UNIVERSITY OF CYPRIS

DEPARTMENT OF CHEMITSRY

LABORATORY HEALTH & SAFETY RULES

Introduction

For the smooth and safe operation of the Department of Chemistry it is necessary to update both laboratory staff and students regarding the applicable Health & safety rules.

Participants in any laboratory experiment should keep in mind that they are **responsible for their own Health & safety,** as well as for **the Health & safety of all third parties** both inside or outside of the laboratory. For this reason, ignorance of laboratory safety rules is unjustified and may have serious effects, not only on the individual but also on all those present in the laboratory space or near it.

The following Health & Safety Rules are intended for the smooth (and safe) operation experiments in the Department of Chemistry Laboratories. To this end, they point out the correct use of experimental equipment and chemicals and refer to dangerous situations that may arise from any misuse. Safety in a Laboratory is not a static situation, which can be achieved by simply recording rules. On the contrary, it is dynamic state, which results from the correct behaviour and action of all attendees. To maintain safety, all participants must be constantly vigilant and take care, both individually and collectively, of the Safety Rules.

General Safety Rules

1**.** Inside the laboratory are **only** those who have a direct relationship with the ongoing laboratory activities. **Everyone** should know the Laboratory space, the Rules governing it and the activities (experiments) to be carried out.

2. The workbench, equipment and instruments used should be maintained **neat** and **tidy**, both for **safety** reasons and for the accuracy of the experimental given.

3. Unnecessary personal items (clothing, bags, etc.) that on the one hand limit the freedom of movement and on the other hand can be damaged, are **not allowed within the laboratories.**

4. The presence and / or consumption of any kind (solid or liquid) food is strictly forbidden, as well as **smoking** in laboratory areas. **Before** leaving the laboratory, **hand washing** is **mandatory.**

5. Each student is obliged **for the entire period of time they are inside Laboratory area** to wear a **laboratory apron** (100% cotton) and **protective glasses** which they are responsible for purchasing. After the end of the laboratory exercise the apron should be kept in a special case or bag for this purpose.

6. The use of **gloves** is mandatory whenever caustic or corrosive are used substances that may infect the skin causing possible burns. In **Annex 1** the appropriate types of gloves for various chemicals are listed.

7. Open-toed **footwear** are prohibited inside the Laboratory. **Long hair** is a source of many dangers, because they can easily catch fire or come into contact with chemicals, or be trapped in rotating parts of machinery. Therefore, you should take the necessary measures.

8. The **corridors** to the exits of the laboratory must be kept free.

9. The **floor** of the Laboratory must be kept clean and dry. Chemical **spills** on the floor must be reported immediately to the Laboratory Officer.

10. Every student should know where they are and how they are used: **the box First Aid, fire extinguishers** and **emergency showers.** The safety equipment must be kept in good condition and not used without good reason.

11. It is forbidden to work without the **permission of the responsible** professor of the Laboratory. Students are not allowed to depart from the Laboratory during the experiments, unless **authorized by the Head of the Laboratory**. If in doubt about safe execution of an experiment, then ask the person in charge. It is forbidden to remove materials or laboratory equipment without prior permission. It is also forbidden to use larger quantities of reagents other than those predefined by the experimental procedures.

12. Avoid inhaling fumes. Closed containers containing chemicals must be opened inside **the fume hoods.** Experiments that create fumes must to **always** be carried out inside the **fume hoods.**

13. In case of **danger or accident**, it is necessary to remain calm, cooperate and provide mutual assistance. The person in charge of the laboratory should be informed immediately, while at the same time efforts should be made to **provide First Aid by** Laboratory **staff,** who have been **specially** trained.

14. If a **fire** is caused in the laboratory, GREAT care is required in how the extinguish it. Water is **not** suitable in most cases! If ignition occurs of a chemical in a beaker or spherical flask, the fire may be covered by another beaker or damp cloth **only when the fire is low.** If it is larger, a **fire extinguisher** or **special blankets** should be used. In the case of a large fire, the Laboratory should be evacuated immediately, notifying people in surrounding buildings and the Fire Department. In this case all Laboratory users should be assembled at the predetermined assembly point. The present Department teachers are responsible for making sure the evacuation is done properly. The First Aid and Fire Department telephone numbers should be listed next to Laboratory phone. In case of fire from electrical causes (*e.g.* short circuits), do **not** use water for extinguishing it, but the fire extinguishers that exist in the premises of the Laboratories. For the different types of fire there are also the corresponding fire extinguishers:

A. Water: Suitable for solid materials such as wood, paper, fabric, plastic and **unsuitable** for fire from electrical causes and flammable liquids.

B. CO_2: Suitable for low fires from oil or other flammable substances and for fires from electrical causes. It is **unsuitable** for fires from burning metals and solids.

C. Dry powder: Suitable for fires from flammable substances, oil, electrical causes, and for fires on the surface of solids. It is **unsuitable** for fires in Metals and for fires that have already penetrated solid materials.

D. BCF: Suitable for small fires, caused by flammable materials, or due to electrical causes. Toxic derivatives are created from its use, so in this case caution is required as

well as taking appropriate ventilation measures beforehand from the reuse of the space.

Use of laboratory glassware and instruments

Many laboratory instruments are **sensitive** and **expensive.** Users should first read (and understand) the **instructions for use.** If there are doubts or if problems occur, then inform the person in charge of the Laboratory.

1. The installation of **electrical appliances** (heating plates, stirrers, etc.) must be done with due care. More specifically, special attention should be paid to **cables**, which should be away from the benchtop and **not come in contact with heat sources**. All electrical appliances should be inspected periodically. Damaged electrical appliances should be brought to the attention of the Laboratory staff. Keep all electrical appliances dry and handle with dry hands.

2. When physical force must be applied to **glassware** (*e.g.*, to adjust thermometer or glass tube in the rubber cap hole), then use thick leather gloves or a thick cloth and apply the pressure carefully in slow circular motions. **Injuries from broken glass are one of the most common accidents** in Chemistry Laboratories.

3. All glassware must be carefully inspected before use for cleanliness and structural integrity. Cracked glassware are especially dangerous when they are to be used in low- or high-pressure devices. Dirty glassware should be cleaned before use and as soon as possible after use.

4. In the oven of the laboratory, glassware is placed for drying, after previously have been rinsed with distilled water and/or acetone. Do not place **closed glassware** in the oven or plastics. The oven temperature is determined by them Laboratory Technicians and should not be changed.

5. If the tap must be open for a long time, the connecting pipes to your device and water flow should be monitored periodically. After work, **all** the taps will must be checked to be **closed.**

6. Use of gas cylinders. Accidents can also be caused by gas cylinders. Particular attention should be paid to the following points:

A. The cylinder key must be attached to the cylinder for emergencies.

B. The valves must be opened slowly.

C. The bottles must be stored securely, immobilized with a suitable strap or lashing and mounted vertically.

D. There must be a pressure regulator.

E. Never apply grease to the valve or regulator for easier threading. Oxygen forms explosive compounds in many lubricants, *e.g.*, with vaseline.

