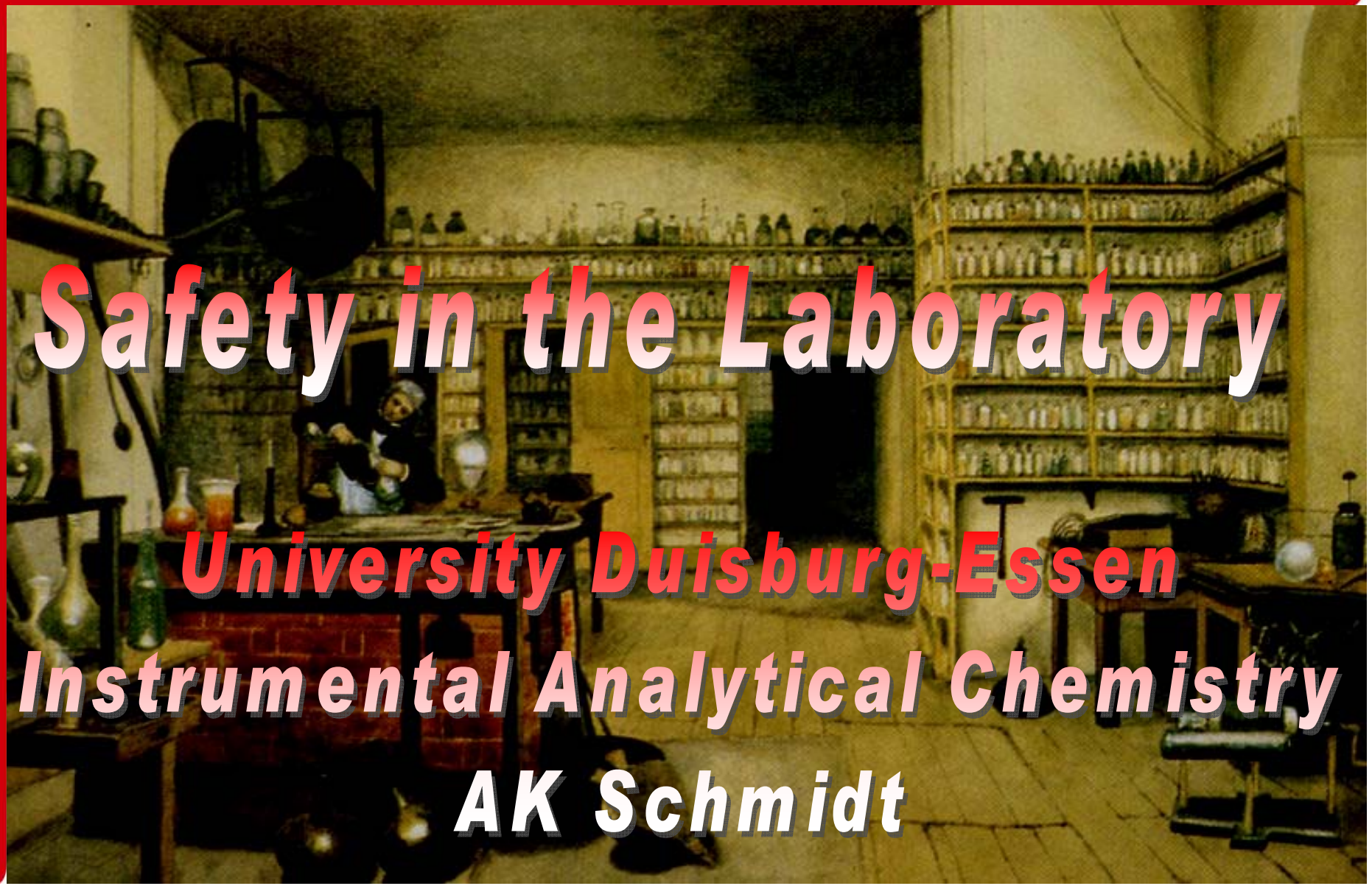
Department of Chemistry
Chair of Instrumental Analysis

UNIVERSITÄT
DUISBURG
ESSEN



Safety in the Laboratory

University Duisburg-Essen

Instrumental Analytical Chemistry

AK Schmidt

Content

- General rules for laboratories
- Escape routes and gathering places
- Personal safety
- Safety installations
- Accidents in the Laboratory and their prevention - First aid
- Lab installations

General rules for laboratories

1. Eating, drinking and putting on make-up is not allowed.
2. Smoking in the lab is not allowed.
3. Mobile phones have to be turned off in the lab.
4. Personal protection such as goggles, cotton lab coat, solid shoes, long trousers have to be worn in the lab.
5. Storage of food and make-up is not allowed in the lab.
6. If you find something extraordinary, e.g. an instrumental error, you have to inform your supervisor.

General rules for laboratories

6. Working without safety introduction is not allowed.

7. People not affiliated in the lab course or that are not a member of the working group are not allowed to enter the lab without permission of the safety instructor.

8. Supervisor instructions have to be followed.

9. Only the lab journal, the instructions, a calculator and a pen are allowed to bring into the lab. (Bags, jackets etc… have to be stored outside the lab.)

10. It is not allowed to work alone in the lab.

11. Never take chemicals out of the lab !

Not allowed in the Lab !

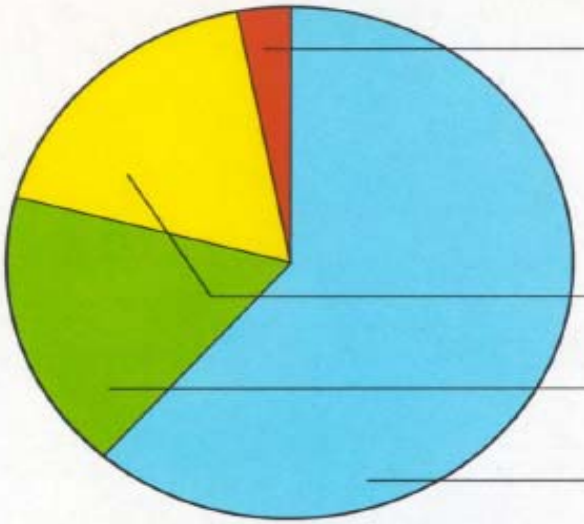
- Smoking is not allowed

- Eating and drinking is not allowed as well as putting on make-up

- No mobile phones

Accidents in the lab

Meldepflichtige Unfälle
(> 3 Tage Ausfallzeit)



Chemietypisch	**2,7 %**
davon Vergiftungen	0,6 %
Verätzungen	2,1 %
Andere Ursachen	**97,3%**
davon Stolpern, Stürzen, Umknicken	18,1 %
Maschinen und Fahrzeuge	18,3 %
Sonstige, z.B. Anstoßen, Quetschen, Schneiden	60,9 %

Erstmals entschädigte Unfälle
(> 20 % Erwerbsminderung)

Chemietypisch	**1,2%**
davon Vergiftungen	0,2 %
Verätzungen	1,0 %
Andere Ursachen	**98,8%**
davon Stolpern, Stürzen, Umknicken	27,4 %
Maschinen und Fahrzeuge	26,0 %
Sonstige, z.B. Anstoßen, Quetschen, Schneiden	45,4 %

Personal safety

Safety clothes in the lab

Lab coat (cotton, **no synthetic**)

Long trousers

Solid shoes

Goggles

Gloves when working with chemicals

Long trousers and solid closed shoes

Wear long trousers made of cotton, e.g. jeans.

Wear only closed and solid shoes!
Never open shoes such as flip flops!

Lab coats

Lab coats should have long arms !

The material should be cotton and not synthetic ! (synthetic will melt and melt with the skin)

It should be white to see potential contaminations !

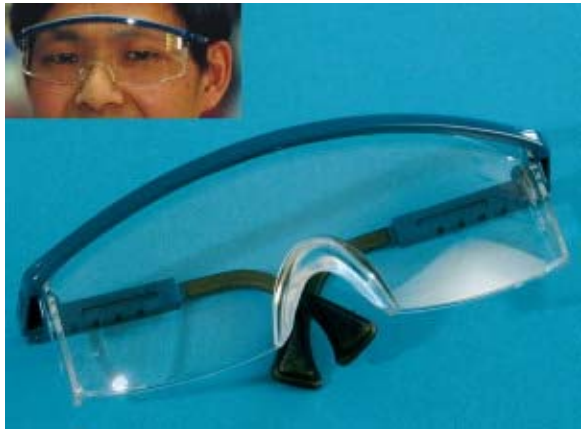
Put it on before entering the lab !

