

THE CHINESE UNIVERSITY OF HONG KONG

Micro-Module Courseware Development Grant

Final Report (August 2015)

Report due 31 August 2015.

Please return by email to The Ad hoc Committee on Planning of eLearning Infrastructure
mmcd@cuhk.edu.hk

PART I

Project title: Teaching Chemical Laboratory Safety by the “Flipped Classroom” Approach

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Department / Unit: Chemistry

Project duration: From January 2015 to August 2015

Date report submitted: 27/8/ 2015

1. Project objectives

The project is on track to meet its original objectives specified in the proposal.

2. Process, outcomes or deliverables

Eight micro-modules were completed. No course has used the micro modules yet.

The nature of the deliverables remains unchanged. The timeline is kept without adjustment.
The project was completed satisfactorily.

3. Evaluation Plan

Evaluation will be executed in the future when the micro-modules are used in the future according to the plans specified in the original proposal.

4. Dissemination, diffusion and impact

The deliverables are expected to be used in some of the laboratory courses of the Department of Chemistry. They may also be used for courses involving laboratory works like those in the Department of Physics and Department of Biology.

PART II

Financial data

Funds available:

Funds awarded from MMCDG	\$ 83000
Funds secured from other sources (please specify _____)	\$ 0
Total:	\$ 83000

Expenditure:

Item	Budget as per application	Expenditure	Balance
Staff cost	----	83000	0
Total:		83000	

PART III

Lessons learnt from the project

The key part of the project is the production of video clips. It relies mainly on the user-friendly filming equipment, video editing software, and high-speed computer.

PART IV

Information for public access

1. Keywords

Please provide five keywords (in the order of most relevant to your project to least relevant) to describe your micro-modules/pedagogies adopted.

- (Most relevant) Keyword 1: Laboratory
 Keyword 2: Safety
 Keyword 3: Demonstration
 Keyword 4: Teaching
(Least relevant) Keyword 5: Flip classroom

2. Summary

Please provide information, if any, in the following tables, and provide the details in Part I.

Table 1: Publicly accessible online resources (if any)
(a) Project website: Nil.
(b) Webpage(s): Nil.
(c) Others (please specify): Nil.

Table 2: Resource accessible to a target group of students (if any)
Nil.

Table 3: Presentation (if any)	
<i>Please classify each of the (oral/poster) presentations into one and only one of the following categories</i>	Number
(a) In workshop/retreat within your unit (eg. department, faculty)	0
(b) In workshop/retreat organized for CUHK teachers (eg. CLEAR workshop, workshop organized by other CUHK units)	0
(c) In CUHK ExPo jointly organized by CLEAR and ITSC	0
(d) In any other event held in HK (eg. UGC symposium, talks delivered to units of other institutions)	0
(e) In international conference	0
(f) Others (please specify)	0

Table 4: Publication (if any)	
<i>Please classify each piece of publications into one and only one of the following categories</i>	Number
(a) Project CD/DVD	0
(b) Project leaflet	0
(c) Project booklet	0
(d) A section/chapter in a booklet/ book distributed to a limited group of audience	0
(e) Conference proceeding	0

(f) A chapter in a book accessible internationally	0
(g) A paper in an referred journal	0
(h) Others (please specify)	0

3. A one-page brief write up

The micro modules will be used on top of the existing laboratory sessions of CHEM2408 and CHEM2850, which are the first courses to be taken by Chemistry-major students. The modules are beneficial to them in these two courses and the ones taken subsequently. Students will watch the video clips at home. Discussions and/or quizzes for each module will be carried out.

List of micro modules:

- (a) Personal protective equipment: allow students to learn the importance of personal protective equipment in laboratory and how to use them. Personal protective equipment is used by students in the laboratory sessions.
- (b) Corrosive chemical: allow students to learn the types of corrosive chemicals; and how they are handled and stored. Students will use this type of chemicals in subsequent laboratory sessions.
- (c) Flammable chemical: allow students to learn the types of flammable chemicals, how they are handled, and how they are stored. Students will use this type of chemicals in subsequent laboratory sessions.
- (d) Toxic chemical: allow students to learn the types of toxic chemicals; and how they are handled and stored. Students will use this type of chemicals in subsequent laboratory sessions.
- (e) Chemical Information: MSDS and Labels: allow students to learn how to get chemical information from MSDS and labels on chemical containers. Students will get chemical information from MSDS and labels on chemical containers in subsequent laboratory sessions.
- (f) System under Pressure: allow students to learn the types of systems under pressure and their hazards. Students will handle this type of systems in subsequent laboratory sessions.
- (g) Extreme Temperature: allow students to learn the types of extreme temperatures and their hazards. Students will face this type of temperatures in subsequent laboratory sessions.
- (h) Electrical hazard: allow students to learn electrical hazards in laboratory. Students will face this type of hazards in subsequent laboratory sessions.

