Chemicals Safety Training in the Empa Lab

What we don‘t know can hurt us

ETH zürich

Empa
Materials Science and Technology

Air Quality & Particle Technology

Dr. Hao Li

2021-12-20

Introduction

Recognizing Chemical Hazards

Minimizing Chemical Hazards in Our Lab

What to Do in Case of Emergency

Golden Rules of Staying Safe

Introduction

- Are you at risk because you work with chemicals?

The answer is: Yes!

- How much the risk?

The answer is: It depends!

- This safety training will attempt to provide some basic information to address your concerns about working with hazardous chemicals.
- Hopefully, it will help you better understand them so you can use them safely and limit your risks.

Chemical Safety and Realities

- **Chemicals** are part of our daily life. Many chemicals can, when properly used, significantly contribute to the improvement of our life and health.

- **Chemical Hazards** are elements and chemical compounds which can negatively affect our health and environment when improperly managed.

- **Exposures** to chemical hazards in the lab can have severe consequences, including death.

- **Chemical Safety** is achieved by undertaking all activities involving chemicals to ensure the safety of human health and the environment. It covers the full range of exposure situations from the natural presence of chemicals in the environment to their extraction or synthesis, industrial production, lab use and disposal.

The first rule of chemical safety is knowing what you are working with!

Recognizing Chemical Hazards

Whether a chemical is hazardous is determined by its physical hazards, health hazards, and environmental hazards

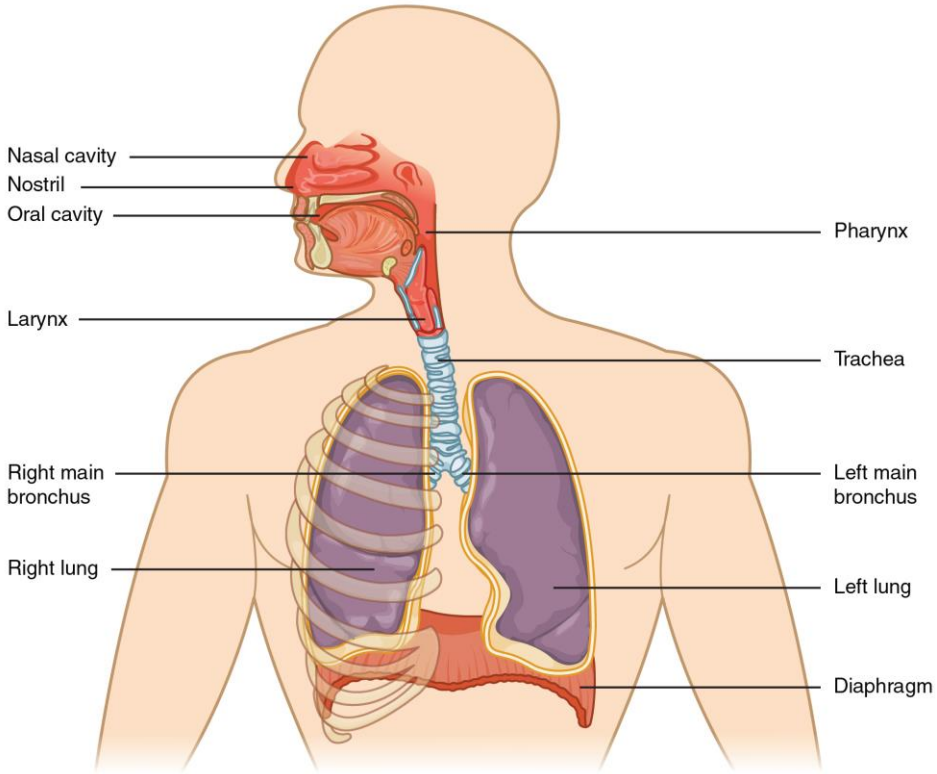
Physical hazards		Health Hazards	Environmental Hazards
Explosives	Self-heating substances	Acute toxicity	Acute Aquatic Toxicity
Flammable gases	Substances which in contact with water emit flammable gases	Skin corrosion	Chronic Aquatic Toxicity
Flammable aerosols	Oxidizing liquids	Skin irritation	
Oxidizing gases	Oxidizing solids	Eye Effects	
Gases under pressure	Organic peroxides	Sensitization (Skin or Eye)	
Flammable liquids	Substances corrosive to metal	Germ cell mutagenicity	
Flammable solids		Carcinogenicity	
Self-reactive substances		Reproductive toxicity	
Pyrophoric solids		Target organ systemic toxicity	
Pyrophoric liquids		Aspiration toxicity	

Keywords: Explosive, Flammable, Oxidising, Gases under Pressure and Corrosive to Metals

Keywords: Corrosive, Toxic, Harmful and Irritant

Health Hazards

*Some chemicals affect specific organs such as your kidneys, liver, reproductive or nervous system.



Hazardous chemicals can enter the body through:

- your lungs if you breath fumes, mists, dust, nanoparticles (Inhalation).
- your skin if liquid or dust touches or spills on you or splashes in your eyes (Absorption & Injection).
- your mouth if you eat after handling chemicals or by accidental swallowing (Ingestion).

- Food and/or drinks provide the opportunity to accidentally ingest chemicals and biologicals.
- Do not store chemicals in a refrigerator used for food storage.
- Do not store food in refrigerators used for chemical storage.

Right-to-Know

Knowing the information about hazardous chemicals that are present in work places available to exposed employees is extremely important!

