الجـــمهـــوريـــــــة الجزائرية الديمقراطـــــــــــية الشعبـــــية

People's Democratic Republic of Algeria

Ministry of Higher Education and Scientific Research

Higher School in Applied Sciences* of *Tlemcen



المدرسة العليا للعلوم التطبيقية
*** تلمســـان ***

Department of Preparatory Education

Annual Handbook of Practical Work in Chemistry for 1st Year Engineering Students

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Academic Year 2023-2024

Summary

Chemistry I	Title	Page
Practical Work N° 01	Introduction to Laboratory Safety……..	**1**
	Practical work report – 1……	**9**
	Corrected Practical Work N° 01……	**11**
Practical Work N° 02	Uncertainty calculations and determination of density……..	**13**
	Practical work report N°2……...	**16**
	Corrected Practical work report N°2…….	**18**
Practical Work N° 03	Volumetric Mass Measurement of Brine Solution…….	**20**
	Practical work report N°3……	**22**
Practical Work N° 04	Preparation of solutions at precise concentrations…….	**24**
	Practical work report N°4……..	**27**
Practical Work N° 05	Dosage of acidity contained in different food products…….	**29**
	Practical work report N°5……..	**32**
Practical Work N° 06	The geometry of molecules……..	**34**
	Practical work report N°6 …….....	**36**

Chemistry II

Practical Work N° 01	Phase change of a simple body……	**38**
	Practical work report N°1……..	**41**
Practical Work N° 02	Introduction to Calorimetry……..	**43**
Practical Work N° 03	Simulation of a Carnot cycle using CyclePad.……	**46**
Practical Work N° 04	Thermal Energy Released by the Combustion of Paraffin…	**50**
	Practical work report N°4……...	**52**
	Correction Practical work report N°4…….	**54**

Chemistry 01 **Practical Work N° 01** **2023-2024**

Introduction to Laboratory Safety

Working in a chemistry laboratory exposes you to risks due to both potentially toxic chemicals and specific equipment.

You must therefore be aware of the risks involved and do everything to protect others and yourself, while keeping in mind that the danger can come from others.

During laboratory work

The simple fact of entering a chemistry laboratory requires strict compliance with certain rules

- Eating and drinking are prohibited in the laboratories.
- Chewing gum is prohibited.
- It is forbidden to use cell phones.
- Do not clutter the floor with various bags, satchels, etc.; leave my aisles and access paths to the exits clear.
- Do not clutter the bench with binders, pencil cases, etc.
- Do not run.
- Do not handle it alone.
- Never pipette by mouth; use a pipette filler.
- Do not taste or smell chemicals.
- Do not play with the equipment.
- It is not recommended to wear contact lenses in the chemistry laboratory.
- Open shoes, such as slippers, should never be worn in the laboratory.
- Promptly report accidents and dangerous incidents (all chemical spills, broken glassware, and fires).

You must also wash your hands regularly during practical work and systematically before leaving the laboratory.

The chemist's outfit:

Entry into a chemistry laboratory requires appropriate clothing

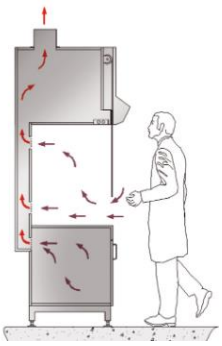
- A long-sleeved cotton blouse that must be buttoned.
- Long hair should be tied up.
- No rings, bracelets, or watches should be worn.

- Contact lenses are not recommended for use during chemistry laboratory class.

Collective protective equipment

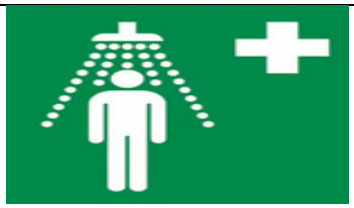
The extractor hood, or the Sorbonne

- Products that are toxic by inhalation must be handled under



The extractor hood

- Start the suction.
- Handle with the window down.
- Never put your head under the hood.
- Avoid the hood benchtop being too cluttered.

The shower	**The eyewash**	**The fire blanket**
		
It is generally located at the entrance to the room and must be used in the event of a burn or extensive chemical splash**.**	It must be used in the case of eye projection.	It allows you to smother a fire in a person. Do not use a fire extinguisher directly on a person.

Fire extinguishers in case of fire

There are three categories of fire extinguishers, depending on the type of fire.

		foam /water	**powder**	**$C0_2$**
Dry fire	papers, fabrics,	✓	✓	**x**
Greasy fire	solvents, plastics	**x**	✓	✓
Gas fire	Propan, butan	**x**	✓	✓
Metal fire	Sodium	**x**	**x**	**x**
Electric fire		**x**	✓	✓



- ❖ Note that **sand** is indicated for **extinguishing metal fires.**

What to do in the event of an accident

In the event of a personal accident, the witness to the accident is the first link in the emergency chain; his role is in the order of:

1. Protect yourself;
2. Protect the victim and other witnesses;
3. Alert emergency services.

Chemical risk

Whether storing or handling them, it is necessary to know the chemicals used and the associated hazards.

Before carrying out an experiment, you must:

- Carefully review the proposed procedure.
- Understand the planned operations.
- Find out what chemicals will be used so you can handle them properly.

There are three main categories of chemical risks.

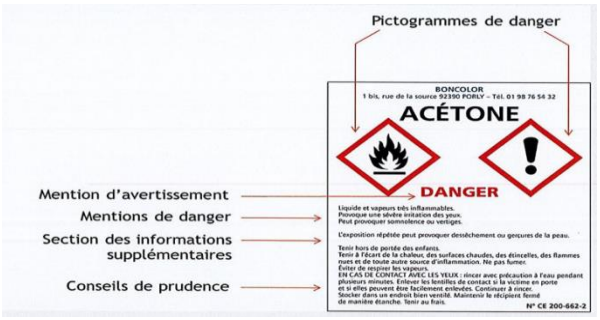
- Physical dangers (risk of explosion, inflammation, etc.)
- Health hazards (toxicity, etc.)
- Environmental hazards

Symbols Used on Labels or Hazard Pictograms:

In public places, we often find schematic drawings to indicate the exit, the ban on smoking, access for disabled people, etc. These designs are called pictograms.

In chemistry, the manipulation of chemical species is not always without danger for users but also for nature. Manufacturers therefore indicate pictograms on each bottle of chemical product to indicate the different dangers.





Pictogram and dangers of the GHS (Generally Harmonized System)

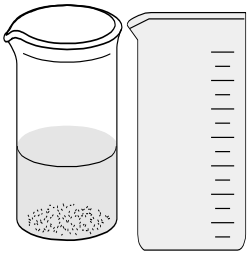
 **SGH01**	**Explosive** **I explode**	Products can explode on contact with a flame, a spark, static electricity, under the effect of heat, shock, friction, etc.
 **SGH02**	**Flammable** **I burn**	Products can ignite upon contact with a flame, a spark, static electricity, etc. But also, under the effect of heat, friction, upon contact with air or even upon contact with water. if they give off gas.
 **SGH02**	**Oxidizer** **I burn**	Oxidizing products (oxidants) which can cause or aggravate a fire, or even cause an explosion in the presence of flammable products.
 **SGH04**	**Gas under pressure**	Gaseous products may explode under heat.
 **SGH05**	**Corrosive**	Corrosive products cause “non-specific” destruction of tissues (skin, mucous membranes and eyes and digestive tract) by contact or projection.
 **SGH06**	**Toxic** **I kill**	Substance or mixture responsible for acute toxicity effects after administration by oral, dermal or inhalation route.
 **SGH07**	**Dangerous**	Products cause multiple dangers. Causes skin sensitization or irritation to the skin or eyes Irritating to the respiratory tract Narcotic, which causes drowsiness or dizziness dangerous to the ozone layer
 **SGH08**	**Carcinogenic products**	Products affecting fertility and the unborn child, Mutagenic products, Respiratory allergenic products that may cause allergies, asthma, or breathing difficulties if inhaled toxic to certain organs Aspiration hazards, which may be harmful or fatal in the event of ingestion or entry into the respiratory tract
 **SGH09**	**Dangerous for the environment**	Substances harmful to the aquatic and non-aquatic environment (fauna, flora, atmosphere) or having a long-term harmful effect. Particularly for organisms in the aquatic environment (fish, crustaceans, algae, etc.) or for the ozone layer.

Usual glassware and utensils used in practical chemistry work:

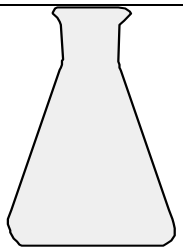
Storage Glassware

Storage glassware is used to preserve a liquid for the duration of handling.

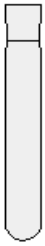
Depending on the nature and quantity of liquid to be stored, several utensils are available.



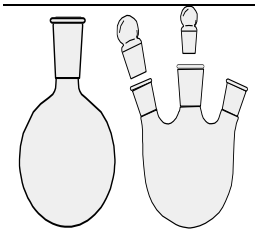
Beaker: a classic container in chemistry, used to transfer solutions or take a solution with a pipette, for example. The graduations on a beaker only give an order of magnitude of the volume contained; they are very imprecise!



An Erlenmeyer flask is an ideal container for preventing solution splashes. Therefore, it is preferable for safety reasons when mixing two liquids.



Test tube: It is used to carry out tests or to serve as a control tube.



The flask has between 1 and 3 necks and is mainly used as a reactor in organic chemistry.

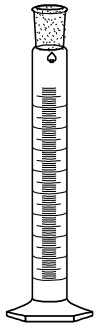
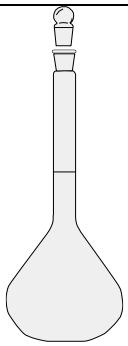
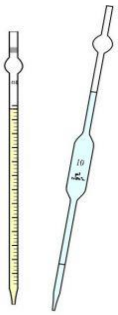
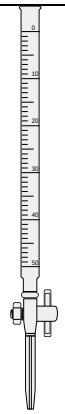


The crystallizer: it can contain a large quantity of liquid, such as a water bath or silicone oil for heating.

