Lab Manual

General Chemistry

2022 - 2023

Contents

ACKNOWLEDGEMENTS

To-be updated!

Preface

This laboratory manual is designed to fulfill the “Chemistry for Engineers” course and several different types of chemistry courses in the International University.

The Data and Report Sheets are attached in the appendix and can be downloaded on the class Blackboard page (https://blackboard.hcmiu.edu.vn/...). The students are directed to enter data into the Data Sheets during the experiment, then copy the finished data and calculations into the Report Sheet. This results in a clean and neat report. Report sheets are designed to give an adequate presentation of observations and results but short enough to be graded easily and rapidly. Each experiment is independent of the others.

All experiments must be completed in a five-hour laboratory period, including a pre-laboratory discussion.

A student finishing a laboratory course will be familiar with several laboratory operations and will learn how to collect and analyze experimental data. These skills will be a strong foundation for further work in general chemistry or another college-level science curriculum.

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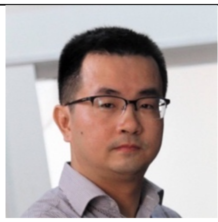
Editorial Team

This laboratory manual cannot be done without the Gen-Chem Editorial Board at the International University

	**HUỲNH KIM LÂM** Assoc. Prof. Ph.D. in Physical Chemistry	**EDITOR-IN-CHIEF** + Chief editing
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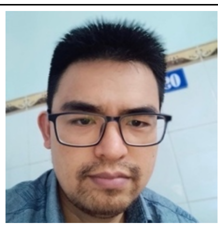
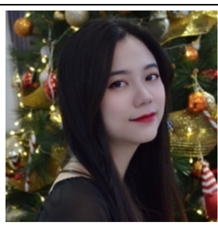
	**PHÙNG THANH KHOA** Ph.D. in Materials Science & Technology	**SENIOR EDITOR** + Section editing - Experiments + Overall content editing
	**NGUYỄN NGỌC ÁNH** B.Sc. in Biotechnology B.L. in Civil Law	**EDITOR** + Content creating & editing - Equipment + Overall layout editing
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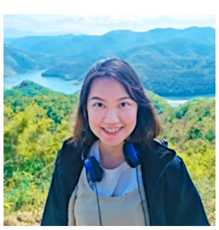
	**NGUYỄN ĐỖ XUÂN AN** B.Eng. in Food Technology	**ASSISTANT EDITOR** + Section editing - Chemicals - Forms & Templates + Proofreading

LABORATORY SAFETY GUIDELINES

If you do not have time to do things correctly and safely, with adequate time for thought, please stay away from the laboratory.

A. CLOTHING

Bắn tung tóe Dung dịch

1. WEAR APPROVED EYE PROTECTION AT ALL TIMES. Very minor laboratory accidents, such as the splattering of solution, can cause permanent eye damage. Wearing laboratory goggles can prevent this eye damage. In the chemistry teaching laboratories safety glasses (goggles) of an approved type must be worn by **all persons** in the room at all times that anyone is working with or transporting glassware or conducting any experimental work. Experimental work includes simple tasks such as transporting chemicals or glassware, obtaining quantitative measurements that involve non-sealed containers, etc. Lightweight ''visitors' shields'' or prescription glasses with side shields are acceptable only for laboratory visitors if your institution permits them but are not suitable for routine laboratory work.

2. WEAR PROPER PROTECTIVE CLOTHING. Proper protective clothing must be worn by all persons in the room at all times that anyone is working with or transporting glassware or conducting any experimental work. Exposed skin is particularly susceptible to injury by splattering of hot, caustic, or flammable materials. Students and instructors need to be protected from their necks to below their knees. This requirement includes no shorts, no short skirts, no sleeveless garments, and no bare midriffs. Long lab coats or aprons are required if shorts or short skirts are worn. Makeshift coverage such as shirts being used as aprons, paper taped over the knees, etc., is not considered to be suitable. Tight fitting clothing, long unrestrained hair, clothing that contains excessive fringe or even overly loose-fitting clothing may be ruled to be unsafe. Long hair must be tied back and no dangling jewelry.

3. WEAR PROPER PROTECTIVE FOOTWEAR No sandals/flip-flops, no open-toed shoes, and no foot covering with absorbent soles are allowed. Any foot protection that exposes any part of one's toes is unsuitable for wear in the laboratory.

B. HANDLING CHEMICALS

4. NEVER WORK IN A CHEMICAL LABORATORY WITHOUT PROPER SUPERVISION. Your best protection against accidents is the presence of a trained, conscientious supervisor, who is watching for potentially dangerous situations and who is capable of properly handling an emergency tận tâm

hương

5. NEVER INHALE GASES OR VAPORS UNLESS DIRECTED TO DO SO. If you must sample the odor of a gas or vapor, use your hand to waft a small sample toward your nose.

6. EXERCISE PROPER CARE IN HEATING OR MIXING CHEMICALS. Be sure of the safety aspects of every situation in advance. For example, never heat a liquid in a test tube that is pointed toward you or another student. Never pour water into a concentrated acid. Proper dilution technique requires that the concentrated reagent be slowly poured into water while you stir to avoid localized overheating.

7. NEVER EAT, DRINK, OR SMOKE IN A CHEMICAL LABORATORY. Tiny amounts of some chemicals may cause toxic reactions. Many solvents are easily ignited. Food and drinks are never allowed in the labs. This includes all visible insulated water bottles or mugs, containers of water or flavored drinks, containers of ice intended for consumption, etc. If a food or drink container is empty or unopened, it needs to be inside a backpack, etc., and out of sight.

8. NEVER RETURN RESIDUE CHEMICALS TO THEIR ORIGINAL CONTAINERS. Used chemicals might contaminate the original chemical, thus never return them to their original containers.

C. HANDLING EQUIPMENT

9. BE CAREFUL WITH GLASS EQUIPMENT. Cut, break, or fire-polish glass only by approved procedures. If a glass-inserter tool is not available, use the following procedure to insert a glass rod or tube through a rubber or cork stopper. Lubricate the glass and the stopper, protect your hands with a portion of a lab coat or a towel, and use a gentle twisting motion to insert the glass tube or rod.

10. NEVER PIPET BY MOUTH. Always use a mechanical suction device for filling pipets. Reagents may be more caustic or toxic than you expect.

11. USING INSTRUMENTS. Before using any instruments in the lab, read the manual carefully. Ask the instructor or lab technician if needed.

D. BEHAVIORS

12. NEVER PERFORM AN UNAUTHORIZED EXPERIMENT. ''Simple'' chemicals may produce undesired results when mixed. Any experimentation not requested by the laboratory manual or approved by your instructor may be considered to be unauthorized experimentation.

13. NO REMOVAL OF CHEMICALS OR EQUIPMENT FROM THE LABORATORY. The removal of chemicals and/or equipment from the laboratory is strictly prohibited and is grounds for severe disciplinary action.

14. NO HORSEPLAY. Horseplay and pranks do not have a place in instructional chemistry laboratories.

15. NO LAPTOPS, TABLETS, ETC. Laptops and tablets (iPad, tab ...) are not allowed in the lab. Only notebooks and pens/pencils are allowed.

16. CLEANING. Wash hands with soap and water after performing all experiments. Clean (with detergent powder), rinse, and dry all work surfaces and equipment at the end of the experiment.

E. EMERGENCY PROCEDURES

17. KNOW THE LOCATION AND USE OF EMERGENCY EQUIPMENT. Find out where the safety showers, eyewash spray, and fire extinguishers are located. If you are not familiar with the use of emergency equipment, ask your instructor for a lesson.

18. DON'T UNDER-REACT. Any contact of a chemical with any part of your body may be hazardous. Particularly vulnerable are your eyes and the skin around them. In case of contact with a chemical reagent, wash the affected area immediately and thoroughly with water and notify your instructor. In case of a splatter of chemical over a large area of your body, don't hesitate to use the safety shower. Don't hesitate to call for help in an emergency.

19. DON'T OVER-REACT. In the event of a fire, don't panic. Small, contained fires are usually best smothered with a pad or damp towel. If you are involved in a fire or serious accident, don't panic. Remove yourself from the danger zone. Alert others of the danger. Ask for help immediately and keep calm. Quick and thorough dousing under the safety shower often can minimize the damage. Be prepared to help, calmly and efficiently, someone else involved in an accident, but don't get in the way of your instructor when he or she is answering an emergency call.

These precautions and procedures are not all you should know and practice in the area of laboratory safety. The best insurance against accidents in the laboratory is thorough familiarity and understanding of what you're doing. Read experimental procedures before coming to the laboratory, take special note of potential hazards and pay particular attention to advice about safety.

Take the time to find out all the safety regulations for your particular course and follow them meticulously. Remember that unsafe laboratory practices endanger you and your neighbors. If you have any questions regarding safety or emergency procedures, discuss them with your instructor. Then sign and hand in the following safety agreement.

SAFETY AGREEMENT

I have carefully read and understood the laboratory guideline printed above for working in the lab 501. It is my responsibility to observe them and agree to abide by them throughout my laboratory working course. I hereby take the full responsibility for my experiments and commit a compensation claim for any failure from my working time in the lab.

Signature: ____

Print Name: ___________________________ Student's ID: __________________________________

Phone: _______________________________ Email: ____

Date: ____

Course: _______________________________Session: ______________________________________

Instructor: ____________________________ TA: ____

Person(s) who should be notified in the event of an accident:

Name: __________________________________

Phone:__________________________________

Email: __________________________________

Mailing Address:

____

____

____

____

MAKEUP LAB FORM

In order to make up a missed lab:

- **Fill out the middle of the form below**
- **Have your Instructor/TA sign it.** Your Instructor/TA MUST sign the form BEFORE you attend the makeup lab.
- **Give it to the Hosting Instructor for the section you attend to make up the lab. *Note:*** If a section is full, students registered for the lab have priority. It is the Hosting Instructor's discretion as to whether there is enough room for you to attend when the lab is full. EVEN WITH the Instructor's signature, the Hosting Instructor is NOT required to allow you to attend that lab as a makeup.
- **Make sure your name is on the group list for the day.**

The following are approved reasons for missing and making up a lab. Mark the reason for your request:

- ☐ University-sponsored events
- ☐ Illness
- ☐ Family emergency
- ☐ Other: ____

Student Name: ___________________________ Student's ID: _______________________

Lab Session for which student is officially registered:
Instructor's Name: _____________________
Lab Session number: _____________________
(If you don't know your section number, circle the day and time your lab meets)
Day: M T W Th F Sa **Time:** Morning Afternoon

Lab Session for which student plans to do the make-up experiment
Hosting Instructor's Name: _____________________
Lab Session number: ___________________________
If you do not know the section number, circle the day and time the lab meets)
Day: M T W Th F Sa **Time:** Morning Afternoon

____
Signature of your Instructor Date

For the Hosting Instructor's Use Only:

Lab Session:_________ Date: ___________ Time:___________ Grade Received: ____________________

Signature of the Hosting Instructor

COMMON LAB TECHNIQUES

Please see the video clips on essential lab techniques on the course website

https://sites.google.com/view/genchemlab/

- Chemical preparation
- Dilution pha loãng
- Titration chuẩn độ
- Acid handling xử lí acid
- Calibration of pH meter
- Pipetting technique

• Chuẩn bị hóa chất
• Pha loãng
• Chuẩn độ
• Xử lý axit
• Hiệu chuẩn máy đo pH
• Kỹ thuật pipet

Experiment 1 – Chemical Reactions

Student name:____ ID:__________________________________

OBJECTIVES

kết tủa tạo khí

- To perform different types of chemical reactions, including acid-base, precipitation, gas forming, complex compound forming and oxidation-reduction reactions.
- To identify the products in these reactions and describe the chemical changes.
- To write and balance the chemical equations for the reactions observed.

1. INTRODUCTION

Vật chất

Vật chất

Matter can undergo both physical and chemical changes. Chemical changes result in the formation of new substances. When a chemical reaction occurs, substances called reactants are transformed into different substances called products that often have different appearances and different properties. In this experiment, you will perform and observe a number of chemical reactions. Observable signs of chemical reactions can be a change in color, the formation of a solid, the release of gas, and the production of heat and light. You will also learn how to classify chemical reactions. One classification system involves five general types of reactions: synthesis, decomposition, single displacement, double displacement, and combustion.

TỔNG HỢP, PHÂN HỦY , DỊCH CHUYỂN ĐƠN , DỊCH CHUYỂN KÉP , ĐỐT CHÁY

CLASSIFICATION INVOLVE: SYNTHESIS, DECOMPOSITION, SINGLE DISPLACEMENT, DOUBLE DISPLACEMENT, COMBUSTION

II.Learning Objective:

-To perform different types of chemical reactions (acid-base, precipitate, gas forming, complex compound forming, and oxidation-reduction reactions).

-To identify some of the products in these reactions and describe the chemical changes.

-To write and balance the chemical equations for the reactions observed.

Equipment	
Test tubes Test tube rack Test tube holders Beakers	Alcohol lamp Looped wire Distilled water bottle

2. PROCEDURE way to do

2.1. Reactions of Cu^{2+}

$CuSO4 + 2 NaOH \rightarrow Cu(OH)2 + Na2SO4$

CuSO4 is dissociated completely: CuSO4 → Cu2++ SO42-

NaOH is also dissociated completely to form Hydroxide ion OH-: NaOH → Na+ + OH

Test tube

#1

10 drops 0.5M $CuSO_4$

↓

10 drops 2M NaOH

↓

#2

10 drops 0.5M $CuSO_4$

↓

10 drops 2M NH_4OH

↓

CuSO4+ 2NH4OH → Cu(OH)2+ (NH4)2SO4

Cu(OH)2 + 4NH3 → [Cu(NH3)4](OH)2

CuSO4 is dissociated completely: CuSO4 → Cu2++ SO42-.

NH4OH is also dissociated completely: NH4OH → NH4++ OH-

OBSERVATION *(Mix tubes gently)*

#1: ↓ 10 drops 2M NaOH ↓

#2: ↓ 10 drops 2M NH_4OH ↓

OBSERVATION *(Mix tubes gently)*

2.2. Reactions of Silver halides

Section 1: Reactions of Potassium Chloride (KCl)

AgNO3 + KCl → AgCl + KNO3

#1

10 drops 0.5M KCl

↓

10 drops 0.1M $AgNO_3$

↓

#2

10 drops 0.5M KCl

↓

10 drops 0.1M $AgNO_3$

↓

10 drops 2M NH_4OH

↓

AgNO3 + KCl → AgCl + KNO3

AgCl + 2NH4OH → [Ag(NH3)2] Cl + H2O

OBSERVATION *(Mix tubes gently and wait at least 2 minutes)*

Section 2: Reactions of Potassium Bromide (KBr)

$AgNO3 + KBr \rightarrow AgBr + KNO3$

#1

10 drops 0.5M KBr → 10 drops 0.1M $AgNO_3$ → OBSERVATION

#2

10 drops 0.5M KBr → 10 drops 0.1M $AgNO_3$ → 10 drops 2M NH_4OH → OBSERVATION

$AgNO3+KBr \rightarrow AgBr + KNO3$
$AgBr + 2NH4OH \rightarrow [Ag(NH3)2]Br + H2O$