Health Hazard Pictogram

- Carcinogen
- Mutagen
- Reproductive Toxicity
- Respiratory Sensitizer
- Target Organ Toxicity
- Aspiration Toxicity

Flame Pictogram

- Flammable liquids, solids, and aerosols
- Pyrophorics
- Self-Heating
- Emits Flammable Gas
- Self-Reactives
- Organic Peroxides

Exclamation Mark Pictogram

- Irritant (skin and eye)
- Skin Sensitizer
- Acute Toxicity (harmful)
- Narcotic Effects
- Respiratory Tract Irritant
- Hazardous to Ozone Layer

Gas Cylinder Pictogram

- Gases under Pressure: Substances that are compressed, liquefied, or dissolved at 29 psi or more

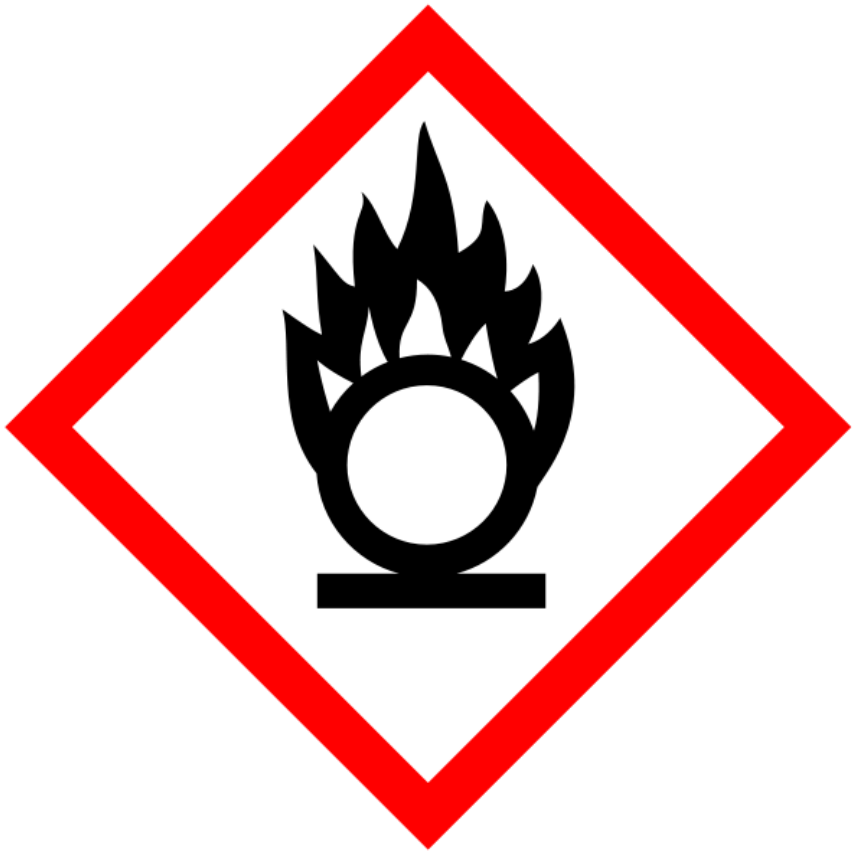
Corrosion Pictogram

- Skin Corrosion/Burns
- Eye Damage
- Corrosive to Metals

Exploding bomb Pictogram

- Explosives
- Self-Reactives
- Organic Peroxides

Flame over circle pictogram

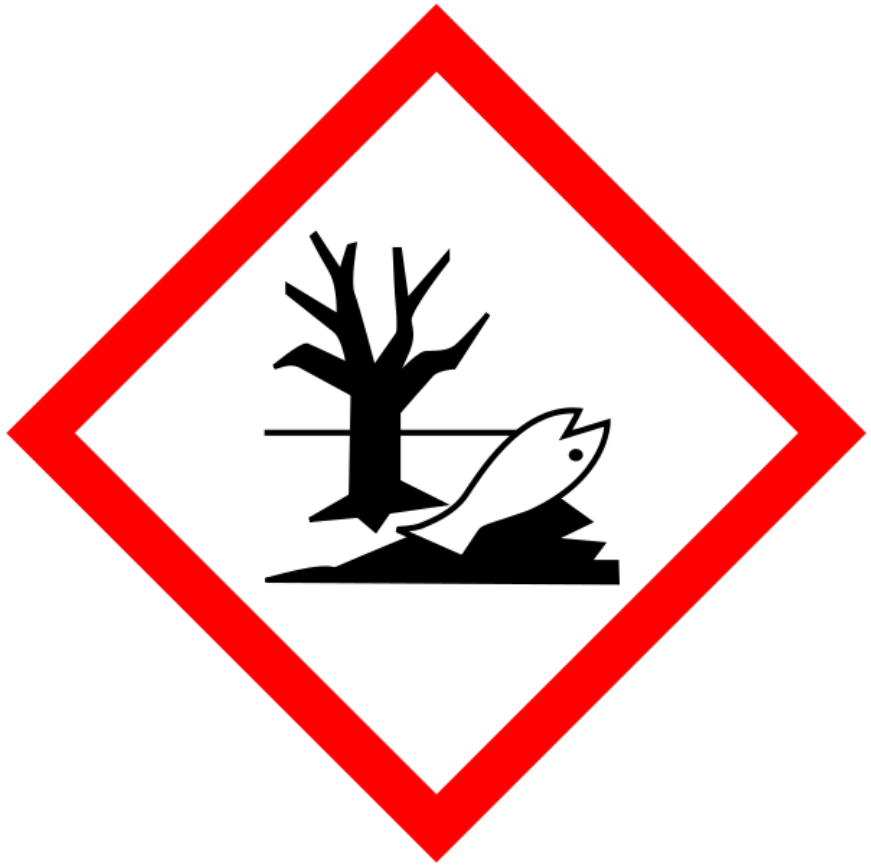


- Oxidizers: Substances that release oxygen to another material for purpose of combustion

Skull and crossbones pictogram

- Acute Toxicity (severe): Overexposure may be toxic or fatal

Environment pictogram



- Aquatic Toxicity: Toxic to plants and aquatic life

Other Pictograms Related to Safety

Biological hazards

Activities with biological material are separated in 4 class, related to the hazard of the strain manipulated, the scale of the activity, the steps, etc.

