Laboratory Safety and Environmental Management

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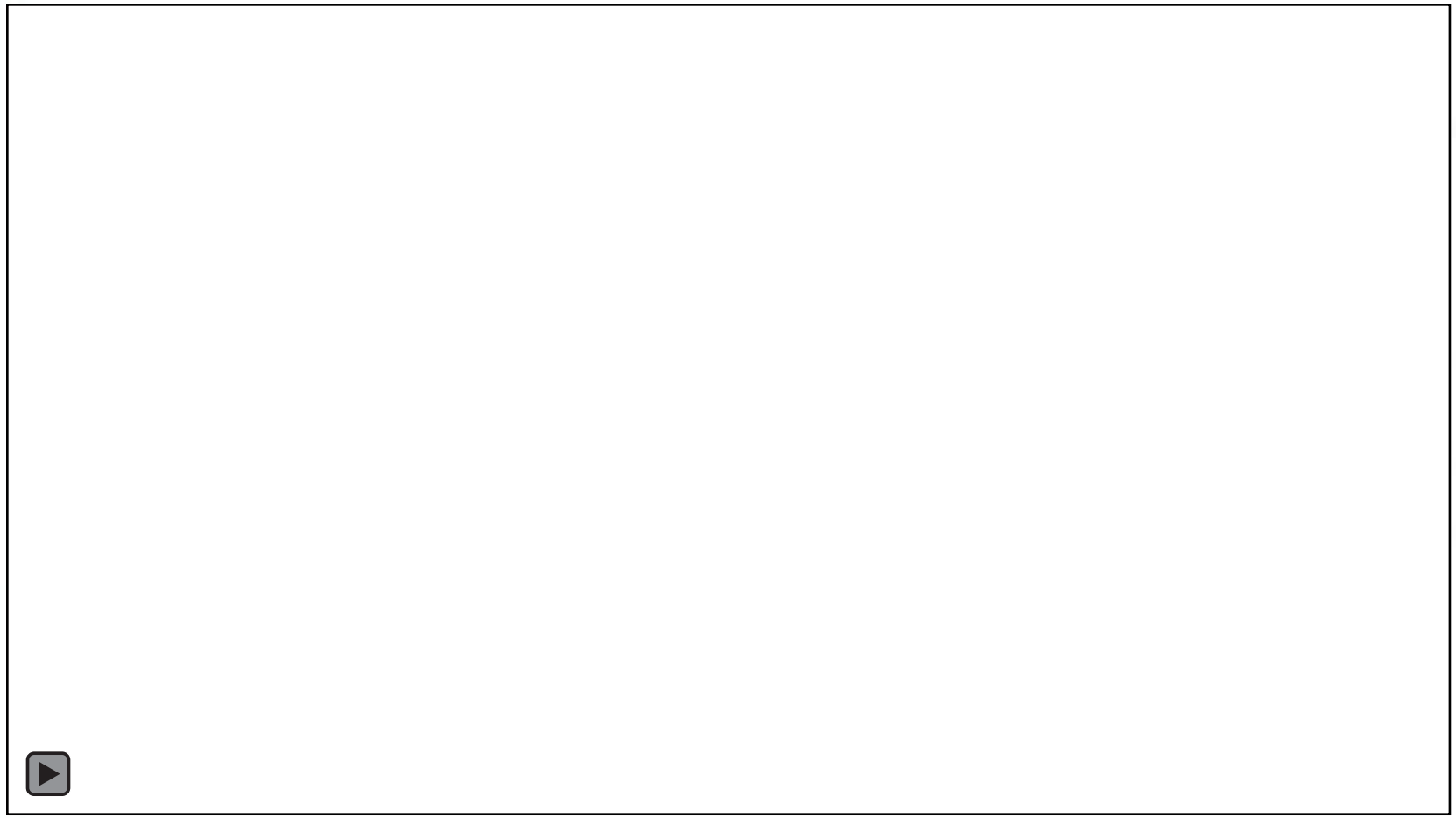
Safe Laboratory Operation

Safe Laboratory Operation (1/2)



- ❑Wear gloves
- ❑Wear goggles
- ❑Use safety pipette filler when taking samples or reagent with the pipette.
- ❑For operations which generates hazardous gas, handle it in the fume hood.