- **Use of Chemical Reagents**

General safety rules for chemical reagents

1. Work No **hazardous reagents** (flammable, toxic or releasing reagents) dangerous individuals) occurs only in the **abductors.**

2. The use of pipettes in the mouth is prohibited. Their proper use is in tires aspirators (poir).

3. They must use **only** the amounts of reagents **required** by the experience. Any excess is **not returned** to the reagent container. For the processing of contact the Head of the Laboratory (see Disposal waste).

4. Avoid **exposure to chemicals** or solutions (especially for the eyes but also the mucous membranes of the oral and nasal cavities).

5. It is forbidden to **heat** volatile and flammable liquids or their solutions in open containers or with Bunsen lamps. Bottles of these liquids should be stored away from fire hobs or hot areas. When performing experiments that require naked flames should previously remove all flammable substances. Generally, in the Laboratory **should not more than three litres of flammable solvents are exposed.** The remaining solvents will should be stored in metal fireproof cabinets.

6. All bottles or containers containing reagents, including and containers where reactions must be **accurately and legibly** marked with their contents.

Labelling of Chemical Reagents

Chemical labels are designed to inform users about the risks from chemical reagents and their safe handling. In the European Union chemicals labels should clearly indicate:

(a) the **name of the chemical**;

(b) the name, address and telephone number **of the manufacturer** and importer;

(c) the **hazard symbol** of the chemical (Annex 2);

(d) the **hazard** number (R-phrases, Annex 3) and the safety number (S-phrases, Annex 4);

(f) the quantity contained in the container.

The labels should be written in the official national language of the state. Usually a label may contain up to four names of chemicals, which are the most dangerous, Up to two hazard symbols, up to four hazard numbers and up to four safety numbers. Generally, the labels do not show chemicals that are in quantities < 0.1% by weight and are not considered very toxic (T+) or just toxic (T). Also they do not refer to chemicals in quantities < 0.1% and not classified in categories of harmful (Xn), corrosive (C) or irritating (Xi).

Marking example:

100 mL 1,1,1-Trichloroethane $C_2H_3Cl_3$

Xn Contains
1,1,1-Trichloroethane 97%
1,1,1,2-Tetrachloroethane 1.5%
1,1-Dichloroethane 1.0%

N

R20, R59, S2, S24/25, S59, S61

The above marking means: The container contains 100 mL of a chemical whose composition is 97% **by weight** 1,1,1-trichloroethane, 1.5% 1,1,1,2-tetrachloroethane and 1.0% 1,1-dichloroethane. These three chemicals make up 99.5% of the chemical. The remaining 0.5% will be some other or other chemicals, which are not **T** (toxic) or **T+** (very toxic). Often the rest of the mass is water. The chemical 1,1,1-trichloroethane is harmful and dangerous to the environment. Also designated **R20** (harmful by inhalation), **R59** (ozone depleting), **S2** (to be stored Keep out of the reach of children), **S24/25** (avoid contact with eyes or skin), **S59** (for recycling or refusing to seek instructions from the manufacturer), **S61** (this material should be considered hazardous waste).

Hazardous Reagents (Annexes 5-8)

1. Explosives

The use of an explosive chemical should be avoided if it can be replaced by a non-explosive chemical. If a substance with explosive properties must be used, this should be done in the smallest possible quantities. Containers with explosive compounds must be protected from vibrations and high temperatures. In the case of explosive solids, avoid any form of impact including friction 'rubbing' (*e.g.*, when transporting them by spatula). In some cases, the use of a metal spatula is prohibited and alternatives should be used *e.g.*, Teflon or Teflon-coated spatulas.

Explosive compounds

A) Acetylene and **heavy metal acetylene (Ag, Cu). Polyacetylene** and some of **their halogenated analogues**.

B) Hydrazoic acid and all **azides** (**azide**, N_3^-) other than sodium azide.

C) Diazonal salts (solids) and **diazo-compounds**.

D) Inorganic nitrates (nitrate, NO_3^-), especially ammonium nitrate. **Nitrates polyalcohol esters**.

E) Polytheno compounds, such as picric acid and heavy metal bitter salts, trinitrobenzene (TNB), trinitrotoluene (TNT). These compounds are safe when they contain water.

F) Nitrophenol metal oxides.

G) Peroxides. They are formed over time or during processing (*e.g.*, heating, distillation etc) in the ethers and are the most common cause of explosions in laboratories.

H) Fluoride, trichloride and nitrogen triiodide: very explosive!

I) Strong oxidizing agents. They are especially dangerous when they come in contact with polyalcohols, carbohydrates and cellulose-containing materials (such as paper, fabric or wood). Also when sulfur or phosphorus and metals in powder form, such as magnesium and aluminum. The following compounds belong to the strong oxidants:

(a) Perchloric acid ($HClO_4$), chlorides (chlorate, ClO_3^-) and **perchlorates, (perchlorate, ClO_4^-)**

(b) Chromium trioxide, chromates (chromate, CrO_4^{2-}) and **dichromates (dichromate $Cr_2O_7^{2-}$)**

(c) Concd nitric acid and **nitrate**

(d) Concd peroxide hydrogen peroxide (H_2O_2)

(e) Liquid oxygen and **liquid air.**

There is a special risk of explosion in the following cases:

A) Peroxides in ethers. Simple dialkyl ethers (diethyl and diisopropyl ether) and cyclic ethers [1,4-dioxane, tetrahydrofuran (THF)] form under the influence of light radiation and oxygen peroxides. Bottles containing ethers should therefore be made of dark glass, stored in a dark place and not leave ground floors for Long period of time. Because peroxides have a higher boiling point than them corresponding ethers, Great care is required in distillation, especially during the process drying of ethers. Peroxide testing must always be performed before distillation. **Caution:** Solutions, which may contain peroxides, must **not** be concentrated to dryness, that is, a sufficient volume of solution should remain in the distillation flask.

Peroxide test: 1 mL of ether is stirred with potassium iodide solution acidified with acetic acid. If the dye appears yellow (I_2), the ether contains peroxides (see section on waste disposal). In the absence of peroxides the solution remains colorless.

B) Solid sodium amide and sodium metal's. They are easily oxidized on their surface, forming explosive oxides. Potassium is oxidized even when stored in paraffin oil. Metal joints covered by a thick layer of oxide should not to be used, but to be neutralized by large amounts of isopropanol. Oxidized $NaNH_2$ pellets (yellow coating) are neutralized with solid ammonium chloride chloride).

C) Alkali metals in chlorinated solvents. The metals lithium, potassium, sodium as well aluminium and magnesium in powder form react violently with chlorinated solvents, such as dichloroethane, chloroform and carbon tetrachloride (**RISK OF EXPLOSION**).

D) Perchloric acid. Reacts violently to all organic materials. Must be stored away from wood or organic compounds. Avoid mixing perchloric and sulfuric acid, because the particularly dangerous anhydrous perchloric acid is formed.

E) Chromic acid and nitric acid. When used for cleaning glassware **DO NOT HEAT**! The use of **nitric acid and ethanol is also prohibited** for cleaning glassware.

F) Liquid nitrogen (mp -196 °C) always contains a small amount of liquid oxygen (mp -183 °C). During the sublimation of nitrogen the concentration of liquid oxygen is gradually increased, so that the last residues of liquid nitrogen contain up to 80% oxygen. Every contact with organic materials (*e.g.*, solvents) could cause explosion. For this reason, no other materials are placed in liquid nitrogen Dewar containers unless the containers are completely dry.