OBSERVATION ***(Mix tubes gently and wait at least 2 minutes)***

2.3. Reactions of H_2O_2

$2KMnO4+ 3H2SO4+ 5H2O2 \rightarrow 8H2O + 2MnSO4 + 5O2 + K2SO4$

$2KI + H2SO4+ H2O2 \rightarrow K2SO4 + 2H2O + I2$

#1

1 drop 0.1M $KMnO_4$ → 5 drops 2M H_2SO_4 → 5 drops 3% H_2O_2 → OBSERVATION

#2

5 drops 0.1M KI → 5 drops 2M H_2SO_4 → 5 drops 3% H_2O_2 → OBSERVATION

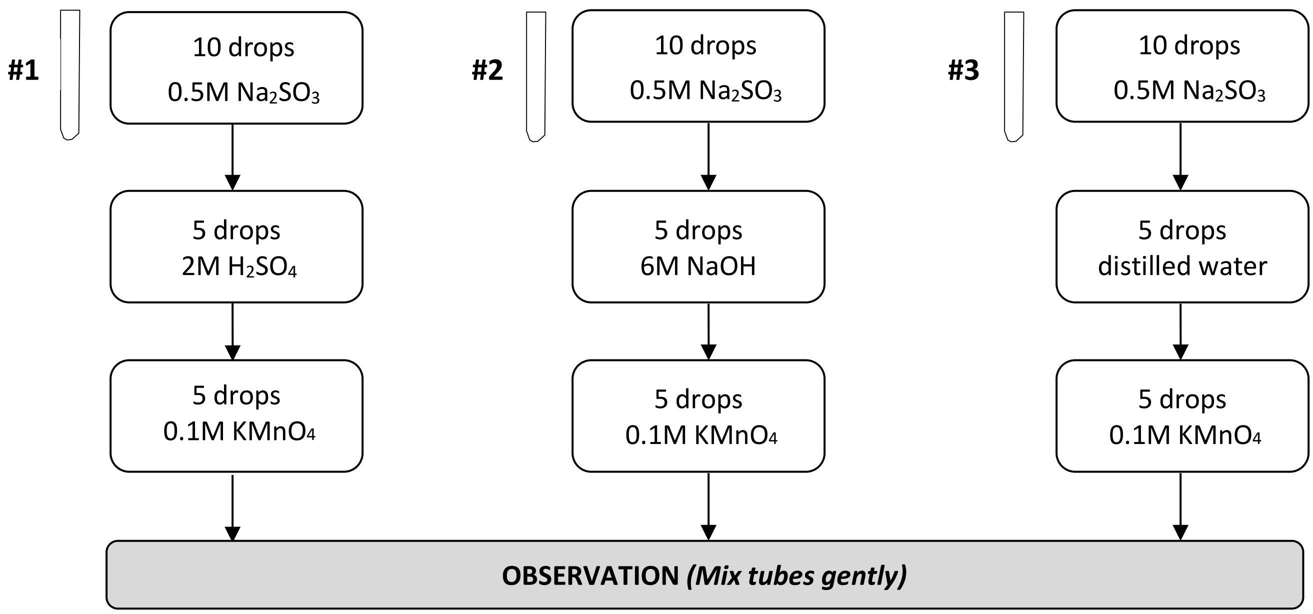
#3

10 drops 3% H_2O_2 → A pinch of MnO_2 → OBSERVATION

2H2O2 O2 + 2H2O

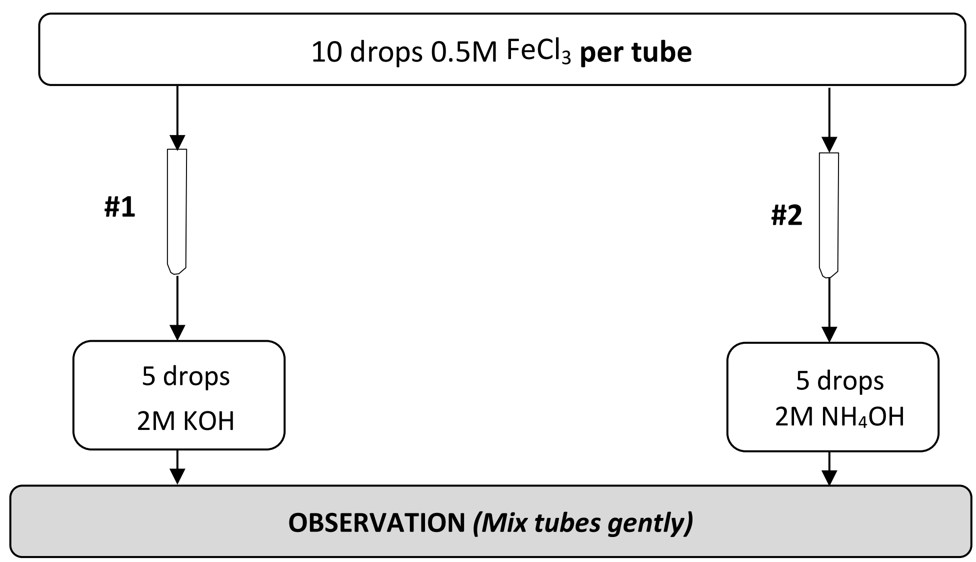
OBSERVATION ***(Mix tubes gently and wait at least 2 minutes)***

2.4. Reactions of $KMnO_4$

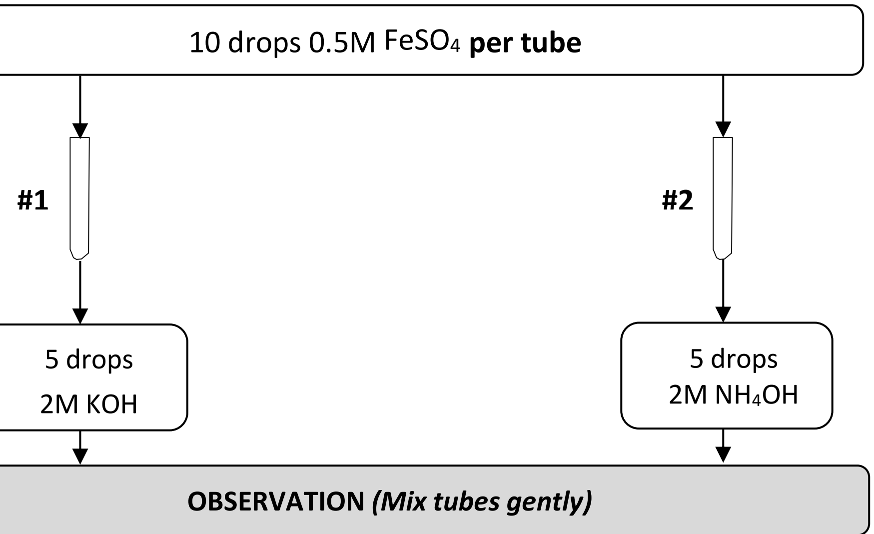


2.5. Reactions of Fe^{2+} and Fe^{3+}

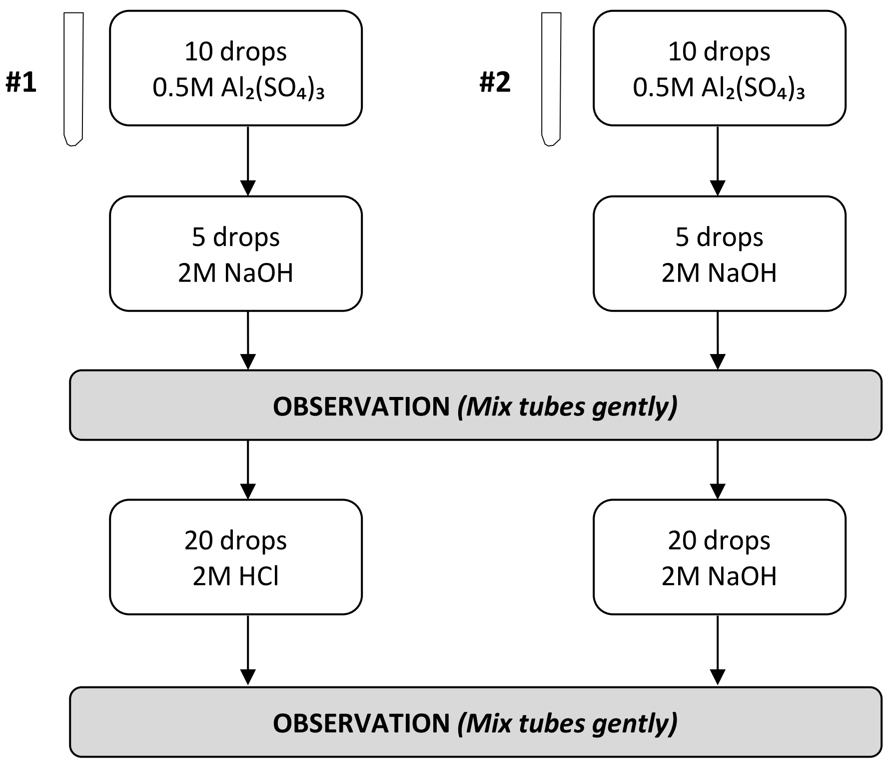
Section 1: Ferric ion (Fe^{3+})



Section 2: Ferrous ion (Fe^{2+})



2.6. Reactions of Al^{3+}



2.7. Flame tests

Light the Bunsen burner → Clean the loop with distilled water → Dip the loop into the tested solution → Hold it in the flame → Record the dominant flame color

Dip the loop into one of the following compounds (LiCl, NaCl, KCl, $CaCl_2$ and $BaCl_2$), then repeat the same process for other known solution.

- Clean the looped wire for the next solution.

Using the wavelengths shown below, calculate the frequency and energy of the photons emitted during the flame tests.

Hãy tính tần số và năng lượng của các photon phát ra trong ngọn lửa kiểm tra

Dominant color	Approximate wavelength (nm)
Red	701
Red-orange	622
Orange	609
Orange-yellow	597
Yellow	587
Yellow-green	577
Green	535
Green-blue	492
Blue	474
Blue-violet	455
Violet	423

Note: Wavelength values are given for mid-range of the color indicated.

tan so

The relationship between the wavelength, frequency and speed of an electromagnetic wave is given by the equation:

buoc song

$$\boxed{C = \lambda \times \nu} \quad (1.1)$$

Where C is the speed of light **(3 x 10^8 m/s)**

λ is the wavelength (nm)

10^-9 = m

ν is frequency

And the energy per photon is given by the equation:

$$\boxed{E_{photon} = h \times \nu} \quad (1.2)$$

Where E_{photon} is the energy per photon (J)

h is Planck's constant **(6.626×10^{-34} J.s)**

ν is frequency

3. SUGGESTED QUESTIONS

1. What are the purposes of today's lab work?
2. What is a chemical reaction?
3. Please give examples of different types of chemical reactions?
4. What are observable signs when chemical reactions occur?
5. What is a synthesis reaction? Give an example
6. What is a decomposition reaction? Give an example
7. What is a single displacement reaction? Give an example
8. What is a double displacement reaction? Give an example
9. What is a combustion reaction? Give an example
10. Please name all of the experiments that you will do in today's lab work?
11. What are molarity and normality?
12. What is the equation that shows the relationship between wavelength, frequency, and speed of an electromagnetic wave?

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4. DATASHEET

The datasheet template is attached in the appendix and can be downloaded @ https://blackboard.hcmiu.edu.vn

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5. REPORT

The report template is attached in the appendix and can be downloaded @ https://blackboard.hcmiu.edu.vn

Experiment 2: pH and Buffers

Student name:____ ID:___________________________________

OBJECTIVES

- To distinguish between strong and weak acids
- To learn how to calculate and prepare a buffer solution and test its buffering ability

1. INTRODUCTION

axit là chất phân li trong nước tạo thành ion hydroni (H3O+),

According to the Arrhenius theory, an acid is a substance that dissociates in water to form hydronium ion (H_3O^+), and a base is a substance that dissociates in water to form hydroxide (OH^-) ions. For the Lewis-Brønsted theory, an acid is a proton donor, and a base is a proton acceptor. In an aqueous solution, the H^+ from an acid is associated with water to form H_3O^+ (a hydronium ion), while a base accepts a proton from water to form OH^- (a hydroxide ion). Strong acid/strong base is completely dissociated in water to produce hydronium ion/hydroxide ion, respectively. Weak acid/base dissociates only partially in an aqueous solution and forms little or very little H_3O^+/OH^-.

Acid : $\quad HA\,(aq) + H_2O \rightleftharpoons H_3O^+(aq) + A^-(aq) \quad\quad K_a$

Base : $\quad A^-(aq) + H_2O \rightleftharpoons HA\,(aq) + OH^-(aq) \quad\quad K_b$

We have:

$K_a \times K_b = K_{water} = 1.0 \times 10^{-14}$ at 25°C

$$K_a = \frac{[H_3O^+][A^-]}{[HA]}$$

$$K_b = \frac{[HA][OH^-]}{[A^-]}$$

$pK_a = -\log(K_a)$

$pK_b = -\log(K_b)$

The pH scale is a compact way to specify the acidity of a solution: $pH = -\log[H_3O^+]$

Therefore:

- Acidic solution: $pH < 7$ or $[H_3O^+] > [OH^-]$

- Basic solution: pH > 7 or $[H_3O^+] < [OH^-]$
- Neutral solution: pH = 7 or $[H_3O^+] = [OH^-]$

Strong acids and strong bases are completely dissociated in water to produce hydrogen ions or hydroxide ions, respectively. Weak acids dissociate only partially and form little or very little H^+.

A buffer is a solution of a weak acid or weak base and its conjugate weak base or weak acid, respectively. Buffers have the function that resists a large change in pH on the addition of H^+ or OH^-. This is because the weak base, A^-, will react with added H^+ and the weak acid, HA, will react with added OH^-. Changes in pH of buffer solutions can be determined using the **Henderson-Hasselbach** equation:

$$\boxed{\mathrm{pH} = \mathrm{pK_a} + \log\left(\frac{[\mathrm{A^-}]}{[\mathrm{HA}]}\right)} \qquad (2.1)$$

A pH meter can be used to measure the pH of prepared solutions. Different classes of chemicals behave differently when dissolved in water. By doing this experiment, you will gain a better understanding of strong acids and strong bases, weak acids and weak bases, salts and buffers.

A solvent is a substance that dissolves a solute, resulting in a solution. A solvent is usually a liquid but can also be a solid, a gas, or a supercritical fluid

Dilution is the process of reducing the concentration of a solution by adding solvent into that solution.

In fact, the moles of solute after being diluted in solution are equal to the moles of solute in the initial solution

$$\boxed{n_i = n_f} \qquad (2.2)$$

Where n_i is the moles solute before dilution (mol)
n_f is the moles solute after dilution (mol)

Furthermore, based on the concentration formula, we can know that **the moles of solute = the solution volume x the concentration of the solution**. Therefore:

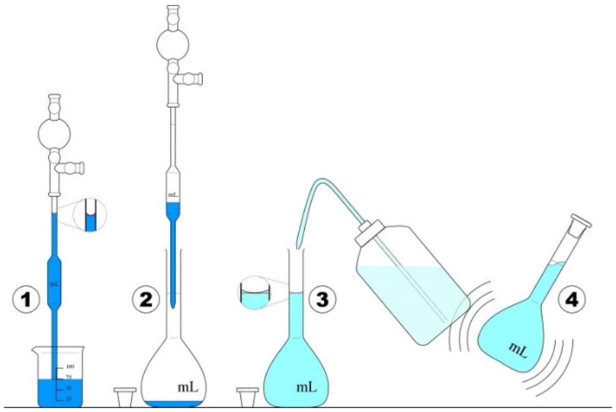
$$\boxed{M_i \times V_i = M_f \times V_f} \qquad (2.3)$$

Where M_i is the initial solution concentration (M)
V_i is the initial solution volume needed for dilution (mL)
M_f is the final solution concentration after dilution (M)
V_f is the final solution volume after dilution (mL)

❖ The protocol to make a standard solution-solution dilution:

a) **Calculation**: First, **determine the volume of initial solvent needed** for dilution by substituting the given values into the formula $M_i \times V_i = M_f \times V_f$. Finally, V_i can be obtained.

b) **Equipment**:
  - 1 Volumetric Flask (The value of Volumetric Flask must be equal to V_f)
  - 1 Pipette (The volumetric pipette is highly recommended due to its high accuracy measurement)



- A container containing the amount of known concentration
- Solvent (must be the same as the solvent of the initial solution)

c) Dilution process

(1) First take the needed volume of initial solution (V_i) by pipette

(2) Transfer the needed volume into volumetric flask

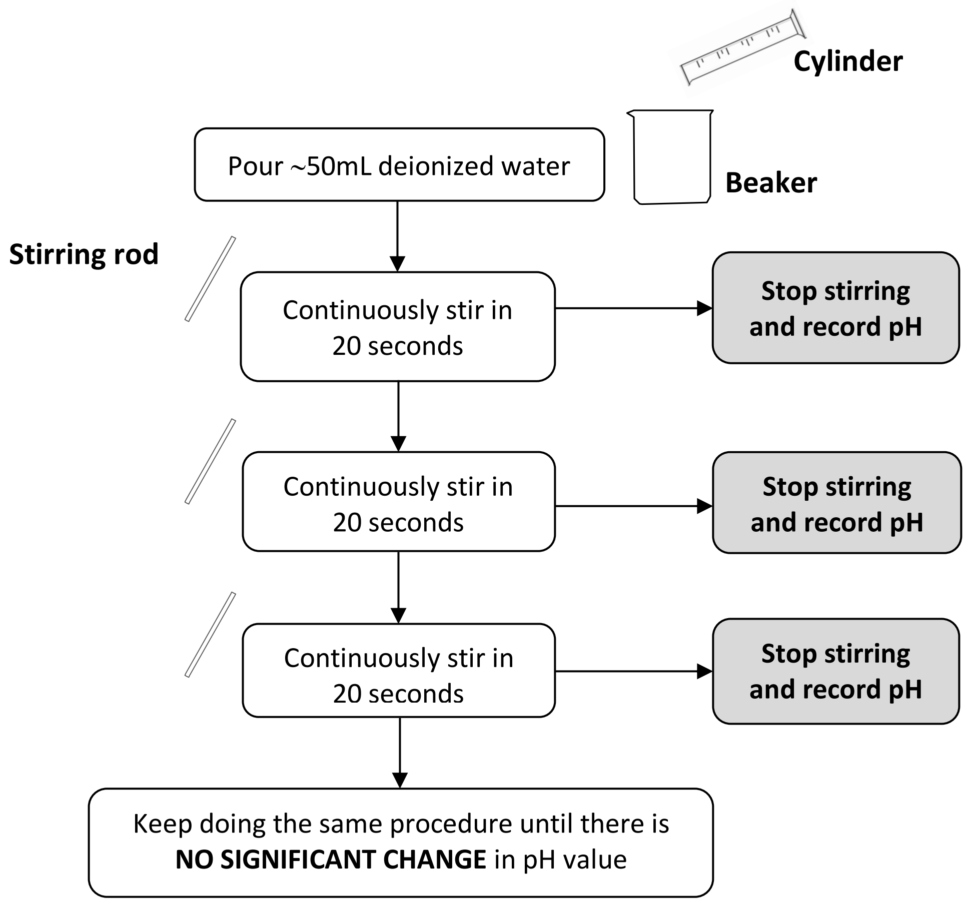
(3) Add solvent into the volumetric flask until the solution reaches the marked level of flask **(meniscus)**