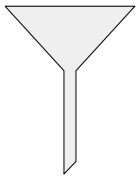
Sampling and measuring glassware are used to measure a volume of liquid precisely.

Class A corresponds to an accuracy of less than 0.2 % on the total volume indicated.

While class B corresponds to an accuracy of less than 0.5 % on the total volume indicated.

	Graduated cylinder: it is used for the rough measurement of a volume of liquid, it is less precise than the flask.
	The volumetric flask: is precise measuring glassware and bears either the words In (interior) or Ex (redact)
	Volumetric pipettes: these are the most precise instruments. Graduated pipettes are less precise and can be used when the precision of the volume taken is not critical.
	Graduated burettes are used to precisely deliver variable volumes, particularly during volumetric titrations.

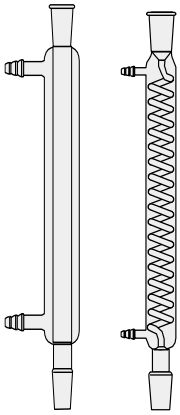
Some glassware used in a chemistry laboratory



Funnel



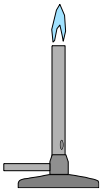
Propipette



Refrigerant



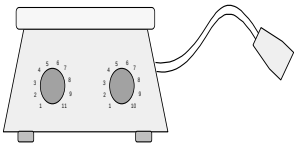
Tripod



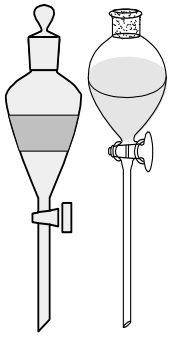
Bunsen burner



Mortar



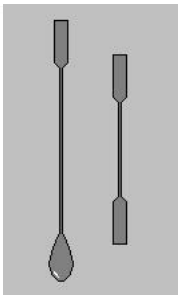
Hot plate with stirring



Separating funnel



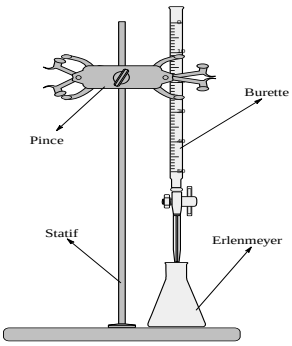
Wash



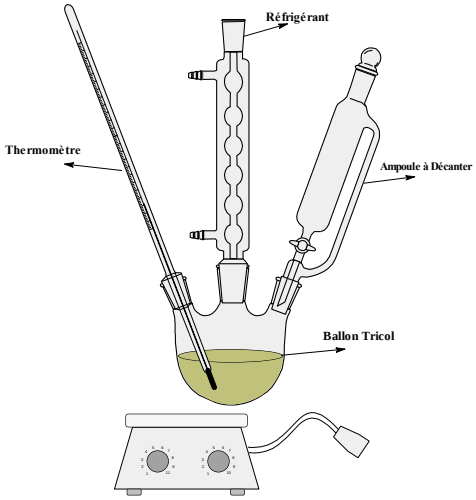
Spatula



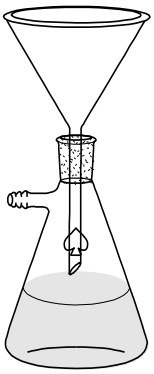
Watchglass



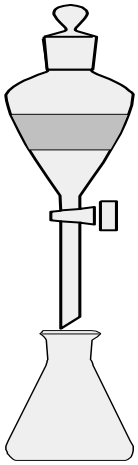
Dosing setup



Setting up a chemical reaction



Filtration
Separation of solid from liquid



Separation of two heterogeneous liquid phases

Weighing apparatus

Measuring the mass of a chemical species is a common and fundamental operation in chemistry. This process, known as 'weighing,' allows us to determine the amount of a substance with precision. In modern laboratories, electronic balances are commonly employed for this purpose. These

electronic balances offer accurate measurements and are equipped with features such as taring and calibration to ensure reliable results. Weighing plays a crucial role in chemical analysis, formulation, and various laboratory experiments, providing essential data for scientific research and quality control.

The principle of the technique

There are two main types of electronic scales:

Coarse weighing scales (Technical balance): they are used to weigh objects whose mass does not have to be known very precisely.

Their precision is of the order of 0.01 to 1 g.

Precision balances (analytical balance): they have significant sensitivity and therefore make it possible to weigh objects whose mass must be known as precisely as possible.

Their precision is generally around 0.1 mg, and the most efficient can reach 1 µg.



Analytical balance



Technical balance

Handling Precautions

A precision balance should always be used with great care:

Never move it. Do not exceed the maximum load indicated on the device.

Check that the scale is clean before each use, and clean it afterward.

Practical implementation

Check the horizontality of the balance platform (adjust the balance feet).

Make sure the balance pan is clean.

Place the watch glass in the center of the tray and close the compartment if the scale is equipped with one.

Tare the scale. Place the product in the watch glass using a suitable-sized spatula, then close the compartment.

Read the value indicated by the scale.

Remove the weighing container, then clean the balance.

Practical work report - 1 -

Chemistry 01 **2023-2024**

First Name	.....	**Note**
Family Name	.....	
Group	.....	

I- What is the incorrect safety instruction?

1-Wear protective glasses

2-Wear a white polyester blouse

3- Handle while standing

✓ The incorrect safety instruction is
……

II-On a safety poster, we find the pictogram below; what is the adjective that should be associated with this pictogram?



- Nocif
- corrosive
- Irritant

✓ The adjective that should be associated with this pictogram is
……...

III- Among the 3 pictograms below, which means that the product concerned is flammable?



A



B

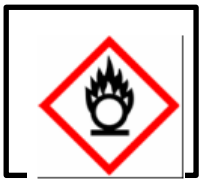


C

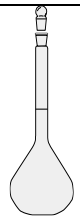
✓ The flammable product is:

……..

VI- Associate each pictogram with its risk phrase as well as the precautions to take.

Risks		Precautions
Substance harmful to the environment		It should not come into contact with the eyes; the skin, and do not breathe, use under the hood while wearing gloves and glasses.
Substance likely to explode		Substance to be kept away from flames and combustible substances
Substance that poisons quickly even at low doses		You must wear gloves and glasses.
Substance that causes or aggravates a fire (oxidant)		Substance that should not be thrown down the sink or in the trash.
Corrosive substance, attacks metals		Substance to be kept away from flames, avoid shocks

V- Name and classify the following glassware

	Name	Storage Glassware or Measuring glassware
	……..	……
	……	……
	……	……

Corrected Practical Work N° 01

Chemistry 01 **2023-2024**

I- What is the incorrect safety instruction?

1-Wear protective glasses

2-Wear a white polyester blouse

3- Handle while standing

✓ The incorrect safety instruction is : **(2) Wear a white polyester blouse** **1 pt**

II-On a safety poster, we find the pictogram below; what is the adjective that should be associated with this pictogram?



- Nocif
- corrosive
- Irritant

✓ The adjective that should be associated with this pictogram is : **corrosive** **1 pt**

III- Among the 3 pictograms below, which means that the product concerned is flammable?



A



B



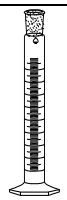
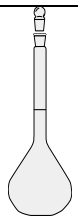
C

✓ The flammable product is: **A** **1 pt**

VI- Associate each pictogram with its risk phrase as well as the precautions to take.(0.5*10) =5pts

Risks		Precautions
Substance likely to explode		Substance to be kept away from flames, avoid shocks
Substance harmful to the environment		Substance that should not be thrown down the sink or in the trash.
Corrosive substance, attacks metals		You must wear gloves and glasses.
Substance that poisons quickly even at low doses		It should not come into contact with the eyes; the skin, and do not breathe, use under the hood while wearing gloves and glasses.
Substance that causes or aggravates a fire (oxidant)		Substance to be kept away from flames and combustible substances

V- Name and classify the following glassware (1*6) = 6pts

	Name	Storage Glassware or Measuring glassware
	Pipette	**Measuring glassware**
	Graduated cylinder	**Measuring glassware**
	Volumetric flask	**Measuring glassware**

Chemistry 01 **Practical Work N° 02** **2023-2024**

Uncertainty calculations and determination of density

Part 1: Uncertainty calculations

In experimental sciences, there are no exact measurements. These can only be tainted by more or less significant errors depending on the operating method chosen, the quality of the measuring instruments or the role of the experimenter.

- The error is the difference between the value obtained and the exact value.

Therefore, a measurement is always accompanied by uncertainty. If the measurement of a volume is accurate to within 0.1 ml, there is no need to write V = (7.42 ± 0.1) mLl. Just write V= (7.4 ± 0.1) mL.

I- Absolute uncertainty, Relative uncertainty:

Absolute uncertainty Δx is the maximum error that one is likely to commit in the evaluation of x. The absolute uncertainty is therefore **expressed in the units of the measured quantity**. Absolute uncertainty = upper limit of the absolute error.

Relative uncertainty $\Delta x / x$ **:** represents the importance of the error in relation to the measured quantity. Relative uncertainty has no units and is generally expressed as a percentage %.

Example 1: Assume a measurement V= (25.1 ± 0.5) ml. The value of the measurement is V = 25.1 ml and the absolute uncertainty of this measurement is denoted by ΔV = 0.5 ml. The relative uncertainty of the measurement is therefore expressed by: $\Delta V / V$= 0.5/25.1 = 0.02. The relative uncertainty is therefore 0.02 or 2%. This means that the measurement is accurate to within 2%.

To calculate uncertainty, we will use the following rules:

a- Absolute uncertainty about a sum (or a difference): The absolute uncertainty on a sum (or a difference) is the sum of the absolute uncertainties on each term.

Example : X= A+B-C	**Absolute uncertainty** $\Delta x = \Delta A + \Delta B + \Delta C$

- Absolute uncertainties are added for addition and subtraction.

b- Relative uncertainty on a product (or a quotient): The relative uncertainty on a product (or a quotient) whose terms are independent, is the sum of the relative uncertainties on each of the terms.