2. Flammable Substances

A) Flammable solvents. Particular attention should be paid to flammable volatile solvents. These solvents should only be used in the fume hoods and their bottles should always be carefully closed. If a large amount of solvent is spilled, the whole laboratory should be vacated and left to ventilate. Until the venting is over, do not turn on / off electrical switches or move electrical cables, because there is risk of ignition of solvent vapour due to spark formation.

The flammability of a compound is given by the "flash point", *i.e.* the temperature at which the liquid forms flammable vapour. When a compound has a flash point < 15 ^{o}C it is considered flammable. The most common organics belong to this category solvents. There should never be **> 3 L** of flammable solvents in one laboratory, unless protected in suitable refractory metal containers. (The ignition temperatures of certain solvents are given in Annex 7)

B) Sodium residues. Bottles with sodium residues, used for drying solvents, are possible sources of explosion or fire. The pieces of sodium, that is usually covered by a thick layer of oxide, must be stirred with an excess of isopropanol for many hours. Then carefully ethanol is added until all of the sodium is neutralized. The powder is carefully poured **into a large** amount of water (**not vice versa**!) and stirred. Rinse the flask adequately with alcohol before finally rinsing with water. If sodium residues cause the solvent to ignite, a fire extinguisher must be used for extinguishing dry powder or salt. **Caution: The use of CCl_4 or CO_2 fire extinguisher is prohibited for sodium fires**.

C) Metal hydrides. Lithium and sodium hydrides and lithium alkyl hydride react violently with water releasing hydrogen. Because the reaction is very exothermic, it can ignite the hydrogen. Hydride residues must be carefully neutralized with ethyl acetate or acetone.

3. Reactive inorganic reagents

*****: Reagents marked with an asterisk emit strong corrosive fumes or are solid compounds that form equally dangerous powders. All experiments (including weighing of these materials) must be done **inside a fume hood**!

A) Strong acids. All of the following acids react violently at bases and most are released dangerous people.

* **Hydrobromic acid** and **HBr (g)**

* **Hydrochloric acid** and **HCl (g)**

* **Hydrofluoric acid** and HF (g): corrode glass and rapidly destroy organic tissues. Use only in thick rubber gloves and protective glasses. In the event of a burn, seek medical advice immediately.

* **Nitric acid** (concd and fuming)

* **Perchloric acid** is an oxidant and its salts can be explosive

* **Sulfuric acid** (concd and fuming)

* **Chromic acid** (CrO_3 + H_2SO_4): combines the corrosive properties of sulfuric acid with the oxidants of CrO_3.

B) Strong bases. Calcium oxide and potassium and sodium hydroxides react violently with acids. They release heat in contact with water. They corrode the skin and can damage the eyes.

* **Ammonia (g)** and ammonium hydroxide (gas or concd aqueous solution d = 0.880).

* **Hydrazine** and its salts (concd solutions).

* **Sodium amide**: reacts violently with water, is corrosive and can irritate the skin and when it is in the form of fine granules airways.

C) Halogens [F_2, Cl_2, Br_2, I_2]. They are all corrosive and toxic. Great care is required in the use of fluorine, which reacts violently with a wide range compounds.

D) Reactive chlorides. All of the following chlorides are very active, especially in contact with water.

* boron trichloride (BCl_3), phosphorus tri- and penta-chloride (PCl_3 and PCl_5), phosphorus tribromide (PBr_3), silicon tetrachloride ($SiCl_4$), aluminium trichloride ($AlCl_3$) and titanium tetrachloride ($TiCl_4$).

E) Chromium trioxide, chromatic and dichroic salts. They form a fine powder that is corrosive. Water-soluble chromates are particularly dangerous because they dissolve in nasal fluids and sweat, causing **cancer.**

4. Toxic substances

Because almost all chemical compounds, depending on their quantity and concentration, may be toxic, **contact with any chemicals** should be **avoided**. As a rule, all chemicals should be treated as potential poisons, unless of course they are known to be harmless. The toxic activity of the chemicals is characterized as either 'immediate' or 'chronic'. Well known poisons, such as hydrocyanic acid or chlorine, which have a direct toxic effect, are treated usually with due care. Certain chemical compounds are characterized by chronic toxicity action, the effects of which appear after repeated exposure to the substance often in small quantities.

Threshold Limit Value (**TLV**) is a measure of how dangerous a compound is, *i.e.* the maximum permissible value), measured in ppm/m^3 or mg/m^3. TLV values give maximum concentration

of vapours or dust below which the chemical compound may be designated as harmless. Examples of such compounds are given in Annex 8.

5. Carcinogens

If work with known carcinogens is unavoidable, you must avoid inhalation or contact with skin. Work must only be carried out in a working **hood** using gloves. Carcinogenic compounds are classified in categories **A1** (causes proven cancer in humans), **A2** (causes proven animal cancer) and **B** (there is strong evidence that the compound is carcinogenic). Examples of such compounds are given in Annex 9.

The most dangerous carcinogenic compounds include:

1) Aromatic amines and their derivatives.

2) *N*-Nitro compounds, such as nitrodiamines [R´-N(NO)-R] and nitrides [R´-N(NO)-COR].

3) Polycyclic aromatic compounds, contained in tar, such as benzo[*a*]pyrene, dibenzo[*a,h*]anthracene etc.

4) Alkylating agents, such as chloroalkyl ethers, alkyl halides, alkyl sulfates, diazoethane, etc.

5) Organic sulfur compounds, such as thioacetamide and thiourea.

6) Asbestos powder (in the respiratory tract).

6. Dangerous compounds that accumulate in the body

Benzene. Prolonged exposure to benzene may manifest from anaemia to leukaemia. Human odour usually does not detect benzene at concentrations lower than 75 ppm (*i.e.* 7 × the TLV of benzene). When benzene is detected by smell, it means that a significant amount of it has already been inhaled. **In most cases benzene can be replaced by the less dangerous toluene (TLV 100 ppm)**.

Complexes of lead are very powerful poisons because they accumulate in the human body. Organic compounds of lead (*e.g.*, tetraethyl lead) are volatile and inhalation of their vapours should be avoided. They are also easily absorbed by the skin.

Mercury and its compounds are characterized by very high toxicity. Generally, the salts of divalent mercury are more toxic than those of monovalent salts. Mercury and its volatile compounds are dangerous poisons.

7. Radioactive substances, use of radiation

Some basic things about working with radioactive substances are:

A. Know the nature, half-life and penetration of the radiation produced by the substances you work with.

B. Thick plastic Disposable gloves are required to manipulate radioactive substances.

C. When conducting experiments on radioactive substances, be careful not to get exposed to the energy emission beam.

D. Employees must also always remember the basic principles of ionizing protection radiation which is: Short exposure time; Long distance from the source and "isolation of source".

In terms of **radiation,** the most serious dangers arise from radioactive sources, ultraviolet radiation lamps, X-ray devices, laser devices.

Special protective eyewear should be used in areas with laser operation. The beam of the laser should not be aimed at people (especially the eyes) or on flammable materials such as clothes, wood, etc.

