MARITIME UNIVERSITY OF SZCZECIN

Institute of Mathematics, Physics and Chemistry
Department of Chemistry

EXERCISE INSTRUCTION

Introduction to chemistry laboratory exercises
The laboratory health and safety rules and regulations
Hazardous chemicals

Prepared by:	dr inż. Andrzej Kozłowski dr inż. Agnieszka Kalbarczyk-Jedynak dr Magdalena Ślączka-Wilk dr inż. Konrad Ćwirko mgr inż. Czesław Wiznerowicz Grażyna Gorzycka
Teacher in Charge:	dr Magdalena Ślączka-Wilk
Approved by:	dr inż. Agnieszka Kalbarczyk-Jedynak
Effective from: 01.10.2023	

EXERCISE SHEET

Introduction to chemistry laboratory exercises
The laboratory health and safety rules and regulations
Hazardous chemicals

<table>
<tr><td>1</td><td colspan="3">Relation to subjects: ESO/25, 27 DiRMiUO/25, 27 EOUNiE/25, 27</td></tr>
<tr><td></td><td>Specialty/Subject</td><td>Learning outcomes for the subject</td><td>Detailed learning outcomes for the subject</td></tr>
<tr><td></td><td>ESO/26 Chemistry of water, fuels and lubricants</td><td>EKP3
K_U014,
K_U015,
K_U016.</td><td>SEKP3 – Water quality indicators;
SEKP6 – Performing determinations of selected indicators of technical water quality;</td></tr>
<tr><td></td><td>DiRMiUO/26 Chemistry of water, fuels and lubricants</td><td>EKP3
K_U014,
K_U015,
K_U016.</td><td>SEKP3 – Water quality indicators;
SEKP6 – Performing determinations of selected indicators of technical water quality;</td></tr>
<tr><td></td><td>EOUNiE/26 Chemistry of water, fuels and lubricants</td><td>EKP3
K_U014,
K_U015,
K_U016.</td><td>SEKP3 – Water quality indicators;
SEKP6 – Performing determinations of selected indicators of technical water quality;</td></tr>
<tr><td>2</td><td colspan="3">Purpose of the exercise:
1. Getting to know the regulations of the classes, getting to know the equipment of the chemical laboratory and the basics of the technique of laboratory work.
2. Learning the basic concepts related to work safety with hazardous chemicals.
3. Getting to know the typical hazards in the laboratory and the principles of safe work and first aid.
4. Getting to know the basic methods of neutralizing strong acids, bases and petroleum products.
5. Getting to know the rules of labeling of hazardous substances.
6. Getting acquainted with the safety data sheets of selected hazardous substances.
7. Mastering how to search for the characteristics of hazardous substances in databases based on their name or code.</td></tr>
<tr><td>3</td><td colspan="3">Prerequisites:
the student is familiar with the general principles of occupational health and safety in a chemical laboratory and basic hazardous substances,
before the relevant classes, the student undergoes a workplace health and safety training in the chemical laboratory, which he confirms with his own signature on the appropriate form.</td></tr>
<tr><td>4</td><td colspan="3">Description of the laboratory workplace:
a typical basic set of laboratory glassware, a set of MSDS for basic chemicals, materials for neutralizing acids and bases, a set of sorbents for neutralizing hazardous substances, pH-meter, indicator papers, indicators, samples of substances to be neutralized (strong acid, strong base, lubricating oil).</td></tr>
<tr><td>5</td><td colspan="3">Risk assessment:
Chemical burns resulting from contact with 0.2 M sulfuric acid and caustic soda are very unlikely, the possible effects are minor.
In the event of contact with a corrosive substance, it is recommended to carefully remove it, rinse with running water and appropriate neutralization.
Final assessment – VERY SMALL THREAT</td></tr>
</table>

	Security measures required: 1. protective clothing and equipment (lab coats, gloves and glasses), 2. typical neutralizing agents, paper towels, running water.
6	**The course of the exercise:** 1. Getting acquainted with the regulations of the laboratory and the rules of health and safety in the laboratory. 2. Getting to know the workplace manual (appendix 1). 3. Performing neutralization of samples of hazardous materials. Getting to know the set of safety data sheets for hazardous substances.
7	**Exercise report:** 1. Develop an exercise in accordance with the instructions contained in the workplace manual. 2. Using the safety data sheets, assess the degree of risk and the method of neutralization for hazardous chemical compounds given by the academic teacher. 3. Solve the given task and/or answer the questions included in the set of tasks and questions to be completed by the student.
8	**Archiving of research results:** report on exercises - prepared in accordance with the rules applicable in the laboratory - should be submitted in writing to the academic teacher during the next classes.
9	**Assessment method and criteria:** a. EKP1, EKP2 – checking the knowledge of basic chemical concepts related to hazardous substances and health and safety rules in the laboratory, b. SEKP – the detailed learning outcome for an individual student will be assessed on the basis of the solutions to tasks and problems presented in the report, given for independent solution/development: – **mark 2,0** – has no basic knowledge of the risks resulting from contact with hazardous chemicals, or is unable to use it in practice; – **mark 3,0** – has basic chemical knowledge of identifying hazardous chemical substances, assessing and minimizing the risk; – **mark 3,5 – 4,0** – has extensive knowledge of chemicals and the hazards of hazardous substances and the ability to neutralize typical hazardous materials in his environment; – **mark 4,5 – 5,0** – has the ability to use complex chemical knowledge to solve complex tasks, carry out a partial risk assessment and select special neutralizing agents and sorbents to neutralize specific types of hazardous substances.
10	**References:** 1. A. Kozłowski, A. Kalbarczyk-Jedynak, M. Ślączka-Wilk, K. Ćwirko, C. Wiznerowicz, G. Gorzycka, Workplace instruction for laboratory exercises: *Wprowadzenie do zajęć. BHP w laboratorium chemicznym. Substancje chemiczne niebezpieczne,* AM Szczecin, 2022 (in Polish). 2. https://www.afrox.co.za/en/images/Ammonia%20%28Rev%203%29_tcm266-27591.pdf (accessed 20.09.21). 3. GHS hazard pictograms for download – REACH Compliance GmbH (accessed 15.07.22) 4. https://assets.openstax.org/oscms-prodcms/media/documents/Chemistry2e-WEB.pdf (15.07.22). 5. M. Charmas, „English for Students of Chemistry", Maria Curie-Skłodowska University Press, Lublin 2012. 6. Stundis H., Trześniowski W., Żmijewska S.: *Ćwiczenia laboratoryjne z chemii nieorganicznej*. WSM, Szczecin 1995 (in Polish).
10	Notes

