University Abou-Bekr Belkaïd
Faculty of technology
Department of Tronc Commun ST

Structure of Matter
Practical Work

ST Engineer
Semester 1

Academic year 2025/2026

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Faculty of Technology
Department of Tronc Commun ST

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TP N°01 Introduction to Chemistry Lab Work

I. Objectives of the Practical Work

- Introduction to basic chemistry gestures.
- Acquisition of practical knowledge, experimental know-how and manual habits allowing efficient and precise handling.
- Know how small common equipment used in a chemistry laboratory works.
- Teach students that chemistry is part of their daily environment.

In this context, the experiments proposed are simple, practical and thus allow to complete and concretize the theoretical concepts of the course; the duration of 2 hours easily allows to start again, to deepen and to discuss the results with **a knowledge control test at the end of each session**.

II. Safety Rules

The performance of practical chemistry work in a laboratory involves the handling of toxic, flammable, corrosive and explosive products, etc.

Any student in the chemistry laboratory must be aware of the implications and risks associated with the handling in progress. Therefore, it is imperative to know and rigorously apply the safety rules.

The greatest danger in a laboratory is **YOU**! You are a danger whenever you are ignorant or negligent, or both at the same time.

Remember this because the person who has the most to suffer is **YOU**.

1. Never enter a laboratory without authorization.

2. Identify the locations of safety equipment (showers, fire extinguishers, etc.).

3. Wearing a **lab coat** is **obligatory**. It must be made of **cotton** and **not polyester** (cotton burns if it comes into contact with a flame, while polyester melts and sticks to the skin), **white** and **long enough to protect the legs** and **hands**.

4. Leave the passages between the workbenches free, put your jackets, coats, helmets, bags, etc. on a table (away from the workbench) and store the stools under the workbenches when you are not using them.

5. Immediately clean up any product, liquid or solid, spilled on the bench or on the floor.

6. Be aware of your own work and the work done by your neighbors and be aware of the dangers they may present.

7. Never run or rush into a laboratory, work in a stable position.

8. Do not touch the material in a laboratory without reason.

9. Never take anything in a laboratory without permission.

10. Always wear glasses when you start manipulations.

11. Long hair must be tied behind the head; ties, vests and other clothing must never hang loosely. Remove all jewelry, do not wear makeup.

12. Never point a test tube at yourself or at someone else during heating or a test. Never look down the axis of a test tube.

13. All bottles must, without exception, have a label on which you can find the name, formula, and safety pictogram(s).

14. Read the instructions for a commercially available material or bottle.

15. Check glass equipment before use (remove any cracked or star-shaped glass, etc.).

16. Any accident or any breakage or deterioration of equipment must be reported immediately to your teacher.

17. If you burn yourself or if a product is splashed on your skin and eyes, immediately wash the affected area with water.

18. Never pour water into a concentrated acid solution (risk of splashing and burning).

19. At the end of the practical work, empty all containers, rinse and put away the dishes, fill the burettes with distilled water and clean the work surface.

III. Prohibitions

☹ Smoking, drinking, eating.

☹ Wearing unsuitable clothing (floating or flammable).

☹ Pipetting with the mouth is strictly prohibited. This operation must be carried out with the equipment provided (suction bulbs, pipettor, etc.); Do not put anything in the mouth in a laboratory.

☹ Breathing in the contents of a container to identify it by its smell.

☹ Handling chemicals directly with the fingers or tasting them is strictly prohibited.

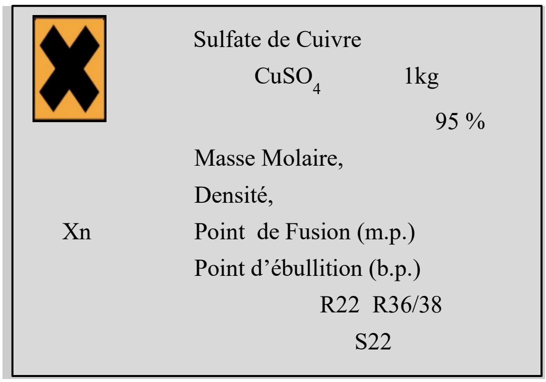
✍ Reading a product label

Here is the different information that can be read on the label of a chemical product:

• We find the name, the formula and the hazard pictogram;

• We can also know the specific risks of the products (R1…, S1…, F1…);

• As well as the physicochemical properties and other indications.