Nanomaterials

Material whose 50% (at least) particles have one or more dimensions within 1 to 100 nm in size. Nanomaterials can be more harmful than their bulk counterpart.

Laser hazards

Most lasers can cause eye and skin injuries to anyone who is exposed to the direct beam or its reflections.

Cryogenic hazards

Frequently used for cooling systems, cryogenics combine, as for compressed gases, both chemical and physical hazards.

Radioactivity

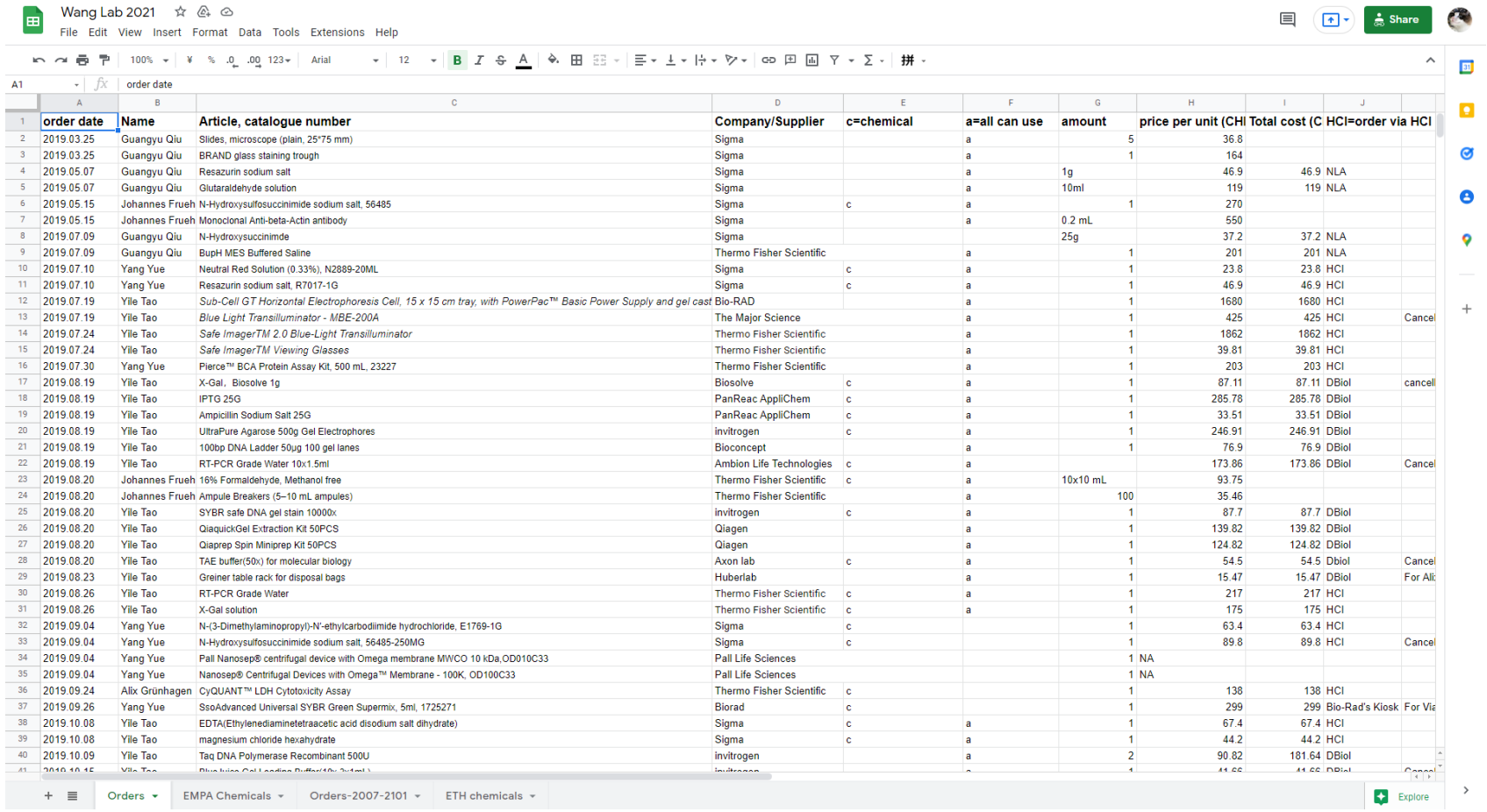
All radioactive activity is monitored and regulated as per legal bases. It is mandatory to follow measures and procedures indicated for any work with radioactive sources.

Static magnetic fields hazard

Magnetic fields generated by magnets are more and more powerful and involve a non negligible risk which must be mitigated.