CHEMISTRY LABORATORY
SAFETY RULES AND REGULATIONS

General rules of working in the chemistry laboratory: health and safety plus regulations specific to the chemistry laboratory:

1. Students come to the laboratory on time.
2. Before beginning any preparation in the chemistry laboratory, the student must study the theory and the details of experiments.
3. During the scheduled laboratory experiments all students must wear their own lab coats. Lab coats must be buttoned all the way up.
4. Students must wear safety glasses (goggles, spectacles) when required.
5. Tasting chemicals, smoking, drinking, eating (including chewing a gum) in the laboratory is prohibited.
6. Students with long hair should keep it tied back.
7. Students must follow all the lab instructions, read all chemical labels and walk with care in the laboratory. Only authorized experiments are allowed. Unauthorized experiments are forbidden!!! Students must listen to the academic teacher.
8. Students must be careful with laboratory water bath, other heat sources and also hot laboratory glassware (for example test tubes, beakers). Do not touch it by bare hands, use test tube/beaker holder.
9. Looking directly into the test tube, beaker, etc. is prohibited. Never point the mouth of the test tube toward yourself or anyone else during heating. Smelling directly solutions containing chemicals is forbidden. Wafting near the nose is allowed but only when instructed.
10. All used chemicals/liquids containing chemicals must be discard properly (ask the academic teacher). Unused chemicals must not be returned to stock bottles.
11. Pipettes must be used carefully – never use one pipette for different solutions – use the one that is labeled for the solution/reagent.
12. Students must report all injuries and spills immediately to the academic teacher. Students are responsible for cleaning up spilled chemicals or broken glassware.
13. Jackets, coats are not allowed in the laboratory. Bags, etc. must be placed on the designated area.
14. Mobile phones are forbidden in the laboratory.
15. Students keep their work area (workplace) clean and tidy.
16. Students wash hands during (if necessary) and after lab work.
17. Students know the location of first aid kit, eye wash, emergency shower and fire extinguishers.
18. Students are supposed to perform seven laboratory exercises during term.
19. In the beginning of the laboratory exercise students write an „entry test” (based on given keywords in order to check basic knowledge and preparation for the lab exercise).
20. Students work in groups of two, sometimes if necessary (an odd number of students) in group of three. Students follow the given lab instructions and submit the final lab report (one report per person) at the next laboratory meeting.
21. Students must take part in every laboratory exercise. Laboratory attendance is mandatory!!! If student misses a lab with medical excuse, student must bring a medical report and make-up the missed laboratory (during the week the missed laboratory exercise is run or by the last lab of the term).

22. In order to pass the chemistry laboratory course students must perform every laboratory exercise, submit all the final reports from the laboratory exercises (accepted by the academic teacher) and pass all the „entry tests".

Safety in handling acids (working with acids)

Concentrated acids such as sulfuric acid, hydrochloric acid and nitric acid are dangerous and toxic. These concentrated acids are capable of causing severe burns. Anytime when working with mentioned concentrated acids lab coats buttoned all the way up must be worn, as well as safety goggles, acid-resistant gloves. Students must also locate the emergency shower and the eye wash.

Any work with concentrated acids must be performed under the fume hood. In terms of preparation of the diluted acid, concentrated acid must be slowly added to distilled water and not the other way round!!! The hydration reaction of sulfuric acid is highly exothermic. Never add water to the concentrated acid because this can generate acidic steam (water can boil and it can lead to the dispersal of a sulfuric acid aerosol and can lead to even the explosion). It is related to the acid and water density (water is less dense than acid).
„A.A.: Add Acid"; „Drop acid, not water"
[source:https://www.cs.mcgill.ca/~rwest/wikispeedia/wpcd/wp/s/Sulfuric_acid.htm]

First Aid

Emergency phone numbers: 999 (Ambulance) or 112 (The general emergency number for mobile phones).

Eyes

Flush eyes immediately with plenty of cold water (direct water stream from the nose to the temple), get medical help while you are doing this.

Injuries of the Skin (cuts, scratches, punctures)

Minor cuts can be washed with a 3% hydrogen peroxide solution or running water, dried with an antiseptic wipe and covered with a plaster (band aid). In case of severe bleeding apply sterile gauze pad or if necessary raise the area above the level of the heart and call the Emergency. In case of the foreign object (for example glass) that seems to be more deeply placed in the skin apply gently sterile gauze and bandage and call the Emergency.

