient fume cupboard must be used.
<i>Metaldehyde</i>			see Ethanal tetramer

Methanal (Formaldehyde)	T, Carc 3					FC	The solution is corrosive and causes skin sensitisation. Specimens that have been preserved in methanal solution should be soaked in distilled water for at least an hour and then thoroughly washed especially inside the specimen where methanal may have been trapped. If possible the methanal should be replaced by a methanal - free preservative after the specimen has been washed. Sealed specimens containing methanal do not present a risk provided they are not opened.
> 25%	T	Y12	N13	S6			
1% to 25%	Xn	Y9	N10	S6			
0.2% to 1%	Xi						Hydrochloric acid should not be used as the catalyst in the production of condensation polymers involving methanal. Concentrated sulfuric acid (10M) is suitable as an alternative, the reaction being carried out in a fume cupboard. Do not store methanal near concentrated hydrochloric acid or readily hydrolysable chlorides as hydrogen chloride reacts with methanal vapour to form bis-CME, a potent carcinogen; see Topics 12.3.6
Methanamide (Formamide)	T	Y12	N13	S6			
Methane	F+	Y7	N8	S3			Use mains gas supply, not cylinders
Methanoic acid (Formic acid)	C					(FC)	Causes severe burns. Use fume cupboard if heated. Dehydrating agents will release Toxic carbon monoxide.
solutions > 10% (approx. 2M)	C	(Y12)	(N13)	S6			
2% to 10% (0.4M to 2M)	Xi	(Y11)	(N12)	S6			
Methanol (Methyl alcohol)	F, T	(Y10)	(N11)	(S4)		FC	Toxic by all routes of entry, including skin absorption. Use under supervision with younger students. Methanol is not generally a suitable alternative to ethanol. The reaction with concentrated sulfuric acid is very exothermic. Use a water bath for all heating activities.
solutions, aqueous 3 to 10%	Xn						
Methoxybenzene (Anisole)	F, Xn	Y12	N13	S6			
<i>Methyl acetate</i>						see	Methyl ethanoate
Methylamine , liquid (40%; 12M)	F+, C	Y12	N13	S6		FC	For simple test tube reactions first dilute twenty-fold in fume cupboard.
solution 5 to 10%	Xi	Y12	N13	S6			The resulting solution has greatly reduced volatility, flammability and corrosiveness and can be used in well ventilated laboratory.
Methylbenzene (Toluene)	F, Xn	(Y9)	(N10)	S6		(FC)	For preparation of the allotropes of sulfur, dimethyl benzene is a much safer alternative. The liquid must be heated in a fume cupboard on an electrical heater or an oil bath which is not heated by a bunsen burner. Methyl benzene can be used as a safer alternative to benzene to show electrophilic substitution but methyl benzoate is a much better substitute.
Methyl benzenecarboxylate (Methyl benzoate)	Xn	Y11	N12	S4		(FC)	This is an excellent substitute for benzene to show electrophilic substitution. Nitration produces mainly methyl-3-nitrobenzoate if the temperature is kept below 15 ^o C.
<i>Methyl bromide</i>						see	Bromomethane