Minimizing Chemical Hazards in Our Lab

1. Get to know our chemical inventory



Wang Lab 2021

File Edit View Insert Format Data Tools Extensions Help

Share

A1 order date

	order date	Name	Article, catalogue number	Company/Supplier	c=chemical	a=all can use	amount	price per unit (CHI	Total cost (C	HCl=order via HCl	
2	2019.03.25	Guangyu Qiu	Slides, microscope (plain, 25*75 mm)	Sigma		a	5	36.8			
3	2019.03.25	Guangyu Qiu	BRAND glass staining trough	Sigma		a	1	164			
4	2019.05.07	Guangyu Qiu	Resazurin sodium salt	Sigma		a	1g	46.9	46.9	NLA	
5	2019.05.07	Guangyu Qiu	Glutaraldehyde solution	Sigma		a	10ml	119	119	NLA	
6	2019.05.15	Johannes Frueh	N-Hydroxysulfosuccinimide sodium salt, 56485	Sigma	c	a	1	270			
7	2019.05.15	Johannes Frueh	Monoclonal Anti-beta-Actin antibody	Sigma		a	0.2 mL	550			
8	2019.07.09	Guangyu Qiu	N-Hydroxysuccinimde	Sigma			25g	37.2	37.2	NLA	
9	2019.07.09	Guangyu Qiu	BupH MES Buffered Saline	Thermo Fisher Scientific		a	1	201	201	NLA	
10	2019.07.10	Yang Yue	Neutral Red Solution (0.33%), N2889-20ML	Sigma	c	a	1	23.8	23.8	HCl	
11	2019.07.10	Yang Yue	Resazurin sodium salt, R7017-1G	Sigma	c	a	1	46.9	46.9	HCl	
12	2019.07.19	Yile Tao	*Sub-Cell GT Horizontal Electrophoresis Cell, 15 x 15 cm tray, with PowerPac™ Basic Power Supply and gel cast*	Bio-RAD		a	1	1680	1680	HCl	
13	2019.07.19	Yile Tao	*Blue Light Transilluminator - MBE-200A*	The Major Science		a	1	425	425	HCl	Cancel
14	2019.07.24	Yile Tao	*Safe ImagerTM 2.0 Blue-Light Transilluminator*	Thermo Fisher Scientific		a	1	1862	1862	HCl	
15	2019.07.24	Yile Tao	*Safe ImagerTM Viewing Glasses*	Thermo Fisher Scientific		a	1	39.81	39.81	HCl	
16	2019.07.30	Yang Yue	Pierce™ BCA Protein Assay Kit, 500 mL, 23227	Thermo Fisher Scientific		a	1	203	203	HCl	
17	2019.08.19	Yile Tao	X-Gal, Biosolve 1g	Biosolve	c	a	1	87.11	87.11	DBiol	cancel
18	2019.08.19	Yile Tao	IPTG 25G	PanReac AppliChem	c	a	1	285.78	285.78	DBiol	
19	2019.08.19	Yile Tao	Ampicillin Sodium Salt 25G	PanReac AppliChem	c	a	1	33.51	33.51	DBiol	
20	2019.08.19	Yile Tao	UltraPure Agarose 500g Gel Electrophores	invitrogen	c	a	1	246.91	246.91	DBiol	
21	2019.08.19	Yile Tao	100bp DNA Ladder 50µg 100 gel lanes	Bioconcept		a	1	76.9	76.9	DBiol	
22	2019.08.19	Yile Tao	RT-PCR Grade Water 10x1.5ml	Ambion Life Technologies	c	a		173.86	173.86	DBiol	Cancel
23	2019.08.20	Johannes Frueh	16% Formaldehyde, Methanol free	Thermo Fisher Scientific	c	a	10x10 mL	93.75			
24	2019.08.20	Johannes Frueh	Ampule Breakers (5–10 mL ampules)	Thermo Fisher Scientific		a	100	35.46			
25	2019.08.20	Yile Tao	SYBR safe DNA gel stain 10000x	invitrogen	c	a	1	87.7	87.7	DBiol	
26	2019.08.20	Yile Tao	QiaquickGel Extraction Kit 50PCS	Qiagen		a	1	139.82	139.82	DBiol	
27	2019.08.20	Yile Tao	Qiaprep Spin Miniprep Kit 50PCS	Qiagen		a	1	124.82	124.82	DBiol	
28	2019.08.20	Yile Tao	TAE buffer(50x) for molecular biology	Axon lab	c	a	1	54.5	54.5	Dbiol	Cancel
29	2019.08.23	Yile Tao	Greiner table rack for disposal bags	Huberlab		a	1	15.47	15.47	DBiol	For Ali
30	2019.08.26	Yile Tao	RT-PCR Grade Water	Thermo Fisher Scientific	c	a	1	217	217	HCl	
31	2019.08.26	Yile Tao	X-Gal solution	Thermo Fisher Scientific	c	a	1	175	175	HCl	
32	2019.09.04	Yang Yue	N-(3-Dimethylaminopropyl)-N'-ethylcarbodiimide hydrochloride, E1769-1G	Sigma	c		1	63.4	63.4	HCl	
33	2019.09.04	Yang Yue	N-Hydroxysulfosuccinimide sodium salt, 56485-250MG	Sigma	c		1	89.8	89.8	HCl	Cancel
34	2019.09.04	Yang Yue	Pall Nanosep® centrifugal device with Omega membrane MWCO 10 kDa,OD010C33	Pall Life Sciences			1	NA			
35	2019.09.04	Yang Yue	Nanosep® Centrifugal Devices with Omega™ Membrane - 100K, OD100C33	Pall Life Sciences			1	NA			
36	2019.09.24	Alix Grünhagen	CyQUANT™ LDH Cytotoxicity Assay	Thermo Fisher Scientific	c		1	138	138	HCl	
37	2019.09.26	Yang Yue	SsoAdvanced Universal SYBR Green Supermix, 5ml, 1725271	Biorad	c		1	299	299	Bio-Rad's Kiosk	For Via
38	2019.10.08	Yile Tao	EDTA(Ethylenediaminetetraacetic acid disodium salt dihydrate)	Sigma	c	a	1	67.4	67.4	HCl	
39	2019.10.08	Yile Tao	magnesium chloride hexahydrate	Sigma	c	a	1	44.2	44.2	HCl	
40	2019.10.09	Yile Tao	Taq DNA Polymerase Recombinant 500U	invitrogen		a	2	90.82	181.64	DBiol	

Orders | EMPA Chemicals | Orders-2007-2101 | ETH chemicals | Explore

Checking before purchasing!

https://docs.google.com/spreadsheets/d/1BnpL2NX7lUTwlL-5SAu396_2V04F-ZcEzlODNFsmQbM/edit#gid=0