- **Laboratory Waste**

Collection and disposal of laboratory waste

Chemical waste, as found in a Chemistry Lab, is basically subject to waste laws and **may not be disposed of in sinks,** or in any other public utility drain. Although waste in a Chemical Laboratory is in small quantities, it must be collected in special containers and delivered to the local special centres to neutralize them. Waste is collected in special containers which are classified into different categories to avoid the emergence of incompatible chemicals (to exclude the possibility of any dangerous reactions). In many cases, before waste collection some processing of them is necessary.

Chemical waste containers must be chemically resistant, seal securely, and be stored in well-ventilated areas to avoid the accumulation of hazardous fumes. Annex 9 describes the chemical waste containers according to the existing European Community laws and specifications TRGS 102 (Technical Regulations for Dangerous Substances).

Pre-treatment of laboratory waste

The following instructions should be followed when converting chemical waste to harmless secondary compounds, as well as during storage - until their destruction. The following procedures refer to the **small quantities** used in general physiology usually in a Chemical Laboratory and in no case is it suitable for larger quantities. To become familiar with the procedures below, **tests must be made on a small-scale**, which will protect against potentially dangerous situation due to inexperience. The application of these procedures requires the assistance of specially trained staff with appropriate chemical knowledge.

Tips for disposal and recycling of laboratory waste - accident management

1) Dispose of **inorganic acids** by slowly adding them to water or ice (**note:** add the acid to water, not vice versa) and then neutralize them with a solution of caustic soda (until the pH is 6-8), collection container A.

2) The **inorganic bases** are diluted into water and neutralized with dilute sulfuric acid (until the pH is 6-8), collection vessel B.

3) The **inorganic salts**, collection container S, solvates, collection vessel A. If necessary to neutralize them, is done as in cases 1 and 2.

4) The **metal inorganic compounds** are carcinogenic, very toxic (T+) or toxic (T): at form of solutions or in solid form, collection vessel M.

5) Radioactive compounds should be collected in the special precautions provided for radioactive bodies, in accordance with the Atomic Energy Commission.

6) Remnants of the inorganic salts of mercury and **mercury** collected container Q. Mercury residues are neutralized with sulfur or zinc powder.

7) Cyanide compounds, the **mineral acids** and the **mixtures of diazonium** salts are oxidized in sodium hypochlorite solution to be converted to less hazardous compounds. Residues of oxidizing compounds are neutralized with sodium thiosulfonate. The combined oxidation products can be tested for the presence of cyanides (Aquanal test). The final solution is collected in vessel A.

8) Inorganic peroxides and **oxidizing agents** such as bromine and iodine can be converted to harmless compounds by treatment with sodium thiosulfonate solution. Collect them in container A.

9) Hydrofluoric acid and solutions of mixtures **of inorganic fluoro compounds are** precipitated from calcium hydroxide solution in the form of calcium fluoride. The precipitate is filtered off and collected at collection vessel S. The filtration is collected in collection vessel A.

10) The **halogenated inorganic salts,** susceptible to hydrolysis and like mixtures are carefully diluted into water or ice, after they have been previously neutralized, container A.

11) The **phosphorus** and **mineral salts** are passed carefully into a solution (*e.g.*, from 100 mL of 5% sodium hypochlorite and 5 mL of 50% caustic soda) to oxidize. Because there is a risk of ignition during the above procedure, this should be handled in a fume hob. After filtration the precipitate is collected at container S, and the solutions in container A.

12) The alkali metals, the **hydrides of metals,** the **amides of metals** and the **their alkoxides** decompose causing an explosion if they come in contact with water. The compounds These are neutralized by treatment with butanol (the suspensions of these compounds in butanol should not be refrigerated with water or dry ice). The suspensions of the compounds in butanol are kept for at least 24 hours, so that the last traces of alkali metals or alkalis to disappear. Then the butanol solution is carefully diluted with water and the resulting solution is neutralized with dilute sulfuric acid. The final solution is stored in the collection vessel O.

13) Noble metal ores: solid residues and their solutions are collected in containers M.

14) Non-chlorinated organic solvents: container O.

15) Chlorinated organic solvents: container H.

16) Miscellaneous organic mixtures of moderate activity: Halogen-free liquid mixtures: container O. Halogenated, liquids: container H. Solids: container M.

17) Organic bases and **amines:** after neutralization with hydrochloric acid or sulfuric acid, collected in container H or O as before.

18) Organic acids are carefully neutralized with sodium bicarbonate solution or sodium hydroxide. They are then placed in container A. Aromatic carboxylic acids, after neutralization are placed in vessel A, otherwise in vessel C.

19) Organic peroxides, potent other oxidizing agents, or compounds which may ignite are reduced in sodium sulfite solution. Collection container O or H.

20) The **nitriles** are **mercaptans** and similar compounds are oxidized by stirring for several hours in a solution of sodium hypochlorite. The organic layer is placed in container H and h aqueous in container A.

21) Mixtures of organo-metal compounds that are easily hydrolysed are carefully added to stirred *n*-butanol followed by stirring for several hours (10-16 hours). Then the solution carefully added to water. The organic layer is stored in vessel H and the aqueous layer in container A.

22) Carcinogenic mixtures, highly toxic and / or flammable: collection container O.

23) Acid halides are placed in ethanol to deactivate them. The process can be accelerated by the addition of a few drops of hydrochloric acid. Neutralize with a dilute solution of caustic potassium. Collection container H.

- **Laboratory first aid for accidents**

Burns

1) From **heat:** Wash with plenty of water for 10-20 minutes. Superficial Burns where the skin has not been damaged are sprayed with a suitable mild burn spray or smeared with ointments and are loosely bandaged. For more severe burns **do not** used oil, cremes or powders, but seek medical attention as soon as possible.

2) From **corrosive compounds:** The burn is first washed with plenty of water. Depending on its type corrosive union first aid differs.

Concentrated acids: wash with 1% aqueous sodium bicarbonate solution.

Concentrated bases: wash In aqueous solution of 1% acetic acid.

Bromine: spread on glycerin and bandage.

Phosphorus: Wash with 3% copper(II) sulfate solution and water.

Dimethyl sulfate: wash in concentrate solution of eternity and water.

Organic corrosive compounds: alcohol cleaning and soap, water.

The necessary ointments, sprays and cremes **must be in the first aid kit**.

Medical attention should be sought as soon as possible.

Cut wounds

In the event of a minor injury, the free flow of blood is allowed for a few seconds. If the injury is caused by broken glass, only non-imbedded broken fragments are removed. No attempt **should** be made to remove debris, even if visible. The wound is then dissected and bandaged. In case of strong bleeding, by compress the blood vessel to a suitable point (vein or artery) to stop the bleeding and bandage with gauze (**not** cotton!). Seek immediate medical attention.

Injury to the eye

If any chemical gets in the eye, rinse immediately with plenty of water for at least 5 minutes keeping the eyelids open. If glass gets into the eye, **do not wash**, but bandage it closed and seek immediate medical attention.

Poisons

In general, ingestion of a chemical is treated by administering an appropriate substance, or antidote or promoting vomiting, as the case may be.

Acids: Drink plenty of water and then Magnesia milk [$Mg(OH)_2$].

Caustic alkali: Drink plenty of water and then lemon, orange or lime juice citric acid solution.