Thermal Burns

Thermal burns must be immediately uncovered and placed in the stream of cold running water – further treatment depends on the degree of burns, in each case of severe burns (second and third degree burns) call the Emergency.

Chemical Burns

Chemical burns must be rinsed with plenty of cold water and the all contaminated clothing must be removed. Call the Emergency for medical help.

At the beginning of the term the student, before performing chemistry laboratory exercises, declares with his/her signature (on the appropriate form) the acceptance of health and safety rules and specific regulations to the chemistry laboratory.

1. THEORY

KEYWORDS:

- chemical neutralization, sorbents;
- CAS Registry number and SDS – Safety Data Sheet, hazard pictograms.

Chemical neutralization, sorbents

In general, chemical neutralization is a chemical reaction between an acid and a base and this reaction results in formation of salt and water.

The most commonly used chemical neutralization agents (neutralizing chemicals) in the laboratory are:

- sodium carbonate (Na_2CO_3),
- ammonium chloride (NH_4Cl),
- sodium hydrogen carbonate ($NaHCO_3$ – baking soda; sodium bicarbonate),
- calcium hydroxide ($Ca(OH)_2$),
- sodium hypochlorite (NaClO),
- calcium carbonate ($CaCO_3$).

The chemical neutralization reaction leads to the formation of substance that is less aggressive, dangerous and toxic.

Sorbents are materials that soak up for example oil or acid or base from the ground, water, certain surfaces. Sorbents can be either natural organic like sawdust, feathers, natural inorganic like clay, sand, volcanic ash, or synthetic.

Synthetic sorbents are man-made and mostly include chemical substances like polyethylene and nylon. Sorbents used on the ground are mostly in the form of pillows, mats, rolls and these sorbents collect spilled liquids and prevent from further spreading. Sorbents used on the water soak up the oil spill or capture and collect a thin oil film retained on the surface after being liquidated.

There are universal sorbents like gray, camo, yellow, green (these sorbents absorb water-based fluids, oils and most chemicals) and selective sorbents like white (oil spills only), blue (oil spills only) [http://www.unitedsorbents.com/pdf/trifold.pdf].

CAS Registry Number and SDS – Safety Data Sheet

A CAS Registry Number (CASRN, CAS Number) is a numerical identifier that is assigned by the Chemical Abstract Service (CAS) to every single chemical substance. This number can contain up to 10 digits divided by hyphens into three parts, example: 7664-93-9 – the CAS number for sulfuric acid [https://support.cas.org/content/chemical-substances/faqs].

SDS – Safety Data Sheet provides information on chemicals. SDS is the key document in the safe supply, handling and use of chemicals. SDS should help to ensure that those who use chemicals in the workplace do so safely.

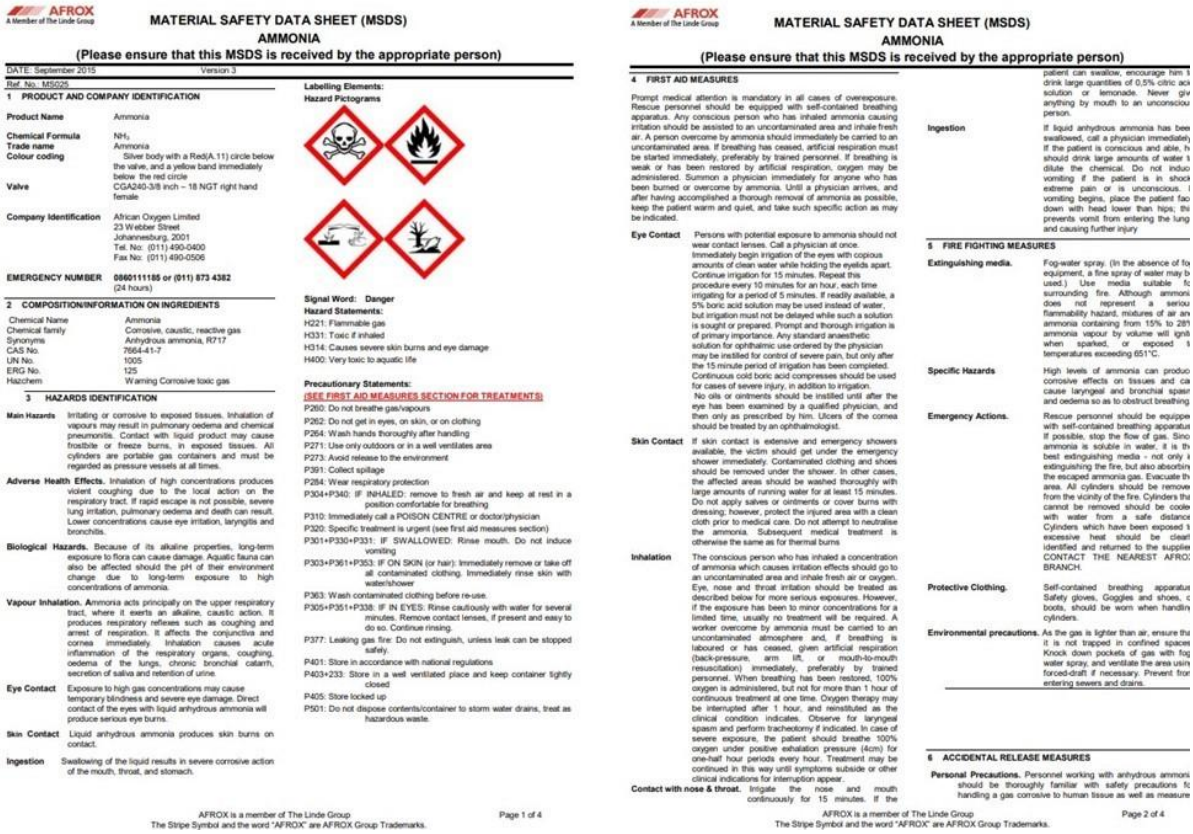
SDS must contain identification of the substance, hazards identification, composition/information on ingredients, first aid measures, fire-fighting measures, accidental release measures, handling and storage, exposure controls/personal protection, physical and

