

Chemical Safety

Asha Bhardwaj

Usasi Chowdhary

Instrumentation and Applied Physics, IISc Bangalore 560012



Examples and analysis of chemical related accidents in the world



Pyrophoric chemical

It ignites on contact with air



*Case of Sheharbano Sangji
UCLA, 2008*

- Improper apparel (Synthetic, no lab coat)
- Working alone.
- She took advice from a senior and did not read about the handling of the chemical herself
- No information was available on how to handle an emergency situation like this, in the lab
- **She died after 18 days of the incident because of severe burn.**

Analysis

1. Appropriate PPE - *Labcoat, appropriate glove*
2. MSDS- Collect Information- Don't Rely on others-seniors
3. INVENTORY of chemicals - in case of emergency
4. Buddy system- *working alone should not be allowed*

Nitric acid *A lot of cases all around the world*

University of Kentucky, 1997



- Common Issue: Mixing nitric acid/ sulfuric acid in organic solvent waste container
- Result: Explosion, Damage, Death

Analysis

- INORGANIC ACIDS AND ORGANIC SOLVENTS SHOULD NOT BE MIXED.
- Always double check the label before pouring anything
- Hoods are not meant for chemical storage.
- Do not perform unauthorized experiments.

Explosion of distillation flask

University of Wisconsin

- Explosion of distillation flask, having **methanol** and **ether** (Ether was old, that lead to some Peroxide formation).
- No lab coat, Synthetic shirt.
- 3rd degree burn, Shard of glass severed his artery in his left arm.
- **Life was saved due to immediate action of a colleague, within 5 min reached the hospital.**



Analysis

- Extra careful with chemicals which can lead to peroxide formation example ethers, Butadiene, hydrated picric acid that becomes dry, alkyl nitrates etc
- Do not use old chemicals
- It is very essential to label the chemical for its date of entering lab and date of opening

HF-Hazards- very small amount can be deadly

Chemistry Centre of Western Australia

- Splashing of 100-230 ml of 70% concentrated hydrofluoric acid on both thighs.
- PPE Used- Two pairs of wrist length rubber gloves, polyvinyl chloride (PVC) sleeve protectors.
- Only water flushed, No **calcium gluconate gel** applied and contaminated cloths were not removed immediately
- **Initially sustained burns 9% of the body surface area**
- **After seven days, right leg amputated. 15 days later, died because of several organ failure.**

Analysis

- 1. Appropriate PPE - *Labcoat, appropriate glove***

- 2. Know first aid requirement**
 - (a) Irrigation-15-30 min**
 - (b) Calcium Gluconate Gel-*neutralizes/deactivate Fluoride ion***

- 3. Don't sit and work in Chemical lab**

Dimethyl Mercury- very small amount can be deadly

Dr Karen Wetterhahn of Dartmouth College, New Hampshire, United States



- While pipetting a small amount of **dimethyl mercury** under a fume hood, a **drop or two** of the colourless liquid on her latex glove.
- Improper PPE, followed all the other safety protocols
- **Five months later, she died because of mercury poisoning**