Example: X= a.b/c

Relative uncertainty $\Delta x/x = \Delta a/a + \Delta b/b + \Delta c/c$ **Absolute uncertainty** $\Delta x = x(\Delta a/a + \Delta b/b + \Delta c/c)$

- Relative uncertainties are added for multiplication and division.

II- Presentation of the results: When we have experimentally determined the value of a quantity X (normality N, concentration C, volume V, etc.),, a question arises: how many digits after the decimal point should we put when we present the result? Answer: you must put as many as the quantity has significant numbers. But what is a significant number ? In a number, digits other than zero are significant. Zeros if placed at the head of the number are not significant.

Exemple

9.1	2 Significant numbers
620	3 Significant numbers
9625	4 Significant numbers
0.91	2 Significant numbers

A quantity is always given with its absolute uncertainty. Two rules must be respected:

- An absolute uncertainty has only one significant number. It must always be increased (the error committed by the experimenter is greater than that calculated).

Example			
	$\Delta X = 0.0035$	**Δx increased = 0.004**	1 Significant number
	$\Delta X = 0.0235$	**Δx increased =0.03**	1 Significant number
	$\Delta X = 0.865$	**Δx increased =0.9**	1 Significant number

After increasing the absolute uncertainty, the measured value must be presented in the form:

X = (X rounded ± ΔX increased)

The rounded value (rounded X) can only be established after determining the uncertainty Δx increased.

- The value X must have the same number of decimal places as the uncertainty Δx

Example1

	X = (X rounded ± Δx increased)	**X = (X rounded ± Δx increased)**
X=0.258925 and $\Delta x = 0.03$	**X=(0.258925 ± 0.03) false**	**X = (0.26 ± 0.03) true**
X=0.253925 and $\Delta x = 0.03$	**X=(0.253925 ± 0.03) false**	**X = (0.25 ± 0.03) true**
X=0.253925 and $\Delta x = 0.032$	**X=(0.253925 ± 0.032) false**	**X = (0.25 ± 0.04) true**

Example 02: C = 0,071475 mole /L and ΔC = 0,000529 mole /L

-**Δx increased** ΔC = 0,0006 mole /1

- **Round the X (C)** in a way to obtain the same number of digits after the decimal point. C = 0.0715 mole /L

C = (0.0715±0.0006) Mole / L.

Part 2: Determining the density of a liquid

II-1 Definition: The volumic mass of a substance is its mass divided by its volume $\rho = m/V$

II-2 Purpose of manipulations

Determine the volumic mass (ρ) of a liquid and a solid

II-2-1 Experiment 1: Determine the volumic mass (ρ) of a liquid

1-Measure, using the technical balance, the mass of an empty 10 mL graduated cylinder (note the absolute uncertainty as well as the uncertainty of the balance (ΔV and Δm)

2- Fill graduated cylinder with liquid up to 10 mL then weigh it again.

V1= (……..± ……) ml

3-Deduct the mass of the liquid

m1= (……..± ……) g

4- Calculate the density of liquid ρ

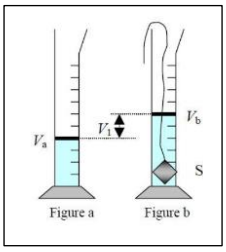
ρ1 = m/V =…….

5- Calculate the relative error (Δρ / ρ). **(Help: see part I-b)**

6- Deduce the absolute error Δρ. **(Help: see part I-b)**

ρ_1 = (……..± ……)…….

II-2-2 Experiment 2: Determine the density (ρ) of a solid



1- Measure, using the same balance, the mass m_2 of the solid S:

m_2= (……..± ……) g.

2- Measure the volume V2 of the solid S, to do this:

- Read the volume Va(about 15 mL) of the liquid contained in the 25 mL graduated cylinder;
- Place the solid S in the graduated cylinder;
- Read the new volume V_b of the liquid.

Record volume of solid with uncertainty

V_2 = (……..± ……) mL

3- Calculate the density of liquid ρ

ρ_2= m/V =…….

4- Calculate the relative error (Δρ / ρ). **(Help: see part I-b)**

5- Deduce the absolute error Δρ. **(Help: see part I-b)**

Chemistry 01 **2023-2024**

Practical work report N°2

First Name	.....	**Note**
Family Name	.....	
Group	.....	

1- Name two pieces of glassware used in this Practical Work?

1……..

2……..

2- **The volumic mass (ρ) of water is** ρ= 1Kg/L equivalent to :

a - ρ= 1Kg/mL **b-** ρ= 1g/L **c-** ρ= 1g/mL **d -** ρ= 1g/cm^3

3-Experiment 1: Determine the volumic mass (ρ) of a liquid

3-1 Collect the results in the following table**:**

	V_1	m_1	ρ_1
Experiment 1	V_1= (……..± ……) …..	m_1= (……..± ……) …	ρ_1 =..... .....

3-2 Calculate the relative error (Δρ / ρ).

3-3 Deduce the absolute error Δρ.

3-4 ρ_1 = (……..± ……)……

4- Experiment 2: Determine the density (ρ) of a solid

4-1 Collect the results in the following table:

	V_2	m_2	ρ_2
Experiment 2	V_2= (……..± ……) …..	m_2= (……..± ……) …	ρ_2 =..... .....

4-2 Calculate the relative error ($\Delta\rho$ / ρ).

4-3 Deduce the absolute error $\Delta\rho$

4-4 ρ_2 = (……..± ……)…….

5-Complete the following table:

X = (X ± ΔX)	**ΔX increased**	**X rounded**	**X = (X rounded ± ΔX increased)**
0.1229 ± 0.0604			
125.66 ± 0.878			
12.65 ± 0.1			
2.65 ± 3.1			

Chemistry 01 **2023-2024**

Corrected Practical work report N°2

First Name	.....	**Note**
Family Name	.....	
Group	.....	

1- Name two pieces of glassware used in this Practical Work? **1 pts**

1……..

2……..

2- The volumic mass (ρ) of water is ρ= 1Kg/L equivalent to : **1pts**

a - ρ= 1Kg/mL **b-** ρ= 1g/L **c-** ρ= 1g/mL **d -** ρ= 1g/cm^3

3-Experiment 1: Determine the volumic mass (ρ) of a liquid **1.5 pts**

3-1 Collect the results in the following table**:**

	V_1	m_1	ρ_1
Experiment 1	V_1= (……..± ……) …..	m_1= (……..± ……) …	ρ_1 =..... .....

3-2 Calculate the relative error (Δρ / ρ). 1.5

3-3 Deduce the absolute error Δρ. 1

3-4 ρ_1 = (……..± ……)…… 1

4- Experiment 2: Determine the density (ρ) of a solid

4-1 Collect the results in the following table:

	V_2	m_2	ρ_2
Experiment 2	V_2= (……..± ……) …..	m_2= (……..± ……) …	ρ_2 =..... .....

4-2 Calculate the relative error ($\Delta\rho / \rho$).

4-3 Deduce the absolute error $\Delta\rho$

4-4 $\rho_2 =$ (……..± ……)…….

5-Complete the following table: 3 pts

X = (X ± ΔX)	**ΔX increased**	**X rounded**	**X = (X rounded ± ΔX increased)**
0.1229 ± 0.0604	**0.07**	**0.12**	**0.12± 0.07**
125.66 ± 0.878	**0.9**	**125.7**	**125.7±0.9**
12.65 ± 0.1	**0.1**	**12.7**	**17.7±0.1**
2.65 ± 3.1	**4**	**3**	**Impossible**

Chemistry 01 **Practical Work N° 03** **2023-2024**

Volumetric Mass Measurement of Brine Solution

Introduction

Volumic mass (symbolized as ρ) is a fundamental property that quantifies the relationship between mass and volume (ρ = m / V) for a substance. In this activity, the mass and volume of brine (sodium chloride aqueous solution) will be measured, and the volumic mass of the solution will be calculated. Our primary objective is to compute the volumic mass of this solution and subsequently compare it with calculations made by other members of our group. Furthermore, we will meticulously assess the accuracy and precision of our measurement techniques.

Aims

1. To become familiar with working in the undergraduate laboratory, including familiarization with the layout of the laboratory and some of the apparatus available. This aim focuses on the introductory aspect of the lab work, getting students comfortable with the lab environment and equipment.
2. To determine the volumic mass of a sample of brine (sodium chloride solution). This is the main objective of the experiment, where students will measure the volumic mass of the given solution.
3. To consider the accuracy and precision of the volumic mass determination. This aim highlights the importance of evaluating the quality and reliability of the measurements made during the experiment, which is a critical aspect of any scientific investigation.

Equipment

25 and 50 mL beakers
10 and 25 mL pipettes
10 and 25 mL measuring cylinders
Top pan balance
Analytical balance
Thermometer
Brine

Experience 1

1-1 Beaker and top pan balance

1. Begin by positioning a clean, dry 100 mL beaker onto the top pan balance. Tare. [‘Tare’ means zero the display – usually by pressing the ‘Tare’ button].

2. Next, remove the beaker from the balance and carefully add a necessary volume of sodium chloride solution into it. Employ the graduations marked on the beaker to determine the volume, and be sure to document this measurement in the designated table.

3. Subsequently, position the beaker back onto the top pan balance and log the mass of the sodium chloride solution in the table.

4. To enhance accuracy, replicate this process for trials 2 and 3, ensuring consistency in your measurements.

Measuring cylinder and top pan balance

1. Place a clean dry 25 mL beaker on the top pan balance. Tare.

2. Pour a small amount of sodium chloride solution into a 25 ml measuring cylinder. Using the cylinder graduations, read the volume as accurately as possible and record it in the painting.

3. Pour the sodium chloride solution into the beaker and place on the balance. Record the mass in the table.

4. Repeat for trials 2 & 3.

Pipette and top pan balance

1. Position a clean and dry 25 mL beaker onto the top pan balance and perform a tare operation.

2. With the use of a volumetric pipette, introduce the sodium chloride solution into the 10 mL beaker. Record the volume of solution added to the beaker.

3. Place the beaker on the balance and record the mass in the table.

4. Repeat for trials 2 & 3.

Analytical balance

Repeat each of the above sets of procedures using the analytical balance (in the balance room) in place of the top pan balance. Please exercise caution to prevent any liquid spillage within the analytical balance room, as these instruments are of significant value. All liquid transfers should be conducted outside of the balance room to minimize the risk of spills.