(4) Close the cap and shake the flask gently

a set of actions which is the usual or official way of doing something

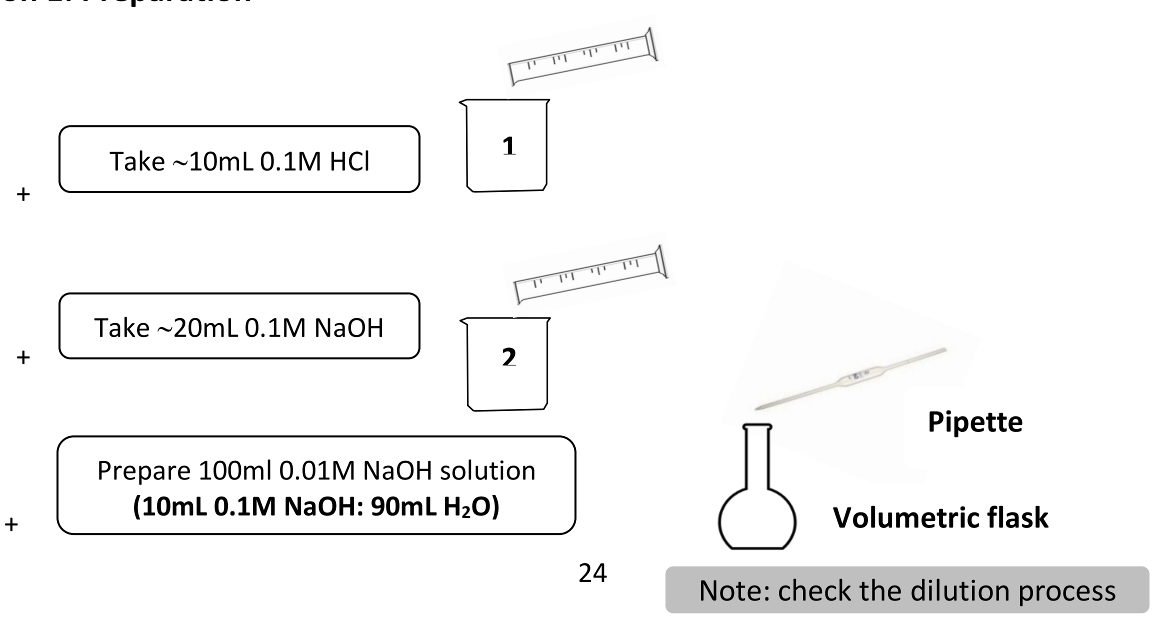
2. PROCEDURE

2.1. DEIONIZED WATER

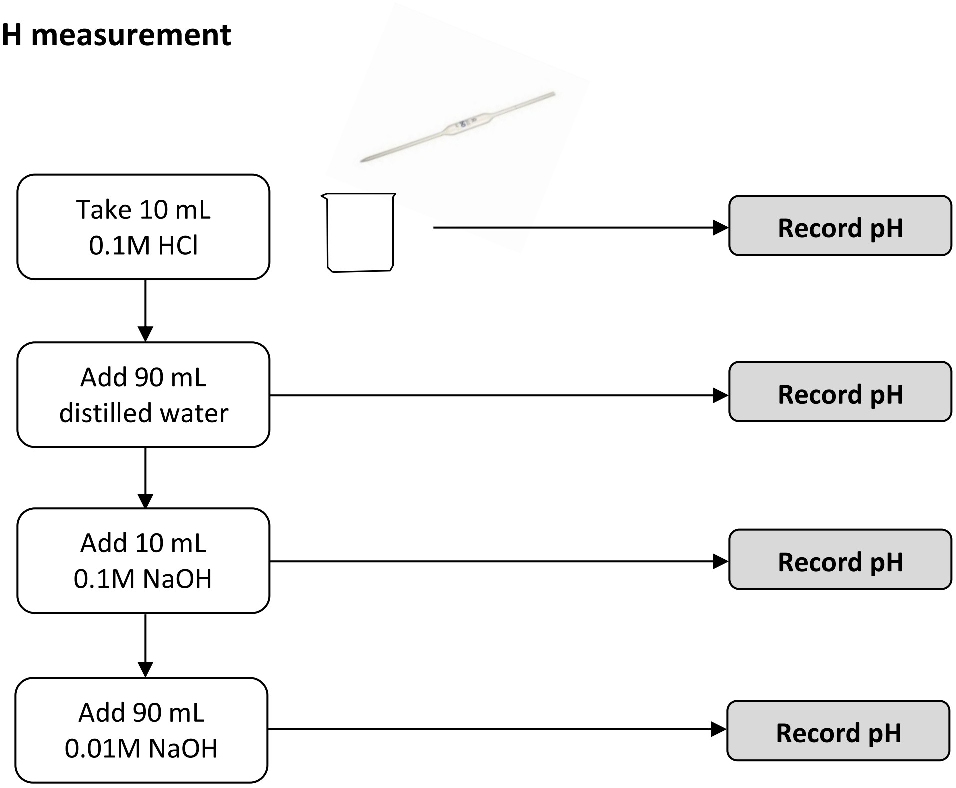


2.2. STRONG ACID

Section 1: Preparation



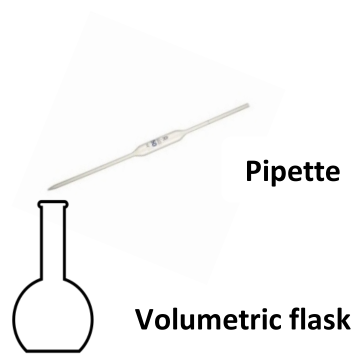
Section 2: pH measurement



2.3. WEAK ACID

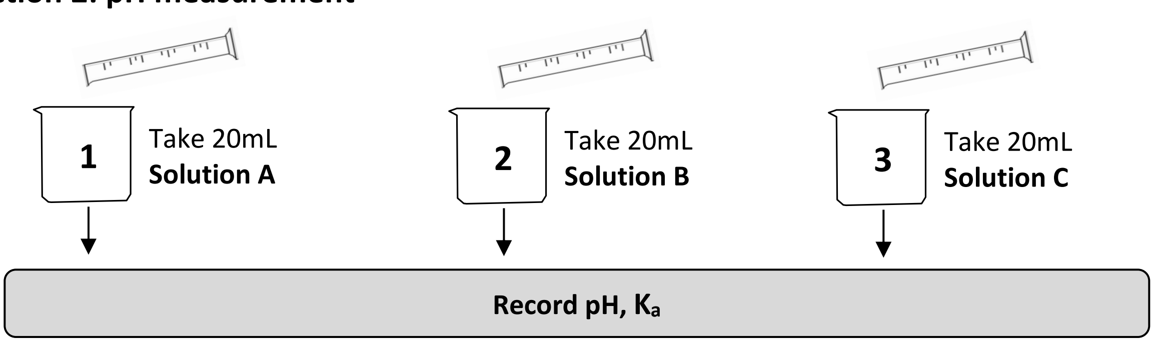
Section 1: Preparation

- **Solution A**: 0.1M CH_3COOH
- **Solution B**: 0.01M CH_3COOH
  (dilute solution A 10 times)
- **Solution C**: 0.001M CH_3COOH
  (dilute solution A 100 times or *dilute solution B 10 times)*



Note: check the dilution process above

Section 2: pH measurement

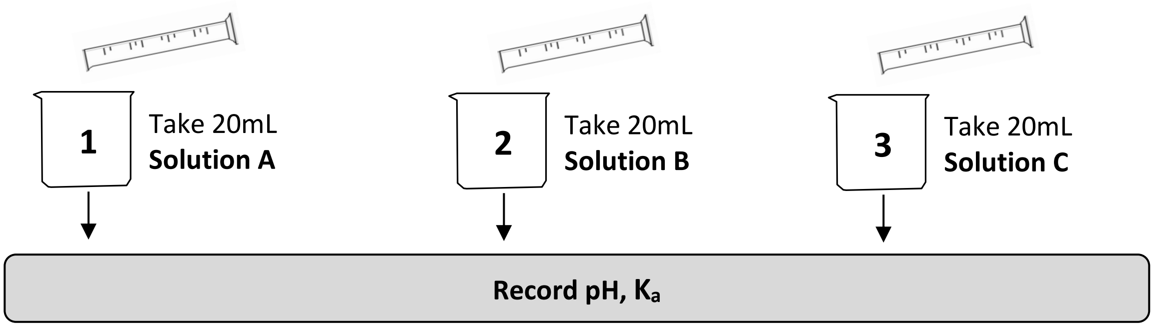


2.4. SALTS

Section 1: Preparation

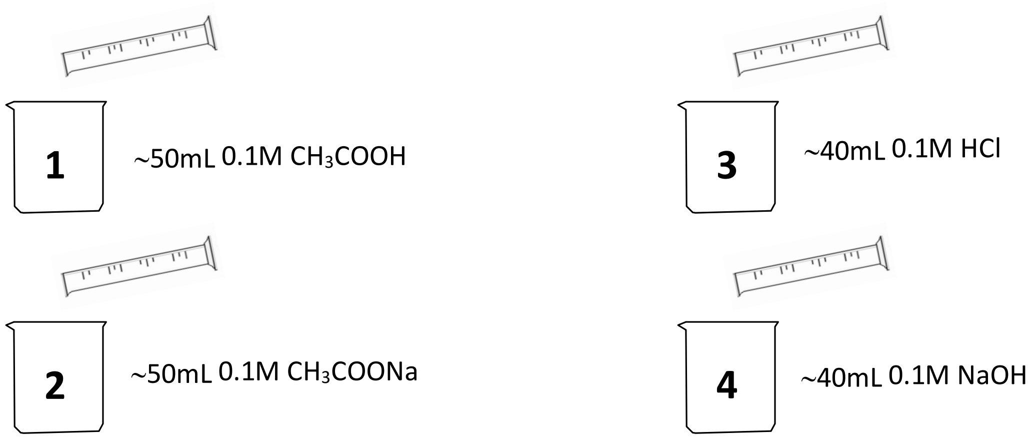
- **Solution A**: 0.1M NaCl
- **Solution B**: 0.1M CH_3COONa
- **Solution C**: 0.1M NH_4Cl

Section 2: pH measurement

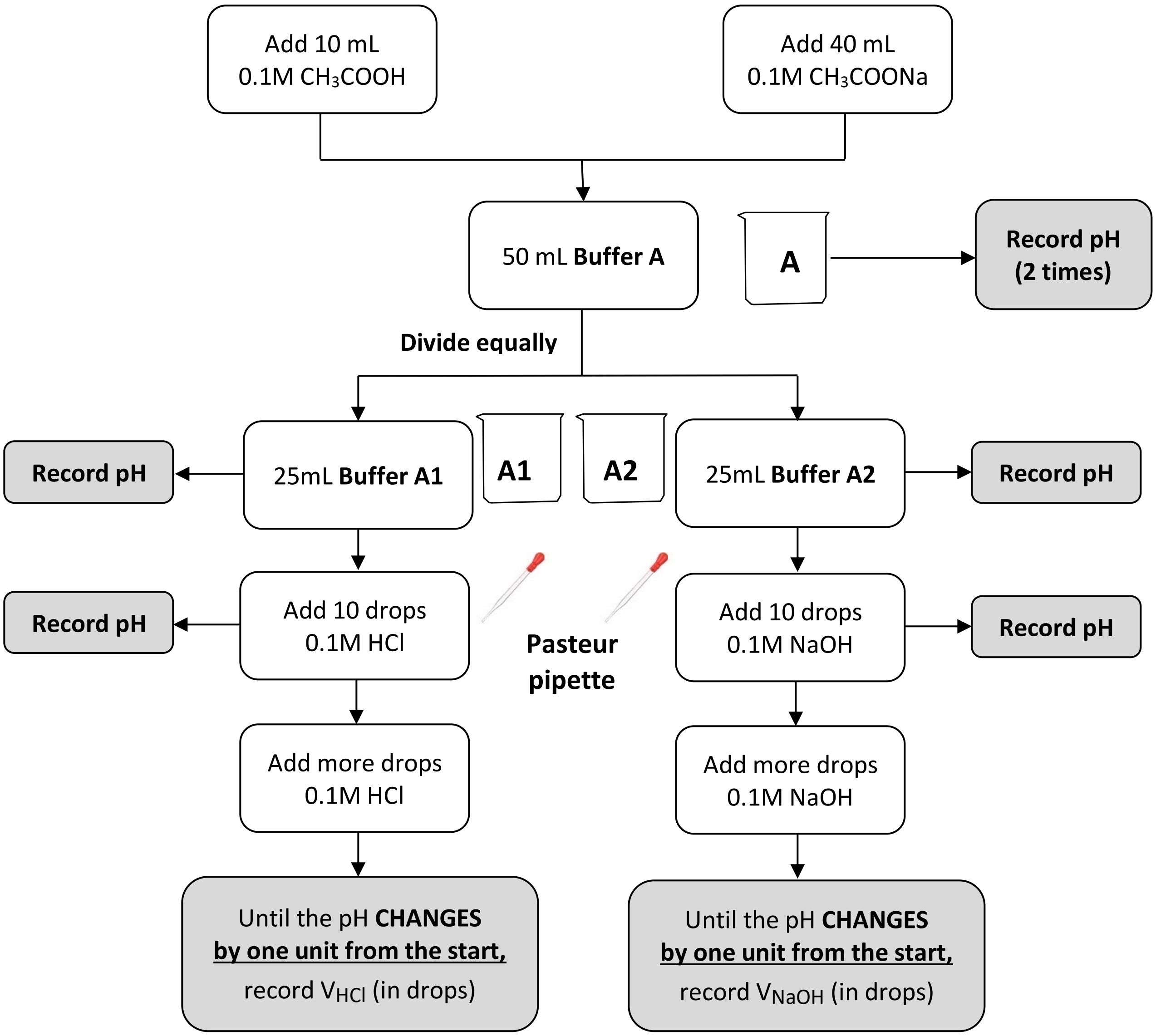


2.5. BUFFERS

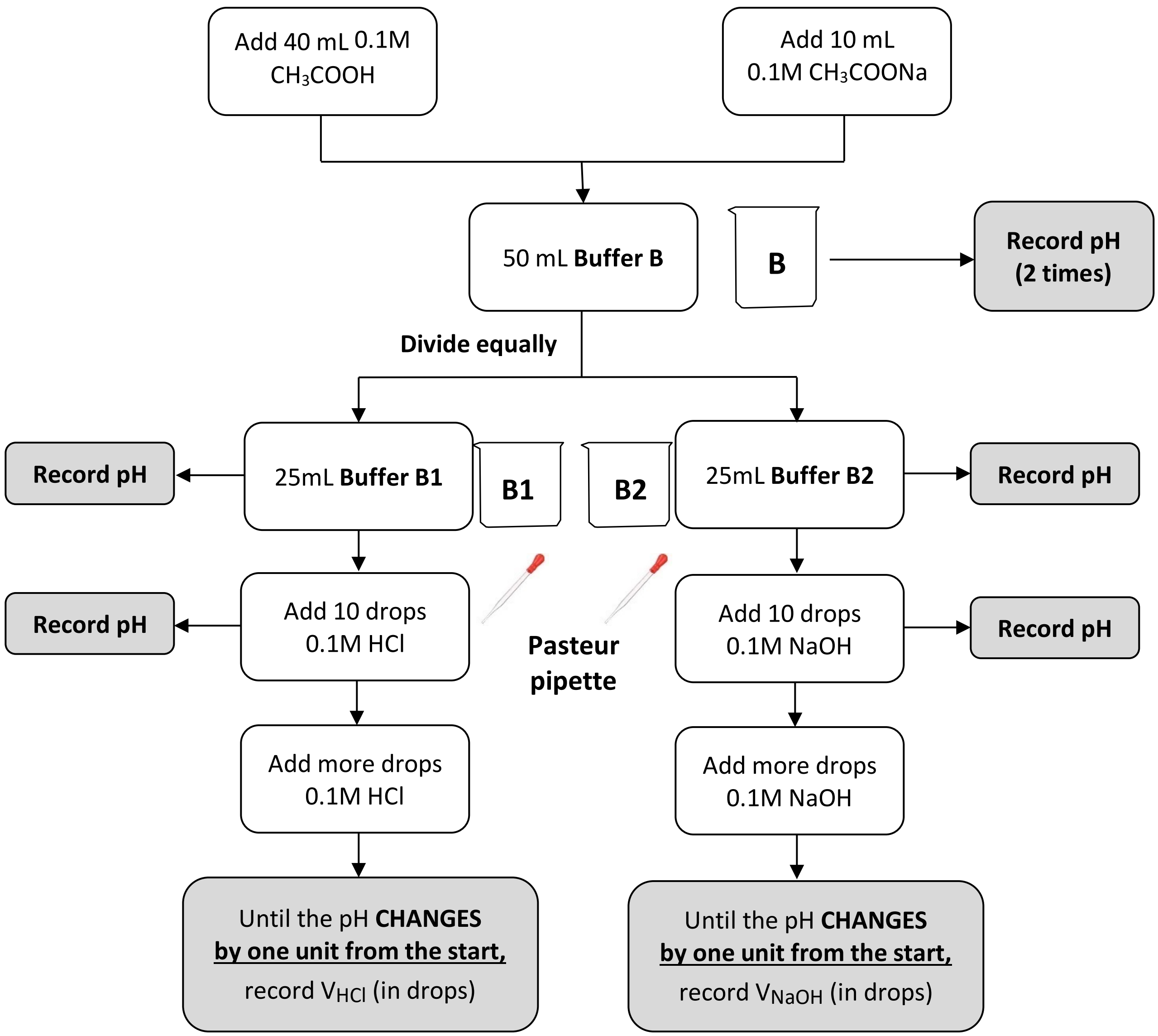
Section 1: Preparation



Section 2: Buffer A



Section 3: Buffer B



3. SUGGESTED QUESTIONS

1. What is the dissociation process? Write down the dissociation constant for CH_3COOH **+ H_2O ⇌** CH_3COO^- + H_3O^+?
2. What are the concentrations of hydronium ions ($[H_3O^+]$) and hydroxyl ions ($[OH^-]$) of pure water?
3. What is the product of the concentration of hydronium ions ($[H_3O^+]$) and hydroxyl ions ($[OH^-]$) in any aqueous solution?
4. What is pH? How do we define/calculate the pH value of a solution?
5. If $[H_3O^+]$ = 0.001 M. What is the pH value?