The lab coat has to be closed by the buttons! (If possible safety buttons.)

Never eat or drink if you wear the lab coat !

Eye protection

Mechanical effect, heat, chemicals or energy emissions can hurt the eyes.
In most cases, such injuries can be prevented by the use of suitable **safety glasses**.



You should **not wear contact lenses** when handling chemicals, since they can strengthen the effect of chemicals penetrating between lens and eyes and, in some cases, certain chemicals make the removal of the lenses difficult!

Goggles

It is not allowed to enter the lab without goggles !

The googles should follow the german norms for laboratories.

Never use cheap goggles from the tool market!

Importance of eye protection

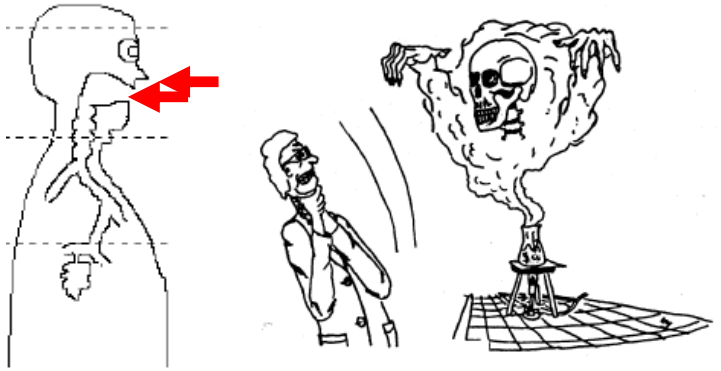
Basic burning with sodium hydroxide solution

Mit Ätznatron hantiert
Schwere Augenverletzungen

PLOCHINGEN (hg) – Ein 53jähriger Angestellter, der weder Schutzbrille noch Handschuhe oder Schutzkleidung trug, wurde bei der Reinigung eines Stahltanks in einer Plochinger Brauerei mit einer Lauge schwer verletzt. Beim Vermischen des pulverförmigen hochkonzentrierten Ätznatrons mit Wasser kam es zu einer explosionsartigen chemischen Reaktion. Der Mann zog sich schwere Verätzungen im Gesicht und vor allem in den Augen zu.

Respiratory Protection

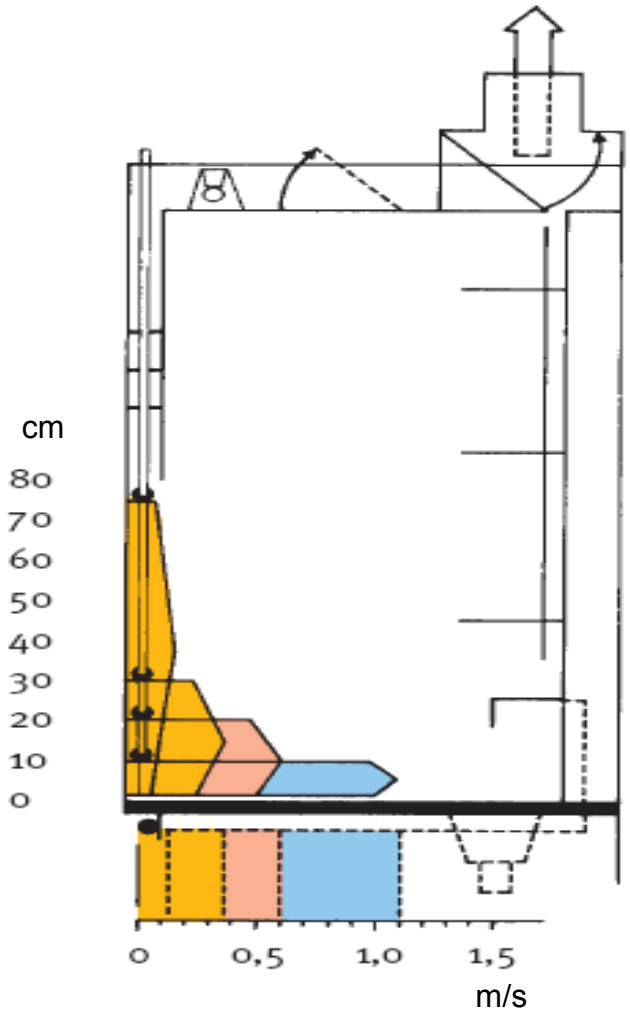
- The respiratory system and lungs can be damaged by dust, chemical gas or steam,and different types of gases.



- Thus, chemical or chemical reactions which can develop harmful steams or gases, should be performed under the fume hood, with the ventilation switched on and the front shields closed whenever possible.

- The possibilities for respiratory protection are easy enough, from a simpledust respirator to half masks.

Fume hoods



An open fume hood is useless !

Work through the windows !

Chemical resistance of gloves

Substance	Resistance time	
	Latex	Nitril
Acetone	> 10 min	0
Acetonitrile	> 10 min	0
Cyclohexane	> 10 min	> 480 min
Ethylacetate	0	> 10 min
Hexane	> 10 min	> 480 min
Toluene	0	> 10 min
Benzene	0	> 10 min
Methylenchloride	0	0

Skin care in the lab

Put on skin protection cream before start working

Wash your hands after working in the lab (especially before eating)

Put on skin protection cream after washing your hands.

Accident in the lab

1. Secure the scene of the accident / Protect yourself
2. Emergency call /First aid
3. Further first aid / Wait for the rescue service

4. Rescue service
5. Hospital

Emergency call

Give the following information's:

Who ? (Name)
Were ? (Labor MF 214)
What? (Event: burning, caustic burning, fire etc.)
How many people injured persons?

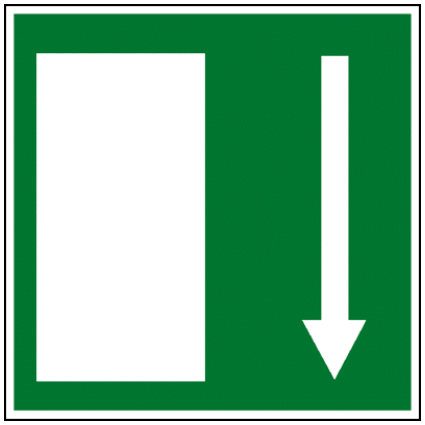
Stay at the telephone for check backs.

Where are safty/rescue installations & escape routes?

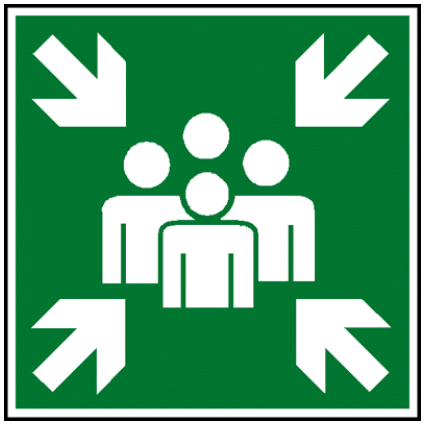
- **How can I find them?**
  - **Fire safty installations**
  - **Rescue installations**
  - **Escape routes**

Escape routes and gathering places

Escape routes



Gathering places



In case of fire signal

Do not use the lifts !

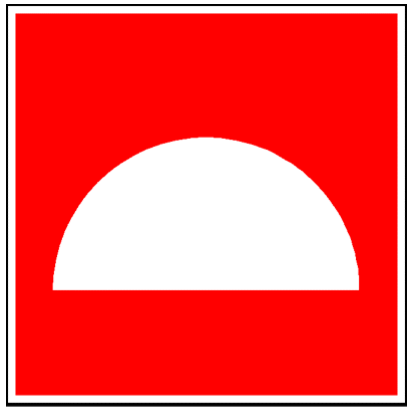
Close the windows if possible.

Keep calm and go to a gathering place.