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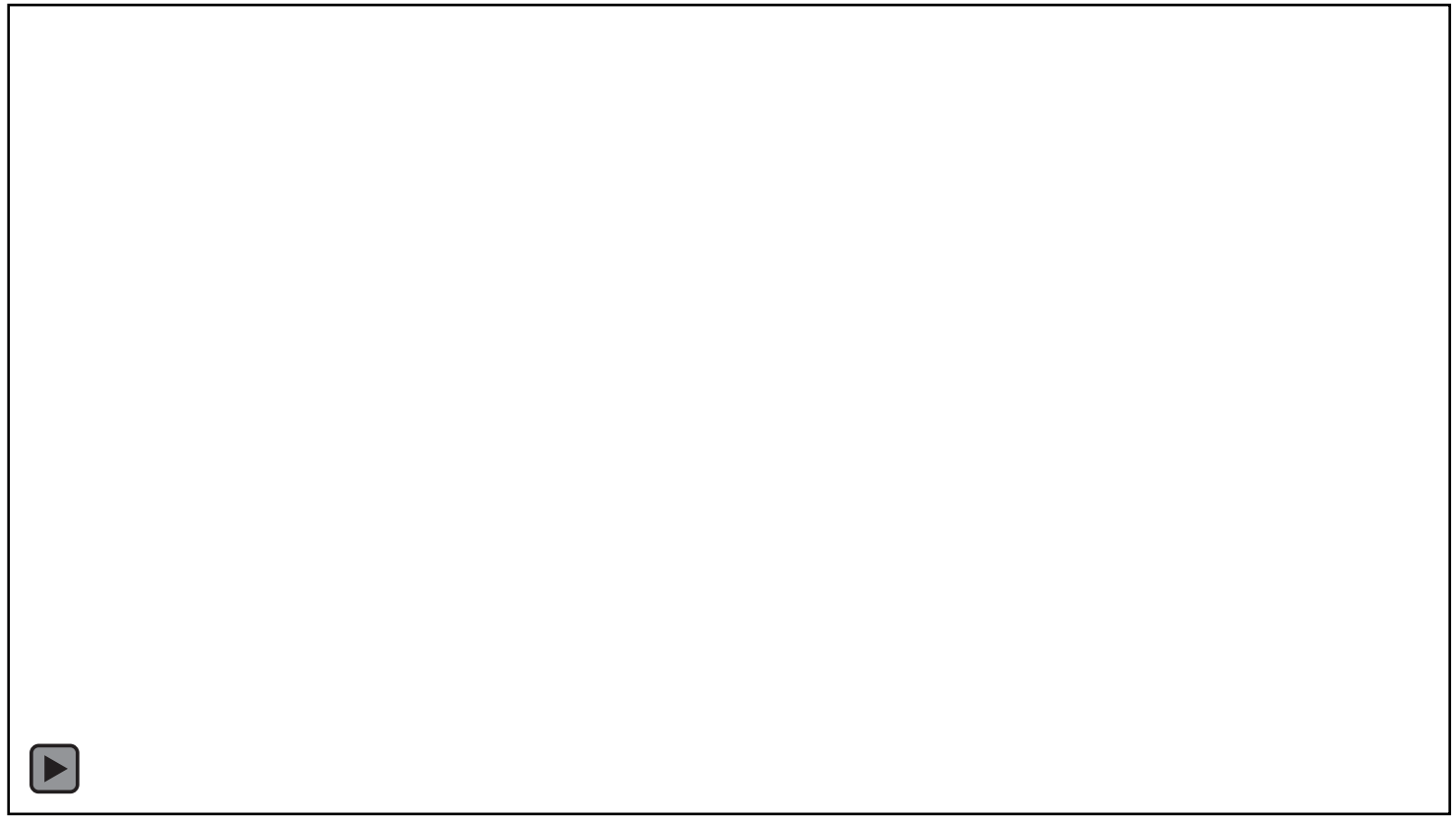
Safe Laboratory Operation