Heavy metal salts: Milk or egg white is given.

Arsenic and mercury compounds: Prompt vomiting as soon as possible.

Cyanide compounds: A special antidote is administered which causes vomiting. Permission must be sought Medical Assistance. The antidote is a mixture of 50 mL of solution A and 50 mL of solution B. (Solution A: 158 g of hydrated $Fe(II)SO_4$ and 3 g of citric acid in 1 L of water. Solution B: 60 g anhydrous sodium carbonate in 1 L of water). **Solutions A and B must be present prepared in the First Aid box.** (Solution A decomposes over time and should to be **renewed)**.

Inhalation of hazardous gas: The patient should be transported immediately to a well-ventilated area and to take deep breaths. Seek medical attention as soon as possible.

- **Compliance with The Health & Safety Rules**

The Health & Safety Rules must be strictly observed. The University is obliged to provide the necessary infrastructure to be able to comply with the Health & Safety Rules and to enable experimental laboratory work to be carried out smoothly and safely. Compliance with the Health & Safety Rules is the **responsibility** of every employee, student, and/or visitor in the Laboratory. It should be emphasized, that **participants** in the performance of a laboratory experiments are **responsible for their own health and safety**, as well as that of **all third parties** who may be affected inside or outside the laboratory. For each laboratory exercise the responsible tutor **must ensure that students are aware of potential risks** that can arise during each exercise and that may not be covered in the rules.

If the **Health & Safety Rules** are not observed, the **person in charge MUST impose penalties** according to the seriousness of the offense. Serious misconduct includes the execution of experiments without the approval of the responsible tutor, as well as the presence within the Laboratory without the necessary **protective clothing** and especially without **protective eyewear**. Repeated cases of serious infringements of the **Health & Safety Rules**, can lead to disciplinary action at the University level.

Recommended compliance with the **Health & Safety Rules**:

1. All students are informed of the **Health & Safety Rules** at beginning of the 1st semester of their studies.

2. All students attend the **Safety Tutorial** during the 1st semester of their studies. After the end of the tutorial and at the beginning of **each experiment**, students will be examined in aspects of laboratory and chemical safety. Success in this examination is mandatory (greater than or equal to 8/10) to be eligible to participate in conducting any laboratory course. For

participating in any laboratory courses of any Academic Year it is mandatory to submit a signed **Responsibility Statement**, a copy of which is provided at the end of this document.

3. Before the beginning of each laboratory exercise the responsible tutor informs students about any dangerous parts of the experiment. These can include but are not limited to: use of experimental techniques (*e.g.*, heating, working with low pressure appliances); and/or chemicals (*e.g.*, concentrated sulfuric acid). It is recommended that each laboratory manual contains an Annex to basic safety information, *e.g.*, **Material Safety Data Sheets (MSDS)** for all chemicals used during the specific Laboratory (except for unknown samples).

4. Students, technicians, laboratory assistants and the responsible tutors must know the location of the First Aid kit, fire extinguishers, fire blankets, the emergency showers, the telephone and the emergency exit(s) of the Laboratory. There should be regular inspection by laboratory technicians that items related to safety of the Laboratory are in the correct position and are operating normally. Special care is required for the First Aid kit, which must be kept supplied with medicines/antidotes, that are in good condition and have not expired.

5. Responsible for the safety supervision in each laboratory exercise will be the tutor in charge, laboratory technicians and teaching assistants. Their names should be written outside the laboratory at the beginning of each semester. They will also be responsible for overseeing safety and compliance with the rules. Problems related to laboratory safety MUST be immediately reported to the **Chemistry Department Safety Officer**.

6. At least twice a year the **Departmental Safety Officer MUST** inspect all the laboratories of the Department and complete the general safety form found in Annex 10. The completed form is submitted to the Chairman of the Department and to the Safety Committee of the University. Weaknesses that arise in the implementation of the Health & Safety Rules should be documented, and attempts made to address and resolve them in a timely manner. In cases where the Chemistry Department is unable to apply the Health & Safety Rules, e.g., in matters related to general laboratory infrastructure, then assistance must be sought from the University.

7. During the laboratory exercises the responsible tutor should be present in the lab to instruct students on proper execution of laboratory exercises. Laboratory safety should be supervised by at least two safety officers (considering that their number trainee students is less than 30). One of the safety officers must be the laboratory technicians. Teaching assistants can be absent, only after obtaining permission from the responsible tutor. The technicians may be absent only after obtaining permission from the Department Chairman and in full knowledge of the Department Safety Officer.

Annexes

1. Types of gloves for use with various solvents (Materials listed in parentheses offer limited protection)

Solvent	**Construction material (Glove type)**
Acetone	Butyl rubber; Polyethylene
Benzene	PVA; Viton; (Polyurethane; Butyl/Neoprene)
Ethanol	Butyl rubber; Nitrile rubber; Neoprene; Natural rubber; Viton
Gasoline	PVA; Nitrile
Hexane	Viton; Neoprene; PVA; Nitrile
Isopropanol	Natural rubber; Neoprene; Nitrile rubber; PVC
Mesitylene	PVA; Viton
Methyl cellosolve	Butyl rubber; PVA;
Methyl ethyl ketone (MEK)	Butyl rubber; (PVA; Viton; Polyethylene)
Methyl isobutyl ketone (MIK)	PVA
Naphtha	Polyurethane; Nitrile rubber
Toluene	PVA; Viton; (Butyl rubber)
Toluene diisocyanate (TDI)	PVA;
1,1,1-Trichloroethane	Viton; (Natural rubber; Butyl rubber; Polythylene)
Trichloroethylene	Viton; (Natural rubber; Butyl rubber; Polyethylene)
Turpentine	PVA; Nitrile rubber
Xylene	PVA; Nitrile rubber

2. Danger symbols and signs for dangerous substances and preparations

E

E Explosive

O

O Oxidizing

F

F Very Flammable

F+

F+ Extremely flammable

T

T Toxic

T+

T+ Very Toxic

Xn

Xn Harmful

Xi

Xi Irritant

C

C Corrosive

N

N Environment danger

3. Nature of specific hazards relating to dangerous substances and preparations.

R-phrases

R1 Explosive in dry state
R2 Risk of explosion due to impact, friction, fire or other sources of ignition
R3 Extreme risk of explosion due to impact, friction, fire or other sources of ignition
R4 It forms very sensitive explosive metal compounds
R5 Heating can cause an explosion
R6 Explosive presence or absence of air
R7 May cause fire
R8 Together with combustible material it can cause a fire
R9 It forms explosive fumes with combustible materials
R10 Flammable
R11 Very flammable
R12 Extremely flammable
R14 Reacts violently with water
R15 Reacts with water, releasing extremely flammable gases
R16 With oxidants it forms explosive liquids
R17 It ignites in the air
R18 In use, atoms may form a flammable / explosive sample in the air.
R19 May form explosive peroxides
R20 Harmful by inhalation
R21 Harmful when in contact with skin
R22 Harmful if swallowed
R23 Toxic when inhaled
R24 Toxic when in contact with skin
R25 Toxic if swallowed
R26 Very toxic when inhaled
R27 Very toxic when in contact with skin
R28 Very toxic if swallowed
R29 Reacts with water releasing toxic gases
R30 It can become very flammable when used
R31 Reacts with acids to release toxic gases
R32 Reacts with acids releasing highly toxic gases