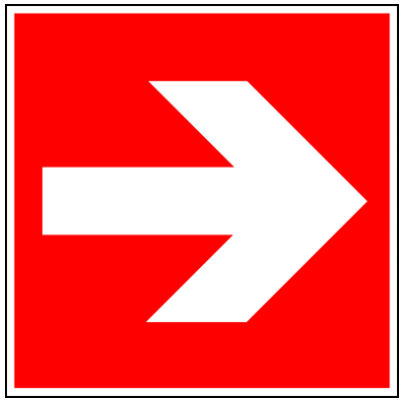
At the gathering place !

- Keep calm !
- Calm down shocked people ! (Talk with this people.)
- Check if everybody is out of the building.
- Stay at the gathering place, do not go home before the supervisor allows this.
- Do not hinder the rescue personal.

Fire safety installations



Fire safety installation



Way to fire safety installation

Fire extinguisher

Fire classes

Fire class A
Fires of solid substances, mainly of organic nature
e.g. wood, paper, straw, coal, textiles, plastics, tyres

Fire class B
Fires of liquids or melted substances,
e.g. fuels, oils, fat, resin, varnish, wachs, tars, alkoholes

Fire class C
Fires of gases,
e.g. methane, propane, hydrogen, acethylene, town gas, natural gas

Fire class D
Fire of metals
e.g. aluminium, manganese, lithium, sodium, potassium and their alloys

Fire Exhauster

Use of fire exhauster

Use of fire exhauster

wrong

rigth

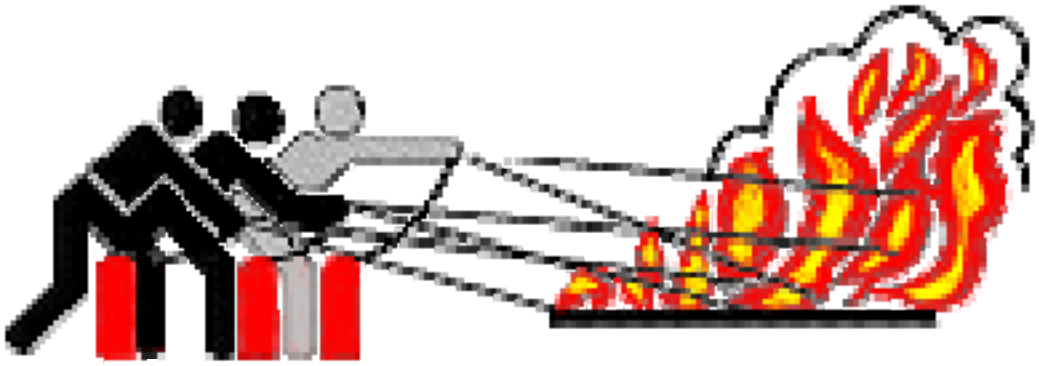
Use of fire exhauster

wrong

correct

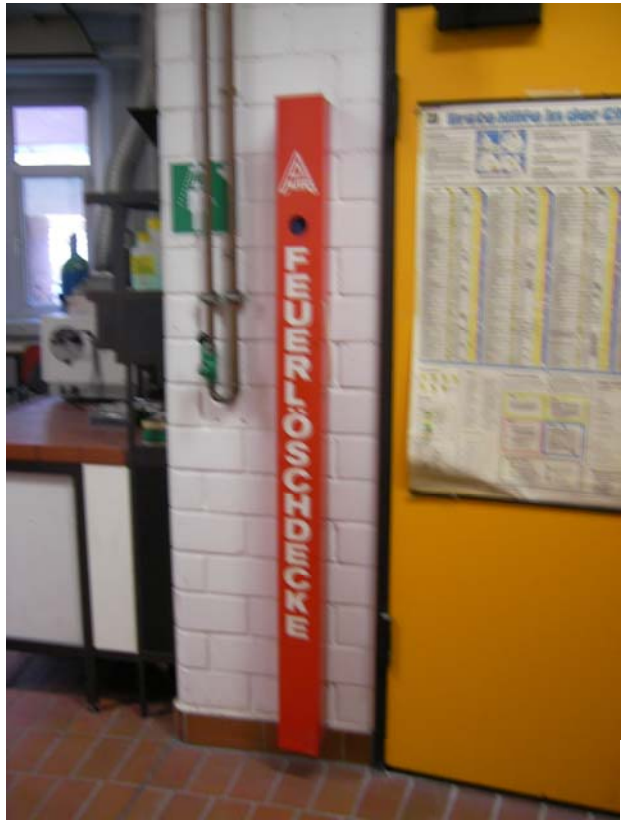
Using fire exhausters

Remark!
In case of bigger fires use a few fire exhausters parallel.



Fire blanket

The coated fire blanket is made of thermo glass and is heat resistent up to 1250°C.



Burns

After extinguishing fire, immediately remove clothing that does not stick to the skin. Cool burned area of skin with cold water until pain is relieved (20 to 30 minutes). Then afterwards, seek further medical treatment!

- Skin only reddened: Repeat cooling of area if pain returns; if large area is affected, seek medical treatment.

- Blistering: Do not use ointments! Do not perforate blisters. Seek medical treatment.

First aid kit

- First aid

Bandage protocol

Every injury has to be protocolled in the bandage protocol.

Lfd. Nr.	Name des Verletzten bzw. Erkrankten	Angaben zum Hergang des Unfalls bzw. des Gesundheitsschadens			
		Datum und Uhrzeit	Ort (Unternehmensteil)	Hergang	Namen der Zeugen
1	2	3	4	5	6

Art und Umfang der Verletzung bzw. Erkrankung	Erste-Hilfe-Leistung		
	Datum und Uhrzeit	Art und Weise der Maßnahmen	Name des Ersthelfers
7	8	9	10

- Lab shower

- Eye effusion shower

Eye affusion shower

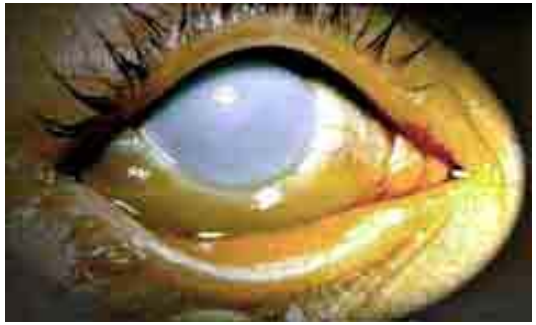
Eye injuries

If **chemicals** come in contact with the eyes, they must be rinsed at least 10 to 15 minutes with the help of an eye bath or calmly flowing lukewarm water jet.
A second person should keep the eyes of the victim open.
If wearing contact lenses, immediately remove them.

Eyes must be rinsed carefully with long flushing after coming into contact with the following substances:

- hydrofluoric acid
- alkaline compounds (soda -, caustic potash solution, ammonia, amines, etc.)

Acid burning of the eye


Different degrees of acid burning of the eye

Basic corrosion of the eye

Eye injuries

Never try to neutralize penetrated substances with other chemicals!
Call the emergency to bring victim to the ophthalmic clinic only **after** flushing

If **foreign bodies** (e.g., glass fragments) penetrate into the eyes:
- the victim must be prevented from rubbing the eyes
- if necessary, flush eyes as described above.
-only loosely sitting foreign bodies may be removed, e.g., with the cornerof a clean cloth, never with tweezers. **Never try to remove imbedded foreign bodies!**

- Transport victim to eye clinic in **lying position**.

Caustic Burns

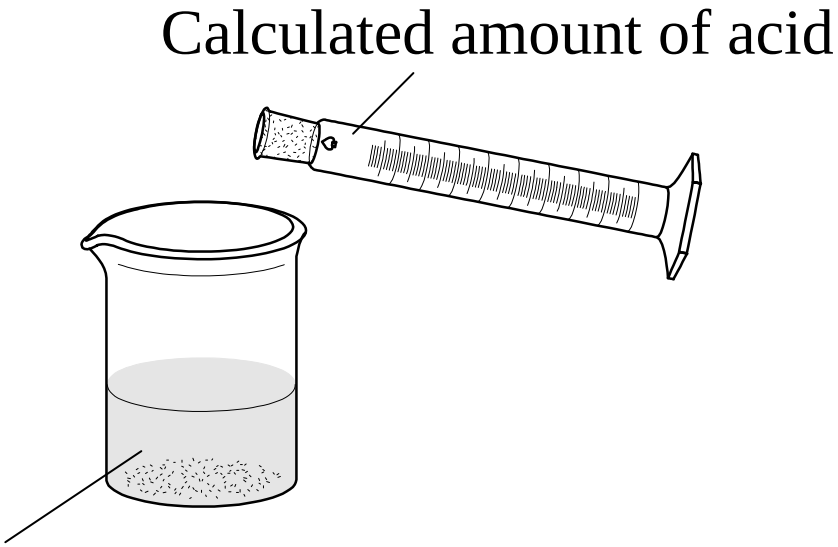
Immediately take off contaminated clothes; do not use anymore. Rinse affected area with large quantities of water. Remove organic substances with soap and water, never with solvents (alcohol etc.).