2. Protect yourself when dealing with chemicals

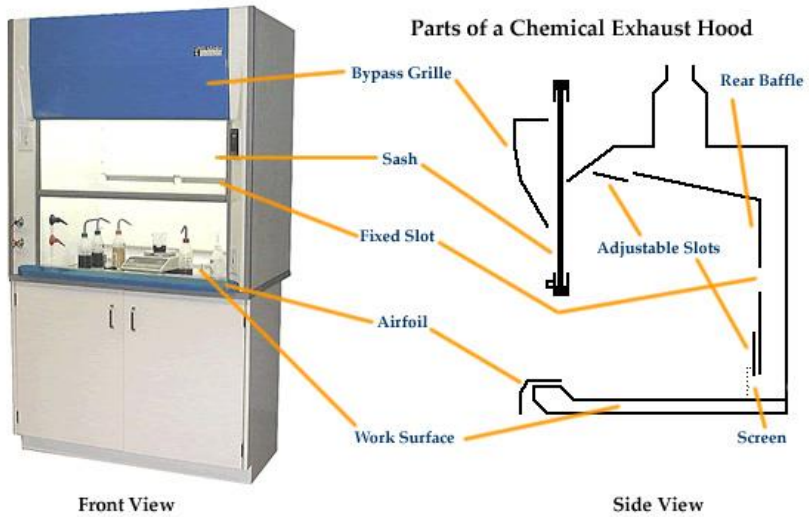
The basic required **Personal Protective Equipment (PPE)**

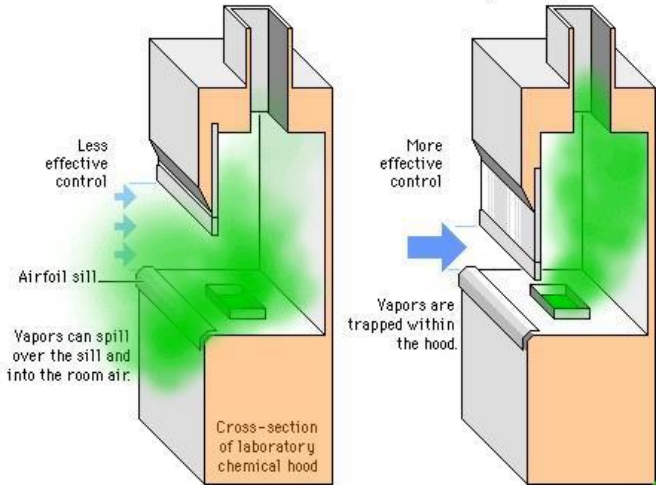
- Lab Coat
- Full length pants
- Closed toe shoes
- Gloves appropriate for the work being conducted
- Use face shield and goggles if there is a splash hazard
- Use the proper respirator for dusts, mists and fumes
- Ensure long hair is tied up and back in such a way as to avoid it falling into your experiment
- Properly clean and store your PPE after use
- Don't take PPE home

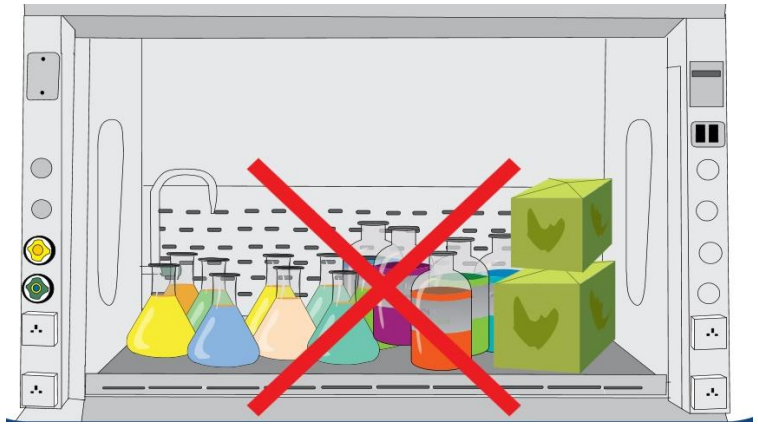
If you are about to use highly agressive chemicals like HF, you should let Prof. Wang know first and then receive verifiable training!

Fume Hoods are ventilated enclosures that protect you from being exposed to chemical fumes, gases and aerosols.

- Hood should always be ON. Ensure it is functioning by closing the sash almost completely and put a tissue at the opening. The tissue should be drawn into the hood.
- If equipped, test that the **air flow alarm** is functioning by opening the sash completely. Lower sash to marked (working level) position – at 6 to 12 inches (15 – 30cm).
- Do not use fume hoods as storage areas.
- Works with easily flammable liquids (flash point <21 °C) and toxic solvents as well as aggressive acids and alkaline solutions must be performed in a ventilated fume hood.







One more tip!

They may look very similar. However, they should never be used inappropriately for items they were not intended for!

Biosafety Cabinet

VS

Fume Hood

Biological Safety Cabinet
Used for work with cells, cultures, & biological agents.
NO VOLATILE CHEMICALS

Fume Hood
Used for chemicals only
NO BIOLOGICALS

3. Label, use, and store the chemicals in a safe manner

Labelling

- Chemical labels provide information on Identity, Hazards and Safe Use. All chemical containers are usually labeled by the manufacturer.
- If chemicals are taken out and placed in another container, this new container must have a label placed on it.