Analysis

1. Know your Chemicals-MSDS- Collect Information

2. Appropriate PPE - *Labcoat, appropriate glove*

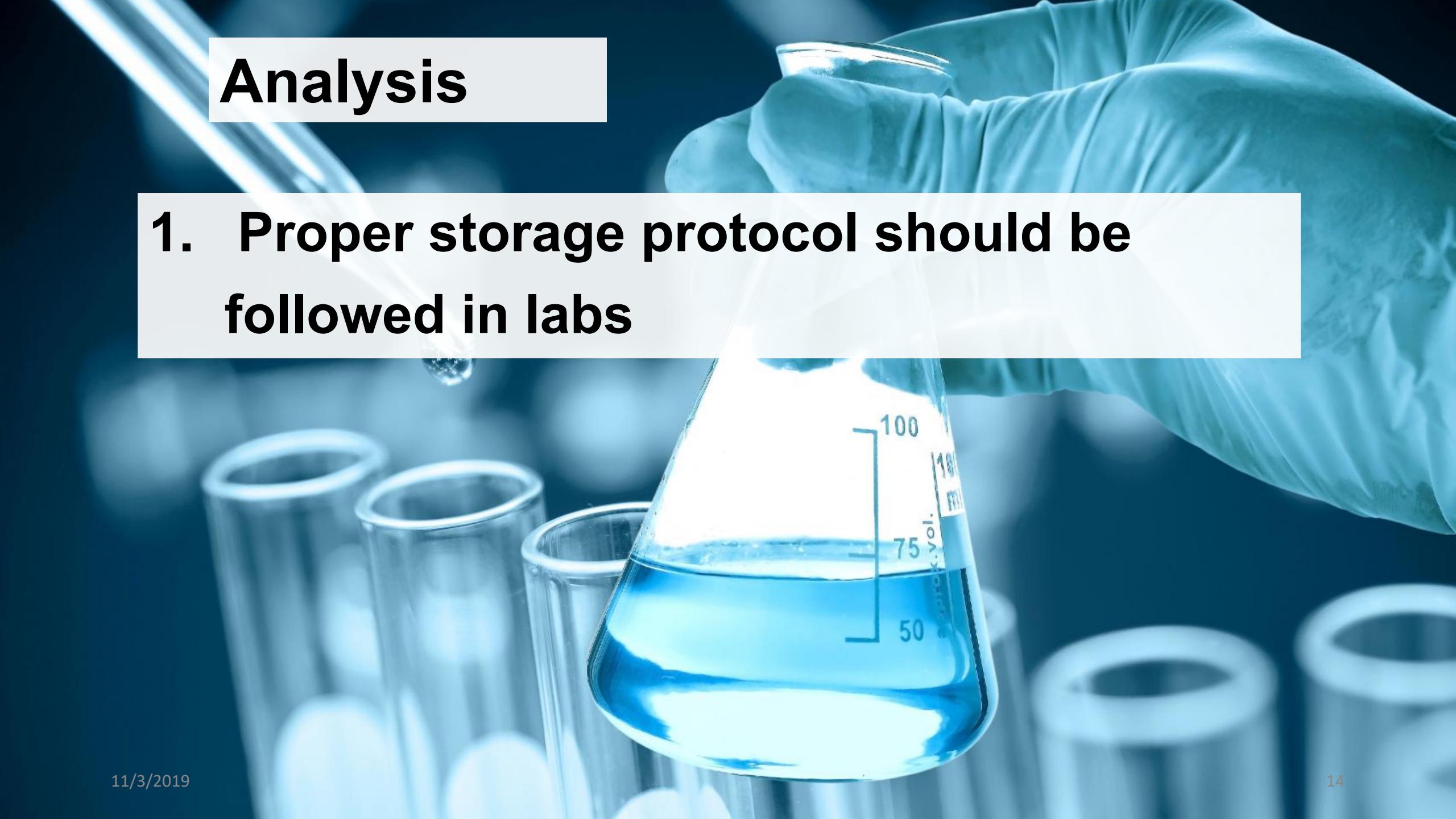
Improper storage of chemicals

UC Santa Cruz

- 4 litre glass bottle of cyclohexane kept on the ground without any secondary containment near fume hood.
- Get kicked over by mistake, Liquid fell down and went under the refrigerator.
- Ignition
- Flash fire burnt the student's face, damage the lab.

Analysis

- 1. Proper storage protocol should be followed in labs**



Outline

- Understanding **type of chemicals**
- **Personal Protection equipment-PPE**
- **Statement of Purpose-SOP-MSDS files**
- **General Lab rules**
- **Chemical transport**
- **Chemical spill**
- **Chemical Waste**
- **Emergency contacts –list should be in each lab**

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Flammables and Combustibles



- Easily ignited and may present a serious fire and explosion hazard.
- Flash point below 38 °C.
- Combustible -38 -93°C
- Acetone, Ethyl ether, Iso propyl Alcohol.



Incompatibles- Oxidizers and toxics

Sources of ignition:

- Open flames
- Hot surfaces
- Electrical sparks

Store flammables separate from other hazard classes, especially oxidizers and toxics. Store flammable liquids in approved safety containers or cabinets.



Corrosives



Strong acids and bases can destroy human tissue and corrode metals.

Organic Acids
acetic acid
citric acid
formic acid

Inorganic Oxidizing Acids
chromic acid
nitric acid
sulfuric acid

Bases
calcium hydroxide
potassium hydroxide

- Acids and bases are incompatible with one another
- Segregate acids from bases
- Segregate inorganic oxidizing acids (e.g., nitric acid) from organic acids (e.g., acetic acid), flammables, and combustibles.
- Don't store on Metal Shelves, use plastic trays as secondary containers

Pyrophorics + Water reactive



Substances that ignite spontaneously upon contact with air/water.