Emergency call !

H_2O_2
$FeCl_3$ solution
H_2SO_4
HCl
HNO_3
HF

Dilution of acids and bases

„Erst das Wasser, dann die Säure,
sonst geschieht das Ungeheuere!“



Cuts and gashs

A) Glassware

B) - Cracked glassware has to be thrown away (Glasswaste! Not into the normal waste!)
- Glass tubes or rods have to be rounded in the flame
- Glasstubes have to be hold directly at the stopper

C) Ligth bleedings: - do not wash out

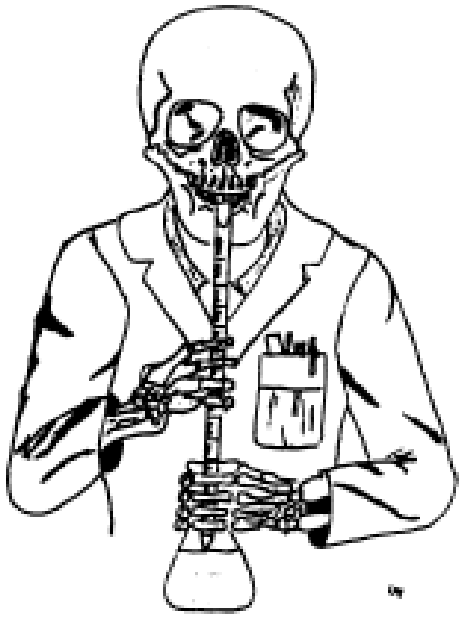
- **- Do not remove alien elements**
- **- Plaster**
- **Bleedings:**
- **- compression bandage**
- **- pressing the artery**
- **- (Bandage !) Wirte down the time!**

Risk of glasware

Damaged glassware should be disposed directly

Attention when removing rubber from glassware

A technique you should not use!



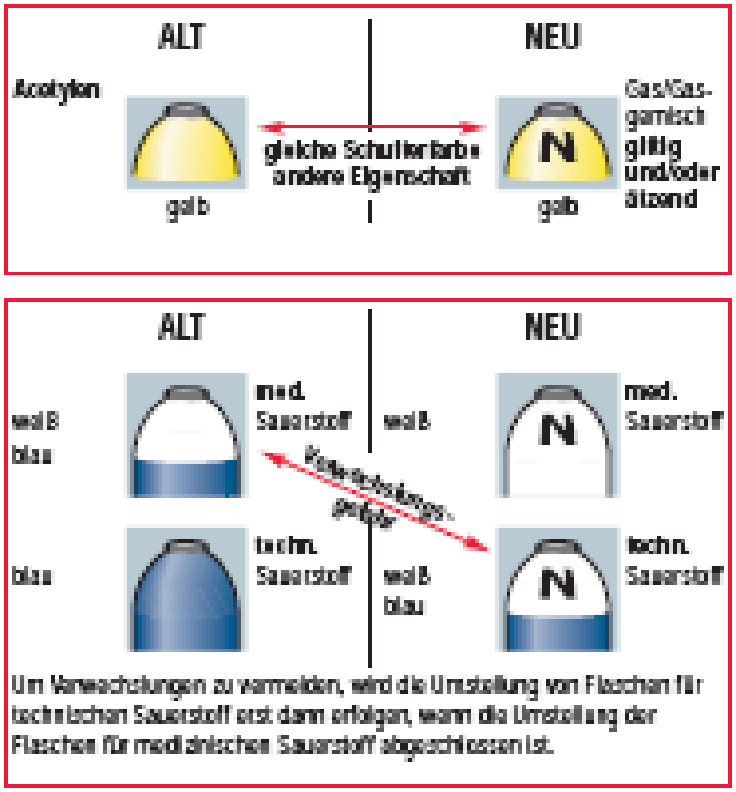
Never use your mouth to suck Chemicals into pipettes!

Carrying chemicals

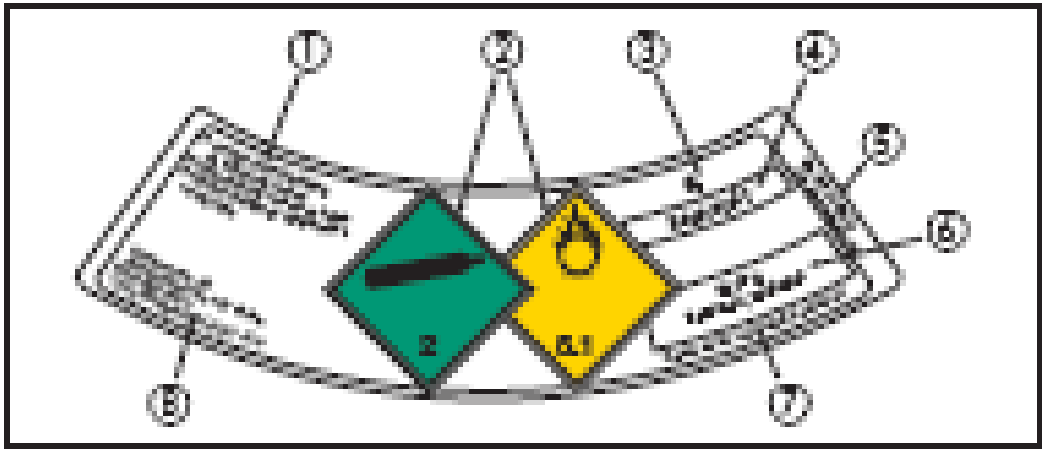
Bottles have to be carried in a box or a bucket.

Evacuation of glass bodies

What kind of gas is in the bottle ?



What kind of gas is in the bottle ?



What kind of gas is in the bottle ?

Eigenschaften	Schulterfarbe		Beispiele
giftig und/oder ätzend [1]	gelb		Ammoniak, Chlor, Arsin, Fluor, Kohlenmonoxid, Stickoxid, Schwefeldioxid
entzündbar [2]	rot		Wasserstoff, Methan, Ethylen, Formiergas Stickstoff/Wasserstoffgemisch
oxidierend [3]	hellblau		Sauerstoff-, Lachgasgemische (außer Inhalationsgemische, Tafel 3)
erstickend [4]	leuchtendes Grün		Krypton, Xenon, Neon, Schweißschutzgasgemische, Druckluft technisch.

1) Abgrenzung giftig/nicht giftig und ätzend/nicht ätzend siehe ADR/RID Anl.A 2.2.2 u. P200 (SV 100) bzw. Kennzeichnung in diesem Fall auf Verwendung medizinischen Gewebes

2) Abgrenzung brennbar/nicht brennbar siehe ADR/RID Anl.A 2.2.2 u. P200 (SV 120-2)

3) Abgrenzung oxidierend/nicht oxidierend siehe ADR/RID Anl.A 2.2.2 u.P200 (SV 120-2)

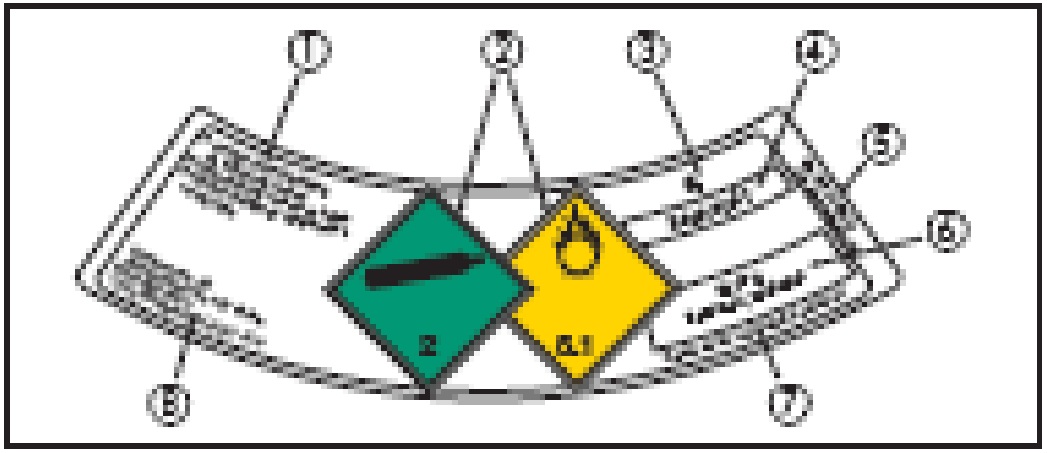
4) Die Farbe leuchtendes Grün darf nicht für Luft zur Inhalation angewendet werden.