chemical properties, stability and reactivity, toxicological information, ecological information, disposal consideration, transport information, regulatory information, other information.

SDS must be provided for:

- chemicals classified as hazardous in accordance with Regulation on the classification, labelling, packaging of substances and mixtures (CLP),
- substances meeting the criteria as persistent, bio-accumulative, toxic to the environment,
- substances that appear on ECHA's Candidate List [https://echa.europa.eu] of substances of very high concern,
- mixtures that themselves are not classified under CLP but that contain at least one substance that is.
  [http://www.hsa.ie/eng/Publications_and_Forms/Publications/Information_Sheets/SDS_hazchem_info_sheet.pdf]

https://www.sigmaaldrich.com/united-kingdom.html a useful link for finding SDS of a chemical substance.
An example of the safety data sheet (SDS) for ammonia is presented in Fig.1.



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MATERIAL SAFETY DATA SHEET (MSDS)
AMMONIA
(Please ensure that this MSDS is received by the appropriate person)

DATE: September 2015 Version 3
Ref. No.: MS025

1 PRODUCT AND COMPANY IDENTIFICATION

Product Name Ammonia
Chemical Formula NH_3
Trade name Ammonia
Colour coding Silver body with a Red(A.11) circle below the valve, and a yellow band immediately below the red circle
Valve CGA240-3/8 inch – 18 NGT right hand female
Company Identification African Oxygen Limited, 23 Webber Street, Johannesburg, 2001, Tel. No: (011) 490-0400, Fax No: (011) 490-0506
EMERGENCY NUMBER **0860111185 or (011) 873 4382** (24 hours)

2 COMPOSITION/INFORMATION ON INGREDIENTS

Chemical Name	Ammonia
Chemical family	Corrosive, caustic, reactive gas
Synonyms	Anhydrous ammonia, R717
CAS No.	7664-41-7
UN No.	1005
ERG No.	125
Hazchem	Warning Corrosive toxic gas

3 HAZARDS IDENTIFICATION

Main Hazards Irritating or corrosive to exposed tissues. Inhalation of vapours may result in pulmonary oedema and chemical pneumonitis. Contact with liquid product may cause frostbite or freeze burns, in exposed tissues. All cylinders are portable gas containers and must be regarded as pressure vessels at all times.

Adverse Health Effects. Inhalation of high concentrations produces violent coughing due to the local action on the respiratory tract. If rapid escape is not possible, severe lung irritation, pulmonary oedema and death can result. Lower concentrations cause eye irritation, laryngitis and bronchitis.

Biological Hazards. Because of its alkaline properties, long-term exposure to flora can cause damage. Aquatic fauna can also be affected should the pH of their environment change due to long-term exposure to high concentrations of ammonia.

Vapour Inhalation. Ammonia acts principally on the upper respiratory tract, where it exerts an alkaline, caustic action. It produces respiratory reflexes such as coughing and arrest of respiration. It affects the conjunctiva and cornea immediately. Inhalation causes acute inflammation of the respiratory organs, coughing, oedema of the lungs, chronic bronchial catarrh, secretion of saliva and retention of urine.

Eye Contact Exposure to high gas concentrations may cause temporary blindness and severe eye damage. Direct contact of the eyes with liquid anhydrous ammonia will produce serious eye burns.

Skin Contact Liquid anhydrous ammonia produces skin burns on contact.

Ingestion Swallowing of the liquid results in severe corrosive action of the mouth, throat, and stomach.

Labelling Elements:
Hazard Pictograms

Signal Word: Danger
Hazard Statements:
H221: Flammable gas
H331: Toxic if inhaled
H314: Causes severe skin burns and eye damage
H400: Very toxic to aquatic life

Precautionary Statements:
(SEE FIRST AID MEASURES SECTION FOR TREATMENTS)
P260: Do not breathe gas/vapours
P262: Do not get in eyes, on skin, or on clothing
P264: Wash hands thoroughly after handling
P271: Use only outdoors or in a well ventilates area
P273: Avoid release to the environment
P391: Collect spillage
P284: Wear respiratory protection
P304+P340: IF INHALED: remove to fresh air and keep at rest in a position comfortable for breathing
P310: Immediately call a POISON CENTRE or doctor/physician
P320: Specific treatment is urgent (see first aid measures section)
P301+P330+P331: IF SWALLOWED: Rinse mouth. Do not induce vomiting
P303+P361+P353: IF ON SKIN (or hair): Immediately remove or take off all contaminated clothing. Immediately rinse skin with water/shower
P363: Wash contaminated clothing before re-use.
P305+P351+P338: IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do so. Continue rinsing.
P377: Leaking gas fire: Do not extinguish, unless leak can be stopped safely.
P401: Store in accordance with national regulations
P403+233: Store in a well ventilated place and keep container tightly closed
P405: Store locked up
P501: Do not dispose contents/container to storm water drains, treat as hazardous waste.