6. What equipment can you use to measure the pH of prepared solutions?
7. Please give the definitions of an acid and a base according to Arrhenius classification?
8. What is the conjugate base of CH_3COOH?
9. What is a buffer? What is its main characteristic?
10. Calculate the initial concentration of each substance when mixing 40.0 mL of 0.1 M CH_3COOH and 10.0 mL of 0.1 M CH_3COONa?
11. If the original pH of buffer A is 4, if we add enough HCl to change pH by one unit, what is the final pH value?
12. If the original pH of buffer A is 4, if we add enough NaOH to change pH by one unit, what is the final pH value?

4. DATASHEET

The datasheet template is attached in the appendix and can be downloaded @ https://blackboard.hcmiu.edu.vn

5. REPORT

The report template is attached in the appendix and can be downloaded @ https://blackboard.hcmiu.edu.vn

Experiment 3: Redox Titration with $KMnO_4$

Student name:____ ID:______________________________

OBJECTIVES

- Learn about the term of gram equivalent weight
- Review of oxidation-reduction reactions
- Standardize the concentration of $KMnO_4$ solution and determine the oxalic acid normality

1. INTRODUCTION

An oxidation-reduction (redox) reaction is a type of chemical reaction that involves a transfer of electrons between two species; therefore, the oxidation states of atoms are changed. The redox reaction involves two (02) half-reactions. Oxidation is the half-reaction in which there is a loss of electrons by a species (or an increase of the oxidation number of an atom). Reduction is the half-reaction in which there is a gain of electrons by a species (or a decrease in the oxidation number of an atom). The substance that gains electrons is said to be reduced; therefore, it is called the oxidizing agent. The substance that loses electrons is said to be oxidized; thus, it is called the reducing agent.

oxidation

$$\underset{\text{reducing agent}}{\overset{0}{\mathrm{Fe}(s)}} + \underset{\text{oxidizing agent}}{\overset{+2}{\mathrm{Cu}^{2+}(aq)}} \longrightarrow \overset{+2}{\mathrm{Fe}^{2+}(aq)} + \overset{0}{\mathrm{Cu}(s)}$$

reduction

The equivalent weight (EW) of an oxidizing or reducing agent for a particular reaction is equal to its formula weight divided by the total number of electrons gained or lost when the reaction occurs (i.e. by the total change in valence). While, gram equivalent weight is the measure of the reactive capacity of a molecule. The solute's role in the reaction determines the solution's normality. Normality is a measure of concentration equal to the gram equivalent weight per liter of solution.

Consider the reaction of potassium permanganate ($KMnO_4$) with oxalic acid ($H_2C_2O_4$) in the presence of excess sulfuric acid(H_2SO_4). The balanced molecular and net ionic equations are as follows, respectively.

$$\mathbf{2KMnO_4 + 5H_2C_2O_4 + 3H_2SO_4 \rightarrow 10CO_2 + K_2SO_4 + 2MnSO_4 + 8H_2O}$$

$$\mathbf{2MnO_4^- + 5H_2C_2O_4 + 6H^+ \rightarrow 10CO_2 + 2\,Mn^{2+} + 8H_2O}$$

The oxidation number of *manganese* in MnO_4^- is +7 while it is +2 in Mn^{2+}. Hence, each *manganese* undergoes a change in oxidation number of five (05). Since each formula unit of $KMnO_4$ contains one Mn^{7+}, and each Mn^{7+} gains five (05) electrons. Thus, the equivalent weight of $KMnO_4$ in this reaction is 31.60 grams.

$$\text{EW of } KMnO_4 = \frac{158.0\ g}{1\ mole} \times \frac{1\ mole}{5\ eq} = \frac{31.60\ g}{eq}$$

The oxidation number of carbon in $H_2C_2O_4$ is +3, while it is +4 in CO_2. Thus each carbon undergoes a change in oxidation number of one. However, each formula unit of $H_2C_2O_4$ contains two carbons, and since each carbon loses one (01) electron. Thus, the equivalent weight of $H_2C_2O_4$ is 45.0 grams.

$$\text{EW of } H_2C_2O_4 = \frac{90.0\ g}{1\ mole} \times \frac{1\ mole}{2\ eq} = \frac{45.0\ g}{eq}$$

In this experiment, you will prepare an approximately 0.05N $KMnO_4$ solution and standardize this solution by titrating it against a standard solution of $H_2C_2O_4$ (primary standard). Then the standardized $KMnO_4$ solution (secondary standard) will be used to determine the concentration of the unknown oxalic acid solution and unknown Fe^{2+} solution. For redox titrations, the number of gram equivalents weight of oxidizing agent must be equal to the number of equivalents of the reducing agent. For the reaction of $KMnO_4$ with $H_2C_2O_4$:

GEW of $KMnO_4$ = GEW of $H_2C_2O_4$

Alternatively, this relationship can be expressed as follows:

$$\boxed{V_{oxidizing} \times N_{oxidizing} = V_{reducing} \times N_{reducing}} \qquad (3.1)$$

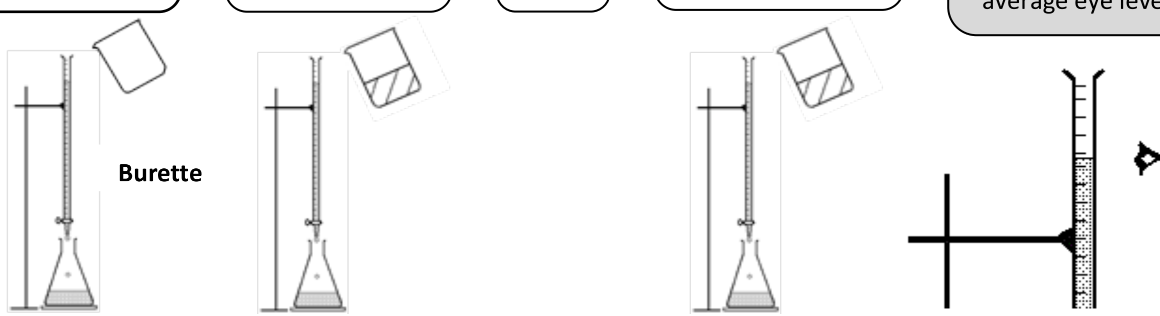
where V is the volume of oxidizing or reducing agents used in titrations and N is the normality of oxidizing or reducing agents.

At the end of a titration, three of the four variables will be known, and the unknown variable can be determined.

2. PROCEDURE

2.1. HANDLING WITH BURETTE

Rinse the burette **3 times** with distilled water → Rinse the burette **3 times** with **~5mL $KMnO_4$** → Discard the waste → Fill with $KMnO_4$ Let it drain through the burette tip → Record the initial point (preferably up to the average eye level)



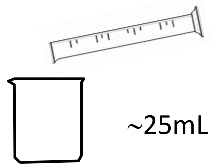
Erlenmeyer Flask

NO AIR BUBBLES REMAIN

NOTE: as $KMnO_4$ solution is dark color, read the burette <u>at the top of the meniscus</u>.

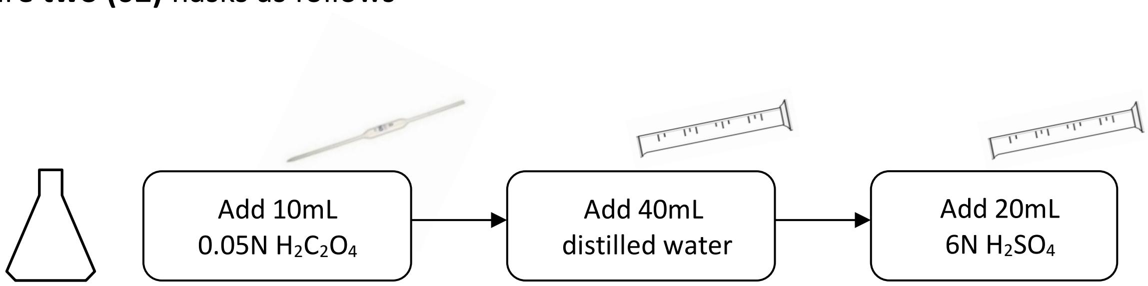
2.2. STANDARDIZATION OF PREPARED $KMNO_4$ SOLUTION

Section 1: Preparation



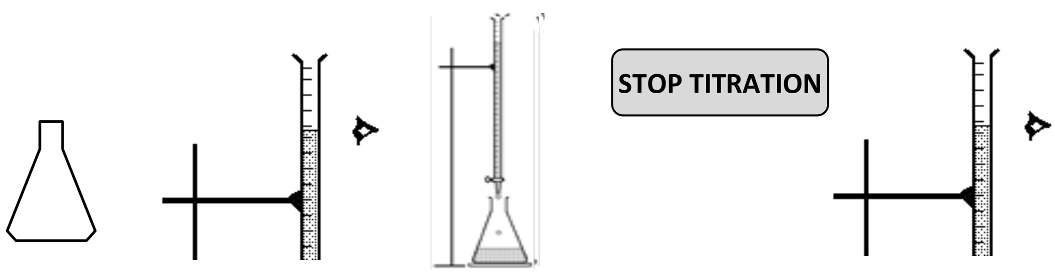
~25mL **0.05N** $H_2C_2O_4$

Prepare **two (02)** flasks as follows



Section 2: Titration

Heat the flask to ~**85 – 90°C** → Record the initial point **(V_i)** → Add $KMnO_4$ slowly and swirl the flask continuously → First sign of color change **(light pink)** → Record the final point **(V_f)** → **Calculate V_{KMnO_4} (V_f – V_i)**

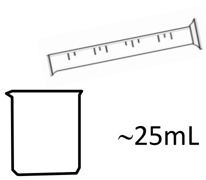


Section 3: Calculation

- The normality of $KMnO_4$
- The average normality and standard deviation

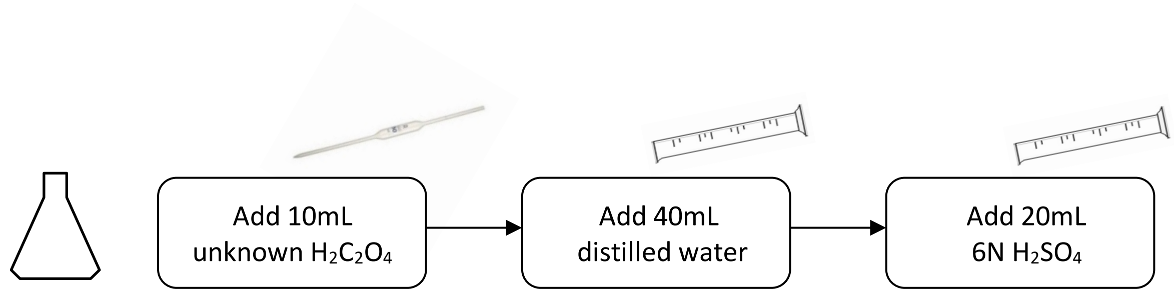
2.3. DETERMINATION OF UNKNOWN CONCENTRATION $H_2C_2O_4$ SOLUTION

Section 1: Preparation

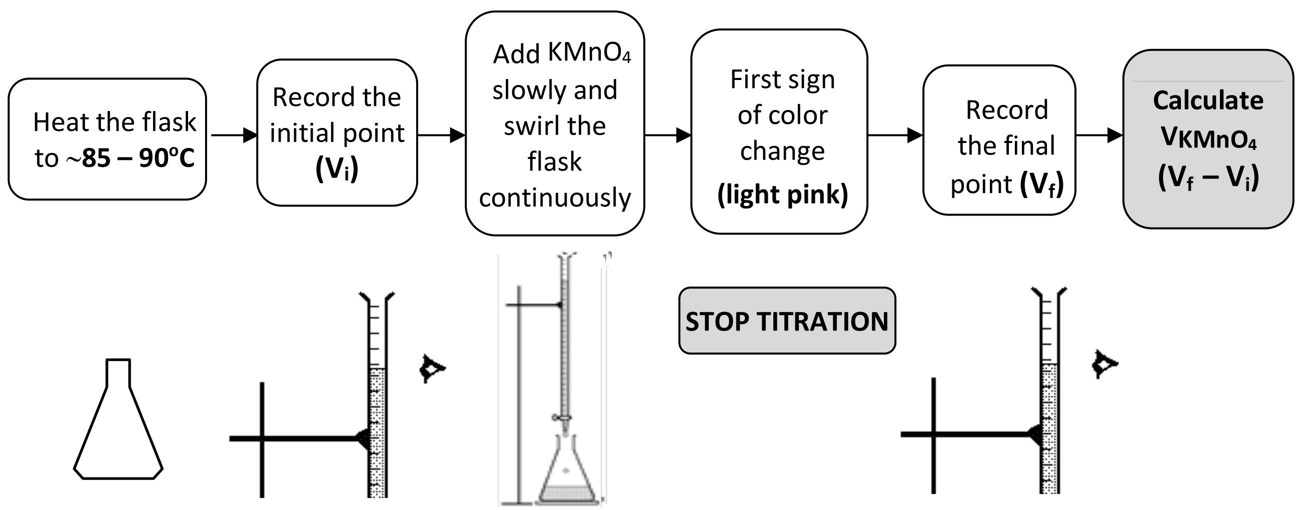


~25mL unknown normality $H_2C_2O_4$

Prepare **two (02)** flasks as follows



Section 2: Titration with the two prepared flasks

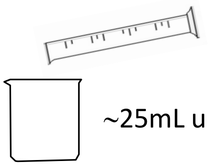


Section 3: Calculation

- The normality of unknown concentration $H_2C_2O_4$
- The average normality and standard deviation

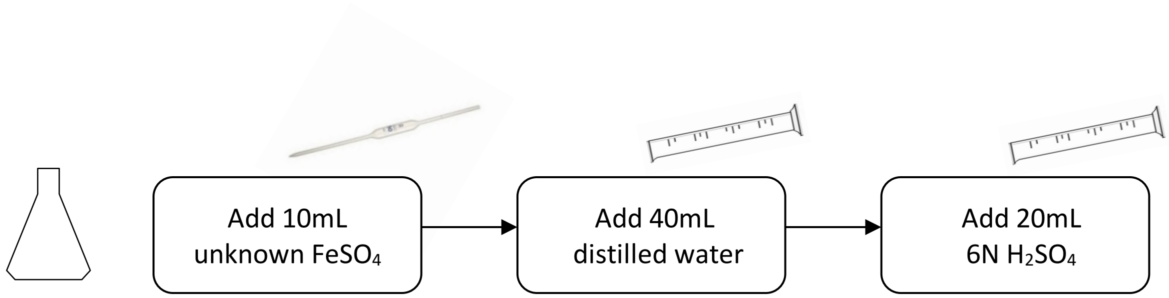
2.4. DETERMINATION OF UNKNOWN CONCENTRATION $FeSO_4$ SOLUTION

Section 1: Preparation

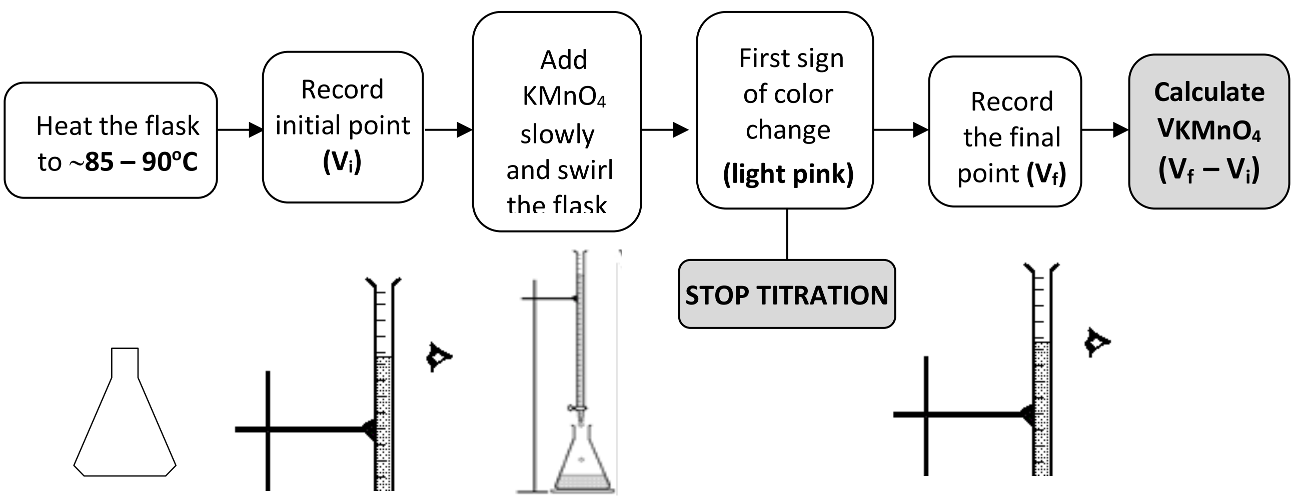


~25mL unknown normality $FeSO_4$

Prepare **two (02)** flasks as follows



Section 2: Titration with the two prepared flasks



Section 3: Calculation

- The normality of unknown concentration $FeSO_4$
- The average normality and standard deviation

3. SUGGESTED QUESTIONS

1. What are the objectives of today's lab work?
2. What is a redox reaction (oxidation-reduction reaction)?
3. In a redox reaction, what are the oxidizing agent and reducing agent?
4. Balance the reaction between potassium permanganate ($KMnO_4$) with oxalic acid ($H_2C_2O_4$) in the presence of excess sulfuric acid (H_2SO_4)? Show your work
5. Please define the gram equivalent weight (GEW) of oxidizing agent and gram equivalent weight of the reducing agent
6. What is normality? How do you calculate the normality of a solution?
7. What is the normality of an 1-M H_2SO_4 solution?
8. What is the normality of an 1-M HCl solution?
9. What is the titration technique? What is its principle?
10. Please watch the following video clip and list out all the steps of titration using a burette: http://www.youtube.com/watch?v=9DkB82xLvNE

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4. DATASHEET

The datasheet template is attached in the appendix and can be downloaded @ https://blackboard.hcmiu.edu.vn

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5. REPORT

The report template is attached in the appendix and can be downloaded @ https://blackboard.hcmiu.edu.vn

Experiment 4: Chemical Equilibrium

Student name:____ ID:___________________________

OBJECTIVES

- To observe the effect of applying stresses on chemical systems at equilibrium
- To apply Le Chatelier's Principle to explain the changes in the system

1. INTRODUCTION

A reversible reaction is a chemical reaction where the reactants form products that, in turn, react together to give the reactants back. Reversible reactions will reach an equilibrium point where the concentrations of the reactants and products will no longer change. A reversible reaction is denoted by a double arrow pointing in both directions in a chemical equation.