Chemistry 01 **2023-2024**

Practical work report N°3

First Name	.....	**Note**
Family Name	.....	
Group	.....	

1)

	Beaker and top pan balance			Beaker and analytical balance		
Trial	*Volume (mL)*	*Mass (g)*	*Volumic mass (g/mL)*	*Volume (mL)*	*Mass (g)*	*Volumic mass (g/mL)*
1			0.25			0.25
2			0.25			0.25
3			0.25			0.25
Average Volumic mass (g/mL)			0.25	**Average Volumic mass (g/mL)**		0.25

2)

	Measuring cylinder and top pan balance			Measuring cylinder and analytical balance		
Trial	*Volume (mL)*	*Mass (g)*	*Volumic mass (g/mL)*	*Volume (mL)*	*Mass (g)*	*Volumic mass (g/mL)*
1			0.25			0.25
2			0.25			0.25
3			0.25			0.25
Average Volumic mass (g/mL)			0.25	**Average Volumic mass (g/mL)**		0.25

3)

	Pipette and top pan balance			Pipette and analytical balance		
Trial	*Volume (mL)*	*Mass (g)*	*Volumic mass (g/mL)*	*Volume (mL)*	*Mass (g)*	*Volumic mass (g/mL)*
1			0.25			0.25
2			0.25			0.25
3			0.25			0.25
Average Volumic mass (g/mL)			0.25	**Average Volumic mass (g/mL)**		0.25

Questions

1-indicate the absolute error of the following glassware and instruments (0.25 *5)= 1.25 Pts

Beaker…… Top pan balance……..

Analytical balance…… Pipette……..

Measuring cylinder……..

2-Calculate the relative error (Δρ / ρ) in the case of:

2-1-Measuring cylinder and top pan balance (Δρ / ρ) (**method1) 1 Pt (0.5 relation + 0.5 calcul)**

2-2. Measuring cylinder and analytical balance (Δρ / ρ) **(method2) 1 Pt (0.5 relation + 0.5 calcul)**

2-3. Pipette and analytical balance (Δρ / ρ) **(method3) 1 Pt (0.5 relation + 0.5 calcul)**

3-2.Which method of determining volumetric mass was most precise? Why?

Method 3 0 .25 **Why??** We used the most precise glassware which is the pipette and the most precise balance which is the analytical balance **0.5 pts**

.4-Calculate the % error for each density average and record the data in the table below. (0.5* 6)pts

The actual volumic mass of sodium chloride solution at 25°C is 1.051 g/mL

[Reminder: % error = ({average calculated density - actual density}/ actual density) x 100 %].

	Top pan balance	**Analytical balance**
Beaker		
Measuring cylinder		
Pipette		

Chemistry 01 **Practical Work N° 04** **2023-2024**

Preparation of solutions at precise concentrations

I. Theoretical reminder:

A solution: A solution is a homogeneous mixture formed by dissolving a chemical species, called a solute, in a solvent. In an aqueous solution, the solvent is water.

Solution = Solute + Solvent.

A solvent: Is a liquid substance that dissolves (absorbs) other substances.

A solute: Is the substance which, in general, is present in smaller quantities and which dissolves in the mixture.

II- Different expressions of the concentration of a solution

Molarity (mol/L): The number of moles of solute in 1 L of solution, C_M= nsolute /V solution

Mass concentration (g/L): The mass of solute per volume of the solution Cmass=m solute /V solution.

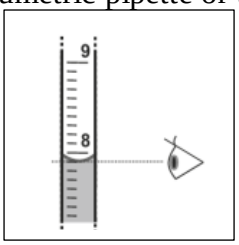
The mole fraction: The number of moles of species i by the total number Xi= ni/ ntotal.

Dilution factor: We note it **f**. It is defined by the relationship $f = C_{mother}/C_{daughte}r = V_{daughter}/V_{mother}$. It is a number necessarily **greater than 1**.

III- How to collect a precise volume

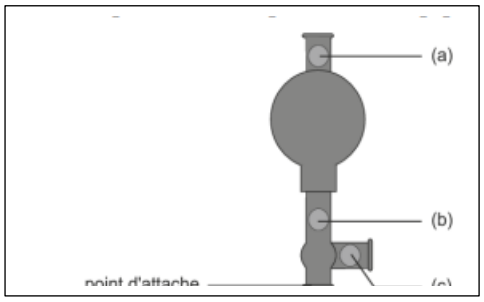
III.1. Correct reading: The bottom of the meniscus serves as visual reference

This reference must be used to adjust the volume of a volumetric flask or a volumetric pipette or to read the volume of a burette.



- The glassware element must be strictly vertical
- Observation of the meniscus must be done in a horizontal plane

III.2. Correct pipetting: There are two types of pipettes: - the graduated pipette - The gauged pipette with a gauge mark. The propipette will allow the aspiration of the liquid into the pipette then its ejection.



(a) Allows air to escape from the propipette when compressed. **(b)** allows the liquid to rise in the pipette **(c)** allows the liquid to be expelled into the pipette

III.3. The different steps:

Step 1: Empty the air from the propipette (simultaneous pressure on the body and in (a)).

Step 2: Attach the pipette to the propipette without pushing it in too much. Hold the 2 instruments at most near the attachment point.

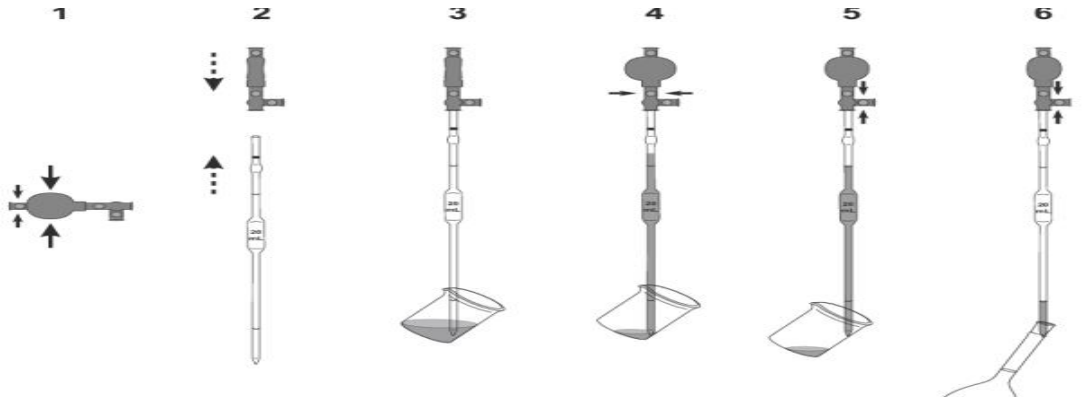
Step 3: One hand holds the top of the pipette, the other holds the inclined sampling beaker, and the bottom of the pipette to ensure the verticality of the whole.

Step 4: Aspirate the liquid by pressing (b)

Step 5: Adjust the liquid level: bottom of meniscus on the gauge line; the line of Gauge is at eye level.

Step 6: Slowly introduce the sample into the volumetric flask. The bottom gauge line is at eye level; the whole is always vertical. For that , the pipette rests on the glass of the vial.

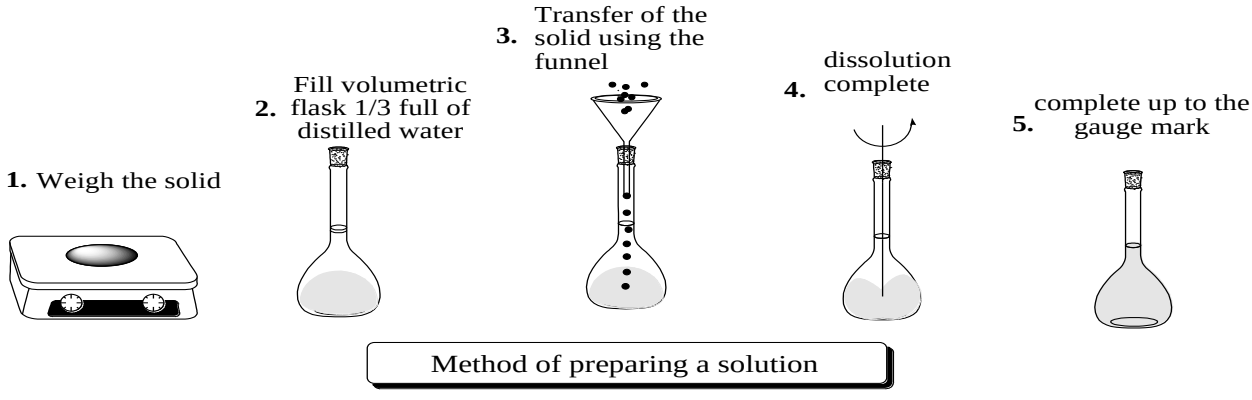
Step 7: Remove the propipette, empty the bottom of the pipette into the stemmed glass serving as trash, place the pipette at the bottom of the bench without it being able to roll.



IV. Goals:

Know how to prepare a solution at a precise concentration, by dissolving a solid compound, and by diluting a stock solution.

<u>V- Preparation of solutions at precise concentrations.</u>



Method of preparing a solution

V-1. <u>Preparation of 100 mL of an aqueous solution of NaCl with a concentration of 0.2 mol/L .</u>

In a 100mL volumetric flask previously filled halfway with distilled water, introduce the necessary mass of NaCl to prepare the required solution. Shake until completely dissolved then make up to the mark.

- Give the expression for the relative error of this experiment (on concentration)?
- Calculate the relative error
- Deduce the absolute error

IV-2 <u>Preparation of a daughter solution 10 times diluted (f =10):</u>

From solution 1, take using a pipette the volume necessary for the preparation of a daughter solution 10 times diluted. Top up with distilled water using the wash bottle to the mark.