Sodium

Finely divided metal

Diborane (Gas)

Magnesium

Aluminum chloride (anhydrous)

Sodium

- Store in a cool, dry place. Stored under an atmosphere of inert gas.
- Take extreme care to prevent contact with **MOISTURE**
- Use within **ONE YEAR**.
- PPE: Closed toed leather shoes, Proper lab attire

Peroxide Forming Chemicals

Over a period of time, these chemicals can form peroxides that may explode when the cap is removed or when they are concentrated during laboratory activities.

Example: Isopropyle ether, Butadiene, hydrated picric acid that becomes dry

- It is important to note on the container the date the chemical arrived in the laboratory,
- when it was opened, when it should be tested for peroxide concentration, and when it should be discarded.
- Test all peroxide forming chemicals prior to distillation, regardless of age.
- Stored away from light and heat, with tightly secured caps.

Oxidizers



Oxidizers are a fire hazard. They will readily decompose under certain conditions to yield oxygen or react to promote or initiate the combustion of flammable or combustible materials.

**Chromic acid
Nitric acid**

Ammonium nitrate

- Do not store oxidisers in wooden cabinets or on wooden shelves.
- Do not return unused material to the original container
- No oxidiser shall be disposed of into the sewer

Toxics/Highly Toxic



Highly Toxic: These chemicals can cause serious injury or death at medium-low concentrations.

Toxic: Cadmium Chloride

Highly Toxic: Organic Mercury compounds

- Maintain the lowest possible quantities of highly toxics
- Store in an area that is cool, well ventilated, and away from light and heat

Pictograms

Physical Hazards



Exploding Bomb
Explosives
Self Reactives
Organic Peroxides



Flame
Flammables
Emits Flammable Gas
Pyrophorics
Water Reactives
Self-Heating
Self Reactives
Organic Peroxides



Flame Over Circle
Oxidizers

Health and Physical Hazards



Corrosion
Corrosive to Metals
Skin Corrosion
Serious Eye Damage

Environmental Hazards



Environment
Environmental Toxicity

Health Hazards



Skull and Crossbones
Acute Toxicity (Severe)



Exclamation Mark
Acute Toxicity (Harmful)
Dermal Sensitivity
Skin and Eye Irritation
Narcotic Effects
Respiratory Tract Irritation



Health Hazards
Carcinogenicity
Respiratory Sensitivity
Reproductive Toxicity
Mutagenicity
Target Organ Toxicity
Aspiration Toxicity



Personal Protection Equipment (PPE)

Absolute essential



Eye safety glasses



Labcoat



Gloves

- PPE should not be taken to your sitting area
- PPE should be worn and removed in a proper order
- PPE should be stored in a separate cabinet

Sequence of putting ON Personal Protective equipment

1. GOWN

- Fully cover torso from neck to knees, arms to end of wrists, and wrap around the back
- Fasten in back of neck and waist



2. MASK OR RESPIRATOR

- Secure ties or elastic bands at middle of head and neck
- Fit flexible band to nose bridge
- Fit snug to face and below chin
- Fit-check respirator



3. GOGGLES OR FACE SHIELD

- Place over face and eyes and adjust to fit



4. GLOVES

- Extend to cover wrist of isolation gown



How to safely remove Personal Protective equipment

1. GLOVES

- Outside of gloves are contaminated!
- If your hands get contaminated during glove removal, immediately wash your hands or use an alcohol-based hand sanitizer
- Using gloved hand, grasp the palm area of the other gloved hand and peel off first glove
- Hold removed glove in gloved hand
- Slide fingers of ungloved hand under remaining glove at wrist and peel off second glove over first glove
- Discard gloves in a waste container



2. GOGGLES OR FACE SHIELD

- Outside of goggles or face shield are contaminated!
- If your hands get contaminated during goggles or face shield removal, immediately wash your hands or use an alcohol-based hand sanitizer
- Remove goggles or face shield from the back by lifting head band or ear pieces
- If the item is reusable, place in designated receptacle for reprocessing. Otherwise, discard in a waste container