Also attached:

"proposalADPgrantSafetyVideo(MC)150803v009.doc": Document for multiple-choice questions (with answers) for all micro-modules:

"proposalADPgrantSafetyVideo(discussion)150729v007.doc": Document for in-class discussion for all micro-modules

"Links for safety videos v002.docx": Links for the videos.

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(a) Personal protective equipment

1. Which of the following eye protections is not allowed to wear in the chemical laboratory?

- (A) Goggles
- (B) Regular glasses
- (C) Contact lenses plus spectacles with side shield
- (D) Regular glasses plus spectacles with side shield

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(a) Personal protective equipment

2. Which of the following about latex gloves is incorrect?

- (A) It is made of natural rubber.
- (B) It has better resistance against puncture than synthetic gloves.
- (C) It can cause allergies to some people.
- (D) It can be used to handle inorganic strong acids and bases.

Micro-Module Courseware Development Grant

(a) Personal protective equipment

3. When several glass bottles (2.5 litre each) of hexane are dropped onto the floor and are broken, which of the following is the most suitable protection to wear in order to handle the chemical spillage?

- (A) A surgical face mask
- (B) A face shield
- (C) A face mask with activated charcoal
- (D) An air-purifying respirator with an appropriate cartridge

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(a) Personal protective equipment

4. When wearing _____ gloves for handling liquid nitrogen, even a very short contact time with liquid nitrogen can cause severe burnt of the hands.

- (A) Cotton
- (B) Cryo-
- (C) Latex
- (D) Nitrile

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(a) Personal protective equipment

5. Which of the following is not allowed to wear in the chemical laboratory?

- (A) Short pants
- (B) Scandals
- (C) Skirt
- (D) All of the above

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(a) Personal protective equipment

6. Which of the following is the main purpose for wearing the personal protective equipment in the chemical laboratory?
- (A) To fulfil the requirement of the law
 - (B) To be allowed to stay in the laboratory
 - (C) To protect you from a health or safety risk
 - (D) To be ready for handling chemical spillage

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(a) Personal protective equipment

Ans. 1. C 2. B 3. D 4. A 5. D 6. C

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(b) Corrosive chemical

1. What is the basic personal protective equipment for handling of corrosive substances?

- 1) goggles
- 2) face shield
- 3) lab coat
- 4) gloves
- 5) anti-corrosive shoes

- (A) Only 3 and 4
- (B) Only 1, 3 and 4
- (C) Only 1, 2, 3 and 4
- (D) All of the above

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(b) Corrosive chemical

2. Which of the following is not a common spill kit found in a laboratory?

- (A) Acid powder
- (B) Base powder
- (C) Radioactive powder
- (D) Solvent powder

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(b) Corrosive chemical

3. Which of the following classes of chemicals are classified as corrosive substances?

- 1) Acids
- 2) Bases
- 3) Oxidizing agents
- 4) Reducing agents
- 5) Radioactive substances

(A) Only 1, 2 and 5

(B) Only 1, 3 and 4

(C) Only 1, 2, 3 and 4

(D) All of the above

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(b) Corrosive chemical

Ans. 1. B 2. C 3. C

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(c) Flammable chemical

1. What is the flash point of chemicals classified as flammable in Hong Kong?

- (A) 40 °C
- (B) 45 °C
- (C) 60 °C
- (D) 66 °C

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(c) Flammable chemical

2. What is the state of matter when a substance combusts?

(A) Solid

(B) Liquid

(C) Gas

(D) It can be any state of matter

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(c) Flammable chemical

3. Which of the following is not suitable to put off an electrical fire?

(A) Water extinguisher

(B) Carbon dioxide extinguisher

(C) Halon extinguisher

(D) Foam extinguisher

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(c) Flammable chemical

4. Which of the following is not correct for fire prevention?

- (A) Keep only what you need on-site
- (B) Store the flammable chemicals in domestic refrigerator
- (C) Work with flammable chemicals in fume hood
- (D) Use intrinsically safe and non-sparking tools