IV. Symbols Used on Labels or Hazard Pictograms

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

In chemistry, handling chemical species is not always safe for users but also for nature. Manufacturers therefore indicate pictograms on each bottle of chemical product to indicate the different dangers.

Pictograms are symbols used to warn you about chemical hazards.

Pictogram Symbol	Pictogram Name	Hazards	General Meaning
	Flame	• Flammable • Pyrophoric • Self-heating • Emits Flammable Gas • Self-reactive • Organic peroxides	These chemicals burn or can release gases that burn.
	Flame over Circle	• Oxidizers	These chemicals give off oxygen and can make a fire spread.
	Exploding Bomb	• Explosive • Self-reactive • Organic peroxide	These chemicals can explode.
	Gas Cylinder	• Gases Under Pressure	Gases and liquids under pressure can explode. This pictogram is used for both pressurized gases and liquefied gases such as liquid nitrogen.
	Corrosion	• Skin Corrosion/Burns • Eye Damage • Corrosive to Metals	These chemicals cause permanent damage to skin or eyes. These chemicals destroy metals.
	Health Hazard	• Carcinogen • Mutagenicity • Reproductive Toxicity • Respiratory Sensitizer • Target Organ Toxicity • Aspiration Toxicity	These chemicals cause serious health problems. Some problems show up immediately, but some may show up much later.
	Skull and Cross-bone	• Acute Toxicity (fatal or toxic)	These chemicals are poisons that quickly cause sickness or death. A toxin may attack one or more parts of the body, such as the liver, kidneys, nerves, lungs, skin, eyes, or bone.
	Exclamation Mark	• Irritant (skin and eye) • Skin Sensitizer • Acute Toxicity (harmful) • Narcotic Effects • Respiratory Tract Irritant • Hazardous to Ozone Layer	These chemicals cause health problems. Usually less toxic than chemicals labeled with the *Health Hazard* or *Skull and Cross-bone* pictograms.This pictogram is also used for chemicals that can destroy the ozone layer.
	Environment	• Aquatic Toxicity	These chemicals are dangerous if they get into rivers, lakes or oceans.

V. Risk Phrases, Safety Phrases and Product Storage and Handling Phrases

There are three types of phrases on a product label:

R1, R2, … R68,……etc: Risk Phrases;

S1, S2, … S64,…. etc: Safety Phrases;

F1, F2, … F35, … etc: Product Storage and Handling Phrases.

For example:

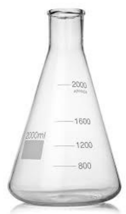
R1: Explosive when dry; R45: May cause cancer; R56: Toxic to soil organisms; R20/22: Harmful by inhalation and if swallowed … etc.

S7: Keep container tightly closed; S25: Avoid contact with eyes; S64: If swallowed, rinse mouth with water; S7/8: Keep container tightly closed and away from moisture … etc.

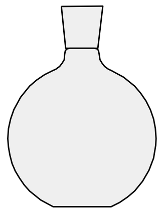
F14: Shake before use; F22: Store away from light and dust; F29: Spontaneously flammable when dry, etc.

