CheSSE
Chemical Safety in Science Education

# Chemical storage and hazardous waste management

Module 3

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Stockholm University

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# Chemical storage

- Ventilated and secure room with specialised organisation of chemicals to ensure safe storage and management of substances

Overall, routines are set for safe storage, inspecting storage and monitoring the inventory

- Chemical inventory: lists chemicals in which room, cabinet, and shelf they can be found. SDSs and GHS pictograms and proper labelling. A cool, windowless environment with continuous room ventilation is recommended.
- Cabinets: made of metal or wood, depending on the substances' properties with mechanical ventilation with separate outlets.
- Organisation: preventative measures to reduce hazardous chemical reactions, contamination, or danger to users i.e., vapours. In addition, contingencies are put in place to reduce repeated exposure and danger in case of fire or explosion.

# Storage guidelines

- Very toxic substances should be contained from substances that contribute to the intensity of fires and explosives.
- Group 1 and 2 metals are very reactive with water and acidic solutions, and should thus be stored separately from oxidisers and aqueous solutions.
- Household chemicals and foods should be stored in their own cabinet away from other chemicals.
- Gases and aerosols should be in their own cabinet with written warning sign “Gas under pressure”.

# Storage guidelines

| | OXIDIZING  | FLAMMABLE  | CORROSIVE: ACID  | CORROSIVE: BASE  | HEALTH HAZARD / TOXIC  |
|---|---|---|---|---|---|
| OXIDIZING  | Compatible | Not compatible | Store according to SDS Section 7 and 10 | Store according to SDS Section 7 and 10 | Store according to SDS Section 7 and 10 |
| FLAMMABLE  | Not compatible | Compatible | Not compatible | Not compatible | Store according to SDS Section 7 and 10 |
| CORROSIVE: ACID  | Store according to SDS Section 7 and 10 | Not compatible | Compatible | Not compatible | Not compatible |
| CORROSIVE: BASE  | Store according to SDS Section 7 and 10 | Not compatible | Not compatible | Compatible | Store according to SDS Section 7 and 10 |
| HEALTH HAZARD / TOXIC  | Store according to SDS Section 7 and 10 | Store according to SDS Section 7 and 10 | Not compatible | Store according to SDS Section 7 and 10 | Compatible |

# Overview: storage

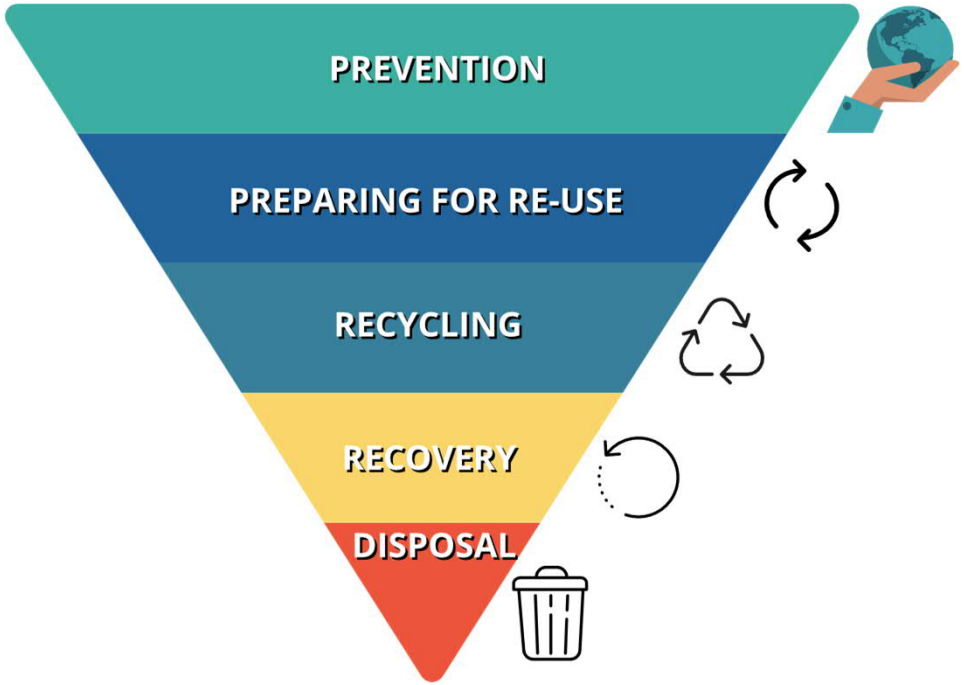
- There’s many ways to arrange the chemicals but clear suggestions can be drawn:

Suggestion of cabinets to store chemicals in a school.

| CABINET | STORAGE REQUIREMENT(S) | HAZARD PICTOGRAM |
|---|---|---|
| **Cabinet 1:**<br>▪ OXIDISING AGENTS | Separated from flammable substances.<br>Metal cabinet. |  |
| **Cabinet 2:**<br>▪ FLAMMABLES – including organic solvents<br>▪ WATER REACTIVE SUBSTANCES | Ventilated metal cabinet.<br>Notes: Flammable chemicals can catch fire spontaneously. Water reactive substances can react violently in contact with water. |  |
| **Cabinet 3:**<br>▪ ACIDS – both organic and inorganic | Ventilated cabinet.<br>Store containers below eye level.<br>Advice: Concentrated acids should be stored in secondary containers. |  |
| **Cabinet 4:**<br>▪ BASES – both organic and inorganic | Ventilated cabinet.<br>Store containers below eye level.<br>Advice: Concentrated bases should be stored in secondary containers. |  |
| **Cabinet 5:**<br>▪ TOXIC – acute toxicity, carcinogenic, mutagenic and toxic for reproduction (CMR). Aquatic acute. | Cabinet, ventilated if containing volatile substances. |  |
| **Cabinet 6:**<br>▪ GASES – propane/butane burners (flammable) and hydrogen | Ventilated, fire-proof cabinet.<br>Do not store near flammable chemicals.<br>The cabinet has to be marked with a yellow “gas under pressure” sign. |  |

# Waste guidelines

- Hierarchy of waste management.
  - Optimize the process to reduce or avoid waste and hazards (more about Green Chemistry).
  - Replace hazardous substances with less hazardous substances (more about Substitution).
  - Make the waste less hazardous by e.g. neutralization, dilution, evaporation, oxidation, decomposition, precipitation or filtration.
  - Hazardous waste that cannot be treated and made harmless in the laboratory, must be collected and disposed according to applicable regulations for sorting and handling hazardous waste.
  - Label and store your waste properly before disposal or recycling.



# Hazardous waste: what do I need to know? (1/6)

- What type of waste can be poured down the drain?
  - Which metal ions can be poured down the drain?
- What type of waste must be collected separately for the waste handling plant?
- In which waste container should you pour the waste you have?
  - Is your waste a heavy metal solution, a hydrocarbon solvent, a solid substance…?

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# Hazardous waste (2/6)

Laboratory work often creates different kinds of chemical waste.

- Most of the chemical waste is classified as hazardous, i.e., waste that may pose a particular risk or cause damage to human health or the environment due to its chemical or other properties.
- The most common types of hazardous waste include solvents, oils, concentrated acids and bases, toxic substances, expired reagents, and laboratory material contaminated by harmful substances.
- The waste producer or their unit has the responsibility for the right handling of waste!

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# Hazardous waste (3/6)

The discharge of hazardous waste into drains is forbidden!

- The harmful substances in hazardous waste may corrode plumbing and interfere with the operations of wastewater treatment plants and the utilisation of wastewater sludge.
  - Wastewater treatment plants have specific limits for different metal concentrations and pH values of wastewater (e.g., pH 6-11 in Helsinki), as well as for other substances that hinder the operations of the plants.
    - The dilution of wastewater so as not to exceed these limits is forbidden!
  - In general, substances that are insoluble in water cannot be discharged into drains.

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# Hazardous waste (4/6)

- Neutralized acids and bases, as well as some water-soluble solvents, can be discharged into drains on a laboratory scale.
- Only moderate amounts of the following elements as compounds can be discharged into drains: Na, K, Mg, Ca, Sr, Fe, Al
  - Very small amounts of Mn, Zn and Cu.
- Flammable solvents that are insoluble in water and degrade slowly in the environment, as well as chlorinated VOC compounds, cannot be discharged into drains (VOC = volatile organic compound).

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# Hazardous waste (5/6)

- For schools and educational facilities, follow waste guidance from national education and environmental authorities. Only small amounts, diluted and neutralised substances should be considered for this action.
  - Finland: Tukes + local municipalities issue school laboratory waste guidance.
  - Sweden: Kemikalieinspektionen, Skolverket & Avfall Sverige provide clear rules for school chemical waste.
  - Denmark: Miljøstyrelsen (EPA) gives school-specific rules for hazardous waste.
  - Norway: UDIR & Miljødirektoratet give guidance for school lab waste disposal.
  - Slovenia: ARSO, ZRSŠ and municipal wastewater utilities provide guidance

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# Hazardous waste (6/6)

- Priority should be regeneration and reuse as the most recommended handling method for chemical waste, making its use cyclical.
  - Selective life-cycle analysis can be used during the design of lab work to identify opportunities for reducing waste and environmental impact. Relevant findings can then be incorporated into the risk assessment for the specific activity.
- The second possibility is making a reaction with the waste in such a way that it becomes non-hazardous.
  - More stabilized products
  - Precipitating dangerous aqueous species.
- The most general way is delivering the waste to a hazardous waste treatment plant by specialised workers in hazardous waste disposal.
  - The handling of waste is performed with the expense of the producer of the waste and has been priced according to the cleanness of the waste.

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# Waste collection and storage

- The following chemicals must be collected separately: acids, bases, flammable substances, oxidising substances, and toxic substances.
- The idea is to stabilise containment by reducing chemical reactions. i.e., Highly reactive waste, such as peroxides, ethers, picric acid, metallic sodium and potassium, potassium carbide, and cyanides are collected separately from each other and from other waste.
- Moreover, the separate sorting of waste containing mercury, bromine and iodine is required.
- In addition, solid and liquid waste, or organic and inorganic waste, should not be mixed.

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# Hazardous waste: containers

- Put the chemical waste in the plastic containers which are suitable for them.
  - Notice that plastic is not good for ethers and chlorinated hydrocarbons!
  - Iodide will also be incompatible with plastics, and some substances should be stored in glass bottles.
- Keep expired chemicals in their original plastic containers because they contain the correct product description and safety information.
- Leave at least 10 % of space empty in all the waste contain
  - The waste might expand/produce gas during long storage

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# Hazardous waste: containers

- Clearly state waste to others. Write with capitalization “WASTE” and follow labelling guidelines below.
- Wear protection, make use of secondary containers and seperation of harmful substances from others, i.e. inorganic waste from organic, and solids from liquids and acquous mixtures.


An example of storage container for liquid waste.

# WASTE STORAGE DECISION TREE


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# Labelling

- Follow labelling according to your supplier's regulations while ensuring local regulation compliance as well.
- However, any solutions that are made locally or by yourself require labelling, such as mixtures and dilutions.

Key information:

  - Name of substances; identifiers such as CAS number
  - Chemical formulae and concentration
  - Hazard pictograms with statements including precautionary statements
  - Information on who made the solution and when

**Aluminium sulphate**
**0,5 % $Al_2(SO_4)_3$**

CAS number 10043-01-3

Warning

May be corrosive to metals.

Date: 19/02/2026

Made by: Tester

# Hazardous waste: destroying the waste

Most of the hazardous waste is combusted at high temperatures

- The waste plant must know whether or not the waste contains flammable solvents.
- Br, Hg, and I could end up in the environment in elemental form: need to be separated from other waste.
- Halogenated hydrocarbons are not easily combustible and must be separated from other hydrocarbons and organic liquids.

# Hazardous waste transport

- Teachers should oversee the preparation of dangerous goods and chemical waste for transport to ensure that all required instructions are followed.
- This oversight is important, as external handlers or transporters may not always be aware of the specific requirements associated with school laboratory materials.
- Usually, it’s beneficial to use the same supplier after competetive tendering.
- More information about the transport of goods in the next module.

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# Test your knowledge (1/3)

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# Test your knowledge (2/3)

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# Test your knowledge (3/3)

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# Congratulations on completing module 3

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