Reversible reaction:

$$A + B \underset{\text{Backward reaction}}{\overset{\text{Forward reaction}}{\rightleftharpoons}} C + D$$

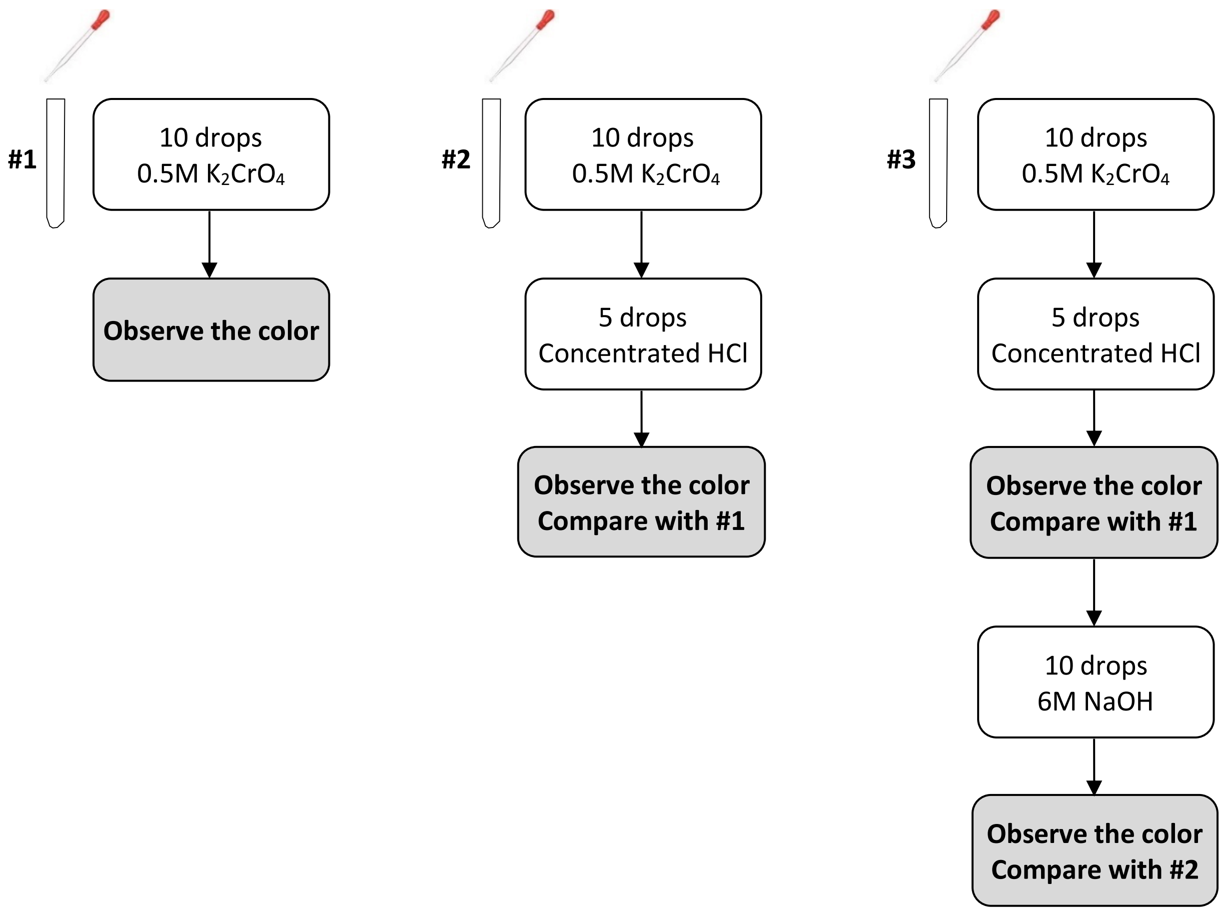
A reversible reaction at equilibrium can be disturbed if stresses are applied to it. Stresses can be changes in **concentration**, **temperature,** or **pressure**. The composition of the reaction mixture will shift until equilibrium has been reestablished. This is known as **Le Chatelier's principle**. In this experiment, the effect of applying stresses to a variety of chemical systems at equilibrium will be observed, and we will also see if the results are consistent with Le Chatelier's principle.

No.	Name	Number
1	Test tube	98
2	Test tube rack	7
3	Beaker 250-mL	7
4	Beaker 100-mL	7
5	Beaker 50-mL	7
6	Stirring rod	7
7	Cylinder 50-mL	7
8	Graduated pipette 10-mL	7
9	Pipette pump	7
10	Distilled water bottle	7
11	Ice bath	2
12	Water bath	2

2. PROCEDURE

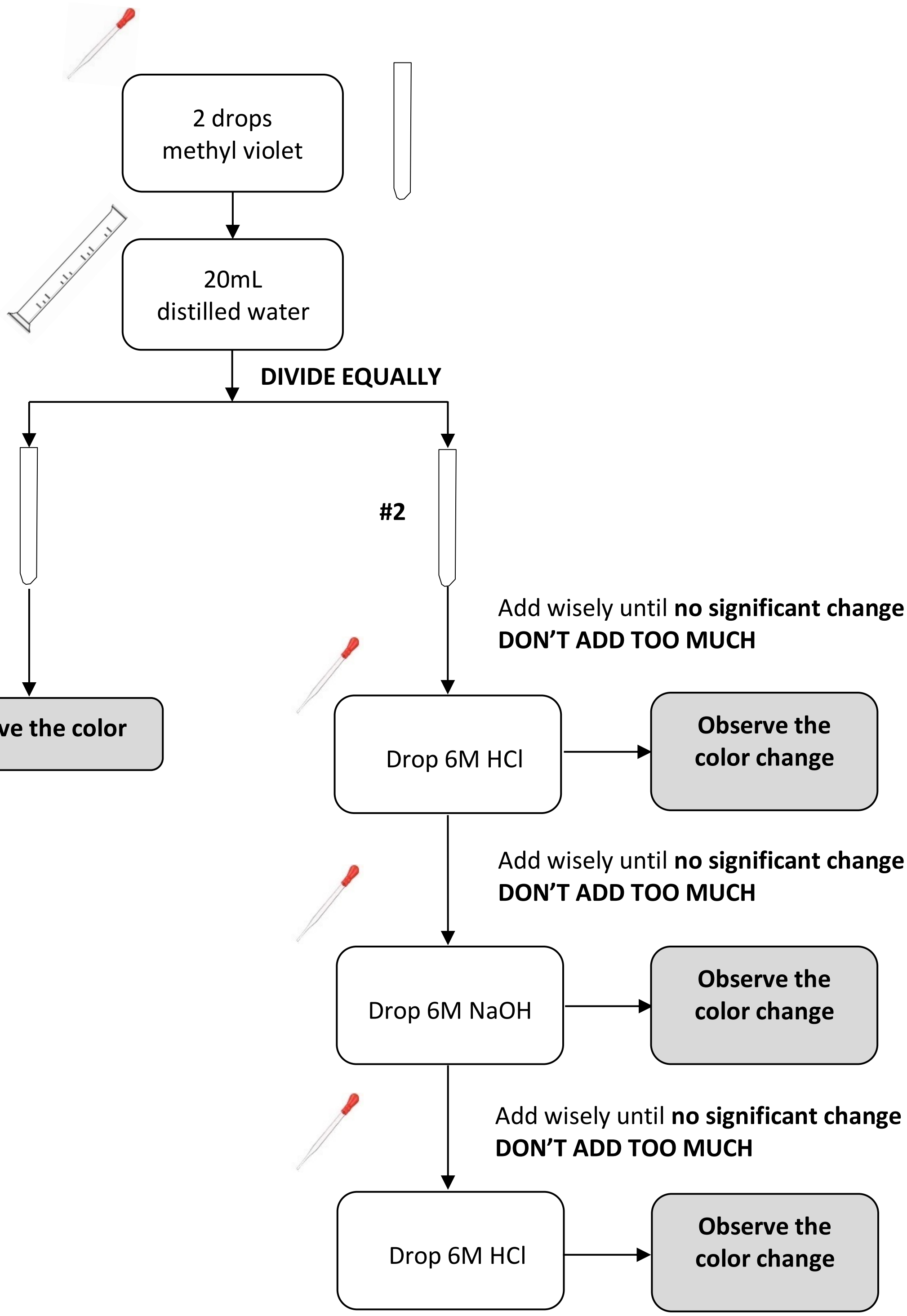
2.1. ACID/BASE EQUILIBRIA

Equilibrium system: $2\ CrO_4^{2-}{}_{(aq)} + 2H^+{}_{(aq)} \rightleftharpoons Cr_2O_7^{2-}{}_{(aq)} + H_2O_{(l)}$



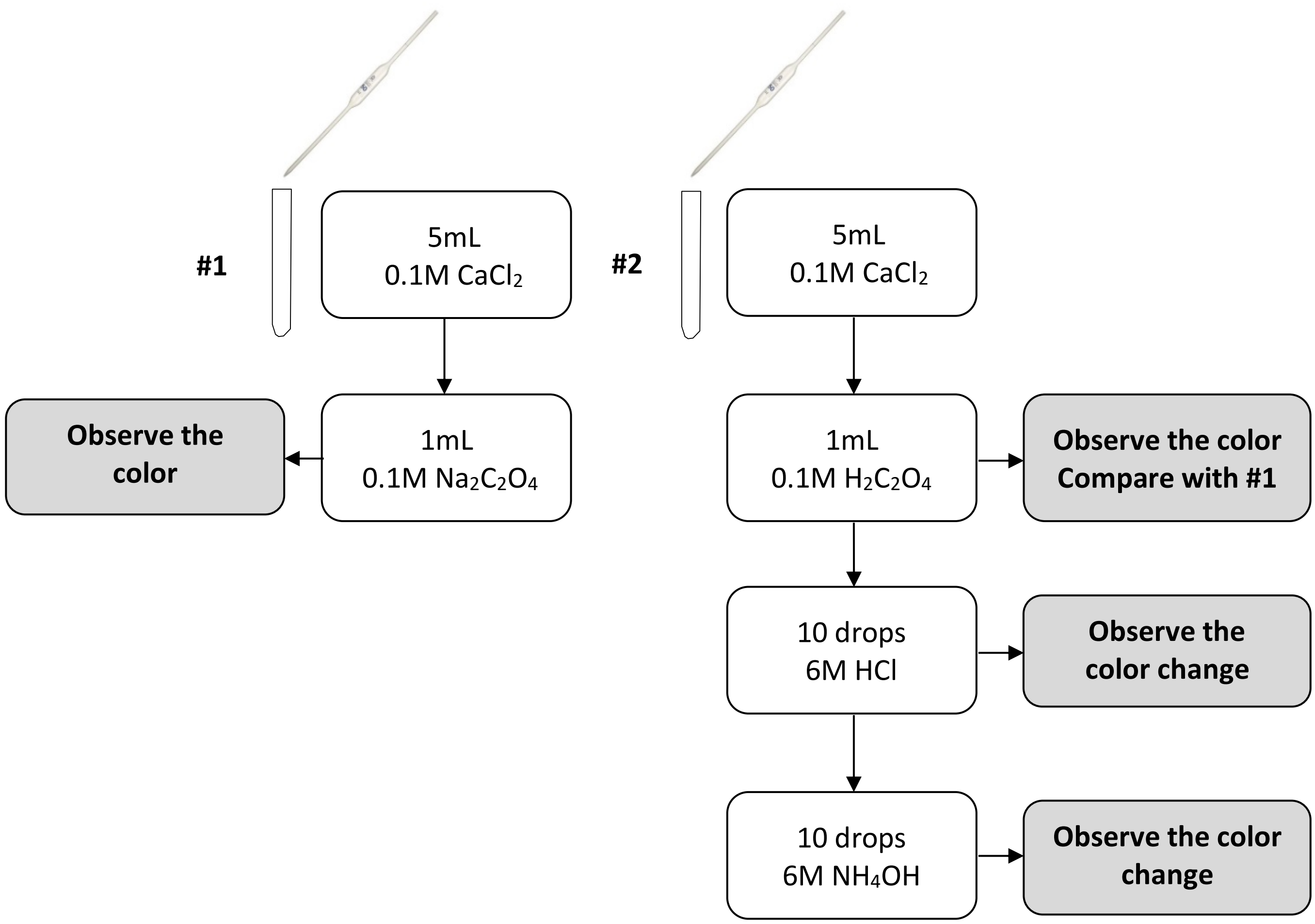
2.2. EQUILIBRIA OF ACID/BASE INDICATORS

Equilibrium system: $\mathbf{H(MV)_{(aq)} + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + MV^-_{(aq)}}$



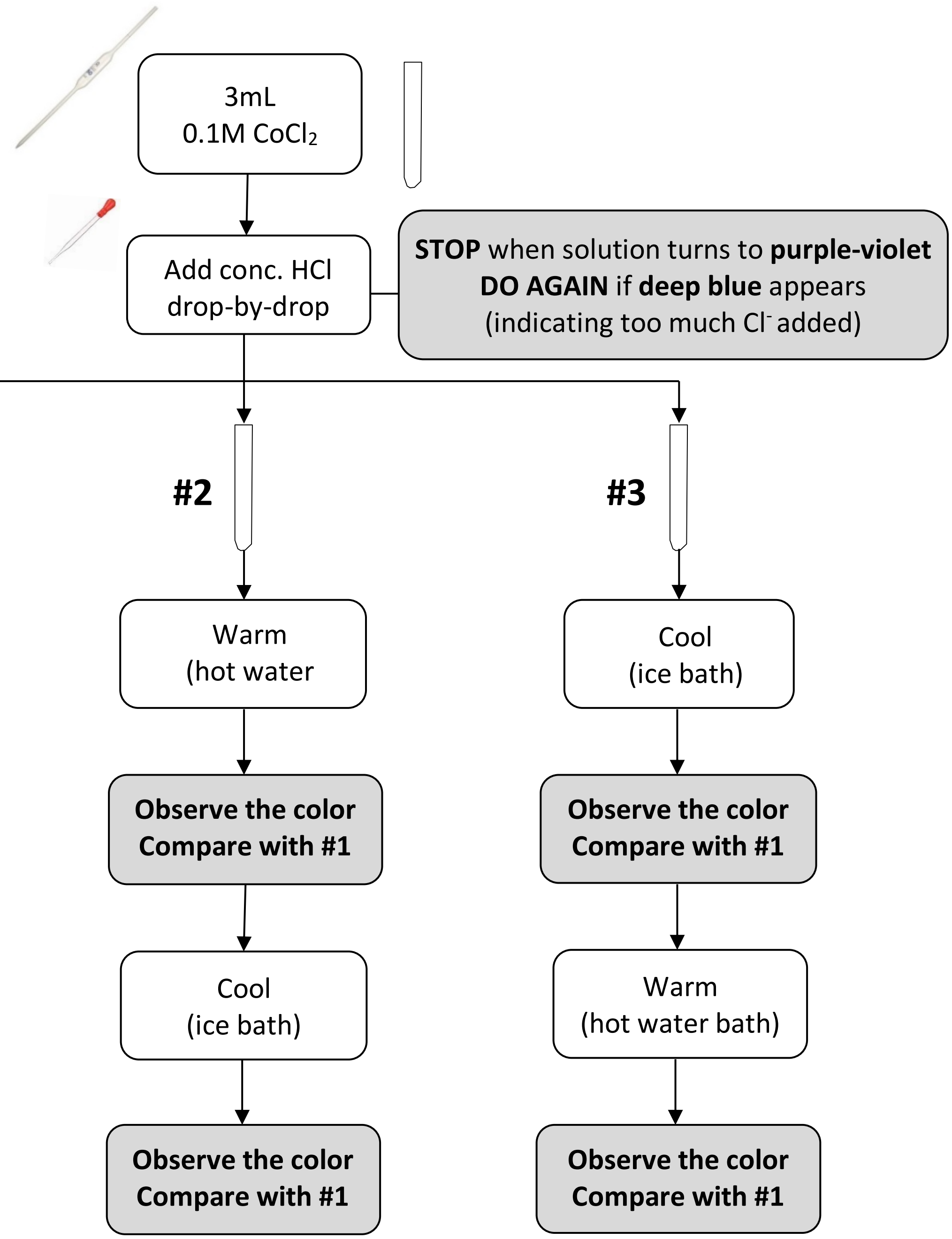
2.3. EQUILIBRIA OF PRECIPITATION REACTIONS