Safe Laboratory Operation (2/2)



- When acid (or other hazardous reagents) adhere to the skin, rinse it with plenty of water immediately.
- Eye wash bottle is effective for treatment when reagent gets into the eye.

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Safe Laboratory Operation

Safe Handling of Hazardous Reagents

Hydrochloric Acid (HCl)

- Strong acid
  But weaker than H_2SO_4
  = When HCl is mixed with H_2SO_4,
  HCl is volatized.
- Vapour in room temperature
  (HCl Reagent is aqueous solution)
- HCl is reduced by strong oxidant.
  (and Chlorine gas is generated.)

- Be careful not to inhale HCl gas (wear the mask).
- Do not mix with H_2SO_4.
- Do not mix with oxidant (e.g., $KMnO_4$).

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Safe Handling of Hazardous Reagents

Sulphuric Acid (H_2SO_4)

- ❑Very strong acid
- ❑Non-volatile acid
  (Even dilute acid, it is concentrated as water volatizes.)
- ❑Strong dehydration performance
  High digestion performance to organic compounds.
- ❑High heat of solution
- ❑Hot concentrated H_2SO_4 is oxidative.

- Different from HCl or HNO_3, H_2SO_4 does not cause pain on the skin.

- When H_2SO_4 may adhere the skin, rinse it with plenty of water.
- Keep away from metal and paper when handling
- For diluting H_2SO_4, add H_2SO_4 little by little into water.
  If dilute H_2SO_4 to small amount of water (e.g., 20N H_2SO_4) it is cooled by ice water.

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Safe Handling of Hazardous Reagents

Nitric Acid (HNO_3)

- ❑ Strong acid
- ❑ Oxidant
  (both concentrated / diluted)
- ❑ Corrodes most metals
- ❑ On heating (digestion), HNO_3 and NO_x gases are generated
- ❑ Nitrogen is a nutrient for plant (phytoplankton)

- On heat digestion procedure, be careful not to touch and inhale acid gas.
- Store away from metals, combustibles or reducing agents.

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Safe Handling of Hazardous Reagents

Perchloric Acid ($HClO_4$)

- ❑Strong acid
- ❑Strong oxidant
- ❑Highly reactive and can explode
- ❑Common reagent in aqueous solution ($HClO_4$ aqueous solution is relatively stable).

- Be sure to use with nitric acid on digestion.
- Do not dry up.
- Be careful not to touch and inhale acid gas on digestion.

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Safe Handling of Hazardous Reagents

Basic (Alkaline) Solution

- Strong base (alkaline) is also very hazardous.
- Strongly digest protein
  - Cause serious burn to skin
  - Especially cause serious damage to eye
- Alkaline alcoholic solution is very permeable to the skin, and more dangerous.
- NaOH has large heat of solution.

- As with acids and other harmful reagents, take good protective measures when handling alkaline solutions. (gloves, goggles, etc.)
- During the preparation of NaOH solution, fine mist may be generated. Be careful not to inhale it.

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Organic Solvent

Toluene, hexane, ethanol

- Volatile (Boiling points at 1 atm):
  - toluene: 111 °C
  - hexane: 69 °C
  - ethanol: 78 °C
- Low flash point
  - toluene: 4 °C
  - hexane: -23 °C
  - ethanol: 13 °C

- Wear gloves to minimize solvent exposure.
- Keep ventilation.
- Operate in a place free from fire.