R33 Risk of cumulative effects
R34 Causes burns
R35 Causes severe burns
R36 Irritating to the teeth
R37 Irritating to respiratory system
R38 Irritating to skin
R39 Risk of very serious ion damage
R40 Suspected of carcinogenesis
R41 Risk of serious eye damage
R42 May cause sensitization by inhalation
R43 May cause sensitization when in contact with skin
R44 Risk of explosion if heated in a closed container
R45 It can cause cancer
R46 It can cause inherited genetic damage
R48 Risk of serious damage to health after prolonged exposure
R49 It can cause cancer when inhaled
R50 Very toxic to aquatic organisms
R51 Toxic to aquatic organisms
R52 Harmful to aquatic organisms
R53 May cause long-term adverse effects in the aquatic environment
R54 Toxic to flora
R55 Toxic to fauna
R56 Toxic to soil organisms
R57 Toxic to bees
R58 May have adverse long-term effects on the environment
R59 Dangerous for the ozone layer
R60 It can weaken fertility
R61 It can harm the fetus during pregnancy
R62 Potential risk of impaired fertility
R63 Potential risk of adverse effects on the fetus during pregnancy
R64 It can harm breastfed babies
R65 Harmful: May cause lung damage if swallowed

R66 Prolonged exposure may cause dry skin or stretch marks
R67 Inhalation may cause drowsiness or dizziness
R68 Potential risk of ionic damage

R-phrase combinations

R 14/15 Reacts violently with water, releasing highly flammable gases
R 15/29 Reacts with water releasing highly flammable gases
R 20/21 Harmful by inhalation and when in contact with skin
R 20/22 Harmful by inhalation and if swallowed
R 20/21/22 Harmful by inhalation when in contact with skin and if swallowed
R 21/22 Harmful when in contact with skin and if swallowed
R 23/24 Toxic by inhalation and when in contact with skin
R 23/25 Toxic when inhaled and if swallowed
R 23/24/25 Toxic by inhalation, in contact with skin and if swallowed
R 24/25 Toxic when in contact with skin and if swallowed
R 26/27 Very toxic by inhalation and when in contact with skin
R 26/28 Very toxic when inhaled and if swallowed
R 26/27/28 Very toxic by inhalation, in contact with skin and if swallowed
R 27/28 Very toxic when in contact with skin and if swallowed
R 36/37 Irritating to eyes and respiratory system
R 36/38 Irritating to eyes and skin
R 36/37/38 Irritating to eyes, respiratory system and skin
R 37/38 Irritating to respiratory system and skin
R 39/23 Toxic: risk of very serious ionic damage when inhaled
R 39/24 Toxic: risk of very serious permanent damage when in contact with skin
R 39/25 Toxic: risk of very serious ion damage if swallowed
R 39/23/24 Toxic: risk of very serious damage µ by inhalation and in contact with the skin
R 39/23/25 Toxic: risk of very serious damage **µ** by inhalation and if swallowed
R 39/24/25 Toxic: risk of very serious permanent damage when in contact with skin and case of ingestion
R 39/23/24/25 Toxic: risk of very serious permanent damage when inhaled, in contact with skin and if swallowed

R 39/26 Very toxic: risk of very serious ionic damage when inhaled
R 39/27 Very toxic: risk of very serious permanent damage when in contact with skin
R 39/28 Very toxic: risk of very serious ionic damage if swallowed
R 39/26/27 Very toxic: risk of very serious damage µ by inhalation and when inhaled skin contact
R 39/26/28 Very toxic: risk of very serious damage µ by inhalation and in case of swallowing
R 39/27/28 Very toxic: risk of very serious permanent damage when in contact with skin and case of ingestion
R 39/26/27/28 Very toxic: risk of very serious damage µ by inhalation, when in contact with the skin and if swallowed
R 40/20 Harmful: potential hazards of permanent damage when inhaled
R 40/21 Harmful: potential risks of permanent damage when in contact with skin
R 40/22 Harmful: potential risks of permanent damage if swallowed
R 40/20/21 Harmful: potential hazards of permanent damage when inhaled and in contact with skin
R 40/20/22 Harmful: possible hazards of permanent damage by inhalation and if swallowed
R 40/21/22 Harmful: possible risks of permanent damage when in contact with skin and case of ingestion
R 40/20/21/22 Harmful: potential hazards of permanent damage when inhaled, in contact with skin and in case of ingestion
R 42/43 May cause sensitization when inhaled and in contact with skin
R 48/20 Harmful: risk of serious damage to health after prolonged exposure by inhalation
R 48/21 Harmful: risk of serious damage to health after prolonged exposure by contact In the skin
R 48/22 Harmful: risk of serious damage to health after prolonged exposure through swallowing
R 48/20/21 Harmful: risk of serious damage to health after prolonged exposure by inhalation and contact with the skin
R 48/20/22 Harmful: risk of serious damage to health after prolonged exposure by inhalation and swallowing
R 48/21/22 Harmful: risk of serious damage to health after prolonged exposure by contact On the skin and swallowing

R 48/20/21/22 Harmful: risk of serious damage to health after prolonged exposure through inhalation, skin contact and ingestion
R 48/23 Toxic: risk of serious damage to health after prolonged exposure by inhalation
R 48/24 Toxic: risk of serious damage to health after prolonged exposure through contact with the skin
R 48/25 Toxic: risk of serious damage to health after prolonged exposure by ingestion
R 48/23/24 Toxic: risk of serious damage to health after prolonged exposure by inhalation and contact with the skin
R 48/24/25 Toxic: risk of serious damage due to prolonged exposure through contact with skin and ingestion
R 48/23/24/25 Toxic: risk of serious damage to health after prolonged exposure by inhalation, skin contact and ingestion
R 50/53 Very toxic to aquatic organisms, may cause long-term adverse effects on the aquatic environment
R 51/53 Toxic to aquatic organisms, may cause long-term adverse effects on the aquatic environment
R 52/53 Harmful to aquatic organisms, may cause long-term adverse effects on the aquatic environment
R 68/20 Harmful: potential risk of permanent damage by inhalation
R 68/21 Harmful: potential risk of permanent damage when in contact with skin
R 68/22 Harmful: potential risk of permanent damage if swallowed
R 68/20/21 Harmful: potential hazard for permanent damage when inhaled and in contact with skin
R 68/20/22 Harmful: possible danger of personal injury by inhalation and if swallowed
R 68/21/22 Harmful: potential risk of permanent damage when in contact with skin and case of ingestion
R 68/20/21/22 Harmful: potential risk of permanent damage by inhalation, when in contact with skin and if swallowed