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(c) Flammable chemical

Ans. 1. D 2. C 3. A 4. B

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(d) Toxic chemical

1. Which of the following class of chemical does not belong to toxic chemicals?

- (A) Mutagen
- (B) Teratogen
- (C) Cryogen
- (D) Cytotoxin

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(d) Toxic chemical

2. Which of the following is/are classified as toxic chemical(s)?

(A) Benzene

(B) Mercury

(C) Snake venom

(D) All of the above

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(d) Toxic chemical

3. Benzene is toxic because

(A) It is a good solvent and can dissolve the cell membrane.

(B) It is very flammable

(C) It is carcinogenic

(D) It gives out irritating smell

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(d) Toxic chemical

4. What session(s) of MSDS is/are important to go through before you work with toxic chemicals?

- 1) Session 1 – Identification of the substances
- 2) Session 2 – Hazard identification
- 3) Session 4 – First aid measures
- 4) Session 11 – Toxicological information

(A) 1 and 2

(B) 2 and 3

(C) 2 and 4

(D) All of the above

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(d) Toxic chemical

Ans. 1. C 2. D 3. C 4. D

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(e) Chemical Information

1. How many hazard pictograms are there in the globally harmonized system (GHS)?

- (A) 7
- (B) 8
- (C) 9
- (D) 10

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(e) Chemical Information

2. Which of the following information cannot be found in the labels on chemical containers?

- (A) Manufacturing company name
- (B) The CAS number
- (C) The emergency contact phone number
- (D) The purity of the chemical

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(e) Chemical Information

3. Which of the following about MSDS is incorrect?

- (A) It provides critical information on how to use, transport and store the chemical.
- (B) You can access to MSDS only from the chemical companies.
- (C) It tells you what to do in case of emergencies and overexposure.
- (D) It is divided into 16 sections.

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(e) Chemical Information

4. If the firefighters want to know the suitable extinguishing medium to contain the fire, which section in the MSDS will provide the information?

(A) 4

(B) 5

(C) 6

(D) 7

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(e) Chemical Information

5. In sections 1-3 of MSDS, they give the information of chemical. Which of the following cannot be found?

- (A) The CAS number
- (B) The synonyms of the chemical
- (C) The appearance of the chemical
- (D) The boiling point of the chemical

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(e) Chemical Information

6. If you want to know the waste treatment method of the chemical, which section in MSDS will provide you the information?

- (A) 6
- (B) 12
- (C) 13
- (D) 15

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(e) Chemical Information

Ans. 1. C 2. C 3. B 4. B 5. D 6. C

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(f) System under Pressure

1. Which of the following is NOT true?

(A) $1 \text{ atm} = 1.01325 \times 10^5 \text{ Nm}^{-2}$

(B) $1 \text{ atm} = 1 \text{ bar}$

(C) $1 \text{ atm} = 760 \text{ mmHg}$

(D) $1 \text{ atm} = 14.6959 \text{ psi}$

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(f) System under Pressure

2. What is the approximate pressure of a new gas cylinder?

(A) 1.5 atm

(B) 15 atm

(C) 150 atm

(D) 1500 atm

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(f) System under Pressure

3. A trolley helps you to:

- (A) mount a gas cylinder to wall or bench firmly.
- (B) transport a gas cylinder safely.
- (C) controls the amount of gas coming out of a gas cylinder.
- (D) to prevent a gas cylinder from being heated up.

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(f) System under Pressure

4. What is the problem if a gas cylinder is put under sunshine?

- (A) The gas pressure of the gas cylinder may increase.
- (B) The gas in the gas cylinder may be decomposed by sunshine.
- (C) The metal case of the gas cylinder may be degraded by sunshine.
- (D) Sunshine may initiate reaction between the gas in the gas cylinder and the air around the cylinder.

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(f) System under Pressure

5. The regulator attached to a gas cylinder is used to:

- 1) monitor the flow rate of gas
- 2) control the flow rate of gas
- 3) prevent gas from leaking out of the cylinder

- (A) 1 and 2 only
- (B) 1 and 3 only
- (C) 2 and 3 only
- (D) All of the above

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(f) System under Pressure

Ans. 1. B 2. C 3. B 4. A 5. A

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(g) Extreme Temperature

1. Which of the following best describe the term “cryogens”?

- (A) A substance which cries when cooled.
- (B) A substance which provides low temperature.
- (C) A process which produces a cool substance.
- (D) A process in which a substance is cooled.