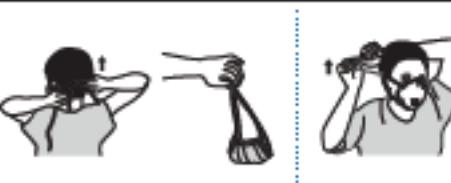
3. GOWN

- Gown front and sleeves are contaminated!
- If your hands get contaminated during gown removal, immediately wash your hands or use an alcohol-based hand sanitizer
- Unfasten gown ties, taking care that sleeves don't contact your body when reaching for ties
- Pull gown away from neck and shoulders, touching inside of gown only
- Turn gown inside out
- Fold or roll into a bundle and discard in a waste container



4. MASK OR RESPIRATOR

- Front of mask/respirator is contaminated — DO NOT TOUCH!
- If your hands get contaminated during mask/respirator removal, immediately wash your hands or use an alcohol-based hand sanitizer
- Grasp bottom ties or elastics of the mask/respirator, then the ones at the top, and remove without touching the front
- Discard in a waste container



5. WASH HANDS OR USE AN ALCOHOL-BASED HAND SANITIZER IMMEDIATELY AFTER REMOVING ALL PPE



Gloves



Latex

Not chemical resistant



Nitrile

Chemical resistant



F-Teflon Gloves

Used in the case of HF/BHF



Rubber Gloves

Chemical leaks cleaning/
Clean containers using baths

Personal Protection Equipment (PPE)



**Gowning for HF
handling**

Lab Footwear



Thick, fully covered Shoes

Outline

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- **Statement of Purpose-SOP-MSDS files**
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Standard operating Procedure (SOPs)-Use MSDS files

Standard Operating Procedures for Chemicals or Processes		
#1 Process (if applicable)		
#2 Chemicals and Hazards		
#3 Personal Protective Equipment (PPE)		
#4 Environmental/ Ventilation Controls		
#5 Special Handling Procedures & Storage Requirements		
#6 Spill and Accident Procedures		
#7 Waste Disposal		
#8 Special Precautions for Animal Use (if applicable)		
Particularly hazardous substance involved?	<input type="checkbox"/> YES:	Blocks #9 to #11 are Mandatory
	<input type="checkbox"/> NO:	Blocks #9 to #11 are Optional.
#9 Approval Required		
#10 Decontamination		
#11 Designated Area		
Name: <i>[Signature]</i>	Title:	Date:

- **Make a SOP** for each reaction and chemical that you are going to use
- Can be for a **single chemical**, a **group** of similar chemicals, or a process
- **Check incompatibility**
- **Check precautions in handling and storage**
- Enlist the **safety measures** required to work with the chemical.
- Check what to be done-In case of **skin contact or spill/emergency**

What is MSDS files?

Material safety Data sheets

3/10/2019

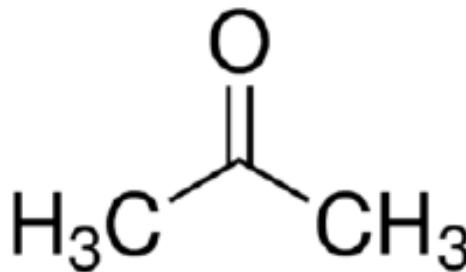
Acetone, HPLC Plus, for HPLC, GC, and residue analysis, ≥99.9% | CH₃COCH₃ | Sigma-Aldrich[India Home](#) 650501 - Acetone**SIGMA-ALDRICH®**

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CAS Number 67-64-1 | Linear Formula CH₃COCH₃ | Molecular Weight 58.08 | Beilstein Registry Number 635680 | EC Number 200-662-2 | MDL number MFCD00008765
eCI@ss 39021201 | PubChem Substance ID 329760025

[SDS](#) [Specification Sheet \(PDF\)](#)[Similar Products](#)

SKU-Pack Size Availability

Price (INR) Quantity

650501-1L

Available to ship on 11.03.2019 - FROM

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Properties

11/3/2019

33

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General Lab rules

- Chemical segregation (and storage) and knowledge of incompatibility of chemicals
- no chemicals bottles SHOULD be left open - unattended
- no chemical bottles must be opened outside fumehood
- Do not work alone in lab
- Good house keeping can prevent accidents too. A cluttered lab is a dangerous lab.
- Maintain chemical lab book- about list of chemicals, where are they are stored, what precautions each requires, what ppe each requires, and what steps to follow in case of emergency