- Give the expression for the relative error of this experiment (on the diluted concentration)?
- Calculate the relative error
- Deduce the absolute error

<u>Exercise</u>

<u>Préparation de 100ml d'une solution de 0.05 mol /L de la vitamine C (ascorbique acid)</u>

In a 100mL volumetric flask previously filled halfway with distilled water, introduce **m= …….. g** mass of **vitamin C** to prepare the required solution. Shake until completely dissolved then make up to the mark.

Solution 1.

- Give the expression for the relative error of this experiment (on concentration)?
- Calculate the relative error
- Deduce the absolute error

<u>Préparation de 100ml d'une solution de 0.005 mol /L de la vitamine C (ascorbique acid)</u>

From solution 1, take using a pipette the volume necessary **V= …… ml** for the preparation of a daughter solution **0.005mol/L** . Top up with distilled water using the wash bottle to the mark.

- Give the expression for the relative error of this experiment (on the diluted concentration)?
- Calculate the relative error
- Deduce the absolute error

<u>masse molaire $C_6H_8O_6$ =176g/mole</u>

Chemistry 01 **2023-2024**

Practical work report N°4

First Name	.....	**Note**
Family Name	.....	
Group	.....	

A syrup is a homogeneous mixture of sugar and water used for the preparation of certain medicines, in pastry…In chemistry, we speak of an aqueous solution of sucrose of formula $C_{12}H_{22}O_{11}$. (^{12}C, ^{1}H, ^{16}O)

1- Give the nature of the solute and the solvent in syrup.

The solute in syrup is ……..

The solvent in a syrup…….

2- **We want to prepare a solution of 100 mL of syrup with a concentration of 0.1 mol / L**

The molar mass of sucrose is …… g/mole

The mass necessary for the preparation of the 100 mL solution: m=…… ……. sucrose

3- What glassware is needed to prepare this solution?

-

-

-

-

4- Complete for a procedure to prepare a solution from a solid: (without mentioning calculation)

- Weigh ……. with ……
- Pour a sufficient volume of the stock solution into a …….
- Using a ……., take the volume necessary for the preparation of the solution
- This volume is introduced into a 250mL …… filled 1/3 with …….
- We stopper and ……..the solution.
- Make up with distilled water up to ……...

5-For experiment 1 (solution 1)

a- Give the expression for the relative error of this experiment (on concentration)?

b- Calculate the relative error

c- Deduce the absolute error

C=(…….)…….

6- For experiment 2 (solution 2)

a- Give the expression for the relative error of this experiment **(on Dilution)?**

b- Calculate the relative error

c- Deduce the absolute error

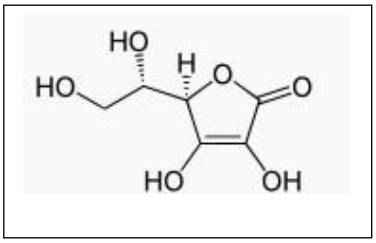
C=(…….)…….

Chemistry 01 **Practical Work N° 05** **2023-2024**

Dosage of acidity contained in different food products

I. Introduction

Vitamin C is water soluble, meaning it is soluble in water. Although most mammals can synthesize it,humans have lost, during their evolution, the ability to synthesize vitamin C, so it must be found in food.



Vitamin C is mainly known to help reduce fatigue and participate in the body's defenses (immune system).

II. Aim

We want to measure by colorimetric titration the concentration of acid contained in pharmacy vitamin C andin orange juice.

III. Principle

Acid/base titration using NaOH solution

III.1 Definition of acid-base dosage by colored indicators

Determining an aqueous solution of an acid or a base means determining its concentration by carrying out an acid-base reaction. The dosage reaction must be rapid, complete, easily observable.

Titration by colored indicators is a titration analysis method which is based on a change in color of themedium during equivalence

At equivalence, the number of gram equivalents of H_3O^+ provided by the acid must be equal to the numberof gram equivalents of OH^- provided by the base. This causes a change in color and above all:

$$\mathbf{NAVA = NB\ VB}$$

In theory, two dosages are used:

The rapid dosage: This allows you to frame the equivalence zone by pouring the reagent titrating mL bymL.

The Precise dosage: where the titrant is poured up to 1.5 mL or 2 mL from the equivalence zone quicklyand then drop by drop until equivalence is reached.

REACTIFS	MATERIELS ET VERRERIES	
	MATERIELS	VERRERIES
• NaOH (0.05M) • Colored indicator • Solution Vit C • Solution Jus de fruits • Distilled water	• Balance	• 1 graduated burette • 2 erlenmeyer • 2 Measuring cylinder • 3 Beakers • Pipette

IV. First experiment: Dosage of the vitamin C solution

IV.1 Preparing the burette:

- Empty the burette containing distilled water.
- Rinse it with the sodium hyroxide solution. Collect the products in the trash bin.
- Fill the burette with sodium hydroxide.
- Adjust the level of the sodium hydroxide solution to the zero level of the burette by makingrun off the excess.

IV.2 Dosage of the vitamin C solution (Carry out one rapid dosage and two precise dosages)

- Place the soda solution in the burette, while setting the level to zero.
- Place 10.0 mL of the vitamin C solution in the Erlenmeyer flask.
- Pour a few drops (2 or 3 drops)of phenolphthalein into the Erlenmeyer flask.
- Pour the soda solution until you observe a persistent color change.
- Titrate slowly, waiting each time for the color to homogenize.
- You will have to be careful not to miss the equivalence.
- Repeat the experiment 3 times

V. Second experiment: dosage of the fruit juice solution

V.1 Preparing the burette: (see previous page)

V.2 Dosage of the fruit juice solution (Carry out one rapid dosage and two precise dosages)

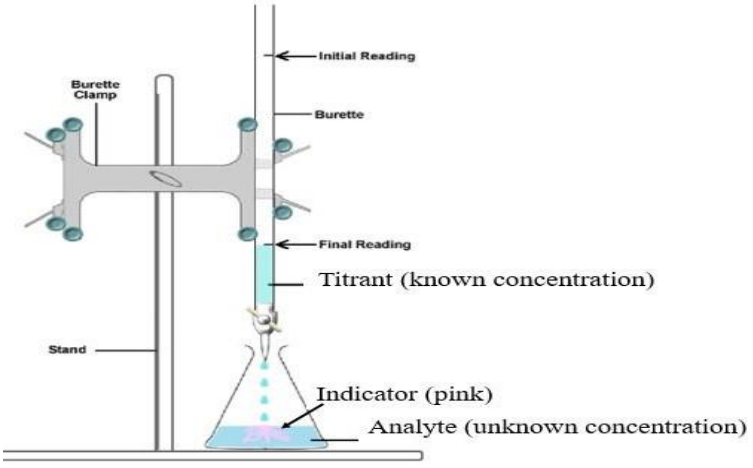
- Place the soda solution in the burette, while setting the level to zero.
- Place 10.0 mL of the fruit juice solution in the Erlenmeyer flask.
- Pour a few drops of phenolphthalein into the Erlenmeyer flask.
- Pour the soda solution until you observe a persistent color change.
- Titrate slowly, waiting each time for the color to homogenize.
- You will have to be careful not to miss the equivalence.
- Repeat the experiment 3 times
- Determine the average equivalence volume

VI. Questions

- Calculate the molar mass of ascorbic acid
- The equivalent volume is assumed to be 10 mL in both experiment

- Calculate the molar and mass concentration in the case of: acid in vitamin C acid in fruit juice

It is assumed that the relative error for the preparation of the NaOH solution $\Delta C_{NaOH} / C_{NaOH} = 0$ Give the expression for the relative error of this experiment (experiment 1 and 2)



Acid base titration setup by colorimetry

Practical work report N°5

First Name	.....	**Note**
Family Name	.....	
Group	.....	

I. Dosage of ascorbic acid in the vitamin C solution

I-1 The rapid dosage: **…….** < Veq <…….

I-2 The Precise dosage:

	1st attempt (V_1)	2nd attempt (V_2)	3rd attempt (V_3)
Volume of NaOH			

Average volume Veq =

I-3 Calculate the molar concentration of ascorbic acid in vitamin C if we know that Na = Ca and Nb = Cb?

I-4 Calculate the relative error during the dosage ΔCa/Ca? if we know that ΔCb/ Cb = 0.025?

I-5 Deduce ΔCa

C= (…….) …….

I-6 Calculate the mass concentration of ascorbic acid ($C_6H_8O_6$)?

II. Dosage of the fruit juice solution

II-1 The rapid dosage: **……..** < Veq <…….

II-2 The Precise dosage:

	1st attempt (V_3)	2nd attempt (V_2)	3rd attempt (V_3)
Volume of NaOH			

Average volume V =

II-3 Calculate the molar concentration of ascorbic acid the fruit juice solution if we know that

Na = Ca and Nb = Cb?

II-4 Calculate the mass concentration of ascorbic acid ($C_6H_8O_6$)?

II-5 What is the richest solution in vitamin C? Justify?

Chemistry 01 **Practical Work N° 06** **2023-2024**

The geometry of molecules

From a Lewis structure, we can predict the three-dimensional structure of a molecule bonds and free doublets repel each other and try to move away from each other as much as possible.

The geometric shape of the molecule is in fact the one which makes it possible to minimize this repulsion.

We call this approach the VSEPR model (Valence-Shell Electron Pair Repulsion) , the VSEPR model considered that double and triple bonds are equivalent to single bonds (we will take into account the fact that they are more voluminous only to slightly adjust the angles around an atom).