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Laboratory Safety and Environmental Management

Safe Handling of Hazardous Reagents

Apparatus and Equipment Safety

Glassware

Biggest cause of injuries in chemical laboratories.

- Fragments of glassware are sharp, and sometimes pierce deeply.
- If the glassware breaks during forceful operation, it can pierce even deeper into skin.

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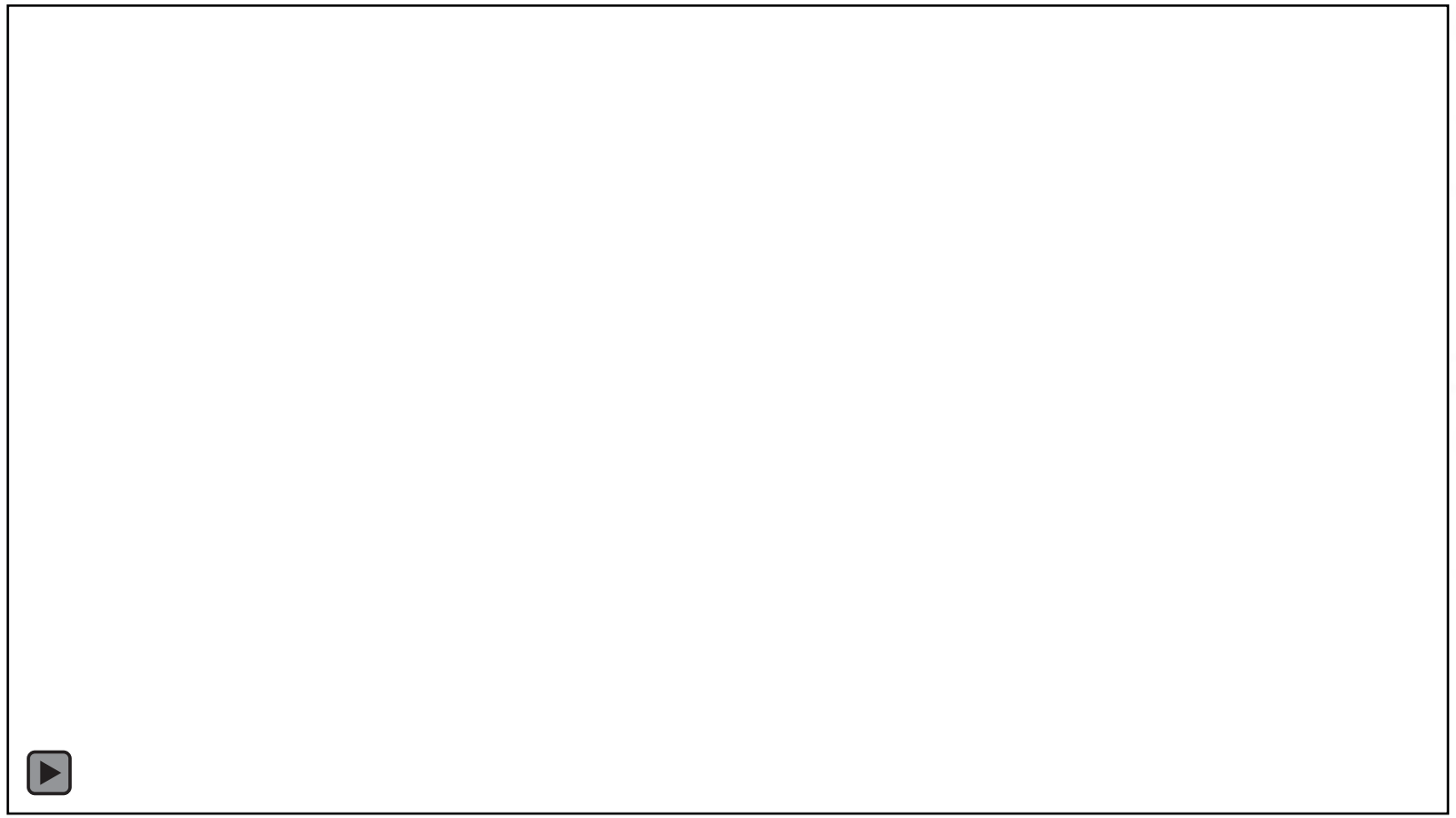
Laboratory Safety and Environmental Management