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(g) Extreme Temperature

2. Dry ice is the solid form of:

(A) water

(B) carbon dioxide

(C) nitrogen

(D) helium

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(g) Extreme Temperature

3. Liquid nitrogen provides a temperature of:

(A) 0 °C

(B) -79 °C

(C) -196 °C

(D) -269 °C

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(g) Extreme Temperature

4. A ventilation system is to:

- (A) supply fresh air
- (B) warm up a room
- (C) absorb toxic gas
- (D) light up a room

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(g) Extreme Temperature

5. To reduce the hazard of spillage of harmful liquid on face,
one should wear:

(A) cryo-gloves

(B) goggles

(C) lab coat

(D) mask shield

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(g) Extreme Temperature

Ans. 1. B 2. B 3. C 4. A 5. D

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(h) Electrical hazard

1. The voltage of wall sockets in Hong Kong is usually:

(A) 110V AC

(B) 110V DC

(C) 220V AC

(D) 220V DC

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(h) Electrical hazard

2. Which of the following concerning fuse wire is true?
- (A) Fuse wire is made of high-melting-point-metal.
 - (B) Fuse wire is melted by overheating.
 - (C) Circuit disconnected by fuse wire can be restarted without replacement of the fuse wire.
 - (D) When a high electrical current passes through a fuse wire, a huge magnetic field is produced to turn off the switch of a circuit.

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(h) Electrical hazard

3. Which of the following concerning residual current device is true?
- (A) It provides a minimal electrical current in case of electricity suspension.
 - (B) It detects fault in earthing and can cut off the electrical supply.
 - (C) It controls the maximum amount of electrical current in a circuit.
 - (D) It charges up a battery which provides power in case of electricity suspension.

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(h) Electrical hazard

4. Which of the following concerning earthing is true?

- (A) It is a tool to make electrical appliances and instruments stand on floor in a stable manner.
- (B) It cuts off electricity supply in case of overheating.
- (C) It turns off electrical appliances and instruments when they are left idle for a specific period.
- (D) It carries away any charge developed on the enclosure and frame of electrical appliances and instruments.

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(h) Electrical hazard

5. High voltage is LEAST likely used in:

(A) laser

(B) mass spectrometer

(C) X-ray fluorescence spectrometer

(D) hot plate

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(h) Electrical hazard

Ans. 1. C 2. B 3. B 4. D 5. D

Micro-Module Courseware Development Grant

(a) Personal protective equipment

For in-class discussion:

What to discuss (initiated by teacher)	Key points
When you are working in a chemical laboratory, explain the purposes of wearing different types of personal protective equipment	Glasses or goggles for eye protection Gloves for handling chemicals and protection against physical hazards such as heat Lab coat for protection of body and the clothing Long pants and shoes with completely coverage for foot protection
Discuss why contact lenses are not allowed in the chemical laboratory	Contact lenses will absorb and concentrate volatile irritants which will cause dangers to your eyes. Even though you wear spectacles, goggles or face shield, you cannot stop contact lenses from absorbing and concentrating volatile irritants.
The use of different types of gloves	Different of latex gloves with nitrile gloves in terms of human allergies, handling of chemical and resistance against puncture Cotton gloves for handling mild heat and cold, and cryo-gloves for handling extreme cold substances such as liquid nitrogen.
Items that are not allowed to wear when working in chemical laboratory	Short pants Skirt Scandals Open-toed shoes

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(b) Corrosive chemical

For in-class discussion:

What to discuss (initiated by teacher)	Key points
How are bases stored in the laboratory?	Bases should be stored carefully in well-designed cabinets. The inside of the cabinet should be made from Teflon which can resist corrosion from bases. There are trays to retain any spillage. The cabinet is connected to the fume hood through a pipe and the alkaline vapor can be evacuated.
How should one react to corrosive spillage on the skin and eyes?	In case of accident, stay calm and ask for assistance. Wash the affected area with flushing water for a minute. If the chemicals get into eyes, immediately go to the eye wash and rinse the eyes for one or two minutes. Consult medical advice if situation does not improve.
What is the disposal method if a chemical is sensitive to water?	Firstly, consult the material safety data sheet about the disposal method on that particular chemical. Generally, if a chemical is sensitive to water, it must not be poured to water directly. Instead, the chemical can be transferred to a beaker and put it in the fume hood. The moisture in air will slowly react and decompose the chemical.
In the disposal of acid waste, why should the acid added to the water instead of the other way round?	Dilution of acid is an exothermic reaction. When acid is poured to the water, the heat is dissipated homogenously and effectively. On the other hand, if water is added to the acid, local heating occurs at the layer between acid and water, possibly leading to acid spillage.