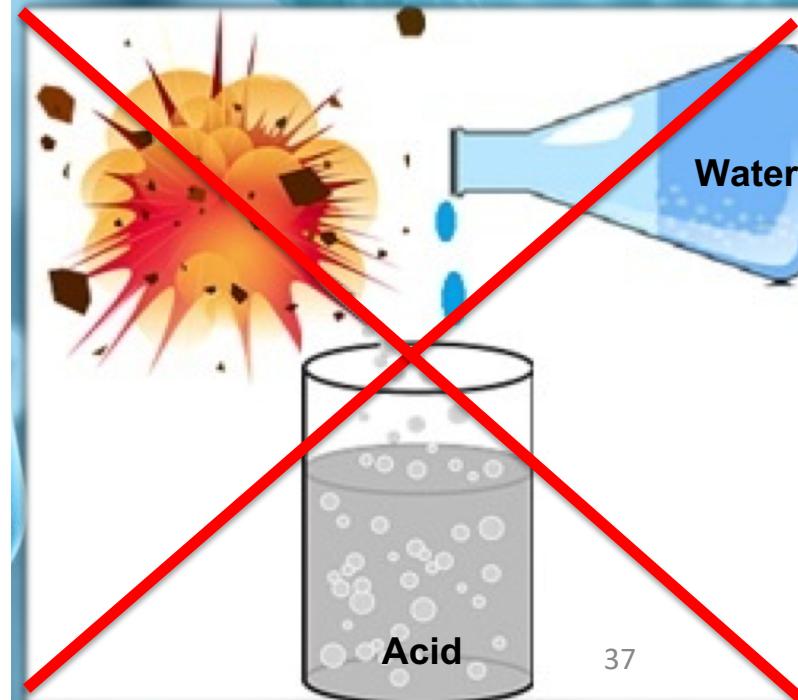
General Lab rules

- Report any abnormality, Discuss.
- Don't admit strangers in the lab.



Lab Protocol

- Inventory
- Label all bottles
- Never **mouth-pipette**.
- Do not smell or taste chemicals.
- **AAA** rule: Always Add Acid (dilute concentrated acids by adding the acid) to water.
- Leave benches, balances etc. clean & tidy after use.
- Never eat, drink or smoke in a laboratory
- Never touch your face, mouth or eyes
- Never suck pens or chew pencils kept in lab
- Tie back long hair.
- Working **ALONE**- Not allowed



Chemical Storage

- ✓ Incompatibles should be stored in separate areas
- ✓ Order Minimum amount possible
- ✓ Go for a less dangerous alternative
- ✓ Do not store ACIDS in flammable liquid storage cabinets
- ✓ Do not store chemicals in direct sunlight or next to heat sources

Chemical Storage

- Label all chemical bottles-mark the date of opening



- Flammables must be stored in metallic cabinets



- Use secondary container/trays to store chemical bottles
- NO chemicals should be stored ABOVE EYE LEVEL
- Separate and dedicated area for storage- Never store- where experiment is going on



Fumehood

- For the handling of **TOXIC, FLAMMABLE, OR CORROSIVE MATERIALS, Exothermic Reactions.**
- Do not allow gloves, paper towels, plastic, or foil to be sucked into the back of the hood.
- **MINIMIZE** use for storage.
- Never **LEAN** your head inside.
- Never **CLOSE** non-bypassed fume hood completely.
- Close the Sash as low as possible while working

Chemical spills

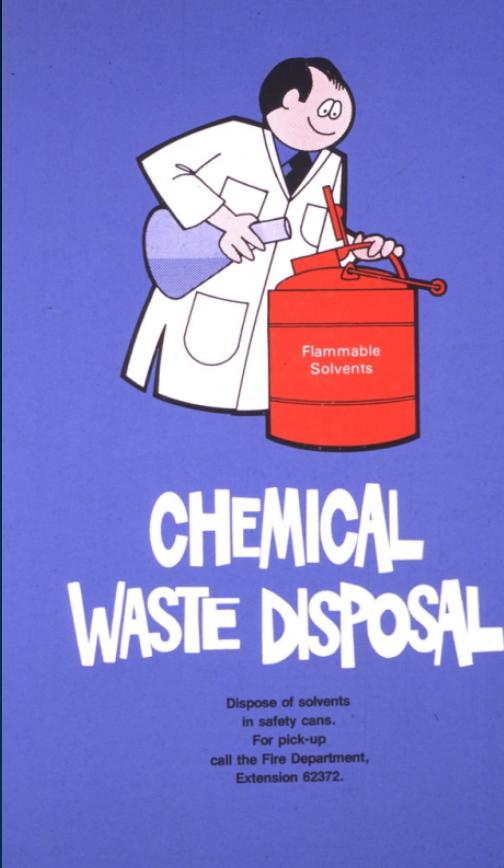


Attempt to deal with chemical spills if:

- ✓ You are in no danger, you are not alone and you have a path to retreat.
- ✓ You have appropriate PPE and a spill kit.