Apparatus and Equipment Safety

Glassware with Chipped Edge



- Glassware with chipped-off edges is dangerous.
- Discard or repair the edge with a burner.
- Do not collect broken piece with bare hand.
- Beware of burn from hot glass, and injury from dropping it.

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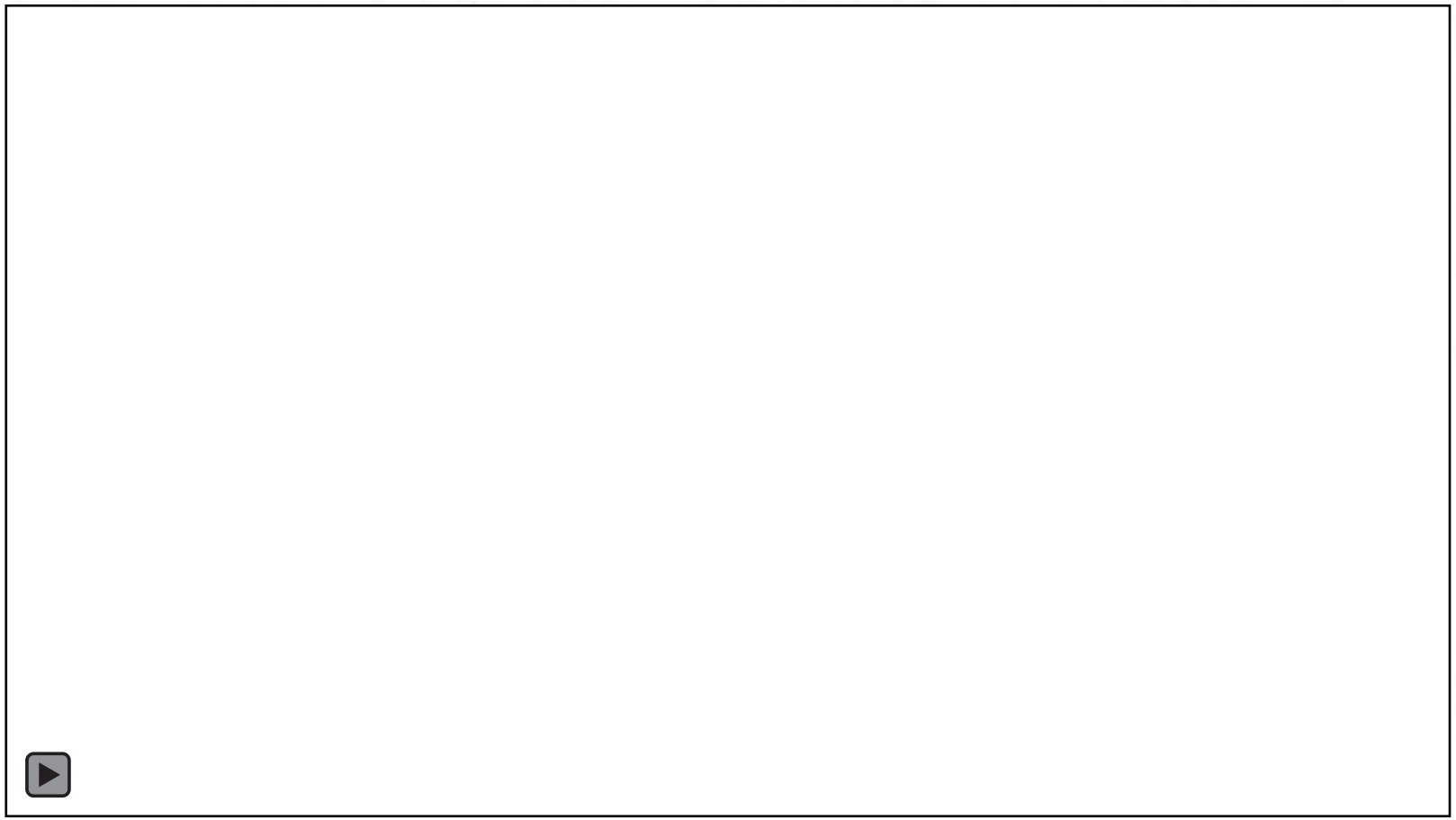
Apparatus and Equipment Safety