Die Schulter wird nur mit der Farbe der primären Gefährdung gekennzeichnet. Auf die farbliche Darstellung von 2 Gefährdungseigenschaften (z.B. giftig/ätzend und entzündbar) in Form von Ringen oder Quadranten wird verzichtet.

Gas	Schulterfarbe		Gas	Schulterfarbe	
Acetylen	kastanienbraun		Stickstoff	schwarz	
Sauerstoff	weiß		Kohlendioxid	grau	
Distickstoffoxid (Lachgas)	blau		Helium	braun	
Argon	dunkelgrün				

Gas/Gasgemisch	Schulterfarben	
Synthetische Luft/ Druckluft für Atemzwecke Für Sauerstoffgehalte zwischen 20 – 22 %	weiß/schwarz	
Gemisch Sauerstoff/Helium Für alle Sauerstoffkonzentrationen	weiß/braun	
Gemisch Sauerstoff/Kohlendioxid Für alle Sauerstoffkonzentrationen	weiß/grau	
Gemisch Sauerstoff/Distickstoffoxid Für alle Sauerstoffkonzentrationen	weiß/blau	

What kind of gas is in the bottle ?



Kennzeichnung von Druckgasflaschen TRGS/DIN EN

Gas	Color	Thread
Acetylene	yellow	Shackle thread
Other burneable gases	red	Left turn thread
Oxygen	blue	Right turn thread
Nitrogen	green	Right turn thread
Compressed air	gray	Right turn thread
Other not-burneable gases	gray	Right turn thread

Transport of gas cylinders

- Transport compressed gas bottles only with the **valve protection cap** in place.
- Always **use a cart when moving bottles**, especially if the regulator is already installed and the valve protective cap cannot be put in place.
- Secure the gas bottle chain during transport.
- **Never attempt** to roll, tow along, or drag over the ground a gas bottle. Avoid dropping and striking gas bottles against each other.

Storage of gas cyclinders

- Compressed gas bottles may be stored, over long periods of time, only in dry,
- well-ventilated, fireproof areas.

- The storage installations of combustible gases must be explosion-proof, and the area should be clear of any sources of heat or ignition. **The laboratory is not asuitable place for the storage of gas bottles!**

- Fittings must be in place, which **prevent** the **gas bottles from falling over**. It is advisable to separate the bottles according to their type (flammable, corrosive, not flammable).

- Empty and full bottles must be stored separately. Empty bottles should be clearlymarked (e.g., tape with label).

Using gas cylinders 1

Withdrawal of gas (not on the first withdrawal)

- 1. Check whether the locking screw is closed; otherwise, close.
- 2. Open cylinder valve slowly and without jerking (only with the hand!).
- Afterwards, examine whether the bolt connection between the cylinder valve and the
- pressure-relief valve is not leaky (for example, with soapy water, never with open
- flame). Leakages are to be repaired immediately.
- 3. Examine the working pressure on the operating pressure manometer. Do not exceed maximum pressure (usually marked red).
- 4. Open locking screw slowly. The gas will now flow out.

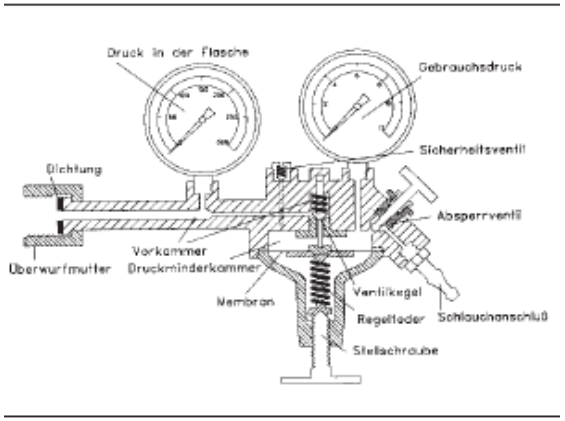
Placing Out of Operation

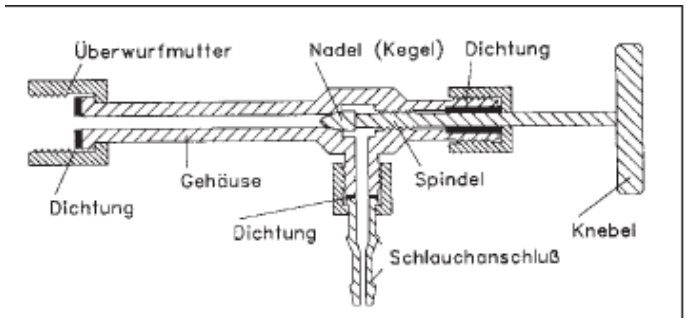
- 1. Close cylinder valve.
- 2. Close locking screw.
- 3. With corrosive gases, the pressure-reduction valve should also be unscrewed and
- flushed with dry nitrogen.
- With toxic gases, flush whole system, if possible.

Using gascylinders 2

- Gas bottles should never completely emptied. They should always have an **excess pressure of at least 2 bars** left over. Empty bottles must be clearly marked as such.
- Return the gas bottles ***before*** **the expiration date** to the distributor.