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(c) Flammable chemical

For in-class discussion:

What to discuss (initiated by teacher)	Key points
What is fire tetrahedron?	Fire tetrahedron is a simple model to understand the necessary ingredients to start a fire. In the fire tetrahedron, there are four elements, namely, fuel, oxidizing agent, heat and propagation.
What is propagation in fire tetrahedron?	Propagation refers to the chemical chain reaction that occurs after the fire is started. Combustion is a radical type reaction. Accordingly, halon type extinguisher is a quite useful extinguisher because haloalkanes are radical scavengers.
“In case of fire accident, quickly put off the fire by water.” Comment on this statement.	It depends on the type of fire. Water is effective for fire from Class A and Class B fuels but not for Class C, Class D and Class K. Class A fire includes combustibles such as wood, paper, trash or anything else that leaves an ash. Class B fire includes combustibles such as oil and gasoline. Fire resulting from electronics (Class C), metals (Class D) or cooking oil and grease (Class K) cannot be put off by water.

Micro-Module Courseware Development Grant

(d) Toxic chemical

For in-class discussion:

What to discuss (initiated by teacher)	Key points
There is no toxicological information on certain chemicals in MSDS. What does it mean?	It means that that chemical has not been deliberately tested on animals. It has no correlation on the toxicity of the chemicals. Students should be more cautious when handling chemicals with no stated toxicological information.
“It is sufficient to handle toxic chemicals when one wears safety goggles, lab coat and gloves.” Comment on this statement.	Personal protective equipment should be specific to the chemicals concerned. Latex gloves, neoprene gloves and nitrile gloves are resistant to certain categories of chemicals but not all. Before working on toxic chemicals, students should consult the MSDS. On the other hand, some toxic chemicals are volatile. The basic PPE could not give enough protection in this case. Volatile toxic chemicals should be handled in fume hood.
Discuss the ways to reduce intoxication by toxic chemicals.	<ol style="list-style-type: none">1. Seek for alternative. Toluene can replace very toxic benzene as an organic solvent.2. Work in fume hood. Toxic vapor can be evacuated.3. Contingency plan in case of accident. Always have sulfur available when working with mercury.4. Consult MSDS before working on any chemicals.

Micro-Module Courseware Development Grant

(e) Chemical Information




For in-class discussion:

What to discuss (initiated by teacher)	Key points
Some hazard labels are black symbols on orange background with black rimmed squares	The orange labels are from the old systems. The nine GHS pictograms are from the new CLP regulations of UN. The regulations came into force on 2009 and will apply directly on June 2015.
How can the manufacturer trace the chemical in the market if there are somethings wrong with certain lot of products.	Normally the label on the chemical container has the product number, lot number or the process number so that the manufacturing company can find out the lot of products that have to be retrieved from the market. The data matrix barcode also contains the information if present.
Where can you access to the MSDS?	Chemical manufacturer Laboratory or workplace University safety office Environment or occupation health office
Is it any fixed format of the MSDS?	No fixed format. Depending on the preparator Contain the same kind of basic information
Who is going to use the MSDS	Employees may expose to hazard chemicals such as laboratory working staff Firefighters Emergency medical personnel

Micro-Module Courseware Development Grant

(f) System under Pressure

For in-class discussion:

What to discuss (initiated by teacher)	Key points
<p>How to read a pressure gauge?</p> 	<p>Pressure gauge used for gas cylinder is usually a “positive” pressure gauge. The value read is the pressure relative to 1 atm. Therefore, if the reading is 2 bar, the actual pressure is $1 + 2 = 3$ bar.</p>
<p>What is the problem in the setup in the photo?</p> 	<p>A regulator is missing in the setup. A regulator consists of two pressure gauges. The first one monitors the pressure of the gas in the cylinder (when the main valve of the cylinder). The second one monitors the actual pressure of the gas to be released. The regulator also consists of a valve which allows a user to control the flow rate of the gas to be released.</p> 
<p>What liquid is used in a gas bubbler? What is the requirement on the property of the liquid?</p>	<p>Usually glycerol. The liquid needs to have high viscosity and it should not vaporize easily.</p>