Stuck Glassware Lid

If the lid of the glassware cannot be removed



- ❑Do not try to open with strong force or with tools
- ❑Never heat.
- ❑Tap the area around the lid slowly (and patiently) many times.
- ❑Ultrasonic bath is effective.

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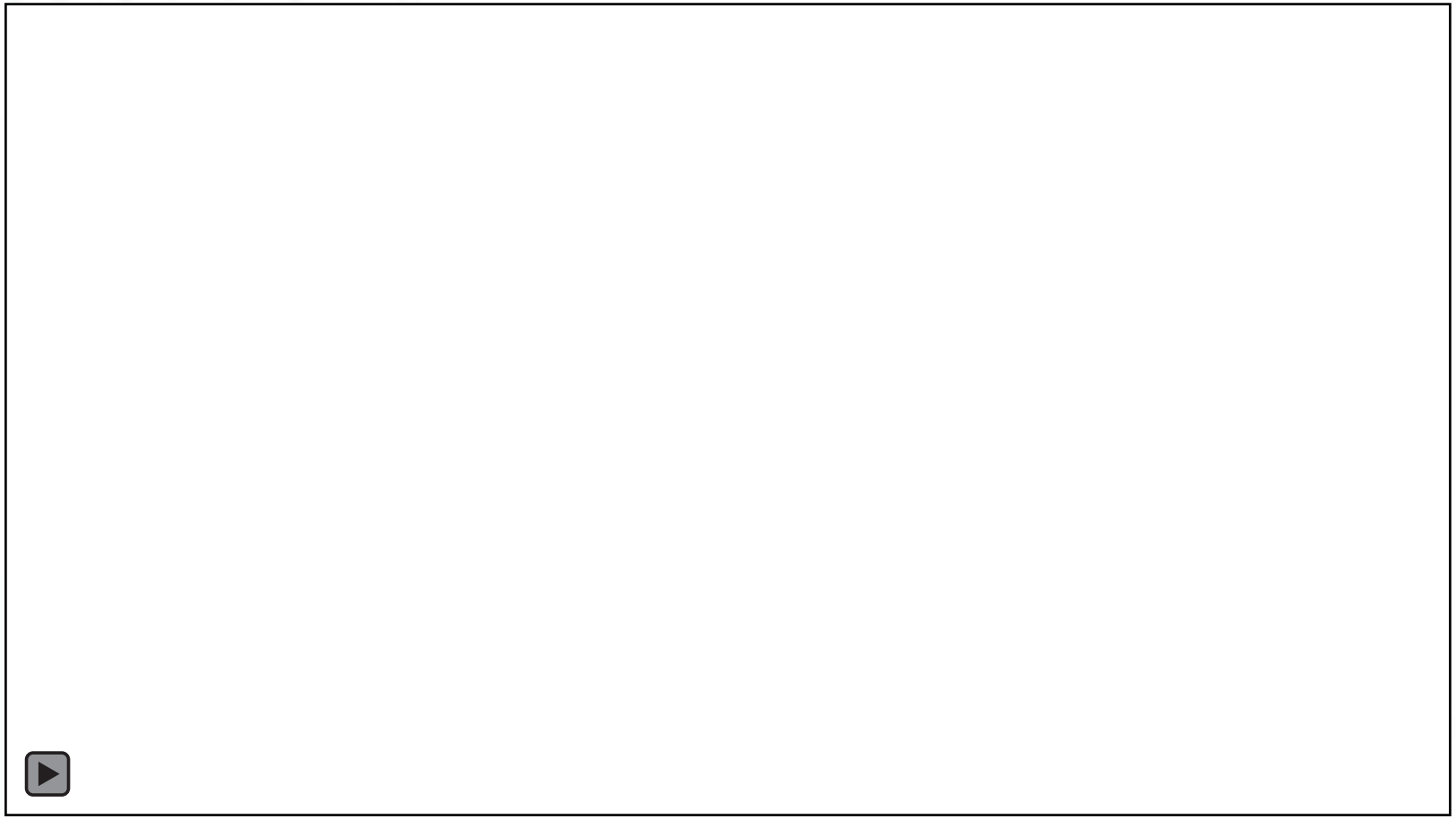
Laboratory Safety and Environmental Management

