CheSSE
Chemical Safety in Science Education

Safety in lab work

Module 5

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Stockholm University

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Safe working in the laboratory

- In general, the most common laboratory accidents are the same as at home and in “normal” jobs i.e. slips and trips, and wounds from broken glassware.
- More unique hazards in the laboratory: hazardous substances to human health, explosions, fire, radiation, electrical apparatuses, and broken glassware.
- Accidents
  - Mistakes by the workers can be avoided with good practices.
  - Parallel and consecutive precautions are methods to ensure safety.
  - For example, using sds’ to study the chemicals and methods in use before working, taking the precautions based on precaution and hazard statement(s)

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Short checklist before lab work

In this module, we provide more information on these principles.

- Use other personal protection equipment if needed.
- Be aware of the hazards.
- Use safe working methods.
- Check the location of the First aid (e.g., medical cabinet, shower) and fire extinguishing equipment and emergency exits.
- Check the container labels, hazard pictograms, hazard and precautionary statements and safety data sheets of the chemicals you use.
- Do not exceed the maximum number of students and personnel in the laboratory.

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Safety tips

- Concentrate on the task at hand!
  - Always wear a laboratory coat and safety goggles, and other protective equipment when necessary.
  - If the laboratory work is dangerous, perform it in a suitable area for that work.
    - Fume hood, glovebox, special lab spaces etc.
- Take care also of the safety of colleagues and visitors, and tell them about special dangers.
- The principal rule is DO NOT work alone in the laboratory!

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Safe working in the laboratory: storing and transporting chemicals (1/5)

- Chemicals must be retained so that outsiders cannot use them, and they must be transported in a safe way (a basket, a bucket, a transport cart).
- Chemical containers must be tightly closed and duly marked.
- Chemicals must not be returned into original containers!
  - When weighing chemicals, any excess should be given to someone else to use, or stored in a separate container
- In the transport and storage of chemicals, make sure that the chemicals that react dangerously among themselves do not mix, even if the vessels break down. Oversee these procedures when using third parties for waste management and transportation of goods.

Safe working in the laboratory: storing and transporting chemicals (2/5)

- Never transport liquid nitrogen (N_2) in any quantity, as well as dry ice (> 5 kg), in the lift when accompanied by people.
  - Evaporation of 1 liter of liquid N_2 produces 700 liters (0.7 m^3) of gas. 1 kg of dry ice produces 500 liters (0.5 m^3) of CO_2 gas.
  - Gaseous nitrogen and CO_2 are heavier than air and displace oxygen from enclosed spaces.
  - Liquid N_2 and dry ice can also cause severe frostbite.
- Do not step in the lift if there is a dewar inside traveling alone!

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Safe working in the laboratory: storing and transporting chemicals (3/5)

- Keep acids, bases and solvents separately.
- Keep cyanides separate from acids!
  - Acids react with cyanide to form hydrogen cyanide gas, HCN, which is extremely toxic in small doses!
- Store strong perchloric acid in a glass bottle on a glass or porcelain plate in which there is room for all the acid.
- Keep materials that react with water in a place that has been protected from moisture also if water damage happens.

Safe working in the laboratory: storing and transporting chemicals (4/5)

- Keep alkali metals under petrol.
- Keep materials that decompose at room temperature in the refrigerator. Remember to use GHS pictograms on the door.
- Keep chemicals that decompose in light in dark vessels and/or store in the dark.
- Keep materials that form peroxides in dark bottles in the refrigerator (and check peroxide concentration before use).
- Pay attention to flammable materials.

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Safe working in the laboratory: storing and transporting chemicals (5/5)

- Keep acids, bases and solvents separately.
- Keep cyanides separate from acids!
  - Acids react with cyanide to form hydrogen cyanide gas, HCN, which is extremely toxic in small doses!
- Store strong perchloric acid in a glass bottle on a glass or porcelain plate in which there is room for all the acid.
- Keep materials that react with water in a place that has been protected from moisture also if water damage happens.

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Safe working in the laboratory: handling of chemicals (1/4)

- Respect chemicals!
- Do not waste chemicals.
  - Cost and environmental issue
  - Reuse if possible
- Handle chemicals in such a way that they will not cause an explosion, fire or health hazard.
- Unknown chemicals are always dangerous. Keep up the practice of labelling samples and products immediately when they're put in vials or containers.
- Process all chemicals so that nobody will be exposed to them. Do not leave hazardous waste or chemicals unsupervised.

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Safe working in the laboratory: handling of chemicals (2/4)

- Chemicals must not get into the mouth in any situation.
- Do not taste chemicals.
- Do not use your mouth as a tool.
- Do not drink, eat or smoke in the laboratory. Contamination will follow from dust.
- Do not store food or drink in the laboratory.
- Do not wear a laboratory coat outside the laboratory.
- Wash your hand when you leave the laboratory.

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Safe working in the laboratory: handling of chemicals (3/4)

- Avoid spreading chemicals into laboratory air.
- Volatile, vaporizing, and dust-forming chemicals are handled in the fume hood.
- Most heating should be done in the fume hood because of added safety and the sensitivity of smoke alarms.
- Glassware is cleaned so that the chemicals in it will not vaporise.
- Do not smell chemicals.
- Do not put your head inside the fume hood.

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Safe working in the laboratory: handling of chemicals (4/4)

- Avoid getting chemicals onto the skin.
- Wear long trousers, supporting shoes, a laboratory coat (button the coat), and safety goggles.
- Do not expose your hands to chemicals.
  - Use gloves
  - Do not use gloves when handling gas burners.
- Do not handle chemicals near the body or above the height of the eyes.
- The working stages where a chemical can splash are done in the fume hood.
- If a chemical ends up on your skin, wash it immediately with water and soap.

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Safe working in the laboratory: fire safety

- Do not keep flammable materials near ignition sources.
- Do not handle organic solvents in the fume hood if there are sources of heat present.
- Keep long hair bound.

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Safe working in the laboratory: reaction safety (1/3)

- You must know the nature of the chemical reactions you are working with.
- You must know the consequences when you combine chemicals.
- First, add the solvent into a vessel and then the other chemicals after that.
- When you dilute a strong acid, add the acid to water!
  - Dilution releases a lot of heat, which can result in a splash if done the other way around
- Use only a proper amount of chemicals and add them in a controlled way in small doses.
- Stir the mixture of chemicals, control the temperature, and keep an eye on the reaction vessel.

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Safe working in the laboratory: reaction safety (2/3)

- In the organic chemistry lab reaction mixtures are heated either in a water bath or an oil bath
  - Water bath when the reaction mixture boils below < 85 °C
- Do not heat an oil bath above 200 °C, for higher temperatures, utilize electric heaters, or use a vacuumed environment.
- Oil bath always needs to have a thermometer so that you can keep an eye on the oil temperature
- Never heat a fully closed system, it's essentially A BOMB!

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Safe working in the laboratory: reaction safety (3/3)

- If you need to build an apparatus out of glassware, always attach the glassware to stands using clamps

Clamp

Stand

- Avoid tensions when connecting glassware
  - Do not use excessive force

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Safe working in the laboratory: order, cleanliness and glassware

Cleaning laboratory glassware of inorganic substances:

1. Rinse with tap water.
2. Wash with detergent, brush and warm water if needed.
3. Finally, rinse with deionized water if available.
   - Clean the sintered glass filter glassware according to the solubility of substances.

Cleaning laboratory glassware of inorganic substances:

1. Use acetone to dissolve fat-soluble substances into a hydrocarbon solvent waste container.
   - In schools, nail polish remover liquid and ethanol can be used to some extent. Remember to pour ethanol into its own container.
2. Wash with detergent, brush, and warm water if needed.
3. Finally, rinse with a small amount of acetone.
4. Pour the acetone into the waste canister and leave the glassware to dry in the washing fume hood

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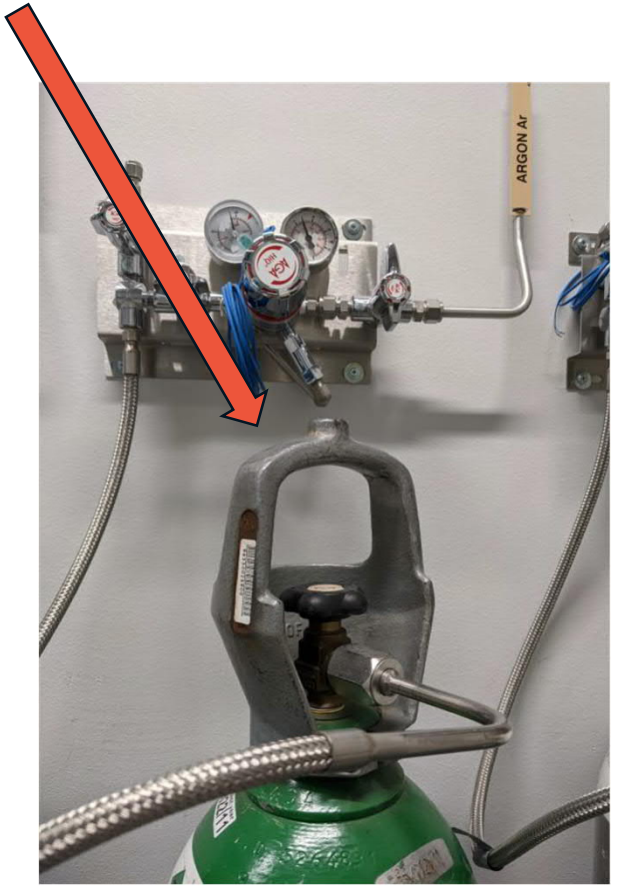
Safe working in the laboratory: gas bottles

- Do not lift a gas cylinder from its cap.
  - Use a trolley to move gas cylinders.
- Store cylinders vertically and securely to prevent them from falling over, for example, with an iron chain and a lock in place.
- Do not open the valve without a pressure regulator, and close it when the cylinder is not in use.
- Leave at least 2 bar of pressure inside the gas cylinder.
- Protect gas cylinders from any external heat sources, such as ovens or the sun.

Don’t lift from this cylinder cap!



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Safe working in the laboratory: electrical apparatus

- Electrical apparatus must not be handled with wet hands and water must not be sprayed over them.
- Make sure that electrical wires are not in contact with hot surfaces or organic solvents.
- When you loosen the plug from the wall socket, take hold of the plug and not the wire.
- Cables must be drawn so that nobody can trip over them.
- Current must be switched off before exchanging a lamp or a fuse.

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Safe working in the laboratory: personal protection (1/3)

- The safety of the laboratory work is not primarily based on the personal protective equipment!
  - The laboratory coat and safety goggles must always be kept on, but they do not guarantee safety.
- Other personal protective equipment must be used according to the risk estimate.

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Safe working in the laboratory: personal protection (2/3)

- Normal glasses do not replace safety goggles. There are safety goggle models that can be worn over normal glasses. Furthermore, it is also possible to have the safety goggles made with one's own prescription.
- Contact lenses must not be used during laboratory work because chemical vapors tend to concentrate under the contact lenses.
  - Furthermore, the contact lenses make the rinsing of chemicals more difficult from the eyes and in this way can make possible eye lesions worse!

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Safe working in the laboratory: personal protection (3/3)

- The properties of the chemicals determine which type of protective gloves are worn.
  - Also, the way of handling chemicals determines if gloves are needed.
  - However, always wear protective gloves in the laboratory courses of organic chemistry.
- The resistance of the protective gloves to the chemicals increases in the following order: vinyl < nitrile < butyl < neoprene < laminated.
- Laboratory air and wearing gloves can dry your skin. It is good to use hand cream after you have washed your hands.

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Short checklist before going to the laboratory

- Wear long trousers and supportive shoes (not sandals) and a laboratory coat (button the coat).
- Always use safety goggles.
- Use gloves, especially during the organic chemistry laboratory work.
- Do not use contact lenses.
- Be mindful of rings (especially with gemstones) and long nails because they can tear the gloves.
- Keep long hair bound and long necklaces under the shirt.
- Good general rule: Do not wear your most expensive/best clothes in the lab.

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Congratulations on completing module 5

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