Pressure regulation

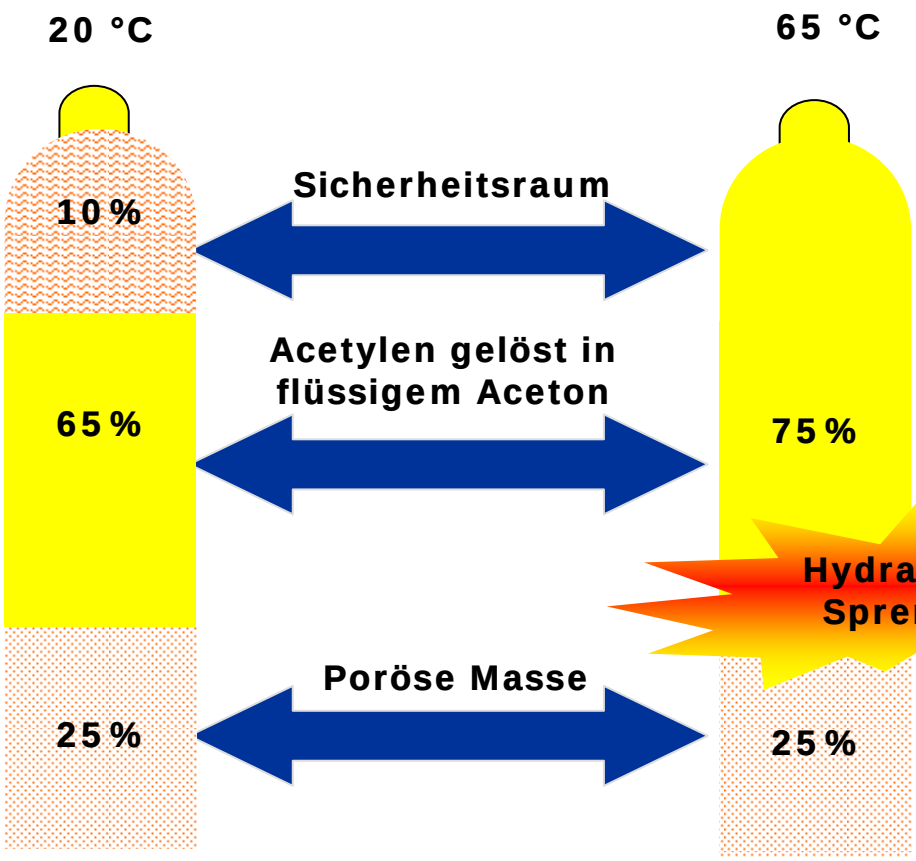


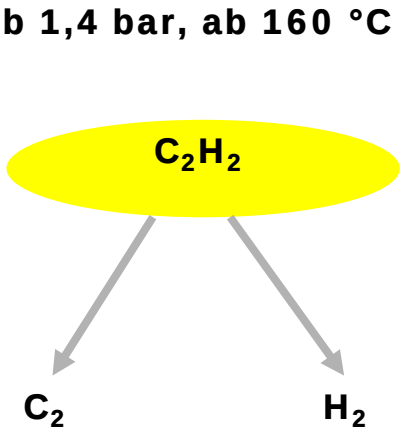


Kennzeichnung nach TRGS/DIN EN

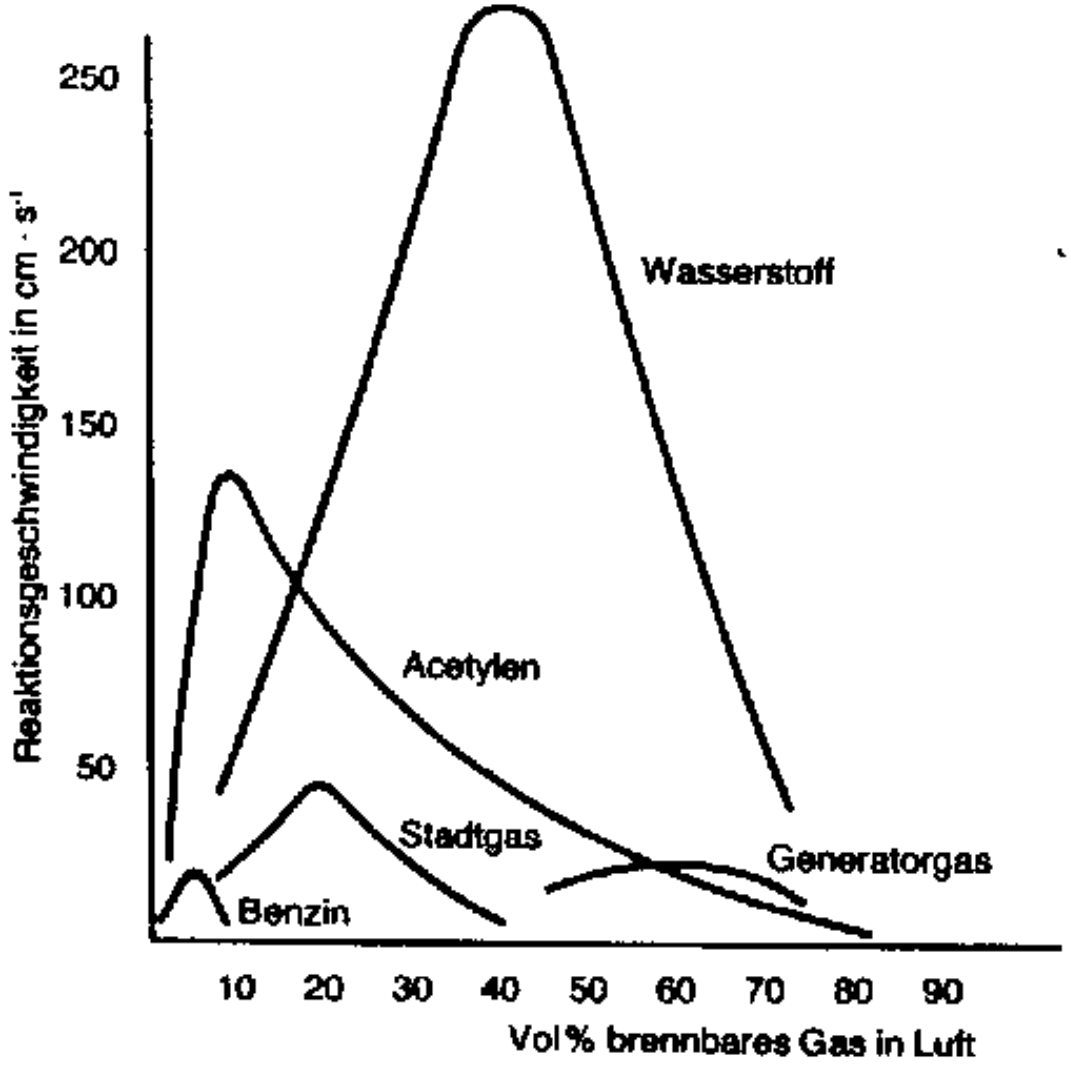
Acetylene:	old	-	yellow
	new	-	brown
with sign „N“			
or			
Nitrogen:	old	-	green
	new	-	black
with sign „N“			

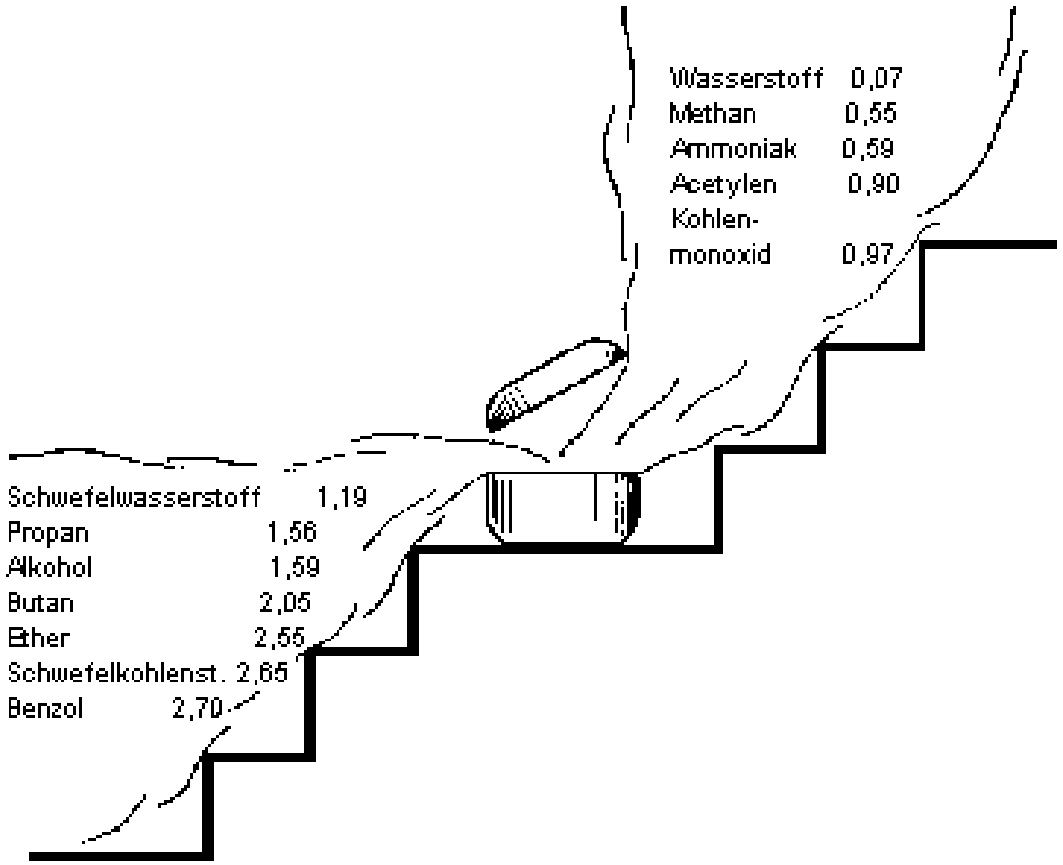
Acetylengas bombs





Hydraulische Sprengung


Reaktionsgeschwindigkeit in cm · s⁻¹
250
200
150
100
50
Wasserstoff
Acetylen
Stadtgas
Generatorgas
Benzin
10
20
30
40
50
60
70
80
90
Vol % brennbares Gas in Luft