The shape of molecules

Consider a **central atom, A**, which contains **n free doublets E** (n can be equal to zero) and which is **linked to m atoms X** (**m is equal to or greater than two**)

The general formula is **AXmEn** and we only consider cases where **(m+n) ≤6** (it is very rare that we see their sum greater than six) the free doublets and bonds adopt the following geometries around the central atom:

- ✓ The diatomic AX which is necessarily linear if m = 1.
- ✓ Linear, if m + n = 2
- ✓ Plane trigonal, if m + n = 3
- ✓ Tetrahedral, if m + n = 4
- ✓ Trigonal bipyramidal, if m + n =5
- ✓ Octahedral, if m + n = 6



The rules to follow to apply the VSEPR model

- ✓ Write the electronic configuration of the central atom as well as the terminal atoms.
- ✓ Observed the valence electrons of each atom (how many single electrons and compared it with the number of bonds).
- ✓ We always try to equalize between the bond number and the valence electrons of the central shell
- ✓ If there is an equality of single electrons with bond number we follow the order of the rules otherwise:

- ✓ We always think of the excited state of the central atom
- ✓ Write the Lewis structure of the molecule, taking into account the electron doublets surrounding the central atom (the free doublets on a terminal atom do not influence the geometry)
- ✓ Count the bonds (m) and free doublets (n) around the central atom
- ✓ Consider double and triple bonds as single bonds
- ✓ Once (m+n) determined, base the molecular form on the linear form if (m+n)=2, the trigonal form if (m+n)=3, the tetrahedral form if (m+n)=4 ,….
- ✓ if we have free doublets, place them in positions to minimize the repulsions between the free doublets and the other doublets (e.g. an equatorial position in the trigonal bipyramid)

N.B. it is impossible to exactly predict the bond angles if we have one or more free doublets or bonds that are not all identical

Practical work report N°6

First Name	.....	**Note**
Family Name	.....	
Group	.....	

Data: $_{1}H$, $_{4}Be$, $_{6}C$, $_{7}N$, $_{8}O$, $_{9}F$, $_{15}P$ $_{16}S$, $_{17}Cl$, $_{53}I$

Molecules	Configuration Electronique de l'atome central	Structure de LEWIS	Règle d'octet	Formule VSEPR	Arrangement des pairs électroniques	Géométrie moléculaire
CH_4						
BeH_2						
PCl_3						
PCl_5						
NH_3						
NH_4+						

Molecules	Configuration Electronique de l'atome central	Structure de LEWIS	Règle d'octet	Formule VSEPR	Arrangement des pairs électroniques	Géométrie moléculaire
CO_3^{--}						
ICl_3						
SF_6						
HCN						

Data: $_1H$, $_4Be$, $_6C$, $_7N$, $_8O$, $_9F$, $_{15}P$ $_{16}S$, $_{17}Cl$, $_{53}I$

Chemistry 02 **Practical Work N° 01** **2023-2024**

Phase change of a simple body

1. Solid, Liquid, Gas Phases

- ✓ A pure body can appear in one or more of the three phases solid, liquid or gas.
- ✓ These three phases are distinguished, on a microscopic level, by the intensity of the intermolecular forces.
- ✓ In the solid state, these only allow atoms to oscillate around fixed positions of random or ordered distribution (crystals).
- ✓ Their intensity decreases in liquids, which do not have their own shape, but remain weakly compressible. We then speak of short-distance order and long-distance disorder.
- ✓ In a gas, the intermolecular forces are very weak, and the molecules move disorderly.

2. Phase change

We will say that there is a change of state or a phase transition when a pure body passes from one phase to another. We can recall the names given to the different phase transitions

Name	Transformation	
vaporization	liquid	gas
Liquefaction	Gas	Liquid
Fusion	Solid	Liquid
Solidification	Liquid	Solid
Sublimation	Solid	Gas
condensation	Gas	Solid

. Table 1 : Phases change's

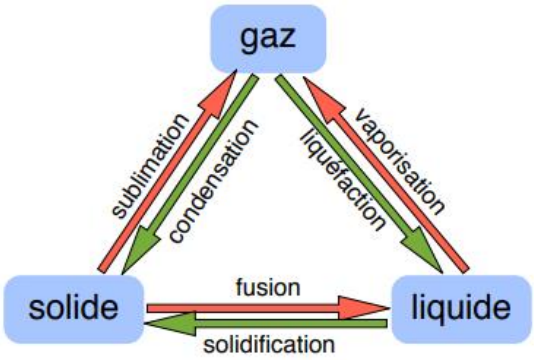


Figure 1. Phase change

3. Remarks :

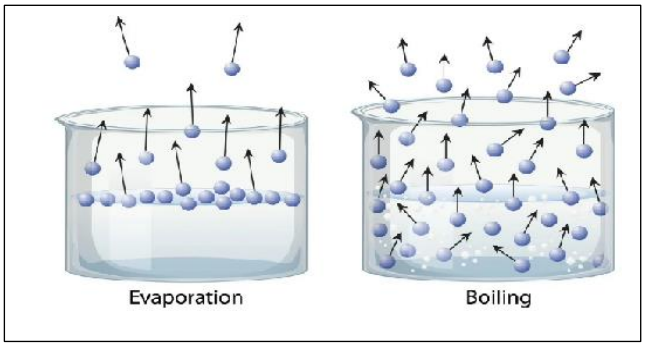
- ✓ **Steam or gas?** We will use the word vapor but when the substance is also present in liquid form, such as water vapor which fills the space above the liquid water in a kettle. In the case where there is no liquid present, we will use the word "gas".
- ✓ **Evaporation?** We use the word "evaporation" to designate a vaporization which takes place in the presence of an unlimited atmosphere. Laundry that is dried outside clearly illustrates this surface phenomenon, when water passes into a gaseous state.
- ✓ **Boiling ?** When vaporization occurs with the formation of vapor bubbles in the liquid, boiling occurs. Most often, boiling is carried out by heating a liquid kept under constant pressure.

4. **Objectives of the TP**

- ✓ Monitoring of phase changes (Vaporization and Solidification).
- ✓ Determination of boiling and solidification temperatures.

5. **Vaporizing distilled water or ethanol Materials and reagents used**

- Hot plate with magnetic stirring
- Stopwatch.
- Erlenmeyer flask.
- Thermometer.
- Distilled water or Ethanol



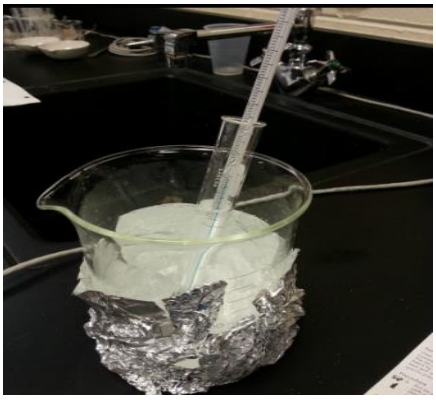
Protocol 1

- ✓ Pour the solvent into an Erlenmeyer flask and record the initial temperature.
- ✓ Place everything on a heating and stirring device.
- ✓ Using the thermometer and stopwatch, record the temperature values versus time.

✓ Record all your observations and complete the table below:

t (min)									
T (°C)									

6. **Solidification of distilled water and cyclohexa**



Materials and reagents used

- Stopwatch
- Crystallizer.
- Test tube.
- Thermometer
- Distilled water
- Cyclohexane
- Refrigerant mixture.

▪ **Protocol 2**

✓ Fill a test tube with liquid to 1/3 of its volume.

✓ Note the initial temperature of the distilled water at t = 0 s.

✓ Using the thermometer and the stopwatch and after introducing the test tube filled with water into the refrigerant mixture.

✓ Record all observations and changes in temperature over time:

t (min)									
T (°C)									

Remarks

❖ The probe thermometer must not touch the walls or bottom of the Erlenmeyer flask or crystallizer and must be properly submerged.

❖ During heating, the water is stirred so that the temperature is uniform throughout the volume.

❖ Strong agitation increases the contact surface between water and air, and therefore promotes cooling some water.

❖ You must therefore be careful not to shake too hard.

Practical work N°1

First Name	.....	**Note**
Family Name	.....	
Group	.....	

Part I Determination of boiling temperatures.

1- Complete the table below.

t (min)										
T (°C)										
t (min)										
T (°C)										

2- Quote your observations during manipulation

-
-
-
-
-
-

3- Draw the vaporization curve of liquid T = f (time). (With details)

4- Give an interpretation of each part of the curve T = f (time).

-
-
-
-

5- From the graph T = f (time), determine the boiling temperature of the liquid

T Boiling =……

Part II: Determination of Solidification temperatures.

1- Complete the table below..

t (sec)										
T (°C)										
t (sec)										
T (°C)										

2- Quote your observations during manipulation

-
-
-
-
-
-

3- Draw the solidification curve of liquid T = f (time). (With details)

4- Give an interpretation of each part of the curve T = f (time).

-
-
-
-

5- From the graph T = f (time), determine the solidification temperature of the liquid

$T_{solidification}$ =……..

Chemistry 02 **Practical Work N° 02** **2023-2024**

Introduction to Calorimetry

A. Theoretical part

I. Definitions:

Calorimetry is based on a fundamental principle: the principle of the equality of heat exchanges, where what is lost by one medium is gained by another: this is the first principle of thermodynamics.

In calorimetry, the transformations take place at constant pressure (they are isobaric). We consider the molar heat capacities (C_{pm}) constant, i.e. independent of temperature and pressure.

We study liquid and solid systems: we consider them incompressible so their volume is constant. The consequence is that any exchange of thermal energy is written:

$Q_p = nC_p\Delta T$ With $\Delta T = T_f - T_i$. The temperature difference of the subsystem in degrees Kelvin (K) .

But subsequently we will omit the indices and we will talk about heat capacity noted C (mass capacity, the only one used)

The measurement of heat quantities is always assumed to be made in **an adiabatic calorimeter**, i.e. without heat exchange between the system and the external environment.

If the system is made up of several subsystems which exchange different quantities of heat Q_1, Q_2, Q_3.then the balance is zero: $Q_1 + Q_2 + Q_3 + \ldots = 0$

II. Heat capacity of a calorimeter:

The instrument used to measure heat exchange and heat capacities is a **calorimeter**.

Calorimetric measurements being based on thermal exchanges between subsystems in the calorimeter, it is also necessary to take into account the thermal exchanges between what contains the calorimeter and the calorimeter: it is the role of **μ** which is called **the water value of the calorimeter.** We consider that in what concerns heat exchanges, the calorimeter and its accessories are equivalent to a mass of water, **μ**. Thus we can write the heat capacity of the calorimeter as: $\mathbf{C = \mu.C_e}$

With: C_e the specific heat capacity of liquid water, i.e. 4180 $J{:}K^{-1}{:}kg^{-1}$;

μ : The equivalent water mass of the calorimeter in kilogram (kg).