LABORATORY EQUIPMENTS

Beaker

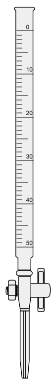


Erlenmayer flask

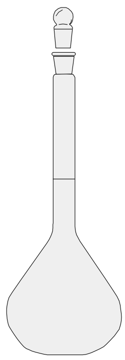


Florence flask

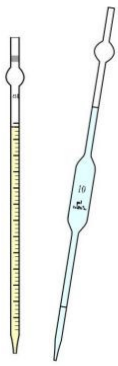
Graduated cylinder



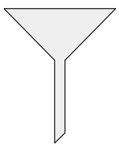
Burette



Volumetric flask

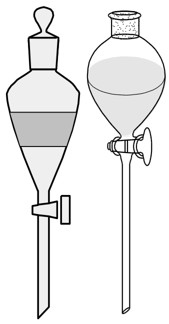


Pipette

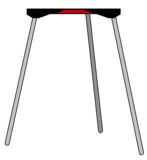


Funnel

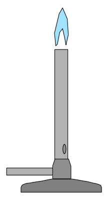
Test tube



Separatory funnel

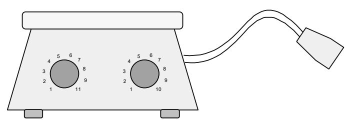


Tripod



Bunsen burner

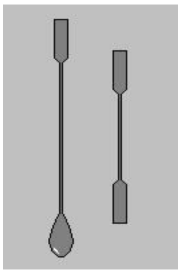
Balance



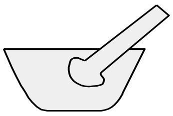
Hot plate stirrer

Thermometer

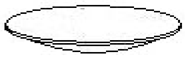
Wash bottle



Spatula

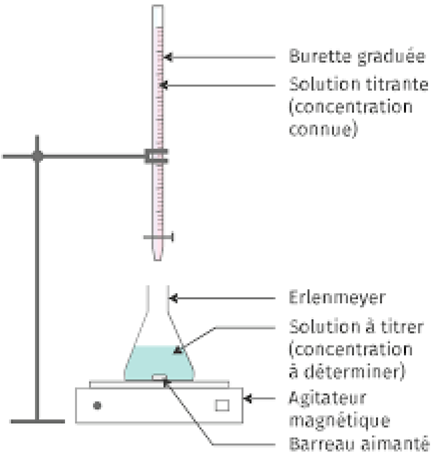


Mortar

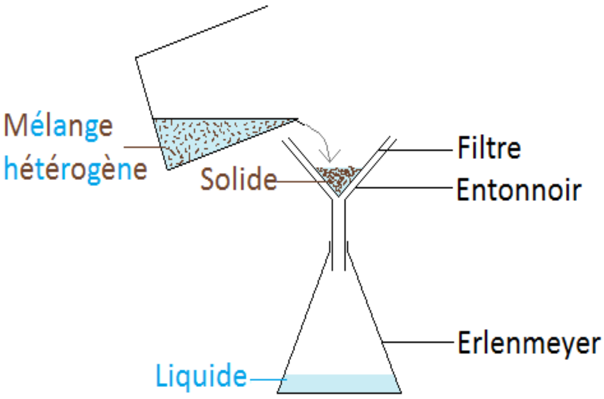


Watch glass

Suction device (plear)



A dosing assembly



Filtration of a solid and a liquid

University Abou-Bekr Belkaïd
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PRATICAL WORK N°02

PREPARATION OF SOLUTIONS

I. Aims

 Prepare a solution by dissolving a solid compound.
 Prepare a solution by diluting a commercial or stock solution.

II. Theoretical background

 Solution: it is a condensed liquid phase made up of several constituents. It is made up of a solvent noted "S" (it is always a greater quantity than the solute) and one or more solutes noted "Si" (i = 1, 2, 3, etc.).

Solution = Solute + Solvent

There are two types of solution:

 Homogeneous solution: made up of a single phase (the constituents are miscible);
 Heterogeneous solution: made up of two or more phases (the constituents are immiscible).

Note:

an aqueous solution is one in which the solvent is water.

 Concentration of a solution:

 Molarity (M) (molar concentration): this is the number of moles of solute per litre of solution (mol. L1); (example: 1 M: 1 mole of solute per 1 litre of solution);

$$\mathbf{M = C_n = n/V}$$

 Mass titre (mass concentration): this is the concentration by weight expressed in units of mass per litre of solution, generally expressed in g. L^{-1};

$$\mathbf{C_m = m/V;\ M.M.\ (molar\ mass) = C_m/C_n}$$

What is dilution?