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AMMONIA
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4 FIRST AID MEASURES

Prompt medical attention is mandatory in all cases of overexposure. Rescue personnel should be equipped with self-contained breathing apparatus. Any conscious person who has inhaled ammonia causing irritation should be assisted to an uncontaminated area and inhale fresh air. A person overcome by ammonia should immediately be carried to an uncontaminated area. If breathing has ceased, artificial respiration must be started immediately, preferably by trained personnel. If breathing is weak or has been restored by artificial respiration, oxygen may be administered. Summon a physician immediately for anyone who has been burned or overcome by ammonia. Until a physician arrives, and after having accomplished a thorough removal of ammonia as possible, keep the patient warm and quiet, and take such specific action as may be indicated.

Eye Contact Persons with potential exposure to ammonia should not wear contact lenses. Call a physician at once. Immediately begin irrigation of the eyes with copious amounts of clean water while holding the eyelids apart. Continue irrigation for 15 minutes. Repeat this procedure every 10 minutes for an hour, each time irrigating for a period of 5 minutes. If readily available, a 5% boric acid solution may be used instead of water, but irrigation must not be delayed while such a solution is sought or prepared. Prompt and thorough irrigation is of primary importance. Any standard anaesthetic solution for ophthalmic use ordered by the physician may be instilled for control of severe pain, but only after the 15 minute period of irrigation has been completed. Continuous cold boric acid compresses should be used for cases of severe injury, in addition to irrigation. No oils or ointments should be instilled until after the eye has been examined by a qualified physician, and then only as prescribed by him. Ulcers of the cornea should be treated by an ophthalmologist.

Skin Contact If skin contact is extensive and emergency showers available, the victim should get under the emergency shower immediately. Contaminated clothing and shoes should be removed under the shower. In other cases, the affected areas should be washed thoroughly with large amounts of running water for at least 15 minutes. Do not apply salves or ointments or cover burns with dressing; however, protect the injured area with a clean cloth prior to medical care. Do not attempt to neutralise the ammonia. Subsequent medical treatment is otherwise the same as for thermal burns

Inhalation The conscious person who has inhaled a concentration of ammonia which causes irritation effects should go to an uncontaminated area and inhale fresh air or oxygen. Eye, nose and throat irritation should be treated as described below for more serious exposures. However, if the exposure has been to minor concentrations for a limited time, usually no treatment will be required. A worker overcome by ammonia must be carried to an uncontaminated atmosphere and, if breathing is laboured or has ceased, given artificial respiration (back-pressure, arm lift, or mouth-to-mouth resuscitation) immediately, preferably by trained personnel. When breathing has been restored, 100% oxygen is administered, but not for more than 1 hour of continuous treatment at one time. Oxygen therapy may be interrupted after 1 hour, and reinstituted as the clinical condition indicates. Observe for laryngeal spasm and perform tracheotomy if indicated. In case of severe exposure, the patient should breathe 100% oxygen under positive exhalation pressure (4cm) for one-half hour periods every hour. Treatment may be continued in this way until symptoms subside or other clinical indications for interruption appear.

Contact with nose & throat. Irrigate the nose and mouth continuously for 15 minutes. If the patient can swallow, encourage him t drink large quantities of 0,5% citric aci solution or lemonade. Never giv anything by mouth to an unconscious person.

Ingestion If liquid anhydrous ammonia has bee swallowed, call a physician immediatel If the patient is conscious and able, h should drink large amounts of water t dilute the chemical. Do not induc vomiting if the patient is in shock extreme pain or is unconscious. vomiting begins, place the patient fac down with head lower than hips; thi prevents vomit from entering the lung and causing further injury

5 FIRE FIGHTING MEASURES

Extinguishing media. Fog-water spray. (In the absence of fo equipment, a fine spray of water may b used.) Use media suitable fo surrounding fire. Although ammoni does not represent a seriou flammability hazard, mixtures of air an ammonia containing from 15% to 28 ammonia vapour by volume will ignit when sparked, or exposed t temperatures exceeding 651°C.

Specific Hazards High levels of ammonia can produc corrosive effects on tissues and ca cause laryngeal and bronchial spasr and oedema so as to obstruct breathing

Emergency Actions. Rescue personnel should be equippe with self-contained breathing apparatu If possible, stop the flow of gas. Sinc ammonia is soluble in water, it is th best extinguishing media - not only i extinguishing the fire, but also absorbin the escaped ammonia gas. Evacuate th area. All cylinders should be remove from the vicinity of the fire. Cylinders tha cannot be removed should be coole with water from a safe distance Cylinders which have been exposed t excessive heat should be clear identified and returned to the supplie CONTACT THE NEAREST AFRO BRANCH.

Protective Clothing. Self-contained breathing apparatu Safety gloves, Goggles and shoes, c boots, should be worn when handlin cylinders.

Environmental precautions. As the gas is lighter than air, ensure th it is not trapped in confined spaces Knock down pockets of gas with fog water spray, and ventilate the area usin forced-draft if necessary. Prevent fror entering sewers and drains.