On the other hand, we will not take into account the exchanges between the calorimeter and the external environment; the calorimeter + accessories **system is therefore isolated.**

III. The adiabatic calorimeter:

The calorimeter is like a "thermos bottle", this is to reduce thermal losses: the instrument then becomes almost an adiabatic calorimeter.

IV. Specific heat

The specific heat or specific heat capacity c of a body expressed in ($J.kg^{-1}.K^{-1}$) or (cal.kg-1.K- 1) is the quantity of heat that must be supplied (or taken) to the unit mass of this body so that its temperature rises by 1°C.

$$Q=m.c.\Delta T$$

The heat capacity of the metal is determined by applying the law of heat conservation for an adiabatic system:

$$\sum Q_i = 0$$

Remark:

Specific heat capacity is formerly known as "Specific Heat", Now we must say Specific heat capacity or Calorific capacity mass or specific heat capacity.

V. Latent heat (L)

In the case of melting ice, it is the quantity of heat necessary to pass the unit of mass of ice at constant temperature (T = 0 °C) from the solid state to the liquid state.

L_f: Latent heat of fusion ($J.kg^{-1}$) or ($cal.kg^{-1}$).

B. Experimental part

1. Objectives of the Tp

- Determination of the heat capacity of the calorimeter.
- Determination of the specific heat of a solid
- Determination of the latent heat of fusion of ice.

2. Operating mode

2.1-Determination of the heat capacity of the calorimeter

Before any measurement, it is essential to know the heat capacity of the calorimeter and its accessories. This thermal capacity C_{cal} is measured under conditions as close as possible to experiment using the method of mixing with water.

- ✓ Make sure the calorimeter is very clean; if not, rinse it with distilled water.
- ✓ Take, in a graduated cylinder, 200 mL of water at room temperature.
- ✓ Introduce it into the calorimeter and note its initial temperature T_1.
- ✓ Heat 200 mL of water to approximately 60°C and note its initial temperature T_2
- ✓ Mix by quickly pouring hot water into the calorimeter.
- ✓ Agitate gently and wait for thermal equilibrium
- ✓ Note the equilibrium temperature Teq_1.

2.2- <u>Determination of the specific heat of a solid</u>

This experiment allows us to measure the heat capacity of a metal. We will work with metals, namely aluminum.

- ✓ Introduce V = 100 mL of water at room temperature into the calorimeter. Wait for balance thermal and note the temperature T_1.
- ✓ Determine the mass m of the piece of aluminum.
- ✓ Put the metal in boiling water, the piece of metal should not touch the bottom of the crystallizer.
- ✓ After 15 minutes in boiling water, we consider that the aluminum is at T_2 = 100 °C.
- ✓ Quickly insert the piece of aluminum into the calorimeter.
- ✓ Stir and observe the water temperature rise in the calorimeter and note the equilibrium temperature T_f.
- ✓ Write the calorimetric equation, deduce the mass heat capacity C of aluminum.

2.3-<u>Determination of the latent heat of fusion of ice</u>

- ✓ Take 100 mL of cold water at room temperature in a graduated cylinder.
- ✓ Introduce it into the calorimeter and note its initial temperature T_1
- ✓ Take a piece of ice (around 30 g), weigh it and note its mass m_2
- ✓ Note the initial temperature of the ice T_2
- ✓ Quickly pour the ice into the calorimeter
- ✓ Agitate gently and wait for thermal equilibrium
- ✓ Note the equilibrium temperature Teq_2
- ✓ Deduce the heat of fusion of the ice, knowing that the law of generalized mixing allows us to write: $\sum \mathbf{Q} = \mathbf{0}$.

Data: water = 1 $cal.g^{-1}.K^{-1}$. C_{ice} = 0.5 $cal.g^{-1}.K^{-1}$.

Chemistry 02 **Practical Work N° 03** **2023-2024**

Simulation of a Carnot cycle using CyclePad

1- General introduction:

In this practical work, we will understand the concept of thermodynamic cycle Thermal machines are often open systems (an engine receives an air-fuel mixture and rejects burnt gases) but we consider closed systems.

The gases will be assumed to be ideal and all transformations will be assumed to be mechanically reversible.

We will first study an ideal cycle: the Carnot cycle. Theoretical calculations will be compared to results obtained with CyclePad software (NorthWestern University, open access). This software allows you to simulate thermodynamic cycles as well as particular transformations encountered in industry without having to concentrate on the details of calculations.

The **CYCLEPAD** software makes it possible to simulate thermodynamic cycles as well as specific transformations encountered in industry.

With the help of this software, we can quickly carry out calculations concerning industrial installations which can be quite complex.

CYCLEPAD also allows you to understand the different developments without having to concentrate on the details of the calculations.

To work with CYCLEPAD you must create a "project" (Design).

CYCLEPAD offers two ways of working on a project:

1. A project construction mode (Build mode) that allows you to build your application by defining devices or transformations and then linking them to form a cycle.

2. An analysis mode (Analyze mode) which allows you to make the hypotheses necessary for the calculation and then note the results. At this stage, you must set constraints that must be respected by your system depending on the nature of the problem being addressed. Each time you make a hypothesis or set the value of a parameter, the possible calculations are carried out and when an

impossibility appears, you are warned by a message. You can then correct your hypotheses or values until you obtain a correct cycle for which all the quantities can be calculated.

3. Contradiction: when you enter a value that contradicts the previous assumptions, cyclepad displays a new window explaining the contradiction. Remove a hypothesis in the lower part of this window to resolve contradictions. ATTENTION ! Do not try to remove the hypotheses in the other windows, it does not work and above all the system risks no longer responding correctly. It is often necessary to start all over again and it is not always possible to save first.

An example covered step by step…….

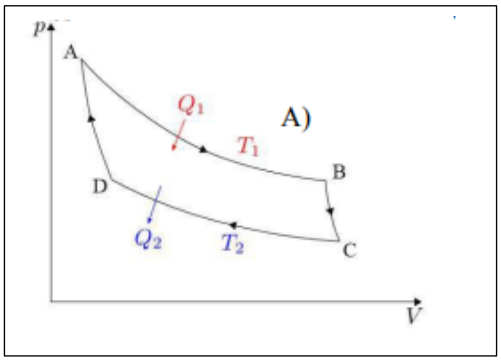
The Carnot cycle is therefore composed of four processes (two reversible isothermal processes and two reversible adiabatic processes):

• Reversible isothermal compression (C→D)

• Reversible adiabatic compression (D→ A)

• Reversible isothermal expansion (A→B)

• Reversible adiabatic expansion (B→C)



Compulsory homework before the practical work session

Exercise 1

We consider an engine whose cold source is at T_2=300 K and the hot source at T_1=900 K (maximum temperature in the cylinder). We also give $P_C=10^5$ Pa, T_C=300 K and V_C/V_D=7.

Exercise 2

We consider an engine whose cold source is at T_2=300 K and the hot source at T_1=2500 K (maximum temperature in the cylinder). We also give $P_C=10^5$ Pa, T_C=300 K and V_C/V_D=7.

Matter (Air) , m= 1 Kg. Avec : R=8.32 $J.K^{-1}mole^{-1}$, Cp =7 cal. K^{-1} $mole^{-1}$, γ =Cp/Cv=1.4.

Questions (The same questions for two exercise)

For each transformation

1- Calculate P_D, P_A?

2- Calculate the work W and the heat Q exchanged as well as the variation in internal energy Δ U. Interpret the signs of these quantities.

Required work

Perform the Carnot cycle in CyclePad as described above. For digital applications, repeat cases 1 and 2 considered in the preliminary work and compare the theoretical values to the values obtained with the CyclePad software. We will take 1 kg of air as the working gas.

Let's move on to the software ……..

We will deal with the case of the Carnot cycle which has already been seen in exercise.

To begin, you must create a new project.

The "create a new design" panel is opened when the program starts (otherwise it can be called by the file then new menu)

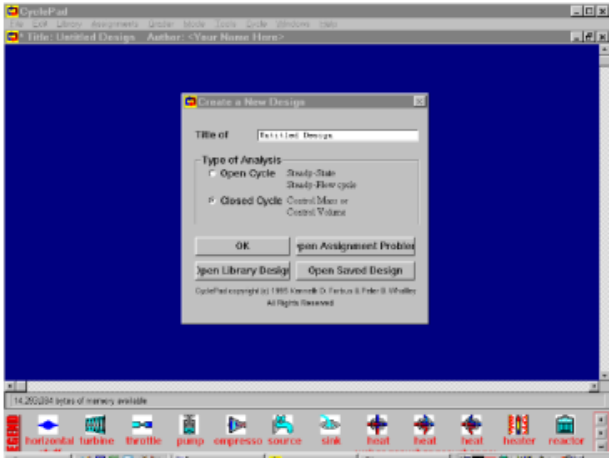


Figure 4: CyclePad home page.

• In the Title of design box, enter a name for your project, for example Carnot.

• Choose the Closed cycle option then click on the "OK" button

• Click on the compression icon then place 2 compressions on the panel

• Likewise place 2 triggers on the panel



Figure 5: 4 elements used to describe a cycle with from left to right: cooling, heating, compression, expansion then start and end.

Connect them to form a Carnot cycle

• When the cycle is complete, the software prompts you to switch to analysis mode. Click "analyze now".