Dilution consists of preparing a sub solution of lower concentration from a principal solution. "Adding solvent (e.g. water) to a solution does not change the quantity of solute, but it does change the concentration of the solution"

$$\mathbf{n_1 = n_2 \quad so \quad N_1V_1 = N_2V_2 \quad ie \quad C_1V_1 = C_2V_2}$$

Safety: When concentrated acid is diluted with water, heat is released. This heat can bring the water to the boil and cause splashing. As a result, droplets of acid solution on you. So it's important to remember this simple safety rule:

"Acid in water, bravo ! Water in acid, danger "

Therefore, when diluting a concentrated acid, a little water should be added to the volumetric flask before introducing the sample of concentrated solution. the sample of concentrated solution. Mix and then make up to the mark.

III. PURPOSE OF THE MANIPULATIONS

1. Preparation of 100 mL of a sulphuric acid solution H_2SO_4 with a molar concentration 1 M from a concentrated solution of density 1.83 and purity 95% by mass.

2. From this solution of H_2SO_4 (1 M), prepare a volume (V = 50 mL) of a sub solution of mass concentration (C_m = 19.6 g/L).

3. Preparation of 100 mL of potassium hydroxide stock solution (KOH) of molar concentration 0.1 M

IV. Products used

Concentrated commercial H_2SO_4 (95%, d = 1.83)

Potassium hydroxide KOH pastille

V. WORK TO BE DONE

1. Prepare 100 mL of sulphuric acid (1 M)

Procedure :

a. Calculate the mass of solute (acid) needed to prepare the required solution?

b. Deduce the volume of concentrated acid required?

c. Place a little distilled water in a 100 mL volumetric flask. Using a micro-burette, remove the volume of acid calculated.

Make up to the mark with distilled water, close then shake (follow diagram 01).

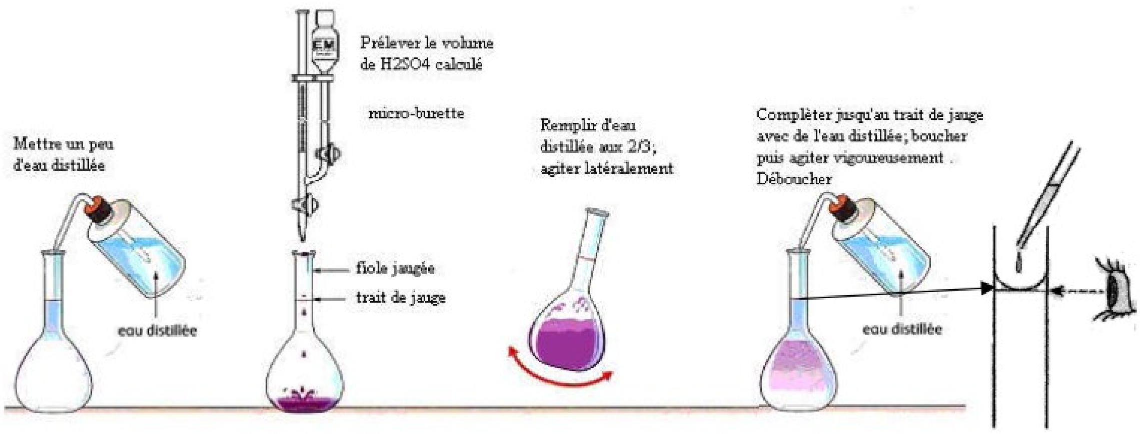


Diagram 01

2. Preparation of 50 mL of sulphuric acid (19.6 g/L)

Procedure

a. Calculate the volume of stock solution to be taken?

b. Into a 50 mL volumetric flask, using a graduated pipette, introduce the volume of stock solution

calculated. Fill the flask to the mark with distilled water, close and shake. (Follow the diagram 02