Wasserstoff 0,07
Methan 0,55
Ammoniak 0,59
Acetylen 0,90
Kohlen-
monoxid 0,97
Schwefelwasserstoff 1,19
Propan 1,56
Alkohol 1,59
Butan 2,05
Ether 2,55
Schwefelkohlenst. 2,65
Benzol 2,70

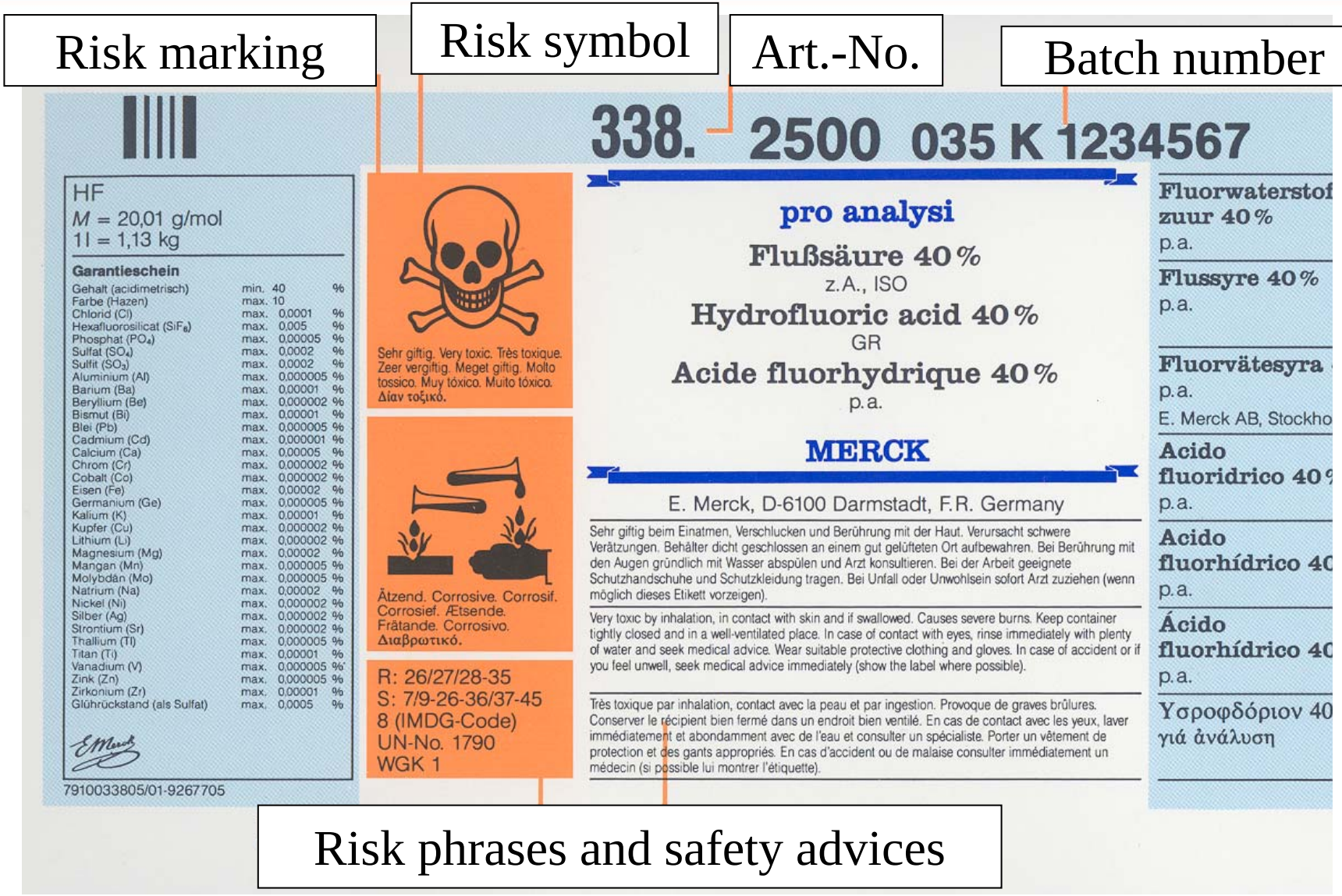
Safety label

Risk marking

Risk symbol

Art.-No.

Batch number



Risk phrases and safety advices

Inscription of instruments

Beyond working hours or in case of an emergency call !

Name
Telephone number

Working with liquid nitrogen

- Liquid nitrogen has a boiling point of: -195.8 °C
- Volume of expansion liquid to gas (at 15 °C, 1atm): 682.1

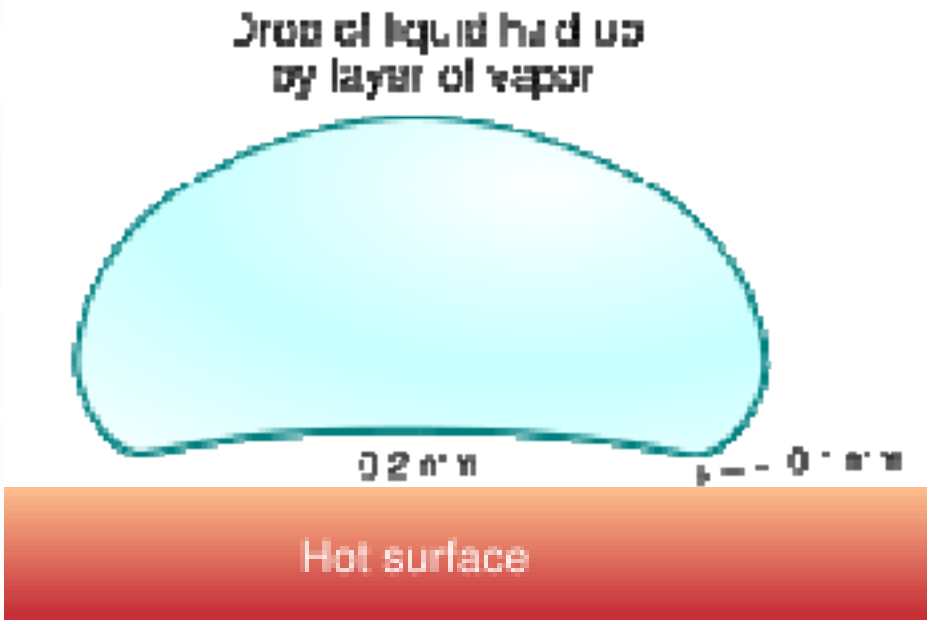
Freezing with Liquid Nitrogen

The exrtemly low temperature can cause burn-like damage to the skin.

The low temperature of the vapour can cause damage to softer tissuee, e.g. eyes and lungs.

The hazard level is higher than that of handling boiling water.

Leidenfrost effect



The **Leidenfrost effect** is a phenomenon in which a liquid, in near contact with a mass significantly hotter than its boiling point, produces an insulating vapor layer which keeps that liquid from boiling Rapidly.

It has also been used in some dangerous demonstrations, such as dipping a *wet* finger in molten lead and blowing out a mouthful of liquid nitrogen, both enacted without injury to the demonstrator.

Do not trust this effect !

	Harmful	Inhalation, ingestion, or absorption through the skin is harmful. Possible irreversible damage through single, repeated, or longer exposure. Avoid contact with the human body, also inhalation of vapors. Consult physician if feeling unwell.
	Irritant	Materials with irritable effects on skin, eyes, and respiratory organs. Do not inhale vapors and avoid contact with skin and eyes.
	Flammable	Self-igniting or water-reactive materials, liquids with low flash point (<0 °C or <35 °C), gases which ignite at normal temperature and pressure and materials that are easily flammable. Avoid any contact with ignition source and if necessary, air.
	Oxidizing	Can burn combustible materials or promote random fires, making fire fighting more difficult. Avoid every contact with flammable materials.
	Corrosive	Living tissues but also many materials would be destroyed upon contact. Do not inhale vapors and avoid contact with skin, eyes, and clothing.
	Toxic or highly toxic	Inhalation, ingestion, or absorption through the skin leads to extensive health damage or death. Possibility of irreversible damage through single, repeated or longer exposure. Avoid all contact with the human body and immediately see physician if feeling unwell.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Leicht-entzündlich
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TRGS 514
TRGS 515
TRGS 514
TRGS 515

Used chemicals

- Mark each chemical bottle with a readable **label** that indicates at least the following information:
  - Name of the substance
  - Molecular formula
  - Date of filling
  - Name of the responsible person

Write only with water-resistant, black felt-tip pens, as other pens become illegible after a short time.