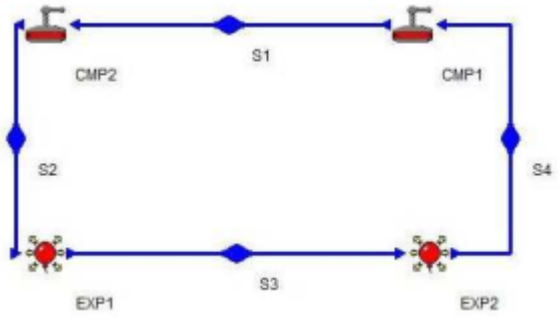
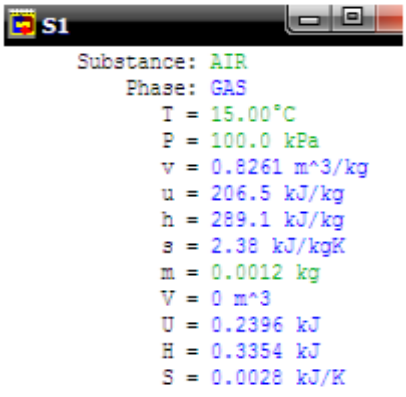
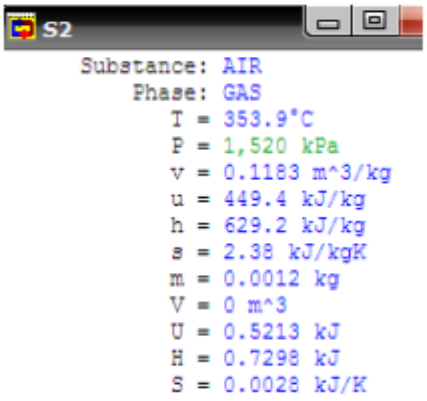


Figure 6: Cycle of 2 compressions and 2 relaxations in analysis mode.

In analysis mode, the background of the screen is white. By clicking on a transformation or on one of the intermediate points (denoted S1, S2, etc.), a panel (meter) appears which indicates the parameter values as well as the hypotheses made on the transformations.





For the Carnot cycle, we must impose:

• Isothermal and reversible compression

• Reversible adiabatic compression, which implies that it is isentropic.

• Isothermal and reversible relaxation.

• Reversible adiabatic expansion.

We will also impose the pressure P_C and the temperature T_C before the first compression, the volume V_D at the end of the first compression as well as the temperature of the hot source T_1. As you enter values, the quantities that can be calculated are calculated and at the end, you can have a summary of the cycle which is displayed by a panel which is brought up by clicking on "**cycle**" then "**cycle properties** "

Chemistry 02 **Practical Work N° 4** **2023-2024**

Thermal Energy Released by the Combustion of Paraffin

1. Objectives:

a. To determine the heat of combustion of paraffin wax.

b. To understand energy transfer in chemical reactions.

2. Principle

The heat released by the combustion of a candle is used to heat an aluminium can containing 100 g of water. The initial and final temperatures are measured to calculate the thermal energy transferred to the water and the can by the combustion of the candle. The change in mass of the candle during combustion (negative Δm) is measured. It is assumed that the candle is made solely of paraffin, a hydrocarbon with the formula $C_{25}H_{32}$.

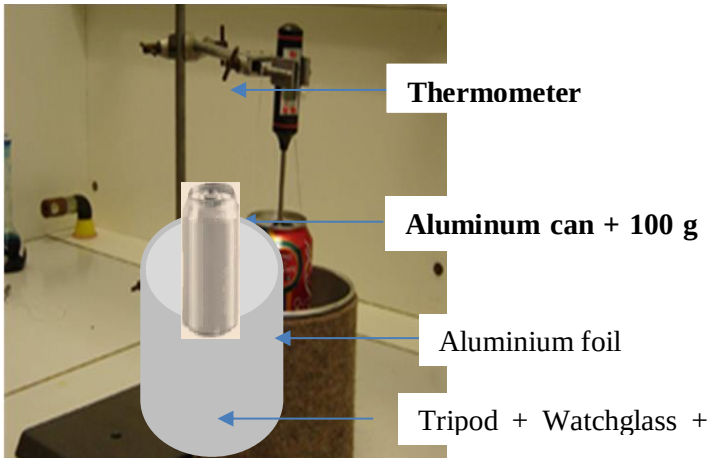
3. Materials:

- Paraffin candle or a small amount of paraffin wax
- Aluminium foil
- Thermometer
- Balance (to weigh the paraffin)
- Stirrer
- Graduated cylinder (to measure water)
- Lighter or matches
- Watchglass

4. Experimental Strategy:

- Measure and record the mass of the aluminum can using the balance (A precise scale accurate to 0.01g).
- Fill the aluminum can with a known volume of water (e.g., 100 mL).
- Measure and record the initial temperature of the water in the can using the thermometer.

- The can and the candle are surrounded by reflective surfaces to minimize radiation losses. Note that the candle must be supplied with oxygen, so there should be no airtight enclosure around it.
- Light the candle and allow it to burn until a steady flame is established.
- Carefully hold the candle under the aluminum can so that the flame heats the bottom of the can.
- Allow the candle to burn until it has completely melted a known mass of paraffin wax (e.g., 1 gram).
- Once the paraffin has completely melted, immediately extinguish the candle and stir the water in the can to ensure uniform heating.
- Measure and record the highest temperature reached by the water in the can using the thermometer.



5. Calculations:

- Calculate the temperature change (ΔT) of the water using the initial and final temperatures.
- Calculate the heat absorbed by the water using the formula: $Q=m\times c\times \Delta T$
  where Q is the heat absorbed (in joules), m is the mass of the water, C is the specific heat capacity of water, and ΔT is the temperature change.
- Assuming all the heat released by the paraffin was absorbed by the water (which is an approximation as some heat will be lost to the surroundings), calculate the heat of combustion of paraffin per gram:

Heat of combustion =Q/mass of paraffin burned

Given: The heat of combustion of paraffin (C_{25} H_{52}) in reference books is = 46.0 kJ/g.
C_{water}=4.18 $J\cdot g^{-1}\cdot °C^{-1}$; C_{Al}=0.90 $J\cdot g^{-1}\cdot °C^{-1}$; C_{steel}=0.47 $J\cdot g^{-1}\cdot °C^{-1}$

Chemistry 02 **Practical work report N°4** **2023-2024**

First Name	.....	**Note**
Family Name	.....	
Group	.....	

3- Fill in the tables below.

a- The masses

	Candle (paraffin)+ Watchglass
Initial mass m_i	……..
Final mass m_f	……..
Δm	……..

b- The temperatures

	tial temperature T_i	Final temperature T_f	$= T_f - T_i$
Water and can	……..	……..	……..

2- Write the equation for the complete combustion of paraffin.

……

……

3- Is this combustion reaction exothermic or endothermic? Justify your answer.

……

……

4- Determine the thermal energy received by the water during this experiment.

……

……

……

……

5- Determine the thermal energy received by the can during this experiment (it is assumed that the temperature of the can is the same as that of the water).

……

……

……
……

It is assumed that all the energy provided by the combustion of the candle was used to heat the water and the can.

6- Deduce the energy released by this combustion during the experiment.

……
……
……
……

7- Deduce the experimental heat of combustion of paraffin.

……
……

8- Calculate the relative deviation from the experimental measurement using $e=|Heat_{exp}-Heat_{the}|/ Heat_{the}$, then comment on the result obtained.

……
……
……
……
……
……

Given: The heat of combustion of paraffin in reference books is = 46.0 kJ/g.

$C_{water}=4.18\ J\cdot g^{-1}\cdot°C^{-1}$; $C_{Al}=0.90\ J\cdot g^{-1}\cdot°C^{-1}$; $C_{steel}=0.47\ J\cdot g^{-1}\cdot°C^{-1}$

Chemistry 02 **Correction Practical work report N°4** **2023-2024**

First Name	.....	**Note**
Family Name	.....	
Group	.....	

1- Fill in the tables below.

a- The masses

	Candle (paraffin)+ Watchglass
Initial mass m_i	***17.50 g***
Final mass m_f	***16.80 g***
Δm	***-0.70 g***

1.5

b- The temperatures

	tial temperature T_i	Final temperature T_f	$= T_f - T_i$
Water and can	***20 °C***	***45 °C***	***25 °C***

2- Write the equation for the complete combustion of paraffin.

$$C_{25}H_{52} + 38\ O_2 \longrightarrow 25\ CO_2 + 26\ H_2O$$

1.5

3- Is this combustion reaction exothermic or endothermic? Justify your answer.

The combustion of paraffin produces heat. It is an exothermic reaction.

4- Determine the thermal energy received by the water during this experiment.

$Q_{water} = (m_{water} \times C_{water}) \times \Delta T$ ⟶

$Q_{water} = (100) \times 4.18 \times 25$

$Q_{water} = 10.45\ kJ$

1 pt

5- Determine the thermal energy received by the can during this experiment (it is assumed that the temperature of the can is the same as that of the water).

$Q_{can} = (m_{can} \times C_{Al}) \times \Delta T$

$Q_{can} = (20) \times 0.90 \times 25$

$Q_{can} = 0.45\ kJ$

2 pts

It is assumed that all the energy provided by the combustion of the candle was used to heat the water and the can.

6- Deduce the energy released by this combustion during the experiment.

$Q_{comb} + Q_{water} + Q_{can} = 0$

$Q_{comb} = -(10.45\ kJ + 0.45\ kJ)$

$Q_{comb} = -10.9\ kJ$

The energy released by this combustion is 10.9 kJ

7- Deduce the experimental heat of combustion of paraffin.

$Q_{comb} = \Delta m \times E_{exp}$ ***therefore*** $E_{exp} = Q_{comb} / \Delta m$

$E_{exp} = -10.9\ kJ / -0.50\ g$

$E_{exp} = 21.8\ kJ.g^{-1}$

2 pts

8- Calculate the relative deviation from the experimental measurement using $e=|Heat_{exp}-Heat_{the}|/ Heat_{the}$, then comment on the result obtained.

$e=|Heat_{exp}-Heat_{the}|/ Heat_{the}$

$e=|21.80-46.0|/46.0$

$e=0.52$

2 pts

- ***The relative deviation is 52%, indicating a substantial difference.***
- ***Neglecting heat loss from the flame to the atmosphere is significant, despite the can's curved bottom.***
- ***The lack of insulation in the can contributes to heat loss.***
- ***Incomplete combustion of paraffin results in carbon formation on the can.***

1 pt

1 pt

Given: The heat of combustion of paraffin in reference books is = 46.0 $kJ.g^{-1}$.

$C_{water}=4.18\ J\cdot g^{-1}\cdot°C^{-1}$; $C_{Al}=0.90\ J\cdot g^{-1}\cdot°C^{-1}$; $C_{steel}=0.47\ J\cdot g^{-1}\cdot°C^{-1}$