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(g) Extreme Temperature

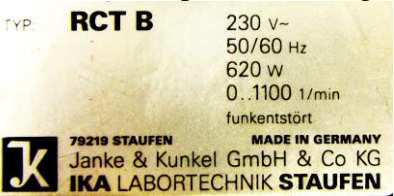

For in-class discussion:

What to discuss (initiated by teacher)	Key points
What are the advantages of using low temperature to speed up crystallization?	<ul style="list-style-type: none">- Larger temperature difference \Rightarrow faster heat transfer \Rightarrow faster cooling down- Lower temperature \Rightarrow lower solubility \Rightarrow more solid formed
What is the temperature of liquid CO ₂ ?	CO ₂ only exists at elevated pressure (> 5.1 atm, at which the temperature is -57 °C)
What kinds of thermometers can be used to measure low temperature? Follow-up: How do you know the working range of a thermometer?	<ul style="list-style-type: none">- Glass thermometers: glass may be broken upon cooling, the liquid inside may not have low enough freezing point (e.g., -114 °C for ethanol, -39 °C for mercury)- Thermocouple and resistance thermometers may work for lower temperature, but not all of them do. - Check the manual of the thermometer.
How do you know that O ₂ is liquefied?	Liquid O ₂ is blue in color.
What should and shouldn't be done when you get a frost bite?	<ul style="list-style-type: none">- Should do: rinse the affected area with warm water.- Shouldn't do: don't rub or massage the affected area.
(For English version only) What is the difference between "suffocation" and "asphyxiation"?	<ul style="list-style-type: none">- Suffocation: you can't breathe in any gas (e.g., under water)- Asphyxiation: you can breathe in gas(es) but the oxygen content is not high enough in the gas(es), so you may also die.

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(h) Electrical hazard

For in-class discussion:

What to discuss (initiated by teacher)	Key points
<p>Overcurrent results in overheating, which, in turn, results in high temperature, and finally fire. What can you tell the current drawn by an electrical appliance or instrument?</p>	<ul style="list-style-type: none"> - There should be a specification on output current for each electrical appliance or instrument, e.g., in the following label, $\text{current} = \text{power} \div \text{voltage} = 2.7 \text{ A}$.  <p>The total current for all appliance or instrument should not exceed the rating.</p> <ul style="list-style-type: none"> - The current actually drawn can also be measured with a plug which shows the current. 
<p>What type of fire extinguishers should be used to put off an electrical fire?</p>	<p>Electrical fire is a Class C fire. Appropriate fire extinguishers include the following types: ABC Dry Chemical, CO₂, and dry chemical.</p>
<p>In some countries, the standard electrical plug consists of two pins. What is the disadvantage of a 2-pin plug, compared with a 3-pin plug?</p>	<p>Both types of plugs consist of a pair of pins for electrical current to pass through (“live” and “neutral”). The third pin in a 3-pin plug connects to the “earth” line which is connected to the metal enclosure and frame of the appliance or instrument for grounding. If there is a leak of electrical current into the enclosure or frame, the current can be brought away from through the “earth” line.</p>

Module and youtube link	QR Code
<p>(a) Personal Protective Equipment http://youtu.be/xrx1ldv-rVo</p>	
<p>(b) Corrosive Chemical http://youtu.be/xOoY7bilN08</p>	
<p>(c) Flammable Substance http://youtu.be/Weji9A0f7EU</p>	
<p>(d) Toxic Chemical http://youtu.be/rBE5ojW1KN0</p>	
<p>(e) Chemical Information: Chemical Labels http://youtu.be/G_ipv6brEGs</p>	
<p>(e) Chemical Information: MSDS http://youtu.be/IFvqZKMajgl</p>	
<p>(f) System under Pressure http://youtu.be/haW3viQQf0k</p>	
<p>(g) Extreme Temperature: Cryogenic Substances http://youtu.be/CVIlCFzrPH8</p>	

(h) Electrical Hazard

<http://youtu.be/zZq9Fy54VKE>