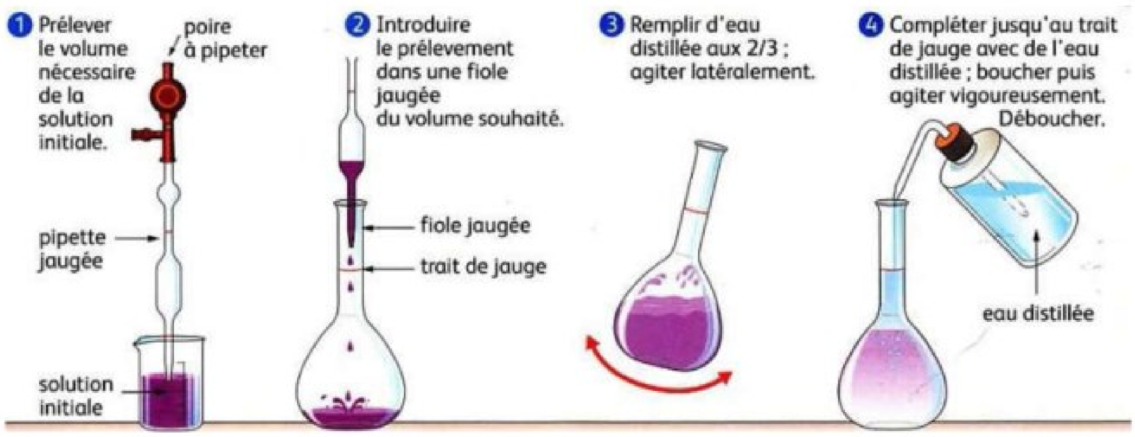


Diagram 02

3. Preparation of 100 mL potassium hydroxide (0.1 M)

Procedure

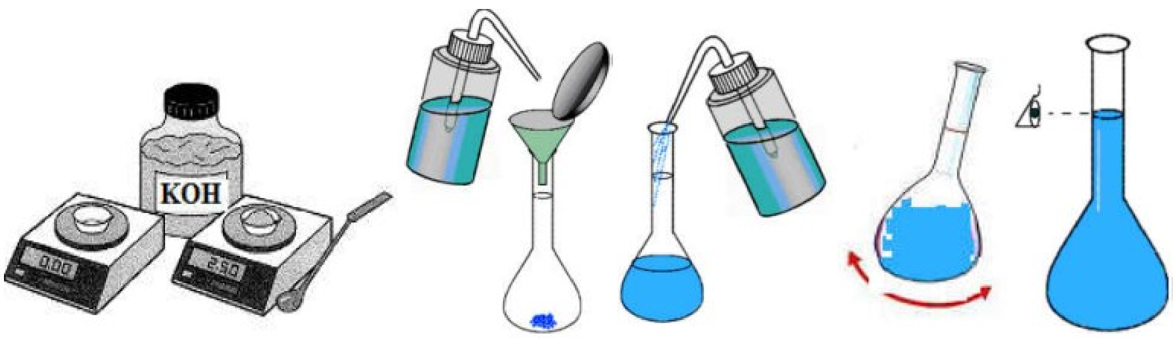
1. Calculate the mass of sodium hydroxide (KOH) needed for the solution required?

2. Weigh the calculated mass without touching it with your fingers (be careful with your eyes, this product is very corrosive).

Close the bottle quickly to prevent the sodium hydroxide hydrating and carbonating in the air.

3. In a 100 mL volumetric flask half-filled with distilled water, add the calculated mass of

mass of KOH calculated. Stir until completely dissolved, then make up to the mark.



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TP N°03
Acid-base dosage

Introduction

- One of the first definitions of an acid and a base was proposed in 1887 by Arrhenius and Ostwald. According to them, an acid was a compound with mobile hydrogen which released H^+ protons into water while a base was a compound which released OH^- hydroxide ions in an aqueous medium.
- In 1923, Bronsted and Lowry questioned the definition of Arrhenius and Ostwald and proposed a new definition. They defined an acid as a substance capable of giving up a proton and a base as a substance capable of capturing a proton.
- At the same time, during the same year, Lewis proposed another definition. He defined an acid as an acceptor of electron pairs and a base as a donor of electron pairs.
- An acid-base couple consists of an acid and its conjugate base (Acid/Base).
- An acid-base reaction involves two acid-base couples: the Acid1/Base1 couple and the Acid2/Base2 couple.
- An acid-base reaction is a chemical transformation between the acid of one pair and the base of another acid/base pair, via an exchange of H^+ ions. The full equation is a linear combination of the two specific half-equations of each pair.

$$\text{Acid1} = \text{Base1} + nH^+$$
$$\text{Base2} + nH^+ = \text{Acid2}$$

Acid1 + Base2 = Base1 + Acid2 (this equation is called a «balance equation»)

Principle of a dosage

A solution contains a dissolved chemical species A. **Determining this chemical species** means determining its **quantity of matter** or its **C_A concentration** in the solution. To measure A, A is reacted with a body B contained in **a solution of known concentration C_B**. The dosage reaction must be rapid, complete, easily observable.