Equilibrium system: $Ca^{2+}{}_{(aq)} + C_2O_4^{2-}{}_{(aq)} \rightleftharpoons CaC_2O_{4\,(s)}$



2.4. TEMPERATURE EFFECTS ON EQUILIBRIA

Equilibrium System: $[Co(H_2O)_6]^{2+}{}_{(aq)} + 4Cl^-{}_{(aq)} \rightleftharpoons (CoCl_4)^{2-}{}_{(aq)} + 6H_2O_{(l)}$



CHEMICAL WASTE: Please dispose **cobalt ion (Co^{2+})** to the **TOXIC CONTAINER.**

3. SUGGESTED QUESTIONS

1. What are the objectives of today's lab work?
2. What is chemical equilibrium in a reversible chemical reaction? And when the equilibrium state of a chemical reaction can be obtained?
3. Please define dynamic equilibrium and static equilibrium
4. Please describe factors that can disturb a reversible reaction at its equilibrium state?
5. What is Le Chatelier's Principle about?
6. Please write the Equilibrium equation
7. Please fill out the following table

K Value	Reaction favors (reactants / products)	Reaction lies to (left / center / right)
K << 1		
K ~ 1		
K >> 1		

8. Please predict the outcome of today lab work and fill out the following table

System No.	System name	Description of conditions	Predicted outcome
1	Acid/base equilibria	Initial solution	
		+ Conc. HCl	
		+ 6N NaOH	
2	Equilibria of acid/base indicators	None (control)	
		6M HCl	
		6M NaOH	
		6M HCl	
3	Complex ion formation	None (control)	
		0.01M $FeCl_3$	
		0.01M KSCN	
		6M NaOH	
		Cold	
		Hot	
		0.1M $AgNO_3$	
4	Equilibria of precipitation reactions	Test tube 1: 0.1M $Na_2C_2O_4$	
		Test tube 2: + 0.1M $H_2C_2O_4$	
		Test tube 2: + 6M HCl	
		Test tube 2: + 6M NH_4OH	
5		Nothing changed(control)	

	Temperature effects on equilibria	Hot water bath	
		Ice-water bath	

4. DATASHEET

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5. REPORT

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Experiment 5: Factors Affecting Reaction Rate

Student name:______________________________ ID:__________________________

OBJECTIVES

- To examine the effects of concentration, temperature, and catalysts on reaction rates.

1. INTRODUCTION

The rate of a chemical reaction describes how fast the reaction occurs. The rate of a chemical reaction is affected by a number of factors, including **(1)** ***the nature of the reactants***, **(2) the** ***temperature of the reaction***, **(3) the** ***concentration of the reactants***, **(4)** ***the surface area of the reactants***, **(5)** ***the presence of a catalyst*** and **(6)** ***the pressure of the reaction system.*** The greater the rate of a chemical reaction, the less time is needed for a specific amount of reactants to be converted into products. The rate of a reaction can be determined by measuring the time of a certain amount of a reactant reacted or a product formed.

2. PROCEDURE

2.1. EFFECT OF CONCENTRATION ON REACTION TIME

In this part 1, solution $Na_2S_2O_3$will be the **limiting reagent**. The reactions involved are:

Reaction 1: $2I^- + S_2O_8^{2-} \rightarrow I_2 + 2SO_4^{2-}$ **(SLOW)**

Iodide ions + peroxydisulfate ions → iodine + sulfate ions

Reaction 2: $I_2 + 2S_2O_3^{2-} \rightarrow 2I^- + S_4O_6^{2-}$ **(FAST)**

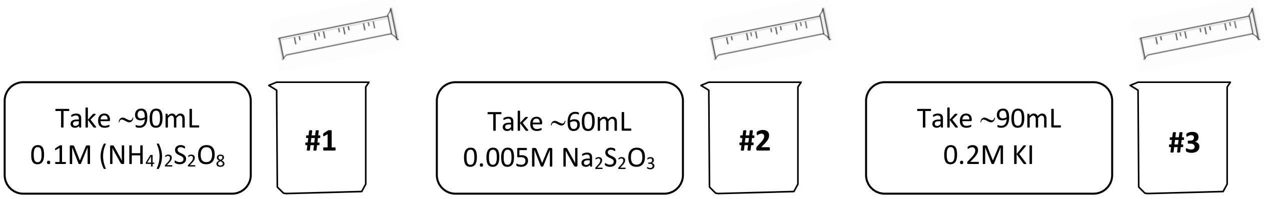
Iodine + thiosulfate ion → iodide ion + tetrathionate ion

Reaction 1 is relatively slow. As the iodine is formed, it is quickly used in reaction 2, which is relatively fast. The limiting reaction ($Na_2S_2O_3$ solution) is a source of the thiosulfate ions. When $Na_2S_2O_3$ is used up, the **excess iodine** will react with starch to form a **deep blue** solution.

$$I_{2(excess)} + \text{starch} \rightarrow \text{complex: deep blue solution}$$

In this experiment, you will vary the concentrations of solutions $(NH_4)_2S_2O_8$. The temperature will remain constant at **room temperature.**

Section 1: Preparation



Section 2: Procedure

Table 1. Chemical preparation for the experiment on the effect of concentration on reaction time

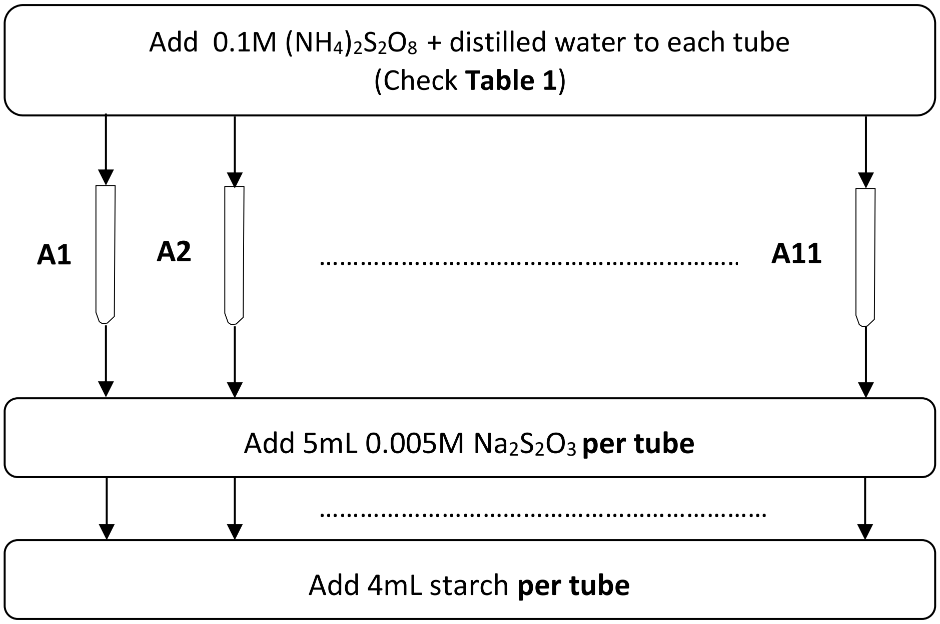
No	Test tube #A1 – #A11			Test tube #B1 – #B11
	$(NH_4)_2S_2O_8$ + Distilled water (mL)	$Na_2\,S_2O_3$ (mL)	Starch (mL)	KI + Distilled water (mL)
1	10.0 + 0.0 water	5.0	~ 4.0	10.0 + 0.0 water
2	10.0 + 0.0 water	5.0	~ 4.0	8.5 + 1.5 water
3	10.0 + 0.0 water	5.0	~ 4.0	7.0 + 3.0 water
4	10.0 + 0.0 water	5.0	~ 4.0	5.5 + 4.5 water
5	10.0 + 0.0 water	5.0	~ 4.0	4.0 + 6.0 water
6	10.0 + 0.0 water	5.0	~ 4.0	2.5 + 7.5 water
7	8.5 + 1.5 water	5.0	~ 4.0	10.0 + 0.0 water
8	7.0 + 3.0 water	5.0	~ 4.0	10.0 + 0.0 water
9	5.5 + 4.5 water	5.0	~ 4.0	10.0 + 0.0 water
10	4.0 + 6.0 water	5.0	~ 4.0	10.0 + 0.0 water
11	2.5 + 7.5 water	5.0	~ 4.0	10.0 + 0.0 water

***Special remarks on reactivity of KI:** moisture sensitive; light sensitive; air sensitive (Air causes decomposition to iodine).

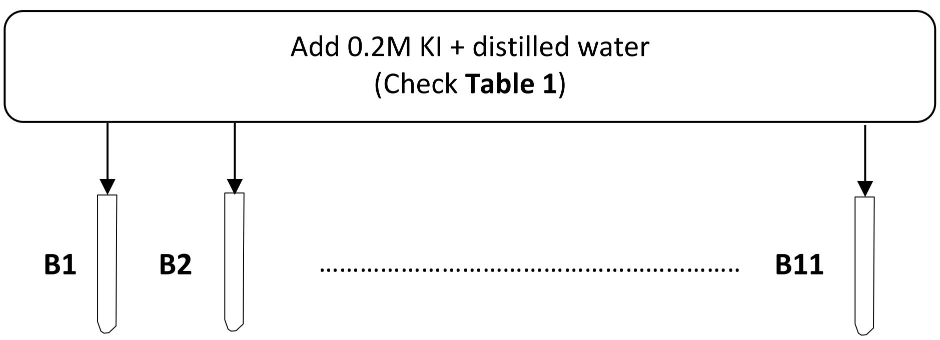
- ### EXPERIMENT 5

No.	Name	Number
1	Test tube	154
2	Test tube rack	9
3	Stirring rod	7
4	Distilled water bottle	7
5	Beaker 250-mL	7
6	Beaker 100-mL	7
7	Graduated Pipette 10-mL	7
8	Pipette pump	7
9	Distilled water bottle	7
10	Water bath	2

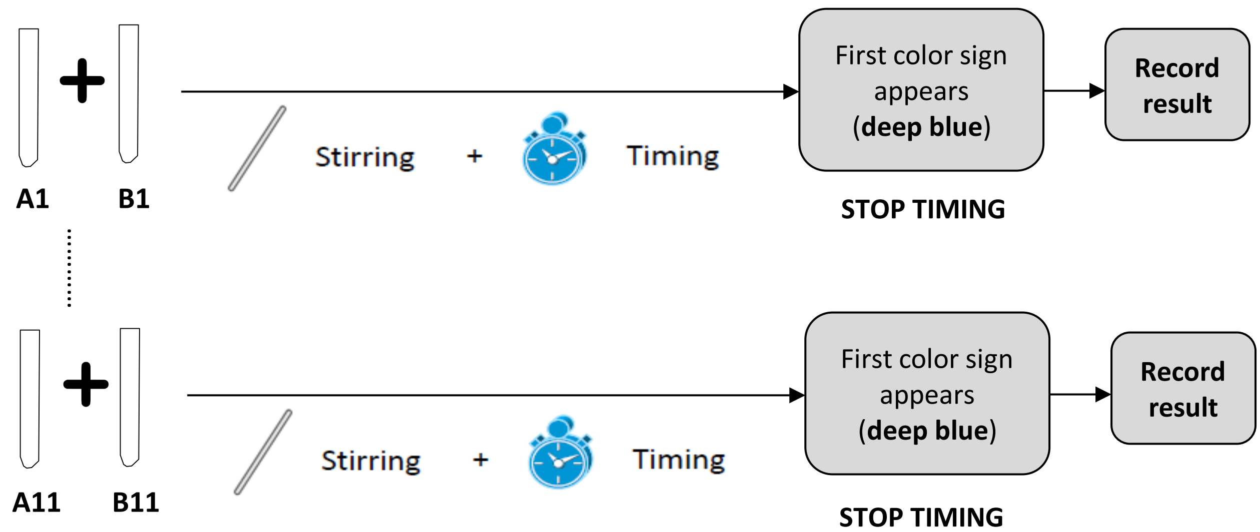
Step 1: Prepare solution A



Step 2: Prepare solution B



Step 3: Mix solution A and solution B



Step 4: Calculate the initial concentrations of iodide and peroxydisulfate ion for each of the mixtures

For example, the concentrations in mixture **#1** are:

Iodide ion:

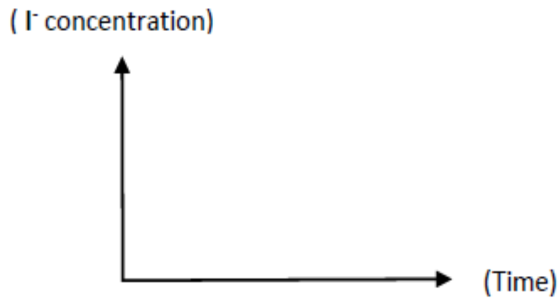
$$\frac{(10\ \mathrm{mL})\ \times (0.20\ \mathrm{ml/L})}{29.0\ \mathrm{mL}} = 0.069\ \mathrm{mol/L}$$

Peroxydisulfate:

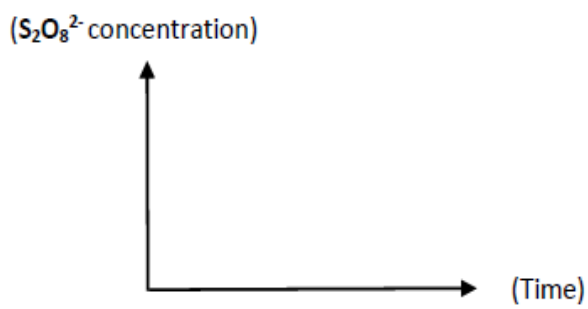
$$\frac{(10\ \mathrm{mL})\ \times (0.10\ \mathrm{ml/L})}{29.0\ \mathrm{mL}} = 0.034\ \mathrm{mol/L}$$

Step 5: Plot the data

Plotting the concentration of **iodide ion** versus **time** for mixtures **# 1-6.** Time should be on the X – axis and the concentrations should be on the Y – axis.



Plotting the concentration of **peroxydisulfate ion** versus **time** for mixtures **# 1, 7, 8, 9, 10**, and **11**. Again, time should be on the X – axis and the concentrations should be on the Y – axis.