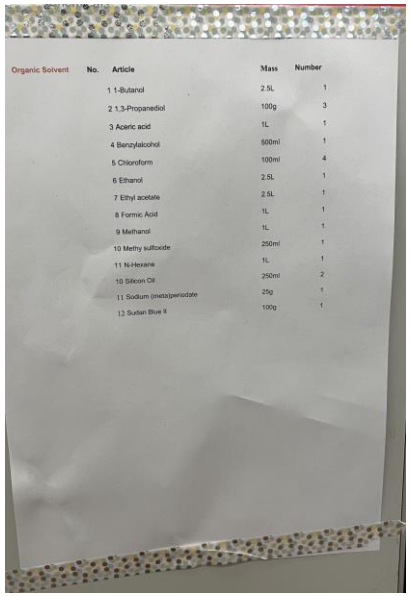
Storage

- Know your Chemical Incompatibilities. Store incompatible chemicals in separated areas.
- Liquid and solid chemicals must NEVER be stored together.
- Organic and inorganic chemicals must NEVER be stored together.
- Limit the amount of flammable material to the minimum needed.
- Store acids or flammable liquids in separated flammable storage lockers.
- Flammable solvents, which are sensitive to heat, may only be stored in special refrigerators protected against explosion.
- Do not store chemicals in a refrigerator used for food storage, and *vice versa*.

Liquid chemicals

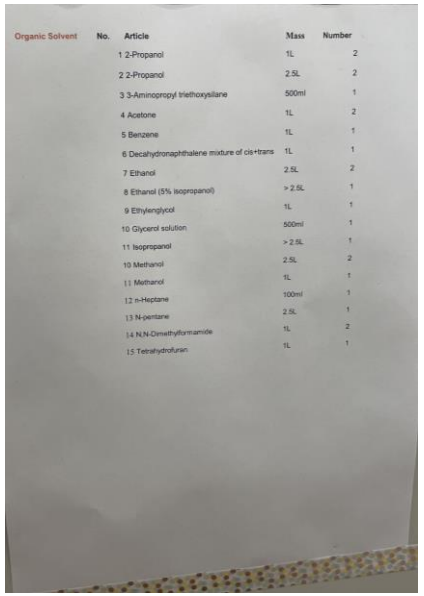
- Store all hazardous liquid chemicals in secondary containment, such as drip trays. This is to minimize the impact and spread of a spill resulting from broken/leaking containers.
- Choose the right trays (photo trays, polypropylene, polyethylene, stainless stell and Pyrex) for certain chemicals. Ask for advice especially if you hope to store highly corrosive chemicals.

Organic solvents I



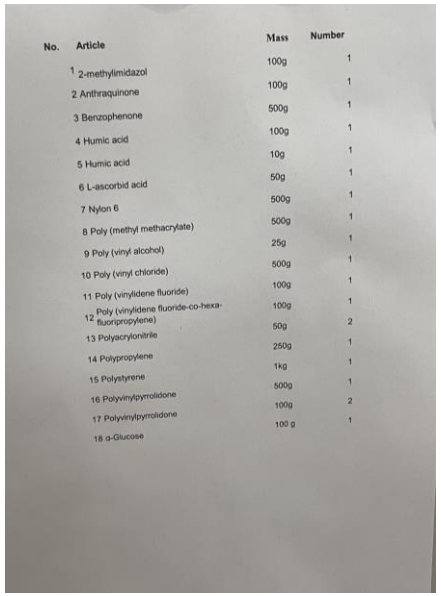
Organic Solvent	No.	Article	Mass	Number
	1	1-Butanol	2.5L	1
	2	1,3-Propanediol	100g	3
	3	Acetic acid	1L	1
	4	Benzylalcohol	500ml	1
	5	Chloroform	100ml	4
	6	Ethanol	2.5L	1
	7	Ethyl acetate	2.5L	1
	8	Formic Acid	1L	1
	9	Methanol	1L	1
	10	Methy sulfoxide	250ml	1
	11	N-Hexane	1L	1
	10	Silicon Oil	250ml	2
	11	Sodium (meta)periodate	25g	1
	12	Sudan Blue II	100g	1

Organic solvents II



Organic Solvent	No.	Article	Mass	Number
	1	2-Propanol	1L	2
	2	2-Propanol	2.5L	2
	3	3-Aminopropyl triethoxysilane	500ml	1
	4	Acetone	1L	2
	5	Benzene	1L	1
	6	Decahydronaphthalene mixture of cis+trans	1L	1
	7	Ethanol	2.5L	2
	8	Ethanol (5% isopropanol)	> 2.5L	1
	9	Ethylenglycol	1L	1
	10	Glycerol solution	500ml	1
	11	Isopropanol	> 2.5L	1
	10	Methanol	2.5L	2
	11	Methanol	1L	1
	12	n-Heptane	100ml	1
	13	N-pentane	2.5L	1
	14	N,N-Dimethylformamide	1L	2
	15	Tetrahydrofuran	1L	1

Polymers and acids



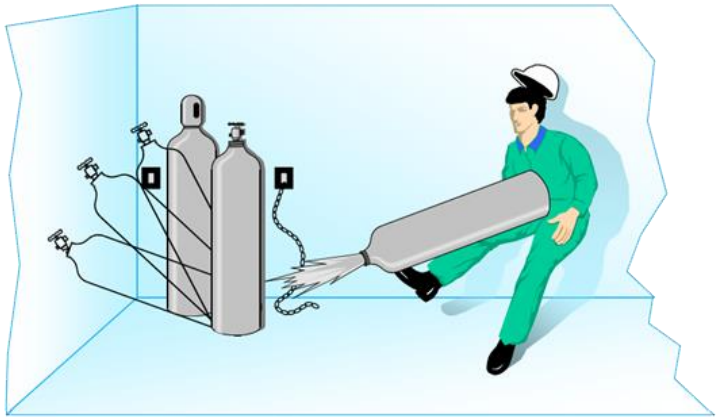
No.	Article	Mass	Number
1	2-methylimidazol	100g	1
2	Anthraquinone	100g	1
3	Benzophenone	500g	1
4	Humic acid	100g	1
5	Humic acid	10g	1
6	L-ascorbid acid	50g	1
7	Nylon 6	500g	1
8	Poly (methyl methacrylate)	500g	1
9	Poly (vinyl alcohol)	25g	1
10	Poly (vinyl chloride)	500g	1
11	Poly (vinylidene fluoride)	100g	1
12	Poly (vinylidene fluoride-co-hexa-fluoripropylene)	100g	1
13	Polyacrylonitrile	50g	2
14	Polypropylene	250g	1
15	Polystyrene	1kg	1
16	Polyvinylpyrrolidone	500g	1
17	Polyvinylpyrrolidone	100g	2
18	α-Glucose	100 g	1

Dry inorganic chemicals

.....