Use a **commercial kit or absorbent material** from your spill kit to absorb spilled materials.

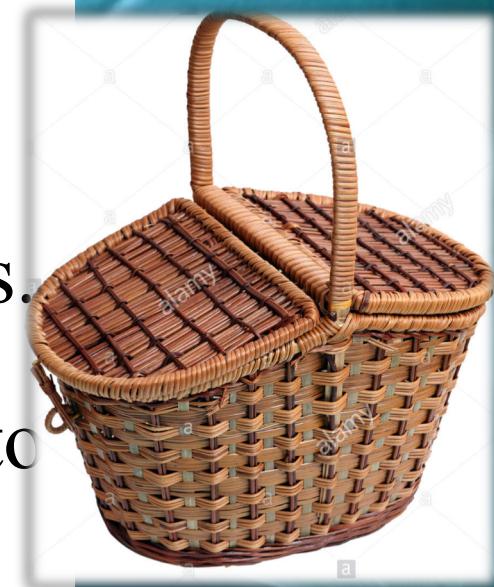
Chemical Waste



- Waste should be segregated carefully
- Use **OPEN, COMPATIBLE** and **LABELLED** container.
- Filled containers of chemical wastes must be **REMOVED** from the laboratory within **90 days of the accumulation start date**
- Always dispose of broken glass in a glass bin or sharps bin.

Chemical transport

- ✓ Chemical containers must be securely **closed** and carried within **secondary container**.
- ✓ **Secondary** containment to transport any chemicals.
- ✓ Wear PPE while carrying chemicals from one lab to another
- ✓ There should be at least 2 inch head space above the liquid surface in the chemical container.



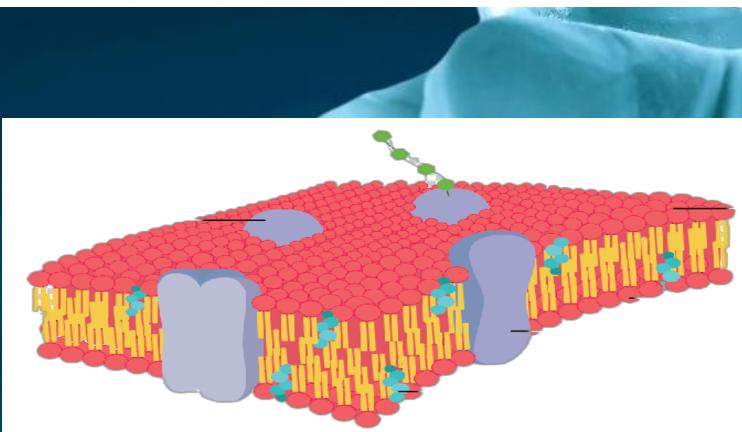
In Case of Emergency (Chemical specific)

- IF INHALED: Remove person to fresh air and keep comfortable for breathing. Call a POISON CENTER/doctor if you feel unwell.
- IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
- If eye irritation persists: Get medical advice/ attention.
- Dermal contact- Rinse 15-30 mins

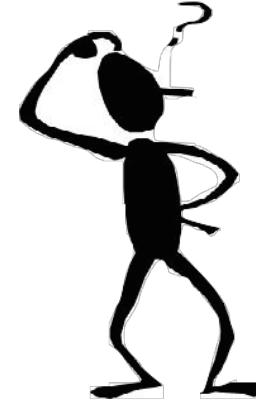
Nano particle Handling



Specific
Mask (N100-
N95),
Proper PPE



HAZARDS???