6 ACCIDENTAL RELEASE MEASURES

Personal Precautions. Personnel working with anhydrous ammoni should be thoroughly familiar with safety precautions fo handling a gas corrosive to human tissue as well as measure

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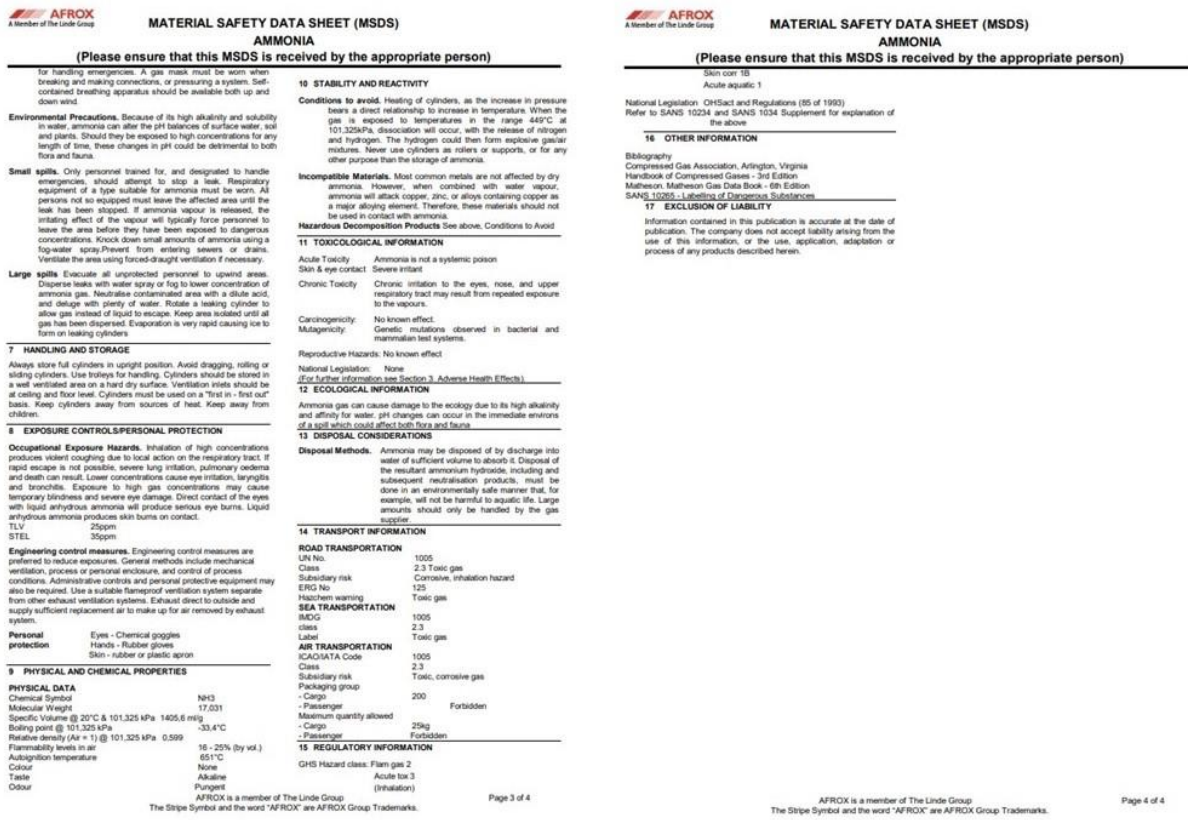

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MATERIAL SAFETY DATA SHEET (MSDS)
AMMONIA
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for handling emergencies. A gas mask must be worn when breaking and making connections, or pressuring a system. Self-contained breathing apparatus should be available both up and down wind.

Environmental Precautions. Because of its high alkalinity and solubility in water, ammonia can alter the pH balances of surface water, soil and plants. Should they be exposed to high concentrations for any length of time, these changes in pH could be detrimental to both flora and fauna.

Small spills. Only personnel trained for, and designated to handle emergencies, should attempt to stop a leak. Respiratory equipment of a type suitable for ammonia must be worn. All persons not so equipped must leave the affected area until the leak has been stopped. If ammonia vapour is released, the irritating effect of the vapour will typically force personnel to leave the area before they have been exposed to dangerous concentrations. Knock down small amounts of ammonia using a fog-water spray.Prevent from entering sewers or drains. Ventilate the area using forced-draught ventilation if necessary.

Large spills Evacuate all unprotected personnel to upwind areas. Disperse leaks with water spray or fog to lower concentration of ammonia gas. Neutralise contaminated area with a dilute acid, and deluge with plenty of water. Rotate a leaking cylinder to allow gas instead of liquid to escape. Keep area isolated until all gas has been dispersed. Evaporation is very rapid causing ice to form on leaking cylinders.

7 HANDLING AND STORAGE

Always store full cylinders in upright position. Avoid dragging, rolling or sliding cylinders. Use trolleys for handling. Cylinders should be stored in a well ventilated area on a hard dry surface. Ventilation inlets should be at ceiling and floor level. Cylinders must be used on a "first in - first out" basis. Keep cylinders away from sources of heat. Keep away from children.