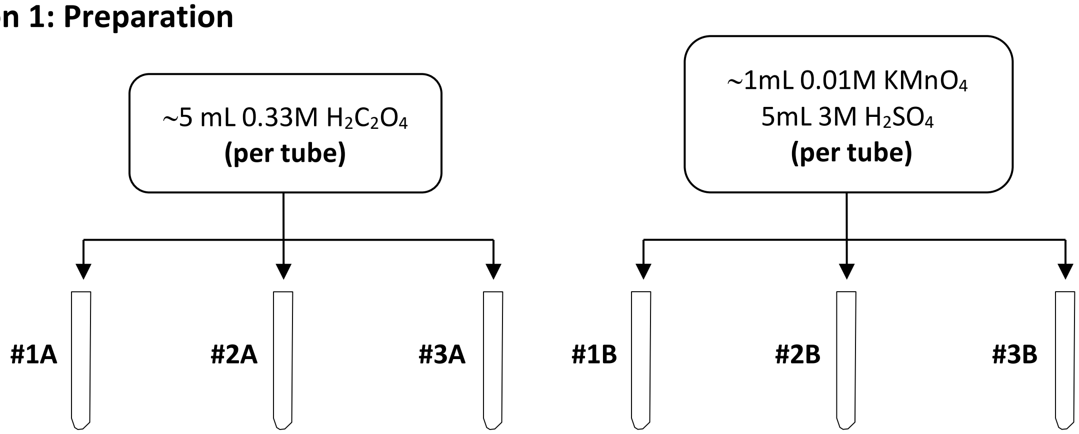


2.2. EFFECT OF TEMPERATURE ON THE REACTION RATE

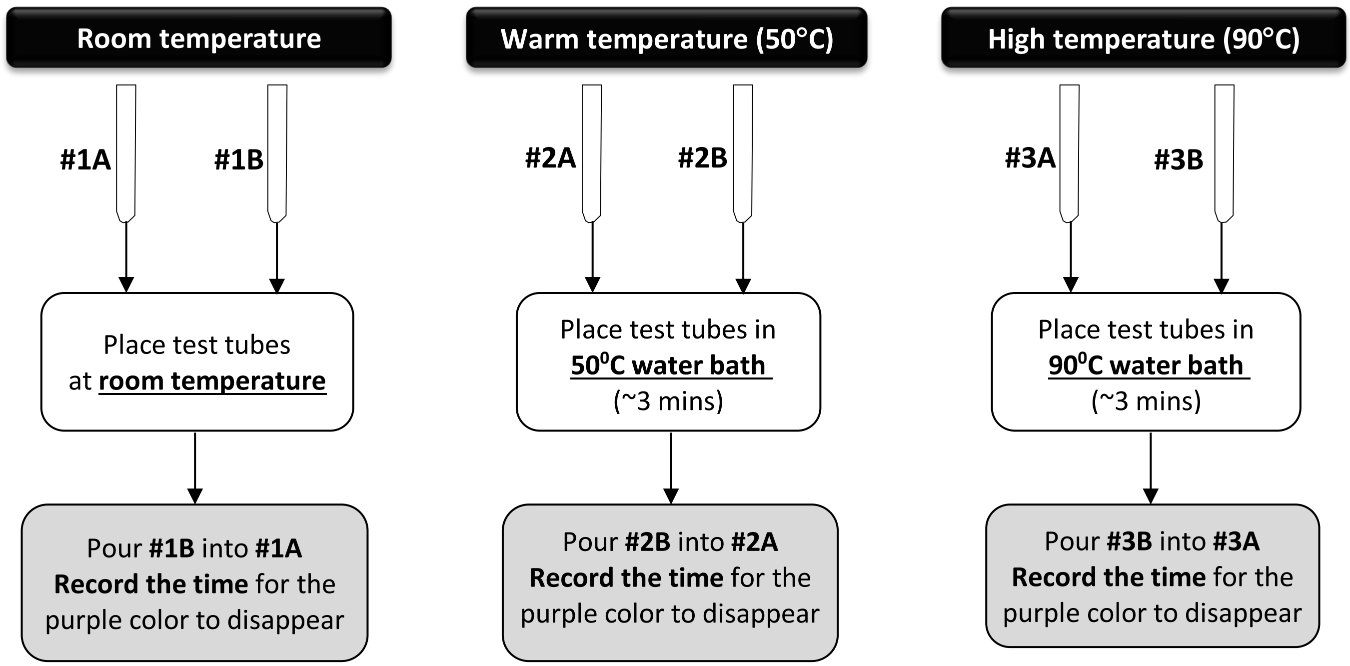
The reaction rate for the oxidation-reduction reaction between potassium permanganate, $KMnO_4$, and oxalic acid, $H_2C_2O_4$, can be measured by observing the time elapsed for the purple color of the permanganate ion, MnO_4^-, to disappear.

$$5H_2C_2O_{4(aq)} + 2KMnO_{4(aq)} + 3H_2SO_{4\,(aq)} \rightarrow 2MnSO_{4(aq)} + K_2SO_{4(aq)} + 10CO_{2(g)} + 8H_2O_{(l)}$$

Section 1: Preparation



Section 2: Procedure



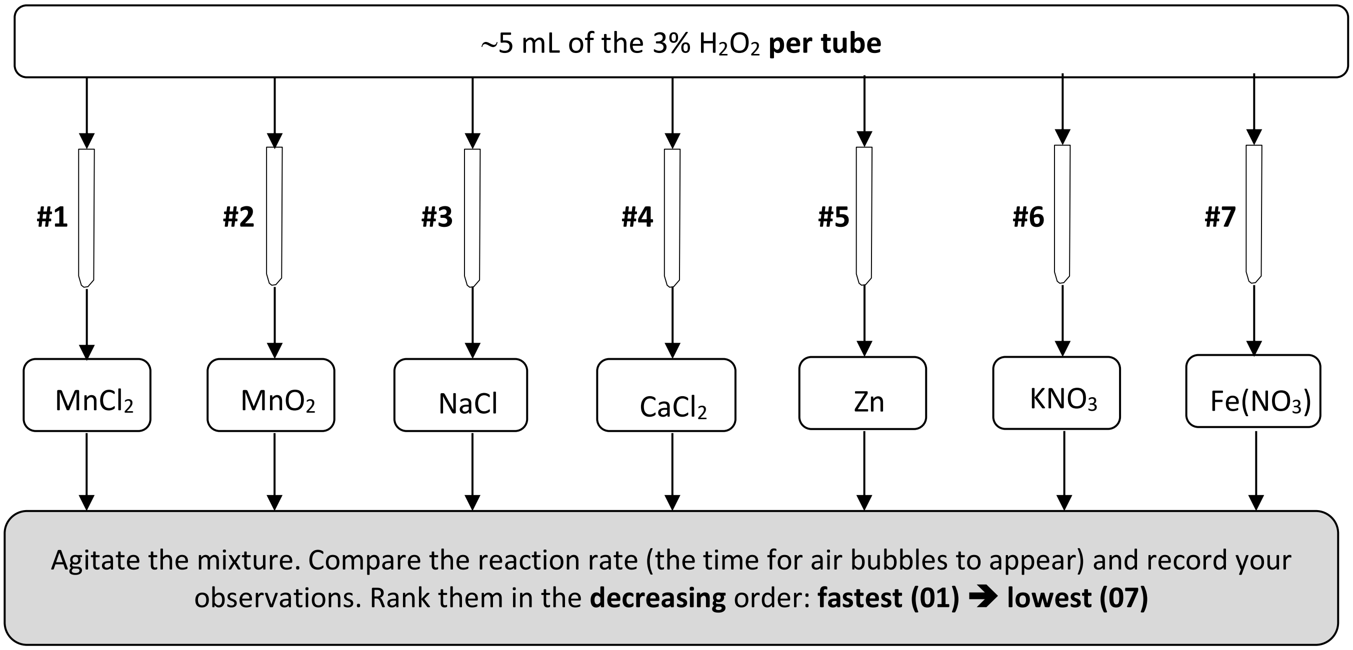
2.3. EFFECT OF A CATALYST ON THE REACTION RATE

Hydrogen peroxide, H_2O_2, is relatively but readily decomposes in the presence of a catalyst. In this part, you will observe which reagent(s) act as a catalyst for the decomposition of hydrogen peroxide.

$$2H_2O_{2(aq)} \rightarrow 2\,H_2O_{(l)} + O_{2(g)}$$

Section 1: Preparation

Section 2: Procedure



3. SUGGESTED QUESTIONS

1. What is the objective of today lab work?
2. What is the rate of a chemical reaction?
3. How can the rate of a reaction be determined?
4. What is the unit expression of reaction rate?
5. Please list out factors that can affect the rate of a reaction?
6. How does temperature affect the reaction rate?
7. How does the concentration of reactants affect the reaction rate?
8. What is a catalyst? Is it consumed during the reaction?
9. In part 1, what is the role of starch? Please explain
10. In part 2, please predict the outcome of the experiment

Description of conditions	Predicted outcome
Room temperature	
50^0C	
90^0C	

4. DATASHEET

The datasheet template is attached in the appendix and can be downloaded @ @ https://blackboard.hcmiu.edu.vn

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5. REPORT

The report template is attached in the appendix and can be downloaded @ https://blackboard.hcmiu.edu.vn

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APPENDIX A

COMMON LABORATORY GLASSWARE AND EQUIPMENT

CONTAINER

ERLENMAYER FLASK

SHAPE

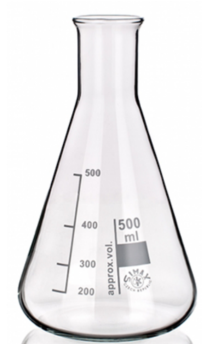
It has a wide base, with sides that taper upward to a short vertical neck. Some of flasks may be graduated.

MATERIALS

Depending on the application, they may be constructed from glass or plastic.

ERROR RANGE

Up to 5%



https://www.dutchchems.com/2019/09/17/laboratory-glass/

HANDLING

It is suitable for titration by placing it under the burette, adding solvent and the indicator because the tapered sides and narrow neck of this flask allow the solution to be mixed by swirling wihout risk of spillage.

Do you know?

Erlenmeyer flask also help reduce volume loss in case of heating. It can be heated.

DURAN BOTTLE

SHAPE

It is a glass bottle using in the laboratory.

MATERIALS

Mostly made of glass, The reason is for better heat, corrosion and expansion resistance.

SIZE

There are many kinds of sizes for Duran bottle, it can be 10ml, 100ml, 250ml, 500ml, 1000ml, 2000ml.

https://www.dutchchems.com/2019/09/17/laboratory-glass/

HANDLING

It is used to contain solutions.

Do you know?

In case of the chemicals are so sensitive to lights, another kind of duran will be used called Amber bottle which has dark color to protect those chemicals.
With some chemicals such as bases, they are ussually contained in plastic bottles.

TEST TUBE

SHAPE

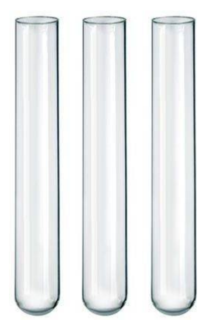
Its shape looks like the finger, U-shaped at the bottom and opened at top.

MATERIALS

All test tubes are made of glass, which helps us observe what happen inside easily.

SIZE

Sizes of test tubes varies a lot depending on the purpose of the experiment. It can be 10-20mm in diameter and 50-200m in length.



https://www.flipkart.com/homeotrade-8-ml-plain-borosilicate-glass-test-tube/p/itmda181fe462a48

HANDLING

Test tubes are widely used be chemists to handle chemicals, esspecially for qualitative experiments and assays. Their spherical bottom and vertical sides help reduce mass loss when pouring, make them easier to wash out and allow convenient monitring of the contents. The long, narrow neck slows down the spreading of gases to the environment.

DROPPER BOTTLE

SHAPE

It is a glass bottle using in the laboratory.

MATERIALS

They are mostly made of glass. The reason is for better heat, corrosion and expansion.

SIZE

There are many kinds of sizes for duran bottle including 50mL, 100mL, 25mL, 500mL, 1000mL, 2000mL.

https://www.uline.ca/BL_510/Glass-Dropper-Bottles

HANDLING

Hold the dropper vertically and check to see if the dropper starts out empty. Gently squeeze the rubber end of the dropper by using thumb and forefinger. This will squeeze the excessed air out of the dropper and prepare to suck up the chemical.

After it has sucked the chemical. Gently squeeze the rubber end again to release chemical until it reach the ammount you need.

Do you know?

There also have dark dropper bottles to contain chemicals which are sensitive to lights.

BEAKER

SHAPE

It is often graduated, to be more specific, some of beakers are marked on the side with linesnto indicate the volume contained. Most beakers are accurate to within ~10%.

MATERIALS

Mostly they are made of glass, but can also metal or plastic.

SIZE

Size of beakers varies depending on the purpose of experiment. They can be found in different sizes: 100mL, 250mL, 400mL marked on the beakers

https://www.dutchchems.com/2019/09/17/laboratory-glass/

HANDLING

Any experiment which yields a liquid product uses beakers to catch liquid. Beakers are also used for experiment like chromatography.

Because of their optimum balance between thermal resistance and mechanical strength due to controlled wall thickness at sides, radius and bottom, they are widely used in research, industry and education. Basically, they are ideally used for heating.

MEASUREMENT

PIPETTE

SHAPE

A long, slender glass tube with a tapered tip at one end. Along the body of the tube are mars arranged to indicate the precise amount of chemical.

MATERIALS

It is usuallt made of high quality glass which benefical to heat and corrosion resistance.

SIZE

Size of pipette varies denpending on the maximum amount of chemical it can contain. It can be 1mL, 5mL, 10mL

HANDLING

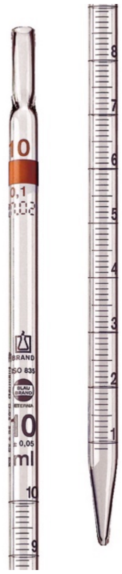
Step 1: Rinse the pipette to prevent error and contamiation.

Step 2: Attach the pump to the pipette (use the right pump for an appropriate one).

Step 3: Operate the pump by rolling the operating wheeling to draw the solution into the pipette.

Step 4: Hold the pipette steadily in the solution without touching the bottom of the container.

Step 5: After getting the requisite volume, the solution can be released into another container by utilizing the quick release bar on the pump.



https://www.banggood.com/th/1251025ml-Glass-Long-Pipette-With-Scale-Lab-Glassware-Kit-p-1434919.html
https://biovisionindia.com/products/

CYLINDER

SHAPE

It has a narrow cylinderical shape. Each marked line on the cylinder represents the amount of solution measured.

MATERIALS

Most of cylinders are made of glass, but some large cylinders are made of propylene making them lighter and less fragile than glass.

SIZE

Size of cylinders varies denpending on the amount of chmical it can contain. It can be 50mL, 100mL, 1000mL,...

ERROR RANGE

Up to $\pm 1\%$

HANDLING

Step 1: Choose the appropriate size of cylinder for the amount of liquid to be measured.

Step 2: Pour the liquid or chemical slowly into the cylinder.

Step 3: Stop pouring when the the liquid reachs the right level.

Step 4: Read the volume of the measured liquid or chemical by putting your eye level equal to the menicus (lower menicus of colorless solution and upper menicus for chromatic solution).

https://biovisionindia.com/products/

VOLUMETRIC PIPETTE

SHAPE

Volumetric pipette is one kind of glass pipette with a large bulb on it and a thin line above to mark the volume. Some kinds of volumetric flasks have two lines but still only can transfer a certain volume.

MATERIALS

Volumetric pipette is one kind of glass pipette with a large bulb on.

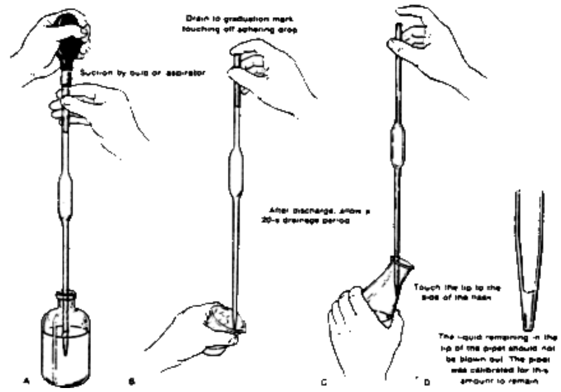
SIZE

Most of them have the same length. Depending on the volume that they can contain, they vary in diameter. Some common volumes are 5mL, 10mL or 20mL.

HANDLING

The technique of operating the volumetric pipette is the same with the graduated pipette.

The difference is the volumetric pipette can only cantain a fixed volume of liquid or chemical, depending on the size of the pipette used.



https://www.exportersindia.com/product-detail/pipettes-surat-india-477357.htm

Do you know?

There are two types of volumetric pipette, which has only one calibration mark and the other has two. Using the pipette with one calibration mark can allow the chemical to be released all. But with the other one with two marks, a bit of chemical must be kept below the mark at the tip. The space between two calibration marks is the fixed volume that need to be transfered.

VOLUMETRIC FLASK

SHAPE

Volumetric flask usually has pear shape with a flat bottom. Its neck is narrow with a thin ring to accurately mark the specific volume contained.

MATERIALS

Volumetric flask is usually made of glass or plastic.

USAGE

When accuracy is required in making solutions, a volumetric flask is used, especially in qualitative experiments.

HANDLING

Volumetric flask has only one mark, so when measutinf the vomune, it is filled so that the bottom of the menicus just touches the line.

https://www.dutchchems.com/2019/09/17/laboratory-glass/

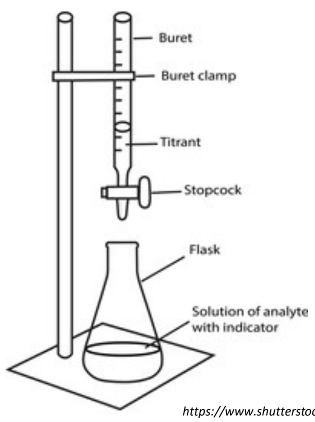
BURETTE

SHAPE

The burette is a glass pf plastic straight tube with a graduation scale, at the end of the burette, there are a stopcock and a valve to control the flow of the solution inside.

MATERIALS

The long tube is made of glass and the stopcock is made from high quality plastic.



https://www.shutterstock.com/image-vector/acidbase-titration-drawing-1104967901

HANDLING

Step 1: Make sure the burette is cleaned. Rinse the burette three times with a small amount of titrant.

Step 2: Fill the burette with titrant to above the zero mark.

Step 3: Remove bubbles within the burette by adjusting the stopcock forward and backward.

Step 4: Drain the amount of titrant to the zero mark or below, and take initial reading.

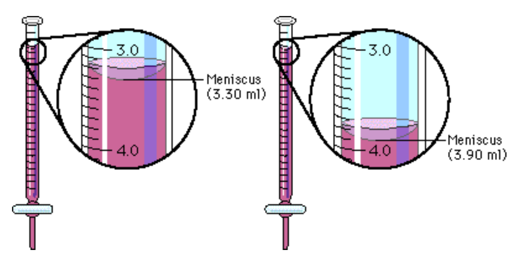
Step 5: Add indicator into the container used to titrate.

Step 6: Titrate rapidly at first, then drop by drop per second until the endpoint is reach.

Step 7: Take the final reading and calculate the final

Do you know?