- An acid-base dosage can be followed by:
  - **pH-metry:** we follow the evolution of the pH during the reaction.
  - **Colorimetry:** we use a colored indicator

A colored indicator is a reagent whose color depends on the medium (or pH).
It can be used to mark the end of a dosage if equivalence is reached in its turning zone.

Examples of colored indicators:

Indicator	Acid / tint	pH range (turning zone)	Base / tint
Helianthin	Red	3,1 -4,4	Yellow
Methyl red	Red	4,08 -6,0	Yellow
Bromothymole blue	Yellow	6,0 -7,6	Blue
Phenol-phthalein	Incolored	8,2 -10,0	Pink-purple
Alizarin Yellow	Yellow	10,1 -12,2	Red

Objective:
Determine the molar concentration of an acid solution, using the colorimetric dosage.

Material:
Graduated or volumetric pipettes (10 mL), Suction device, Burette (25 or 50 mL), Erlenmeyer flask (100 mL), beaker (x2).

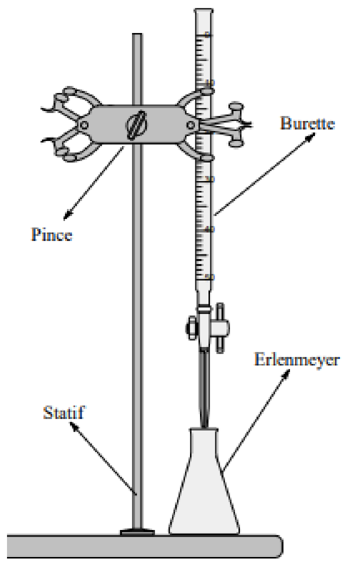
Operating mode:

1. **Dosage of a strong acid with a strong base**

The dosage of the **hydrochloric acid** will be carried out using a **sodium hydroxide** solution (NaOH) with a molar concentration **C_B = 0.1 mol/L** in the presence of phenolphthalein.
The reaction equation is:

$$HCl + NaOH \longrightarrow (Na^{+}_{aq}, Cl^{-}_{aq}) + H_2O$$

Rapid dosing (determination of a framework for the equivalent volume Ve)



□ Check that the burette stopcock is closed.

□ Rinse the graduated burette with the titrant solution (NaOH) of a precise molar concentration (C_B = 0.1 mol/L), then fill it.

□ Adjust the liquid level to the zero level of the burette by draining the excess sodium hydroxide solution into the labeled beaker.

□ Pour approximately 40 mL of solution S1 into a labeled beaker.

□ Introduce into a 100 mL Erlenmeyer flask:

□ 10 mL of hydrochloric acid solution taken using a clean volumetric pipette fitted with a suction device,

□ 1 to 3 drops of phenolphthalein,

□ Place the Erlenmeyer flask under the burette, shake manually without using the magnetic stirre

□ Add the titrant solution (mL per mL) and note the color of the solution by completing table 1:

Table 1:

V sol. titrant (ml)	1	2	3	4	5	6	7	8	…….
Color									…….

Req.: The solution changed color when you added the equivalent volume of titrant solution (Ve).
Indicate approximately this volume (by a frame); **V1 mL < Ve < V2 mL**

Precise dosage (known as "drop dosage")

Add the titrant solution until the color changes (equivalence point) while respecting the following instructions:

 quickly at the beginning, a Volume ≤ V1
 then drop by drop as the color change approaches (equivalence point).
 Read the equivalent volume and note the color of the solution by completing table 2.
 Repeat the operation two to three times

Table2:

	1st test	**2nd test**	**3rd test**
Ve (ml)			
Color			

 Deduce the average equivalence volume (Avg.Veq.)?
 Calculate the concentration of the hydrochloric acid solution to be titrated S2?
 Deduce the concentration of the solution S1

2. Determination of a diacid using a strong base

The dosage of sulfuric acid (H_2SO_4) will be carried out using a sodium hydroxide solution with a molar concentration C_B = 0.1 mol/L in the presence of phenolphthalein.