Compressed gas cylinders

- Chain or strap cylinders to a wall or use a cylinder holder.
- Always use a cart & safety chain when transporting cylinders.
- Store flammable gas bottles in vented flammable storage cabinet.
- Keep non-compatible gases separated [O_2 and CH_4].
- No more than 3 flammable, oxygen or hazardous gas cylinders per lab.



What if a compressed gas cylinder is falling down?

The answer is: **Just run** and ask for help.

Use of specific chemical hazards

- Never heat **alkali metals, metal hydrides or organometallic compounds** on a water bath.
- **Biological material**: When working with biological materials such as activated sludge, tissue, body fluids, etc. protective gloves must be worn for protection against infections.
- Works with **cyanides** must strictly follow the safety instructions indicated in the respective protocol. In particular, cyanides must not be poured into the sink or mixed with acids. Residues have to be disposed of in specifically labeled containers.
- **Explosion hazard**: Works with explosion hazards must be carried out behind a protective windowpane.
- **Hydrofluoric acid, fuming nitric acid**: Works with hydrofluoric or fuming nitric acid have to be carried out in a fume cupboard and respecting special protective measures such as wearing double gloves and a closed lab coat and using a facial shield.
- Works with **nanoparticles** must be carried out in a fume cupboard, and a filter mask the type 3M FMP3 must be worn.

4. Dispose of used or unknown chemicals in a safe manner

Used chemicals

- Do not pour chemicals into sinks, onto the ground or in storm drains.
- Chemical wastes must be disposed of properly and keep all wastes correctly separated.
- Empty containers from toxic, reactive, corrosive or flammable chemicals before they are disposed of as waste.
- It is not allowed to dispose of strong acids and alkaline solutions as well as solvents and heavy metal salts into the sewer.
- Concentrated salt solutions are collected in single-use containers and brought to the chemicals collection point of Empa.
- Nanoparticle residues must not be disposed of together with normal lab waste.

Failure of chemicals disposal can result in a violent reaction. Check the label carefully to avoid accidents!

- **Green canisters** for chlorinated solvents.
- **Yellow canisters** for chlorine free solvents including ether with a negative peroxide test.
- **White canisters** for acids or alkaline solutions.

Check safety manual for more info

Safety at Empa Dübendorf

Safety guidelines
for Lab 502
Version 18, April 2021

Unknown chemicals or samples

Street:	Überlandstrasse 129
ZIP:	CH-8600
Location:	Dübendorf
Room:	SH 633
Phone:	4770
Fax:	+41 58 765 11 22
EMail:	matthias.nagel@empa.ch
Deputy 1:	Faller Markus
Add. Info:	Projektbeauftragter im Bereich Risikomanagement. Beauftragter für den übergeordneten Gefahrenbereich (BeG) Chemie/Nano am Standort Dübendorf. Chemikalien-Ansprechperson. Fachspezialist für Arbeitssicherheit EKAS (Sicherheitsfachmann). Sicherheitsschulungen im Bereich Laborsicherheit (Chemie und Nano). Entsogung von Sonderabfällen.

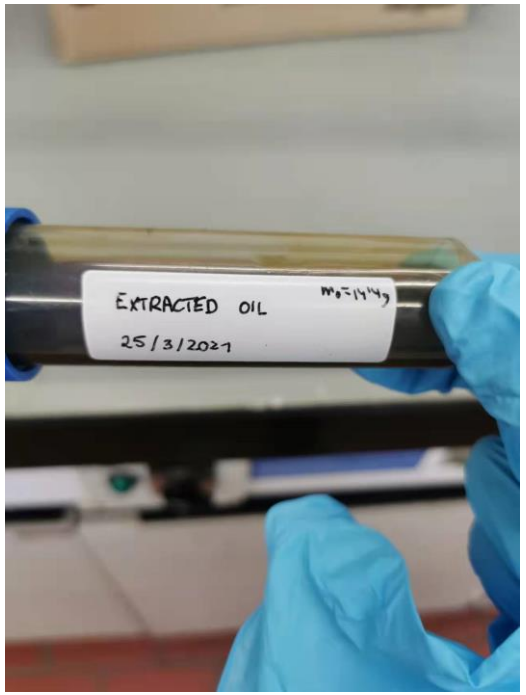
Other lab safety issues

Street:	Überlandstrasse 129
ZIP:	CH-8600
Location:	Dübendorf
Room:	LA 370
Phone:	4403
Fax:	+41 58 765 69 63
EMail:	claudia.schreiner@empa.ch
Deputy 1:	Figi Renato
Add. Info:	anorganische nasschemische Analytik; Stähle; Elementanalytik; Ionenanalytik; Verbrennungsanalytik; Spurenanalytik; Atomspektrometrie; Plasmaspektrometrie

They are very nice and can be extremely helpful to us

in Keeping Us Safe!

5. Dispose of your chemicals or samples after graduation or leaving (suggestion given by Prof. Wang)



These unknown samples or chemicals make our lab chaotic and the deep-cleaning challenging!

Please take care of your chemicals or samples when you are not in Empa anymore!

In Case of Emergency

Two types of spills you need to be aware of

- Spills that are WITHIN your control.
- Spills that are NOT WITHIN your control.