8 EXPOSURE CONTROLS/PERSONAL PROTECTION

Occupational Exposure Hazards. Inhalation of high concentrations produces violent coughing due to local action on the respiratory tract. If rapid escape is not possible, severe lung irritation, pulmonary oedema and death can result. Lower concentrations cause eye irritation, laryngitis and bronchitis. Exposure to high gas concentrations may cause temporary blindness and severe eye damage. Direct contact of the eyes with liquid anhydrous ammonia will produce serious eye burns. Liquid anhydrous ammonia produces skin burns on contact.

TLV	25ppm
STEL	35ppm

Engineering control measures. Engineering control measures are preferred to reduce exposures. General methods include mechanical ventilation, process or personal enclosure, and control of process conditions. Administrative controls and personal protective equipment may also be required. Use a suitable flameproof ventilation system separate from other exhaust ventilation systems. Exhaust direct to outside and supply sufficient replacement air to make up for air removed by exhaust system.

Personal protection	Eyes - Chemical goggles Hands - Rubber gloves Skin - rubber or plastic apron

9 PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL DATA

Chemical Symbol	NH_3
Molecular Weight	17,031
Specific Volume @ 20°C & 101,325 kPa	1405,6 ml/g
Boiling point @ 101,325 kPa	-33,4°C
Relative density (Air = 1) @ 101,325 kPa	0,599
Flammability levels in air	16 - 25% (by vol.)
Autoignition temperature	651°C
Colour	None
Taste	Alkaline
Odour	Pungent

10 STABILITY AND REACTIVITY

Conditions to avoid. Heating of cylinders, as the increase in pressure bears a direct relationship to increase in temperature. When the gas is exposed to temperatures in the range 449°C at 101,325kPa, dissociation will occur, with the release of nitrogen and hydrogen. The hydrogen could then form explosive gas/air mixtures. Never use cylinders as rollers or supports, or for any other purpose than the storage of ammonia.

Incompatible Materials. Most common metals are not affected by dry ammonia. However, when combined with water vapour, ammonia will attack copper, zinc, or alloys containing copper as a major alloying element. Therefore, these materials should not be used in contact with ammonia.

Hazardous Decomposition Products See above, Conditions to Avoid

11 TOXICOLOGICAL INFORMATION

Acute Toxicity	Ammonia is not a systemic poison
Skin & eye contact	Severe irritant
Chronic Toxicity	Chronic irritation to the eyes, nose, and upper respiratory tract may result from repeated exposure to the vapours.
Carcinogenicity:	No known effect.
Mutagenicity:	Genetic mutations observed in bacterial and mammalian test systems.

Reproductive Hazards: No known effect

National Legislation: None
(For further information see Section 3: Adverse Health Effects)

12 ECOLOGICAL INFORMATION

Ammonia gas can cause damage to the ecology due to its high alkalinity and affinity for water. pH changes can occur in the immediate environs of a spill which could affect both flora and fauna.

13 DISPOSAL CONSIDERATIONS

Disposal Methods. Ammonia may be disposed of by discharge into water of sufficient volume to absorb it. Disposal of the resultant ammonium hydroxide, including and subsequent neutralisation products, must be done in an environmentally safe manner that, for example, will not be harmful to aquatic life. Large amounts should only be handled by the gas supplier.

14 TRANSPORT INFORMATION

ROAD TRANSPORTATION	
UN No.	1005
Class	2.3 Toxic gas
Subsidiary risk	Corrosive, inhalation hazard
ERG No	125
Hazchem warning	Toxic gas
SEA TRANSPORTATION	
IMDG	1005
class	2.3
Label	Toxic gas
AIR TRANSPORTATION	
ICAO/IATA Code	1005
Class	2.3
Subsidiary risk	Toxic, corrosive gas
Packaging group	
- Cargo	200
- Passenger	Forbidden
Maximum quantity allowed	
- Cargo	25kg
- Passenger	Forbidden

15 REGULATORY INFORMATION

GHS Hazard class: Flam gas 2
Acute tox 3
(Inhalation)

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MATERIAL SAFETY DATA SHEET (MSDS)
AMMONIA
(Please ensure that this MSDS is received by the appropriate person)

Skin corr 1B
Acute aquatic 1

National Legislation OHSact and Regulations (85 of 1993)
Refer to SANS 10234 and SANS 1034 Supplement for explanation of the above

16 OTHER INFORMATION

Bibliography
Compressed Gas Association, Arlington, Virginia
Handbook of Compressed Gases - 3rd Edition
Matheson. Matheson Gas Data Book - 6th Edition
SANS 10265 - Labelling of Dangerous Substances

17 EXCLUSION OF LIABILITY

Information contained in this publication is accurate at the date of publication. The company does not accept liability arising from the use of this information, or the use, application, adaptation or process of any products described herein.

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Fig. 1. Ammonia safety data sheet
(source: https://www.afrox.co.za/en/images/Ammonia%20%28Rev%203%29_tcm266-27591.pdf)
(accessed 20.09.21)

Hazard pictograms (Fig. 2) – each pictogram consists of a symbol on a white background framed within a red border and represents a distinct hazard(s). One or more pictograms might appear on the labelling of a single chemical. The pictograms help us to know that the chemicals we are dealing with might cause harm to people or the environment [https://www.osha.gov]. Hazard pictograms form part of the GHS (Globally Harmonized System of Classification and Labelling of Chemicals).

Fig. 2. Pictograms
(source: GHS hazard pictograms for download – REACH Compliance GmbH
(accessed 15.07.22)

Perform the following additional task:

1. Find SDS – Safety Data Sheet; Given: CAS Number, printed out and attach it to the Final Laboratory Report:

    a) CAS Number: 1310-73-2,
    b) CAS Number: 1333-74-0,
    c) CAS Number: 7697-37-2.