Radioactive Safety

- In our lab two Electron capture detectors and ion mobility spectrometers

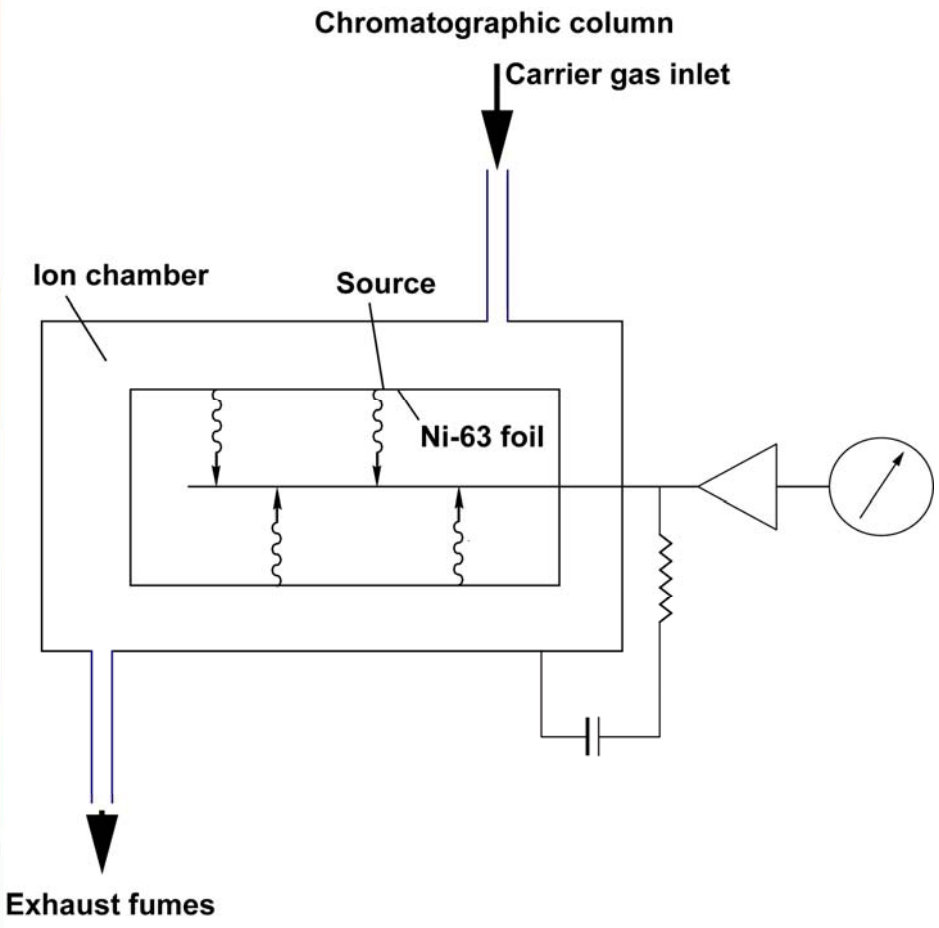
Ni-63 on a immobilized on a Ni foil

β^-- radiation

Range for β^- - radiation in air: 5 cm

Open radioactive source.
The exhaustive fumes have to be dicharged into a sniff port.
(Never remove the exhaustive tube from the

Electron capture detector - ECD

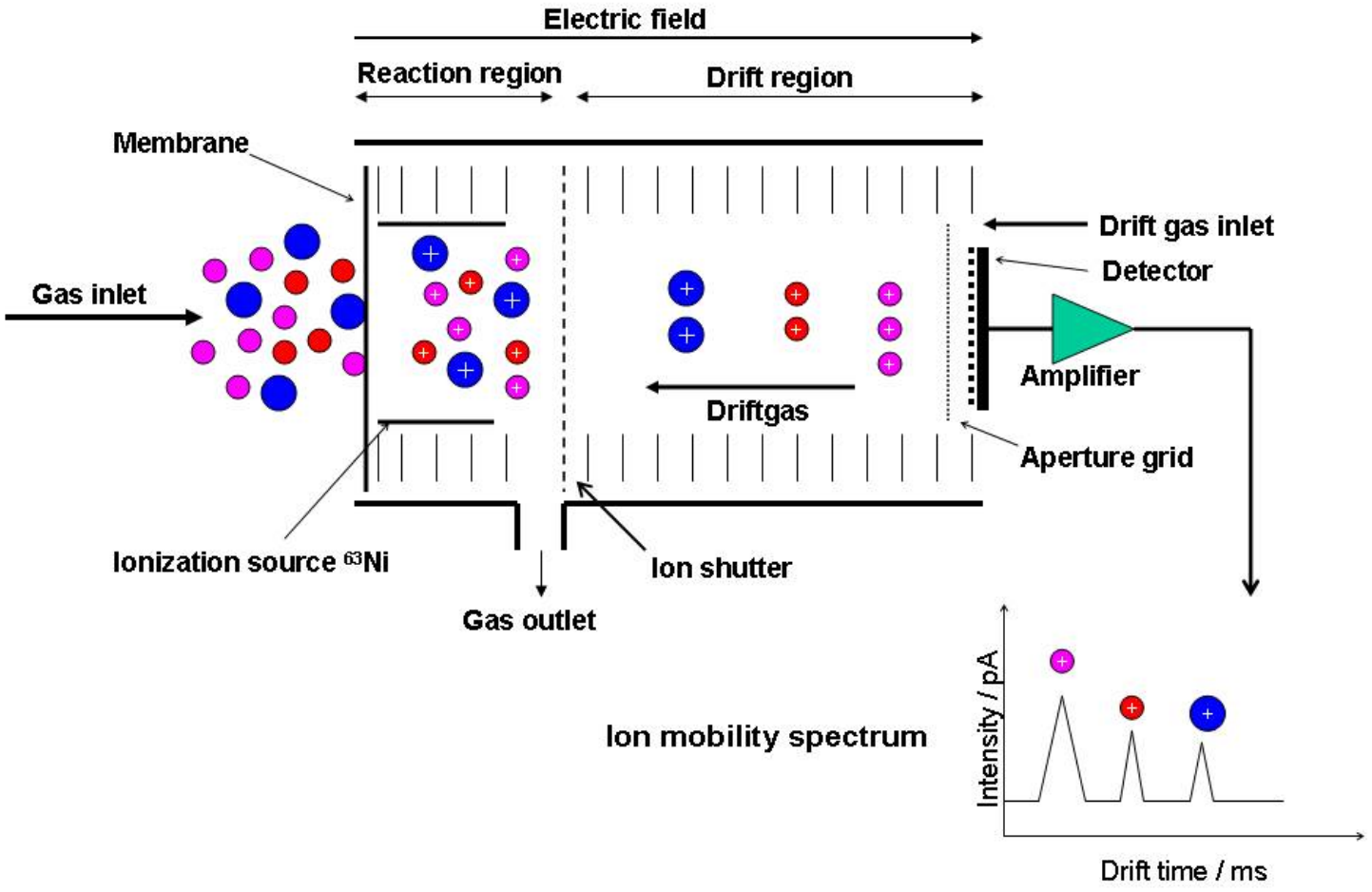


Its not allowed to open the ECD.

Never remove the Ni-63 foil. Cleaning of the ECD is only allowed by vondor.

Temperatures over 400 °C lead to a detachment of the Ni-63 from the Ni foil.

Ion mobility spectrometer



Working with High Voltage

Before each manipulation for which the housing must be opened, the equipment should be **removed** absolutely from the **current supply.**

In case the fuse is to be unscrewed, a **warning card** should be attached tothe fuse box so that no one inadvertently screws in the fuse too early!

Areas where one works with high voltage and devices that are operated with highvoltage are marked by this danger warning:

Electrical accidents

Turn off power source (turn off, unplug and remove fuse at main junction box).

If this is notimmediately possible, separate victim from charged area by using a non-conductive material (such as a wooden slat) or pull away victim from the site by grabbing the clothes.

Youshould insulate yourself by standing on a grounded base (such as a dry board, thick newspaper) making sure to touch nothing (wall, other person etc.)!