4. Safety instructions for hazardous chemicals

S-phrases

S1 Keep locked up
S2 Away from children
S3 Store in a cool place
S4 Away from residential area
S5 Keep the contents in. (*the type of suitable liquid is determined by producer)*
S6 To be stored in an atmosphere. (*the type of inert gas is determined by the manufacturer)*
S7 Keep container tightly closed
S8 Protect the container from moisture
S9 Keep container in a well-ventilated place
S12 Do **not** keep the container tightly closed
S13 Away from food, drink and animal feed
S14 Away from. (*incompatible substances specified by the manufacturer)*
S15 Keep away from heat
S16 Keep away from sources of ignition - No smoking
S17 Away from combustible materials
S18 Be careful when opening and operating the container
S20 Do not eat or drink while using
S21 Do not smoke when using
S22 Do not breathe dust
S23 Do not inhale gases / fumes / fumes / spray (*appropriate wording determined by the producer)*
S24 Avoid contact with skin
S25 Avoid contact with eyes
S26 In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
S27 Remove any contaminated clothing immediately
S28 If it gets on the skin, wash immediately with plenty of. (*the appropriate liquid determined by the producer)*
S29 Do not end up in the sewer
S30 Never add water to this product
S33 Take protective measures against electrostatic discharges

S35 The material and the container containing it must be disposed of safely
S36 Appropriate protective clothing required
S37 Suitable gloves required
S38 In case of insufficient ventilation, use suitable ventilator
S39 Eye / face protection required
S40 To clean the floor and all objects contaminated with the material to used. (*item specified by the manufacturer)*
S41 In the event of fire and / or explosion, do not inhale fumes
S42 Use suitable respirator during fumigation / spraying
device (appropriate wording to be specified by the manufacturer)
S43 In case of fire to be used. (indicate the appropriate means of extinguishing If the water increases the risk, adds: "Never use water")
S45 In the event of an accident or illness, seek medical advice immediately (show this label if possible)
S46 In case of ingestion, seek medical advice immediately and show this container or his label
S47 Keep at a temperature not exceeding. o C (specified *by the manufacturer)*
S48 Maintain liquid **De.** (appropriate *fluid is specified by the manufacturer)*
S49 Keep only in the original container
S50 Not to be promoted by. (specified *by the manufacturer)*
S51 Use only in a well-ventilated area
S52 Not recommended for use on large indoor surfaces
S53 Avoid exposure - Obtain special instructions before use
S56 Store this material and the container containing it in a hazardous collection area or special waste
S57 Use suitable container to avoid contamination of the environment
S59 Request information from the manufacturer / supplier for recovery / recycling
S60 The material and the container containing it should be considered as hazardous waste
S61 Avoid releasing it into the environment. Refer to specific instructions / data sheet safety
S62 In case of ingestion Do not induce vomiting: seek medical advice immediately and seek medical advice. show this container or its label
S63 In case of accident due to inhalation: The patient should be transported to a place with fresh air and allowed to cool

S64 In case of ingestion, rinse mouth with plenty of water (unless the patient retains his senses)

S-phrase combinations

S 1/2 Keep locked away from children
S 3/7 Keep container tightly closed and in a cool place
S 3/9/14 Keep in a cool and well-ventilated place away from. (impermeable *materials that indicated by the manufacturer)*
S 3/9/14/49
Keep only in the original container in a cool and well-ventilated place away from. (incompatible *materials indicated by the manufacturer)*
S 3/9/49 Keep only in the original container in a cool place
S 3/14 Store in a cool place away from. (impermeable *materials indicated by producer)*
S 7/8 Keep container tightly closed and protected from moisture
S 7/9 Keep the container closed and in a well-ventilated place
S 7/47 Keep container tightly closed at a temperature not exceeding. o C (to determine by the producer)
S 20/21 When you use it Do not eat, do not drink, do not smoke
S 27/28 In case of skin contact, immediately remove all contaminated clothing and wash. immediately abundant. (the *type of liquid is determined by the producer)*.
S 24/25 Avoid contact with skin and eyes
S 29/35 Do not dispose of the contents in the drain. This material and the container must reject in a safe way
S 29/56 Do not dispose of the contents in the drain. This material and its container to deposited in a specialized hazardous or special waste collection site
S 36/37 Appropriate protective clothing and gloves required
S 36/37/39 Appropriate protective clothing, gloves and eye / face protection required
S 36/39 Appropriate protective clothing and eye / face protection required
S 37/39 Suitable gloves and eye / face protection are required
S 47/49 Store only in the original container at a temperature not exceeding. o C (specified by the producer)

5. List of chemicals whose use is prohibited or strictly prohibited controlled in the countries of the European Union, due to the problems that cause to health or the environment. (Prohibition is only for industrial or agricultural use, not for research purposes)

List of chemicals banned or severely restricted to certain uses owing to their effects on health and the environment in the countries of EU

Chemical	CAS number	Use category	Use limitation
Mercuric oxide	21908-53-2	P	SR
Mercurous chloride	10112-91-1	P	SR
Other inorganic Hg compds		P	B
Alkyl mercury compds		P	SR
Alkoxyalkyl and aryl mercury compds		P	B
Aldrin	309-00-2	P	SR
Chlordane	57-74-9	P	B
Dieldrin	60-57-1	P	B
DDT	50-29-3	P	B
Endrin	72-20-8	P	SR
HCH (<99% γ isomer)	608-73-1	P	B
Heptachlor	74-44-8	P	B
Hexachlorobenzene	118-74-1	P	B
Camphechlor (toxaphene)	8001-35-2	P	B
Polychlorinated biphenyls (PCBS), except			
Mono- and dichlorinated biphenyls	1336-36-3	I	B
Polychlorinated terphenyls (PCT)	61788-33-8	I	B
Preparations with a PCB or PCT > 0.01% by weight		I	B
Tris(2,3-dibromopropyl)phosphate	126-72-7	I	SR
Tris-aziridinyl-phosphioxide	545-55-1	I	SR
Polybrominated biphenyls (PBB)		I	SR
Crocidolite	12001-28-4	I	SR
Nitrofen	1836-75-5	P	B
1,2-Dibromoethane	106-93-4	P	B
1,2-Dichloroethane	107-06-2	P	B
Amosite	12172-73-5		B
Anthophyllite asbestos	77536-67-5		B
Actinolite asbestos	77536-66-4		B
Tremolite asbestos	77536-68-6		B

Cadmium and its compds	7440-43-9	R
2-Naphtylamine and its salts	91-59-8	B
4-Aminophenyl and its salts	92-67-1	B
Benzidine and its salts	92-87-5	B
4-Nitrophenyl	92-93-3	B

LEGEND

Use category:

P plant-protection product (chemical for plant protection-insecticides etc)

I industrial chemical (biochemical chemical)

Use limitation:

SR severe restriction (strictly controlled use)

B ban (forbidden)

R restrictions (controlled use)

6. Flash point for certain organic solvents

Organic solvent	**A**
Pentane and petroleum ether (petroleum ether or petroleum spirit) 40-60^{o}	-49
Diethyl ether	-45
Carbon disulphide	-30
Hexane and petroleum ether 60-80^{o}	-23
Cyclohexane	-20
Acetone	-18
Tetrahydrofuran (THF)	-17
Benzene	-11
Ethyl acetate	-4
Toluene	4
1,2-Diethoxyethane	4.5
Acrylonitrile	6
Methanol	10
1,4-Dioxane	12
Ethanol	12

7. Tables of toxic compounds

A. Compounds with direct toxic effect

A.1 Solids

Chemical compound	**TLV (mg/m^3)**
Osmium tetraoxide	0.002
Mercury compounds (organometallic)	0.01
Salts of thallium	0.1
Selenium and its compounds	0.2
Arsenic compounds	0.5
Vanadium pentoxide	0.5
Oxalic acid and its salts (oxalic acid)	1
Inorganic cyanides	5