Apparatus and Equipment Safety

Electrical Device

To prevent fire



- ❑Check the cable, plug and outlet on every use. If they are damaged, repair or replace it.
- ❑It is safer to connect the plug only when it is in use and remove it after use.
- ❑Be careful not to spill water on the plug/outlet near the floor.

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Laboratory Safety and Environmental Management

Apparatus and Equipment Safety

Environmental Management

Environmental Impact from Laboratory

Even an environmental laboratory cannot eliminate impact on the environment.

- Laboratory uses resources:
  - Reagents
  - Electricity, water, gas (fuel and reagent)
  - Papers and other office consumables
- Laboratory produce wastes:
  - Exhaust gas
  - Wastewater
  - Solid waste

The efforts to reduce the environmental impact from the laboratory should continue.

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Laboratory Safety and Environmental Management

Environmental Management

Wastewater Management

Wastewater containing hazardous substances should be collected and treated properly.

- Highly acidic/Alkaline wastewater should also be collected.
- Even if the wastewater treatment is outsourced, it is recommended to collect and store the wastewater separately for each harmful substance contained in the wastewater to facilitate the treatment.
- Also, the property and substances in the wastewater should be indicated on the container.

Photo: IDEA Consultants

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Laboratory Safety and Environmental Management

Environmental Management

Exhaust Gas Management

Exhaust gas from the acid digestion contains acid gas and fume.

- Acids in the exhaust gas should be removed before it is released into the atmosphere.
- The gas scrubber should be installed in a fume hood.

(When performing operations that use a large amount of organic solvent, a device that recovers organic matter (e.g., activated carbon filter, etc.) is required.)

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Laboratory Safety and Environmental Management

Environmental Management

ISO 14001 Environmental Management Standard

ISO14001 Standard

Standard for Environmental Management System (EMS):

- ❑ Focused on all activities of the organization.
- ❑ The environmental impact from each activity of the organization is evaluated
- ❑ Documented environmental management system (EMS) is created.
- ❑ System is implemented, outcome is confirmed, and system and activities are continuously improved.

EMS is also implemented under the PDCA (plan-do-check-act) cycle, the scheme is similar to quality management system.

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Laboratory Safety and Environmental Management

ISO 14001 Environmental Management Standard

ISO14001 System Benefit

- Environmental impact from the organization (laboratory) is clarified and evaluated.
  - Systematic evaluation reduces oversight of environmental impact (laboratory activity is complex, thus some impacts often are "forgotten").
  - The planning of management becomes easier.
- The EMS scheme is similar to QMS.
  - For the staff of analysis laboratory, it is relatively easy to understand and implement.

It is not always necessary to obtain ISO14001 certification.
It is useful just to evaluate the environmental impact and conduct management according to the standard.

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ISO 14001 Environmental Management Standard