2. INSTRUCTION 1 – LABORATORY EXERCISE 1

Experiment 1 – chemical neutralization of dilute sulfuric acid (VI) (H_2SO_4) and sodium hydroxide (NaOH) using solid sodium carbonate (Na_2CO_3), solid ammonium chloride (NH_4Cl), solid sodium bicarbonate ($NaHCO_3$) and an universal granular sorbent

Materials and reagents:

Sulfuric acid solution (VI) (0,2M H_2SO_4), sodium hydroxide solution (0,2M NaOH), sodium carbonate (Na_2CO_3 solid), ammonium chloride (NH_4Cl solid), sodium bicarbonate ($NaHCO_3$ solid), universal granular sorbent (Damsorb).

Experimental procedure:

Experiments with corrosive solutions require special care, since even dilute solutions NaOH or H_2SO_4 may cause burns or damage clothing.

Apply a few drops of dilute sulfuric acid (0.2M H_2SO_4) on the first petri dish and add, using spatula (or plastic spoon), solid sodium carbonate (Na_2CO_3) in order to neutralize the dilute sulfuric acid. Then apply a few drops of dilute sulfuric acid (0.2M H_2SO_4) on the second petri dish and add, using spatula (or plastic spoon), solid sodium bicarbonate ($NaHCO_3$) in order to neutralize it. Finally apply a few drops of dilute sulfuric acid (0.2M H_2SO_4) on the third petri dish and cover the chemical spill with the universal granular neutralizing sorbent (Damsorb) starting with the edges first than spread the sorbent over the spill in order to cover the liquid completely. The process of neutralization is finished when the liquid is fully absorbed by the sorbent (sorbent covering the spill is not damp). The neutralized substance after using granular sorbent should be then scooped up with a micro spatula into a labelled container. Rinse the neutralized surface (petri dish) with water and dry it using paper towel.

Apply a few drops of dilute sodium hydroxide (0.2M NaOH) on the first petri dish and add, using spatula (or plastic spoon), solid ammonium chloride (NH_4Cl) in order to neutralize the dilute sodium hydroxide. Then apply a few drops of dilute sodium hydroxide (0.2M NaOH) on the second petri dish and add, using spatula (or plastic spoon), solid sodium bicarbonate ($NaHCO_3$) in order to neutralize it. Finally apply a few drops of dilute sodium hydroxide (0.2M NaOH) on the third petri dish and cover the chemical spill with the universal granular neutralizing sorbent (Damsorb) starting with the edges first than spread the sorbent over the spill in order to cover the liquid completely. The process of neutralization is finished when the liquid is fully absorbed by the sorbent (sorbent covering the spill is not damp). The neutralized substance after using granular sorbent should be then scooped up with a micro spatula into a labelled container. Rinse the neutralized surface (petri dish) with water and dry it using paper towel.

Data analysis**:**

1. Write down the neutralization reactions for both (the acid solution and the hydroxide solution) and justify what products were formed during the neutralization reactions.
2. How do we assess whether neutralization is complete?
3. Search and characterize any three sorbents for different groups of materials (especially for neutralization of corrosive and oxidizing substances).
4. Describe the characteristic features of sorbents and what are the most important criteria for selecting sorbents?

Experiment 2 – neutralization of spilled oil with a selected sorbent

Materials and reagents:

Engine oil sample, set of loose sorbents (universal sorbent, activated carbon, sawdust).

Experimental procedure

Spilled oils and solvents pose a great risk in rooms and at workplaces, therefore, when they are spilled, they must be removed (collected). Appropriate sorbents are used for this purpose (in the form of mats or in loose form). In the absence of a special sorbent, e.g. sawdust can be used for this purpose.

Put about 1 cm^3 of engine oil on three Petri dishes, then pour over the first one – with universal sorbent, the second - with activated carbon and the third - with sawdust. The oil must be completely absorbed. Observe how the colour of the sorbent used changes. The neutralized oil spill should be then scooped up with a micro spatula into a labelled container.
then dry the petri dish using paper towel do not rinse it using tap water or distilled water.

Data analysis:

1. Find and describe two sample sorbents designed to neutralize spilled oil and other petroleum products.
2. Give examples of common materials (inorganic and organic) that can be used interchangeably to deal with larger oil spills or in the absence of sorbents specially designed for this purpose.

3. GUIDELINES FOR WRITING THE FINAL LABORATORY REPORT

1. First page of the report – The Laboratory Report Cover Sheet found on our website: https://www.am.szczecin.pl/en/facilities/institute-of-mathematics-physics-and-chemistry/department-of-chemistry/chemistry-lab-manuals/
2. Second page of the report – „The Theoretical Part" – on a maximum of one page including brief description of keywords.
3. Third page of the report – „The Experimental Part" – including all performed experiments with titles, raw data, reactions, calculations, tables, graphs, etc. It should be written in accordance with „Data analysis (after the experiment)".
4. Additional task/tasks given by the academic teacher.
5. References.

4. IN ORDER TO PASS THE LABORATORY EXERCISE STUDENTS MUST PASS „THE ENTRY TEST" AND SUBMIT THE FINAL LABORATORY REPORT AT THE NEXT LABORATORY MEETING. THE LAB REPORT MUST BE ACCEPTED BY THE ACADEMIC TEACHER.