A.2 Gases

Chemical compound	**TLV (mg/m^3)**
Fluorine	0.1
Ozone	0.1
Diazomethane	0.2
Phosgene	0.3
Boron trifluoride	1
Chlorine	1
Hydrogen fluoride	3
Nitrogen dioxide	5
Hydrogen cyanide	10
Hydrogen sulfide	10
Cyanogen	10
Carbon monoxide	50

A.3 Liquids

Chemical compound	**TLV (mg/m^3)**
Acetyl chloride	-
Alkyl - and arylonitriles	-
3-Chloropropionate chloride	-

Ketene	-
Fluoroboric acid	-
Oxalyl chloride	-
Pentachloroethane	-
Chlorotrimethylsilane	-
Nickel tetracarbonyl	0.001
Ethyl isocyanate	0.02
Acroleine	0.1
Bromine	0.1
Allyl chloride	1
Benzene	1
Boron tribromide and trichloride	1
2-chloroethanol	1
Diethyl and diethyl sulfate	1
Tetrabromoethane	2
Allyl alcohol	2
Crotonaldehyde	2
Hydrofluoric acid	3
Tetrachloroethane	5
Benzyl chloride and bromide	10
Coal	20

- = < 0.001

B. Compounds with chronic toxicity

The following compounds or groups of compounds exhibit toxic effects upon inhalation of their vapours or dust, absorption by the skin, while some are also corrosive.

B.1 Alkyl halides

Chemical compound	**TLV (mg/m^3)**
Bromoform	0.5
Iodomethane	5
Carbon tetrachloride	10
Chloroform	10

1,2-Dibromoethane	20
1,2-dichloroethane	50
Bromoethane	200
Methylene chloride	200

B.2 Aromatic and aliphatic amines

All aromatic amines should be treated as potentially toxic compounds. Many amines are known carcinogens.

Chemical compound	**TLV (mg/m^3)**
Chloroanilines	-
Chloronitroanilines	-
N,N-Diethylaniline	-
N-Ethylaniline	-
p-Nitroaniline	1 ppm
N-Ethylaniline	2 ppm
N,N-Diethylaniline	5 ppm
Aniline	5 ppm
o-Toluidine	5 ppm
Xylidines	5 ppm
p-Phenylenediamine and isomers	0.1 mg
Anisidines	0.5 mg

- = < 0.001

B.3 Phenols and aromatic nitro compounds

They release dangerous byproducts and are easily absorbed by the skin, while phenols are also corrosive.

Chemical compound	**TLV (mg/m^3)**
Catechol and resorcinol	-
Chloro- and dichloro-phenols	-
Nitrophenols	-
Dichloronitrobenzenes	-
Nitrobenzene	1 ppm
p-Nitrotoluene	5 ppm
Phenol	5 ppm

Cresols	5 ppm
Picric acid (it is also explosive)	0.1 mg
Dinitrophenols	0.2 mg
m-Dinitrotoluene and isomers	1 mg
p-Chloronitrobenzene	1 mg
2,4-Dinitrotoluene and analogues	1.5 mg

- = < 0.001

8. Carcinogenic Substances

A'1

Asbestos (dust)

4-Amino diphenyl

Arsenic acid and salts

Aflatoxins

Benzidine and salts

Benzene

Bis(chloromethyl)ether

Coal tar

2-Naphthylamine

Arsenic pentoxide

Arsenic trioxide

Chlorodimethylether

Zinc chromate

A'2

Aziridine

Acrylonitrile

Beryllium and its compounds

Diazomethane

Diethyl sulfate

1,2-Dibromoethane

1,2-Dibromo-3-chloropropane

Dimethyl sulfate

N,N-Diethylnitrodadine

1,1-Dimethylhydrazine

(4-Amino-3-chlorophenyl)ethane

3,3'-Dichlorobenzidine

Epichlorohydrine

Phosphoric acid hexamethyltriamide (HMPA)

Methyl iodide

5-Nitroacenaphthene

2-Nitronaphthalene

2-Nitropropane

β-Propiolactone

Propylenimine (Azetidine)

Nickel tetracarbonyl

Hydrazine

Calcium chromate

Chromium strontium

B

Acetamide

Allyl chloride

Benzyl chloride

(4-Aminophenyl)methane

o-Dianisidine (4,4'-diamino-3,3'-diethoxybiphenyl)

1,2-Dimethylhydrazine

1,4-Dioxane

1,1-Dichloroethane

1,2-Dichloroethane

(2-chloroethyl) ether

Cadmium and its compounds

2,4-Xylidine

p-Xylene

Antimonium trioxide

Chromium trioxide

o-Toluidine

o-Toluidine (4,4'-diamino-3,3'-diethyl-biphenyl)

1,1,2-Trichloroethane

Trichloroethylene

Phenyl dichloroethane

N-Phenyl-2-naphthylamine

Phenyltrichloroethane

Chlorinated biphenyls

Chloroform

Alkali metal chromates

9. Waste Collection

Waste Collection Container	Symbol	Hazard Description	Chemical Category: Waste
O: Organic solvents in chlorinated	FT	Very flammable and toxic	NOT chlorinated Organic solvents
H: Organic chlorinated solvents	T	Very flammable and toxic	Organic Chlorinated solvents
A: Solutions pH 6-8	Depending on solutions used		Neutral Solutions Inorganic residues (EXCEPT mercury)
Q: Residues mercury	T+	Very toxic	Inorganic residues mercury (Hg)
M: Metallic residues that can be recovered	Depending on reagents used		Metal Remnants M (to determine the metal M)
S: Inorganic solids	Depending on materials used		Inorganic salts materials

References

This text was based on the old safety rules of the Department of Chemistry, as well as content from the following books:

1. *Safety measures and rules of conduct in chemistry laboratories*, Liana Iatridou, Thanasis Koutsolelos, Heraklion Crete 1993.

2. *Microscale Inorganic Chemistry. Comprehensive Laboratory Experience*, Zvi Szafran, Ronald M. Pike, Mono M. Singh, John Wiley & Sons, inc, 1996.

3. a) http://ull.chemistry.uakron.edu/erd;

   b) http://msds.pdc.cornell.edu/msdssrch.asp;

   c) http://www.ci.phoenix.az.us/MSDS/msdsweb.htm;

   d) http://www.msdsonline.com/ contains data on many toxic compounds.

4. *Synthesis and Techniques in Inorganic Chemistry, A Laboratory Manual*, Gregory S. Girolami, Thomas B. Rauchfuss, Robert J. Angelici, University Science Books, Third Edition, 1999.

5. VOGEL'S Textbook of Practical Organic Chemistry, Longman Scientific and Technical, Fifth Edition, 1989.

Department of Chemistry

University of Cyprus

Responsible Statement

I..... hereby declare that I have read and fully understand the Health & Safety Rules of the Department of Chemistry, at the University of Cyprus and that I will strictly adhere to them. If an accident occurs due to non-compliance with these Health & Safety Rules, I will bare full sole responsible for any personal injury caused by this accident including but not limited to parties that were close to the accident.

Date: Signature: