

## Chapter 1 Safety Tips in Chemistry Experiments and Practical Exercises

### 1. Basics of experiments using chemical substances

Experiments using chemical substances (chemistry experiments) are conducted not only by chemistry-related faculties and divisions but also in education and research in various areas and fields of natural and life sciences. In chemistry experiments, various types of chemical substances or experiment devices, etc. are handled. Most of them are hazardous and toxic in one way or another. Individuals who handle chemical substances must be responsible for the entire process, including acquisition, storage, use, and disposal. Remember that safety can only be achieved by awareness and care of each individual. The hard-and-fast rule is “ensure safety by yourself.”

The first goal is to understand the basic information about chemistry experiments and chemical substances and acquire the ability to handle even hazardous substances safely.

### 2. Safety tips in chemistry experiments and practical exercises

Experiments and practical exercises start from the preparation phase. Careful preparation leads to safe and successful experiments.

#### (1) Understand the environment of your laboratory

Before conducting an experiment, check the table layout, the position of the draft chamber, emergency exit, and fire extinguisher. If an emergency shower, eye washer, etc. are available, check how to use them. Also monitor the position of other experimenters. Understanding the environment of your experiment helps avoid the impact on other experimenters and ensure safety of yourself and other individuals.

#### (2) Do not eat or drink in a laboratory

In a laboratory where chemical substances, etc. are handled, invisible chemical substances, etc. waft around. Eating and drinking in this environment result in ingestion of chemical substances, etc. with the food and beverages. Oral exposure adversely affects the human body. Do not eat or drink in a laboratory. This also applies to pharmaceuticals and gums. In areas where chemical substances are handled, the following sign is displayed. Make sure to follow the rule.



Fig. 1-1 Sign to prohibit smoking, eating, and drinking

After handling chemical substances, make sure to wash hands and gargle. Avoid chemical burns and oral exposure to chemical substances.

#### (3) Clothes and use of protective equipment

Minimize skin exposure during a chemistry experiment. Chemical substances are absorbed by the human body through oral, percutaneous, and respiratory exposure. Because chemical substances evaporate and scatter, vapors can enter the body without your knowledge. Some substances require the use of protective clothes, etc. At Kumamoto University, information is provided on the Safety Data Sheets (simplified version) issued when chemical substances are acquired. Make preparations

properly. Pay attention to the following points regarding clothes, protective equipment, etc.

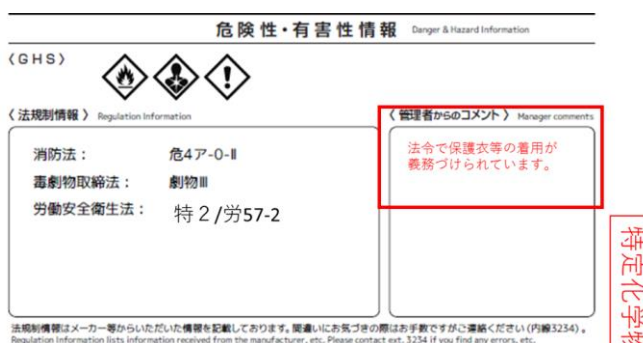


Fig. 1-2 Example of obligation to wear protective equipment

a) Clothes

Basically, wear long-sleeved work clothes and a white robe. It is acceptable to wear short-sleeved clothes under the white robe. However, it is necessary to take precautions to minimize skin exposure in order to avoid injury caused by experiment apparatuses, etc. and percutaneous absorption of chemical substances. Wear pants that are long enough to hide ankles. Do not wear stockings, tights, etc. in areas where chemistry experiments are conducted. Stockings are vulnerable to acids and alkalis. They melt onto the skin with chemical substances, aggravating chemical burns. When using chemical substances that affect the skin, use impermeable protective clothes.

b) Hair

Chemical substances, etc. may adhere to hair. Tie long hair back (for both men and women). Some experimenters keep their side hair in place or tie their back hair on the side, etc. It is meaningless to tie hair in these ways. Such hair arrangements result in chemical burns and other forms of burns. Make sure to tie your hair back.

c) Footwear

Wear low-heeled shoes that cover the instep (e.g., trainers, safety shoes) instead of high heels or sandals. These shoes help you escape when hazards are imminent and protect feet. Shoes made from materials permeable by water, etc. are likely to cause chemical burns when exposed to chemical substances. Use waterproof shoes.

d) Safety glasses

Chemicals, broken glass pieces, etc. may scatter at an unexpected timing during experiments. They may enter the eyes and result in loss of sight in the worst case. Make sure to wear safety glasses during an experiment. Safety glasses are shaped like goggles to block chemical substances from entering through the gaps. Ordinary glasses alone cannot block chemical substances that may enter through the gaps. Those who wear glasses must wear safety glasses on top of ordinary glasses or prepare prescription safety glasses. Take utmost care.

e) Gloves

Wear gloves, etc. depending on the type of experiment and chemical substances used. Gloves are made from various materials, such as latex rubber, nitrile rubber, and polyethylene. Their chemical resistance varies. Select gloves to be used depending on the type of chemical substances used.

f) Mask

Use a mask as needed to avoid dust and vapors. For dust masks, simple masks and masks for complete protection are available. Choose a mask depending on the usage. For chemical substances, there are simple masks using activated carbon, special gas masks, and canisters. Select and prepare them depending on the usage.

#### (4) Preparation of experiment apparatuses and chemical substances

Preparation for experiments determines the success of experiments. Make sure to learn how to use experiment devices in advance, and check operation and safety.

Prepare experiment apparatuses made from glass, stainless steel, plastic, etc. depending on the chemical substances to be used. Some chemical substances cause explosion when apparatuses made from stainless steel are used. It is necessary to confirm the properties of chemical substances. Regarding the use of experiment apparatuses, refer to Chapter 1 (3. Handling of apparatuses).

Check chemical substances for shortage and changes in properties (e.g., deliquescence, decomposition), physical properties, and composition. Dispose of chemical substances that are old or have become discolored, whose content is unknown, that have deteriorated obviously, etc. Regarding disposal of chemical substances, refer to Chapter 6 (Disposal of Chemical Substances). Regarding chemical substances that are not to be used in the future but still can be used, consider the possibility of transferring such chemical substances to other entities. Storing up unnecessary chemical substances leads to an accident.

#### (5) Confirmation of properties of chemical substances

To ensure success of an experiment and safety of yourself and other individuals, it is important to understand the physical properties and hazards of chemical substances, emergency measures, etc. before use. Refer to Safety Data Sheets, etc. to confirm the information before use. Refer to Chapter 3 (3. How to obtain information about toxicity and hazards of chemical substances).

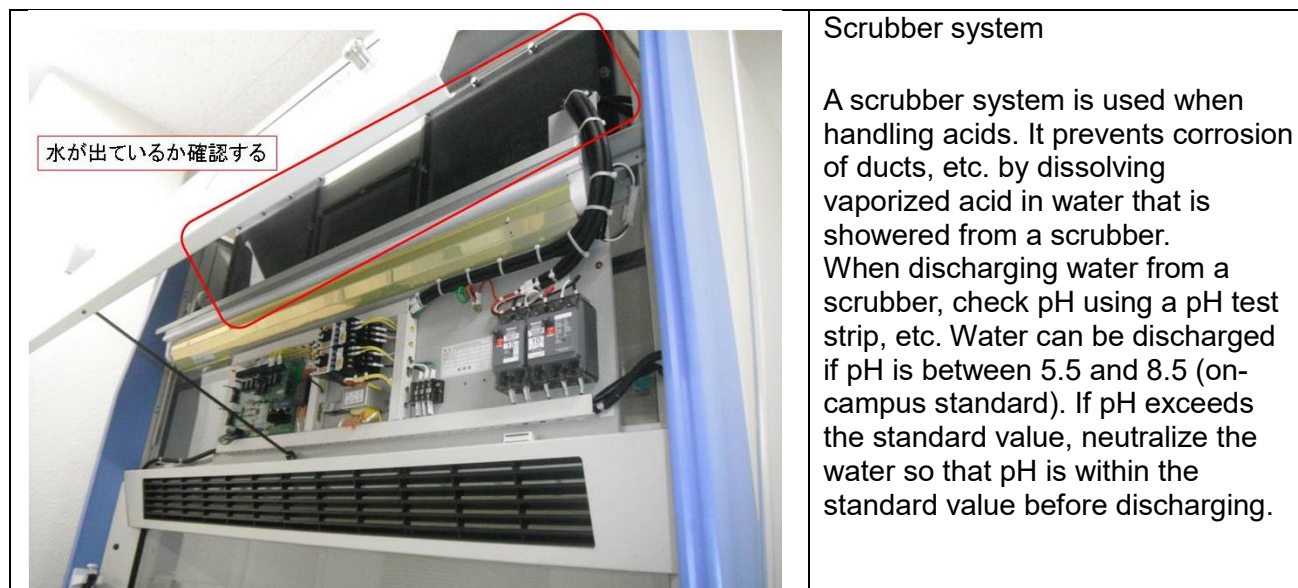
#### (6) Other necessary protective equipment and devices

##### a) Local exhaust ventilation (draft chamber)

When handling volatile chemical substances that generate toxic vapors, use local exhaust ventilation (draft chamber). A fume hood is a device that draws in toxic substances together with air and exhaust to a different area. It is an exhaust device to prevent exposure of workers (experimenters) due to volatilization and scattering of chemical substances. Exposure to toxic substances can be avoided by handling chemical substances in a fume hood. Use a fume hood actively. When handling acids, use a fume hood equipped with a scrubber that is designed to adsorb acids by spraying water in a vacuum device. A fume hood equipped with a scrubber has a water tank in the fume hood and a shower in the upper part of the device.

Before use, make sure to check that local exhaust ventilation is working properly. Also, check the performance regularly using an anemometer. Use an anemometer to check that air is drawn in at the specified velocity.

	<p>How to inspect local exhaust ventilation before use</p> <p>Local exhaust ventilation is a device that draws in air to exhaust vaporized toxic substances. If air is not drawn in, the local exhaust ventilation may have failed for one reason or another. Do not use it.</p> <p>* Local exhaust ventilation must maintain the designated air velocity. It is necessary to conduct an annual voluntary inspection. Use an anemometer to check the air velocity. An anemometer can be borrowed from the administrative office of respective schools/faculties.</p>
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\* Note: When using “specified chemical substances” and “organic solvents” as defined in the Industrial Safety and Health Act, make sure to use such substances while operating local exhaust ventilation. These substances must not be used when local exhaust ventilation is not in place. If you wish to use these substances, consult with the Safety and Health Management Team of the Facilities Management Division.

When using other organic solvents and volatile chemical substances without local exhaust ventilation, ensure sufficient ventilation during use (e.g., open a window, install a ventilation fan).

### 3. Handling of apparatuses

When handling chemical substances, apparatuses made from various materials are used. However, the use of apparatuses made from inappropriate materials can lead to a major accident. When selecting apparatuses, consider the characteristics of chemical substances and the characteristics of materials from which apparatuses are made. This section explains the main materials used for apparatuses.

#### (1) Glass apparatuses

Glass apparatuses melt when exposed to hydrofluoric acid. They are also eroded gradually by strong alkali chemical substances but are highly resistant to chemical substances. They are most frequently used in chemistry experiments. However, they are easily breakable. Glass fragments are sharp and often cause deep cuts. It is necessary to take utmost care when handling them. When using glass apparatuses, take the following precautions in particular.

- [1] Check for scratches before use. Do not use scratched ones.
- [2] Do not hold thin parts (e.g., openings) and weak parts (e.g., joints) of glass apparatuses with a single hand.
- [3] Do not impact glass apparatuses.
- [4] When assembling a system, do not apply excessive force. Use clips, clamps, etc. to prevent them from falling, etc.
- [5] Avoid rapid heating or cooling.
- [6] When inserting a glass tube, thermometer, etc. into a rubber tube, rubber plug, etc., wet the glass with water or alcohol and insert the glass tube, thermometer, etc. gently and gradually while rotating it. Hold glass about 2 to 3 cm from the insertion area. Glass is likely to break when a part further away is held. The same applies to the removal procedure. Do not apply excessive force.
- [7] If the edge of a glass apparatus is sharp, burn and round the part using a burner, etc. It takes time to cool. There are risks of burns even if the glass appears to have been cooled. Take