Rapid dosage (determination of a framework for the equivalent volume Ve)

-Check that the burette stopcock is closed.
- Rinse the graduated burette with the titrant solution (KOH or NaOH) of very precise molar concentration (C_B = 0.1 mol/L), then fill it.
-Adjust the liquid level to the zero level of the burette by draining the excess soda (potash) solution into the beaker labeled (Recovery of used products).
- Pour approximately 50 mL of the sulfuric acid solution into a labeled beaker.
- Introduce into a 100 mL Erlenmeyer flask:
-10 mL of sulfuric acid solution taken using a clean volumetric pipette fitted with a propipette,
-3 drops of phenolphthalein,
- Place the Erlenmeyer flask under the burette. Stir the solution manually without using the magnetic stirrer.
- Add the titrant solution (mL per mL) and note the color of the solution by completing

table 3.

Table 3:

V sol. titrant (ml)	1	2	3	4	5	6	7	8	**…….**
Color									**…….**

Req.: The solution changed color when you added the equivalent volume of titrant solution (Ve).
Indicate approximately this volume (by a frame); **V1 mL < Ve < V2 mL**

Precise dosage (known as "drop dosage")

Add the titrant solution until the color changes (equivalence point) while respecting the following instructions:

 quickly at the beginning, a Volume ≤ V1
 then drop by drop as the color change approaches (equivalence point).
 Read the equivalent volume and note the color of the solution by completing table 4.
 Repeat the operation two to three times

Table 4:

	1st test	**2nd test**	**3rd test**
Ve (ml)			
Color			

 Deduce the average equivalence volume (Avg.Veq.)?
 Calculate the concentration of the sulfuric acid solution to be titrated?
 What is the difference between first dosage and second dosage?

V. Questions:

1. Are there any spectator chemical species in both dosages? Which ones?
2. What are the acid/base pairs involved in each dosage?
3. Write the associated proton half-equations in the two dosages?
4. Derive the equation for the reaction of the dosage in both cases?
5. Give the definition of dosage equivalence? Deduce a relationship between the quantities of matter of oxonium ions (H_3O^+) (n_A) and hydroxide ions (OH^-) (n_B)?
6. List the chemical species present in the dosing beaker:

-for a volume poured less than $V^B{}_e$?
- for a poured volume equal to $V^B{}_e$. What should the pH be at equivalence?
-for a poured volume greater than $V^B{}_e$?

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TP N°04

TITRATION OF THE ACETIC ACID IN VINEGAR

Doing a titration for an aqueous solution of an acid or a base means determining its concentration by carrying out an acid-base reaction. At the equivalence point, the number of moles of H_3O^+ provided by the acid must be equal to the number of moles of OH^- provided by the base. This implies:

$$C_A\ V_A = C_B\ V_B$$

(In case of monoacid or monobase)

An acid-base titration can be monitored colorimetrically using a colored indicator which is a reagent whose color depends on the pH. It is used to mark the end of a dosage if equivalence is reached in its turning zone.

I-The purpose of the manipulation

The vinegar acidity is characterized by its degree (of acidity). The purpose of the this manipulations is to experimentally verify of the degree of acidity indicated on the label of the vinegar bottle . The strength of a vinegar is the mass percentage of pure ethanoic acid (acetic acid) contained in the vinegar. It's mean that the indication in degrees is numerically equal to the mass of pure ethanoic acid, expressed in grams, contained in 100 grams of commercial vinegar. The degree of acidity (d°) of vinegar is calculated using the formula:

$$d° = C_A(\text{In case of vinegar}) \times M_{CH3COOH} \times 0.1$$

II-the manipulation to do

1-the preparation of the diluted solution A

- In a labeled beaker pour roughly 20 mL of vinegar
- Prepare a 10 ml pipette, a 100 ml volumetric flask with its stopper and a wash bottle filled with distilled water.
- Read carefully the operating procedure described below:

-Take 10 ml of vinegar from the beaker using the pipette fitted with a suction device,

-Introduce this volume into the volumetric flask,

- Complete with distilled water to obtain a total solution volume of 100 ml,

- Close the volumetric flask with a cap and shake the solution to homogenize it.