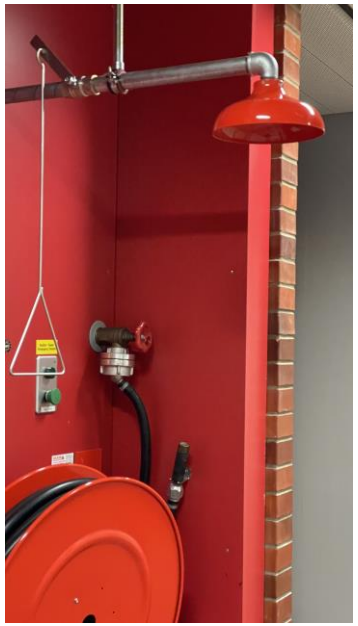
In both cases, ensure you

- Remain calm.
- Ask for assistance from colleagues/lab personnel if needed.
- Alert rescue service (Sanitätsnotruf Empa DU, Tel. 8888) if you are injured.
- Pass the name of the spilled contaminants to the rescue service, isolate the contaminated area, and keep others from entering.
- Notify your supervisor, lab head, and Empa's safety officer about the spill.
- Wait for trained employees to clean up spills.

Chemical works may only be performed during the normal working hours (07:30 a.m. - 04.30 p.m.) and not in the evening or on weekends!

Emergency tools within your reach

Emergency shower

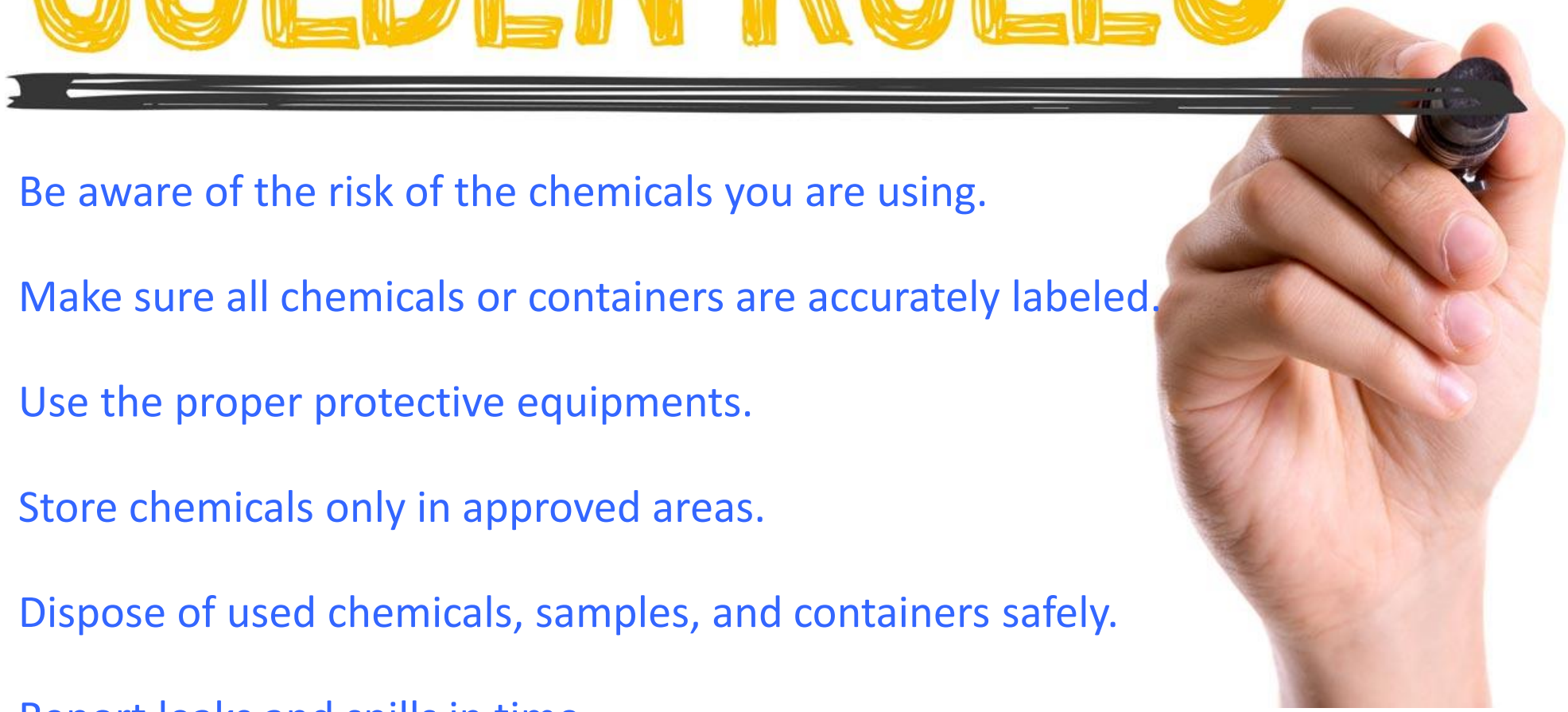


First aid kit: Blood pressure kit, bandages, disinfectant…

In case of chemical contamination of skin, eyes or anatomical airways:

Immediately rinse affected skin and eyes with Diphotérine. Diphoterine solution is an emergency rinsing solution for splashes of chemical products. Its rapid use in case of contact between the skin or eye and a chemical product is intended to quickly eliminate the residual chemical product on the skin or in the eye. This makes it possible to limit the extent of the burns and lesions caused.

GOLDEN RULES



- Be aware of the risk of the chemicals you are using.
- Make sure all chemicals or containers are accurately labeled.
- Use the proper protective equipments.
- Store chemicals only in approved areas.
- Dispose of used chemicals, samples, and containers safely.
- Report leaks and spills in time.
- Reach out for help immediately in case of emergency.

Thanks for your attention!