Small enough to penetrate
into skins and mixed with
blood



Always
double gloves

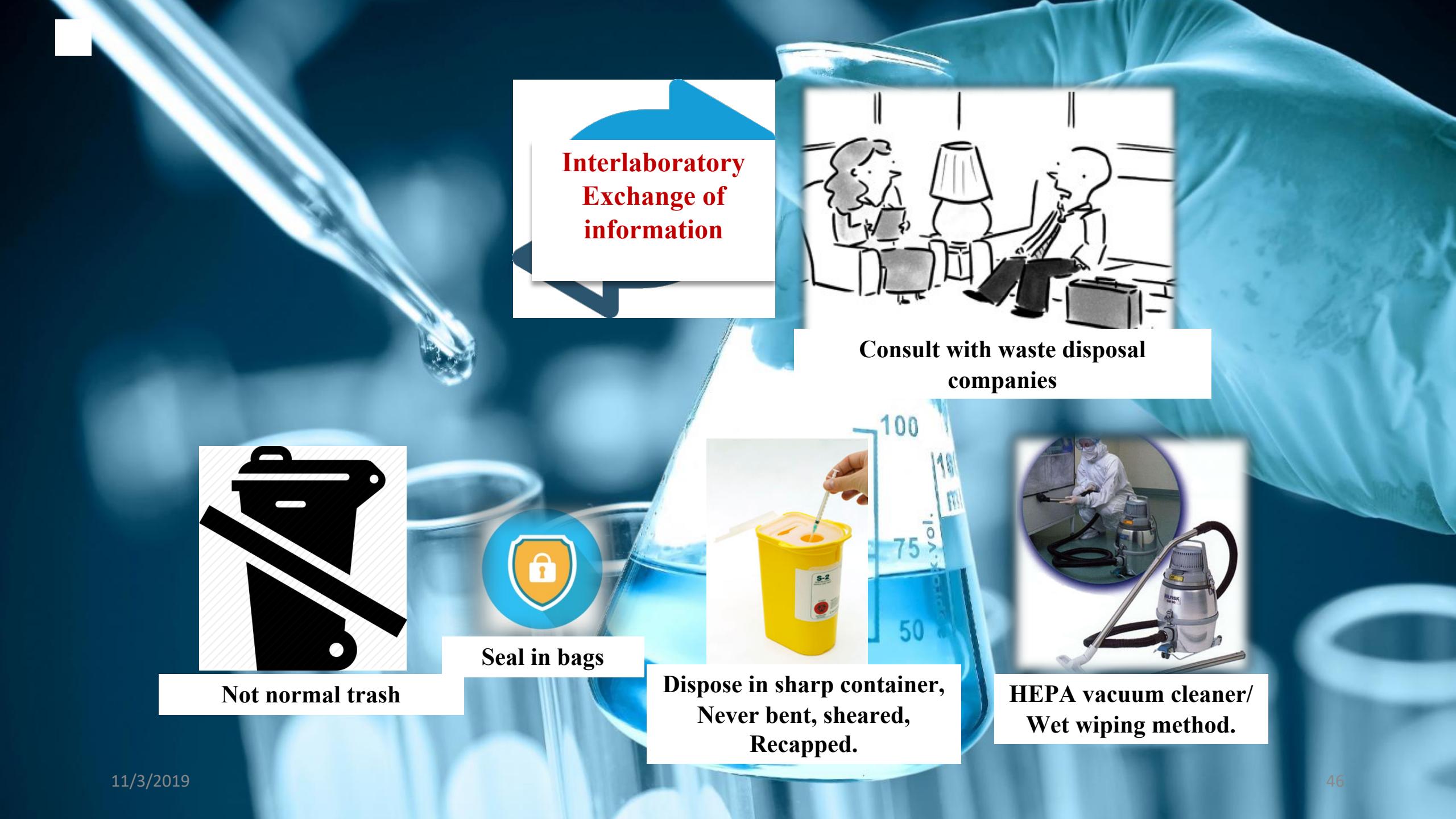


Use Fume Hood/ Ducted
Biological Safety Cabinet

ASBESTOS parallel?
New age PLASTIC?



Search for health
effects in literature



Interlaboratory Exchange of information



Consult with waste disposal
companies



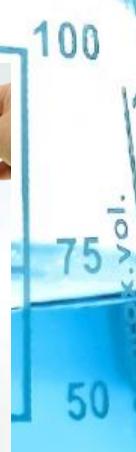
Not normal trash



Seal in bags



Dispose in sharp container,
Never bent, sheared,
Recapped.



HEPA vacuum cleaner/
Wet wiping method.



Stay Safe