The solution thus prepared in the volumetric flask is called solution A.

2-Determination of the molar concentration of the acetic acid in solution A by titration

The determination of acetic acid will be carried out using a sodium hydroxide solution (NaOH) with a molar concentration C_B = 0.1 mol/l in the presence of phenolphthalein. The reaction equation is:

$$CH_3COOH + OH^- \ (NaOH) \longrightarrow CH_3COO^- \ (CH_3COO^-Na^+) + H_2O$$

a-Rapid dosing (determination of a framework for the equivalent volume Ve)

- Check that the burette stopcock is closed.
- Rinse the graduated burette with the titrant solution (NaOH) of a precise molar concentration (C_B = 0.1 mol/L), then fill it.
- Adjust the liquid level to the zero level of the burette by draining the excess sodium hydroxide solution into the labeled beaker.
- Pour approximately 40 mL of solution S1 into a labeled beaker.
- Introduce into a 100 mL Erlenmeyer flask.
- 10 mL of hydrochloric acid solution taken using a clean volumetric pipette fitted with a suction device.
- 1 to 3 drops of phenolphthalein.
- Place the Erlenmeyer flask under the burette, shake manually without using the magnetic stir.
- Add the titrant solution (mL per mL) and note the color of the solution by completing table 1:

Vsol titrant (mL)	1	2	3	4	5	6	7	8	9	10	11	12
color												

Req.: The solution changed colour when you added the equivalent volume of titrant solution (Ve). Indicate approximately this volume (by a frame)

.... ml < V_e <............. ml

b-Precise dosage (known as "drop dosage")

Add the titrant solution until the colour changes (equivalence point) while respecting the following instructions:

- quickly at the beginning
- then drop by drop as the colour change approaches (equivalence point).
- Read the equivalent volume and note the colour of the solution by completing tble 2.

- Repeat the operation two to three times

Table2:

	1st test	2nd test	3rd test
Ve (ml)			
Colour			

3-Experimental determination of the value of the density:

Density, whose symbol is ρ (rho), is a characteristic property which represents the quantity of matter (mass) found in a given space (a unit of volume).

The formula used to calculate density is:

$$\rho = \frac{m}{v}$$

with:

ρ is defined as the density (g/mL or g/cm^3)

m is defined as the mass (g)

V is defined as the volume (mL or cm^3)

a-Density of the vinegar

- **Manipulation:**

1. Place an empty 10 mL graduated cylinder on the electronic balance.
2. Press the tare button.
3. Then delicately pour in a volume V of the liquid.
4. Read the corresponding mass “m” on the balance screen.
5. Calculate the density.

b-Density of a solid

- **Manipulation**

1. Weigh the unknown solid using the balance
2. Add 50 ml of water to the graduated cylinder
3. slowly slide the solid object into the graduated cylinder
4. Record the total water volume
5. Calculate the volume of the unknown solid.

6. Calculate the density of the unknown solid.

- **Results**

The density of a solid substance can be determined by calculating the ratio of the mass of solid to its volume.

the first step the mass was determined with the balance

To find the volume, it is necessary to determine the displacement of water, which mean the difference between the volume of water with the unknown solid (step 4) and the volume of water initially present in the graduated cylinder (in the manipulations above the initial volume was 50 ml).

$V_{solide} = V_{WATER+solid} - V_{WATER}$

V_{solid} is defined as the volume of the solid (ml)

$V_{WATER+solid}$ is defined as the volume of water and solid (ml)

V_{WATER} is defined as the volume of water placed in the graduated cylinder initially (ml).

Finally, the density value allow as either to identify an unknown substance or, if the substance is known, to verify the quality of the manipulations.