*Assume that the burette is filled to the point indicated in the figure at the left. You would record the initial point as 3.30 ml; the ending point would be 3.90 ml. Therefore, the titration would have required 0.60 ml. Remember that you should read the number that is at the bottom of the **meniscus**.*



http://web01.cabeard.k12.in.us/science/Bio2/bc_campbell_concepts_5/media/objects/3993/4089385/assets/labbench/learning/enzyme/burette.html

pH METER

OVERVIEW

A portable machine with the pH electrode is connected to. The pH electrode has a rod-like structure. It has a bulb with the sensor at the bottom.

MATERIALS

The machine is made of hig quality lastiv and the electrode is made of glass.

https://vi.aliexpress.com/item/32761188586.html

HANDLING

Step 1: Make sure that the pH probe are being used has been stored in a storage solution or a pH 4 solution. If this not the case, soak the probe in distilled water for at least 24 hours.

Step 2: Check and make sure the meter is set in pH mode, then rinse the probe in distilled water. Shake it off before putting it in a pH 7 solution for calibration.

Step 3: Let the probe remain in the solution for at least 30 seconds, make time for the meter to stabilize, then adjust the meter so that it can read pH 7.

Step 4: Rinse the probe once again, then place it into a pH 4 solution, giving time for the meter reading to stabilize. Adjust the meter in order for it to read pH 4. The meter has now been calibrated.

Step 5: Rinse the probe one more time as you have done previously, then shake any excess liquid off. The probe is ready to be placed into your sample liquid.

Step 6: After reading the pH values of the sample, store the probe in storage solution or a pH 4 solution when the measuring pH process is finished.

SUPPORTING EQUIPMENT

ALCOHOL LAMP

SHAPE

Alcohol lamp has several different shapes and appearances. It is a small jar with globe-shaped and a screw-top lid. Within the jar are Ethanol and a wick, which are the main components to produce a flame.

MATERIALS

It can be made from glass, brass or aluminum. The wick is woven cotton string or glass fiber.

USAGE

The alcohol lamp is used to produce an open flame to heat chemicals for laboratory purposes

HANDLING

Step 1: Before using alcohol lamp, check alcohol inside. Fill in alcohol if it nearly runs out.

Step 2: Use lighter to light the alcohol lamp.

Step 3: When finishing doing experiment with alcohol lamp, turn off by using the cap to cover the flame.

https://www.turbosquid.com/3d-models/3d-alcohol-lamp-flame-1470622

STIRRING ROD

SHAPE

It shape is a long and thin glass rod rounded at ends.

MATERIALS

The stirring rod is made from borosilicate glass (Pyrex) because of its high thermal expansion resistance and high softening point.

SIZE

The size of stirring rod is various from 10 to 40cm in lengths and about 0.5cm thick.

OTHER NAME

Droper or eye dropper.

USAGE

The stirring rod is used to mix chemicals and liquids for chemistry and laboratory purposes.

https://tiki.vn/2x-250mm-glass-stirring-rod-round-head-laboratory-lab-bar-stir-stirrer-mixer-new-p111371489.html

TESTUBE BRUSH

SHAPE

Many fibers are tight in a sturdy wire handle at one end. The other end is a small loop used for handling.

MATERIALS

Most of fibers are made from nylon, some are made from animal fur bristle. The common material of wire is metals such as aluminium, bronze or brass.

SIZE

The size of test tube brush varies from 10mm-2000mm in length and 3mm-200mm in diameter.

USAGE

The main usage of test tube brush is to brush test tubes and other glassware with narrow mouth such as flask or beak ers.

HANDLING

Step 1: After pouring all chemicals out, taking some water and detergent into test tube.

Step 2: Using test tube brush to clean all chemicals, precipitate inside by twisting it. Do not use test tube brush pusing the bottom of test tube, this may break the test tube at bottom.

Step 3: Rinse test tube again with water to clean it from detergent.

https://www.flipkart.com/vcare-test-tube-brush-cleaning-brushes-science-lab-tap-stailness-steel/p/itm37cc068fb9ee8

PASTEUR PIPETTE

SHAPE

It is a small glass (plastic) tube which is tapered to a narrow point at tip, with a bulb at one end.

TYPES

Glass Pasteur dropper: a small tube made from glass, with a rubber bulb at one end and a tapered tip.

Plastic Pasteur dropper: a small plastic tube bulbed at one end and tapered at the tip.

MATERIALS

It can be made of glass or plastic.

SIZE

The size of Pasteur dropper is various in lengths.

HANDLING

Step 1: Push the bulb of dropper and then insert the tip into solution.

Step 2: Slowly release the bulb to suck up chemicals.

Step 3: Transfer dropper to other container and push it again to release solution out. It also can be used to drop solution.

https://www.amazon.com/Pipette-Medicine-Laboratory-Dropper-Rubber/dp/B07S3Q5CN7
https://www.aliexpress.com/item/32974747395.html

TEST TUBE HOLDER

SHAPE

Its shape looks like a forcept with one spiral in the middle of each side to help holding easily.

MATERIALS

The main materials of test tube holder is metal or wood.

SIZE

There is only one size for test tube holder. Because of working by elastic force, it can hold all sizes of test tube.

USAGE

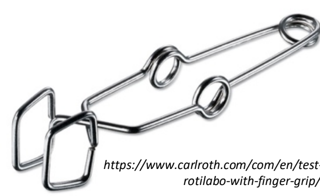
It is used to hold test tube when picking them up to observe, shaking to perform experiment or moving test tube around in laboratory

HANDLING

Step 1: Use both hands pushing and twist a bit to separate to clamps. Pull them a bit and resemble again. This step is to make it tighter to hold test tubes.

Step 2: Press test tube holder from two sides and nest the test tube inside to hold it.

Step 3: When holding test tube, try to avoid pushing from two sides, this can drop the test tube accidentally. The recommended way is putting to fingers inside the space.



https://www.carlroth.com/com/en/test-tubes/test-tube-holder-rotilabo-with-finger-grip/p/x114.1

TEST TUBE RACK

SHAPE

This is one kind of racks which has many holes and in shape similar to a box.

MATERIALS

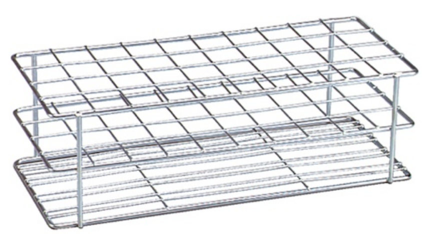
Test tube racks are made from many kind of materials such as wood, metal wire or plastic depending on the require

SIZE

Test tube materials have many sizes depending on the number of test tubes are used such as 8 holes, 10 holes or 12 holes.

USAGE

Test tube rack is used to hold multiple test tubes at the same time which is convenient to compare reactions in test tubes.



https://prolabscientific.com/Wire-Test-Tube-Racks.html

OTHER EQUIPMENT

FUMEHOOD


https://www.yamtoinstruments.org/product/fume-hood/

OVERVIEW

Fume hood are basically boxlike, with an open side (or sides) for access to the interior of the hood. A transparent, movable panel, called a sash, allows the user to restrict or enlarge the hood opening.

SIZE

Fume hoods are generally available in 5 different widths, 1000 mm. 1200 mm, 1500 mm 1800 mm and 2000 mm. The depth varies between 700 mm and 900 mm, and the height between 1900 mm and 2700 mm.

USAGE

Defense against many of the top laboratory dangers, which include:

+ Inhalation of harmful vapors
+ Fires or explosions
+ Chemical or thermal burns
+ Chemical absorption

+ Hít phải hơi độc hại
+ Cháy, nổ
+ Bỏng hóa chất hoặc nhiệt
+ Hấp thụ hóa học

WATER BATH


https://sagote.com/product/be-dieu-nhiet-water-bath-precision-gp10-10-lit/

OVERVIEW

Water bath is one kind of equipment which contains water and heat it up to necessary temperature and keep it at set temperature

APPENDIX B

A1. The Oxidation Numbers of Some Common Cations

Ionic Charge: +1		***Ionic Charge: +2***		***Ionic Charge: +3***	
Alkali Metals: Group IA		*Alkaline Earths: Group IIA*		*Group IIIA*	
Li^{+}	Lithium	Be^{2+}	Beryllium	Al^{3+}	Aluminum
Na^{+}	Sodium	Mg^{2+}	Magnesium	Bi^{3+}	Bismuth
K^{+}	Potassium	Ca^{2+}	Calcium	Sb^{3+}	Antimony
Rb^{+}	Rubidium	Sr^{2+}	Strontium	*Transition Elements*	
Cs^{+}	Cesium	Ba^{2+}	Barium	Cr^{3+}	Chromium(III)
Transition Elements		*Transition Elements*		Fe^{3+}	Iron(III)
Cu^{+}	Copper(I)	Cr^{2+}	Chromium(II)	Co^{3+}	Cobalt(III)
Ag^{+}	Silver	Mn^{2+}	Manganese(II)		
Polyatomic Ions		Fe^{2+}	Iron(II)		
NH_4^{+}	Ammonium	Co^{2+}	Cobalt(II)		
Others		Ni^{2+}	Nickel		
H^{+}	Hydrogen	Cu^{2+}	Copper(II)		
or		Zn^{2+}	Zinc		
H_3O^{+}	Hydronium	Cd^{2+}	Cadmium		
		Hg_2^{2+}	Mercury(I)		
		Hg^{2+}	Mercury(II)		
		Others			
		Sn^{2+}	Tin(II)		
		Pb^{2+}	Lead(II)		

Source: to-be-updated

A2. The Oxidation Numbers of Some Common Anions

Ionic Charge: −1			
Halogens: Group VIIA		*Oxyanions*	
F^-	Fluoride	ClO_4^-	Perchlorate
Cl^-	Chloride	ClO_3^-	Chlorate
Br^-	Bromide	ClO_2^-	Chlorite
I^-	Iodide	ClO^-	Hypochlorite
Acidic Anions			
HCO_3^-	Hydrogen carbonate	BrO_3^-	Bromate
		BrO_2^-	Bromite
		BrO^-	Hypobromite
HS^-	Hydrogen sulfide		
HSO_4^-	Hydrogen sulfate	IO_4^-	Periodate
		IO_3^-	Iodate
		IO^-	Hypoiodite
HSO_3^-	Hydrogen sulfite	NO_3^-	Nitrate
$H_2PO_4^-$	Dihydrogen phosphate	NO_2^-	Nitrite
Other Anions		OH^-	Hydroxide
SCN^-	Thiocyanate	$C_2H_3O_2^-$	Acetate
CN^-	Cyanide	MnO_4^-	Permanganate
H^-	Hydride		

Ionic Charge: −2	
Group VIA	
O^{2-}	Oxide
S^{2-}	Sulfide
Oxyanions	
CO_3^{2-}	Carbonate
SO_4^{2-}	Sulfate
SO_3^{2-}	Sulfite
$C_2O_4^{2-}$	Oxalate
CrO_4^{2-}	Chromate
$Cr_2O_7^{2-}$	Dichromate
Acidic Anion	
HPO_4^{2-}	Monohydrogen phosphate
Diatomic	
O_2^{2-}	Peroxide

Ionic Charge: −3	
Group VA	
N^{3-}	Nitride
P^{3-}	Phosphide
Oxyanion	
PO_4^{3-}	Phosphate
PO_3^{3-}	Phosphite

<u>Source</u>: to-be-updated

A3. Activity Series of Common Metals

K	(potassium)	Most active
Na	(sodium)	
Ca	(calcium)	
Mg	(magnesium)	
Al	(aluminum)	
Zn	(zinc)	
Fe	(iron)	Activity increases
Pb	(lead)	
H_2	(hydrogen)	
Cu	(copper)	
Hg	(mercury)	
Ag	(silver)	
Pt	(platinum)	
Au	(gold)	Least active

<u>Source</u>: to-be-updated

LAB PREPARATION

1. Chemicals

○ EXPERIMENT 1

Chemical	Amount (mL) for 2 classes (14 groups)	Volume of solution required (L)	Concentration required (M)	Molar mass of solute	Grams of Solutes	Stock	Container	Notice
0.1M AgNO3	150	0.150	0.10	169.870	2.548	1 Ambot	1 Ambot	Dark bottle
0.1M KI	50	0.050	0.10		0.000	1 Ambot	1 Ambot	Dark bottle
0.5M KI	50	0.050	0.50		0.000	1 Ambot	1 Ambot	Dark bottle
0.1M KMnO4	50	0.050	0.10		0.000	2 Ambot	2 Ambot	Dark bottle
0.5M BaCl2	250	0.250	0.50		0.000	1 bottle-250 mL	1 bottle-250 mL	
2M CaCl2	250	0.250	2.00		0.000	1 bottle-250 mL	1 bottle-250 mL	
2M LiCl	250	0.250	2.00		0.000	1 bottle-250 mL	1 bottle-250 mL	
2M NaCl	250	0.250	2.00		0.000	1 bottle-250 mL	1 bottle-250 mL	
0.5M KCl	250	0.250	0.50		0.000	1 bottle-250mL	1 dropper bottle; 1 bottle-250mL	
0.1M KSCN	50	0.050	0.10		0.000	1 dropper bottle	1 dropper bottle	
0.1M NaNO2	50	0.050	0.10		0.000	1 dropper bottle	1 dropper bottle	
0.1M NaNO3	50	0.050	0.10		0.000	1 dropper bottle	1 dropper bottle	
0.5M Al2(SO4)3	50	0.050	0.50		0.000	1 dropper bottle	1 dropper bottle	
0.5M CuSO4	50	0.050	0.50		0.000	1 dropper bottle	1 dropper bottle	
0.5M FeCl3	75	0.100	0.50		0.000	1 dropper bottle	1 dropper bottle	
0.5M FeSO4	75	0.100	0.50		0.000	1 dropper bottle	1 dropper bottle	
0.5M K2Cr2O7	50	0.050	0.50		0.000	1 dropper bottle	1 dropper bottle	
0.5M KBr	50	0.050	0.50		0.000	1 dropper bottle	1 dropper bottle	
~~0.5M KCN~~	~~50~~	~~0.050~~	~~0.50~~		~~0.000~~	~~1 dropper bottle~~	~~1 dropper bottle~~	
0.5M Na2SO3	50	0.050	0.50		0.000	1 dropper bottle	1 dropper bottle	
~~2M KCN~~	~~50~~	~~0.050~~	~~2.00~~		~~0.000~~	~~1 dropper bottle~~	~~1 dropper bottle~~	
2M KOH	50	0.050	2.00		0.000	1 dropper bottle	1 dropper bottle	
0.5M K4[Fe9CN)6]	50	0.050	0.50		0.000	2 dropper bottle	2 dropper bottle	
6M NaOH	50	0.050	6.00		0.000	1 dropper bottle	1 dropper bottle	
2M NaOH	75	0.100	2.00		0.000	2 dropper bottle	2 dropper bottle	
Saturated FeSO4	50	500			Put untill can't be disslove	Bottle	Beaker & Pasteur pipette	Fume hood

Chemical	Amount (mL) for 2 classes (14 groups)	Volume of solution required (mL)	Concentration required (M, %)	Molarity of starting or Percent of starting	Volume of Solutes	Stock	Container	Notice
3% H2O2	50	100	3.00	30.0	10.000	1 dropper bottle	1 dropper bottle	Prepare every 2 classes
2M NH4OH	100	100	2.00	14.8	13.514	3 dropper bottle	3 dropper bottle	
2M HCl	50	100	2.00	12.0	16.667	1 dropper bottle	1 dropper bottle	
2M H2SO4	50	100	2.00	18.0	11.111	2 dropper bottle	2 dropper bottle	
6M H2SO4	50	1000	6.00	18.0	333.333	Bottle	Beaker & Pasteur dropper	Fume hood
Chemical						**Stock**	**Container**	**Notice**
96% H2SO4	50	50					Beaker & Pasteur dropper	Fume hood
CH3COOH	100	100					Beaker & Pasteur dropper	Fume hood
C2H5OH	50	50					Beaker & Pasteur dropper	Fume hood
MnO2						1 weighting bottle & spoon	1 weighting bottle & spoon	
Distilled water	???							8 bottles/ class

○ EXPERIMENT 2:

Chemical	Amount (mL) for 2 classes (14 groups)	Volume of solution required (L)	Concentration required (M)	Molar mass of solute	Grams of Solutes	Stock	Container
0.1M NaOH	2000	2	0.1	40.000	8	Duran-2000mL	Beaker-600mL
0.01M NaOH	500	0.5	0.01		0	1 bottle-600mL	Beaker-600mL
0.1M CH3COONa	4000	4	0.1		0	2 Duran-2000mL	Beaker-600mL
0.1M NaCl	1000	1	0.1		0	Duran-1000mL	Beaker-600mL
0.1M NH4Cl	1000	1	0.1		0	Duran-1000mL	Beaker-600mL
Chemical	**Amount (mL) for 2 classes (14 groups)**	**Volume of solution required (mL)**	**Concentration required (M, %)**	**Molarity of starting or Percent of starting**	**Volume of Solutes**	**Stock**	**Container**
0.1M CH3COOH	**4000**	**1000**	**0.1**	**17.0**	**5.882**	**2 Duran-2000mL**	**Beaker-600mL**
0.1M HCl	**2000**	**1000**	**0.1**	**12.0**	**8.333**	**Duran-2000mL**	**Beaker-600mL**
Deionize water	????						Beaker-600mL

EXPERIMENT 3

Chemical	Amount (L) for 2 classes (14 groups)	Volume of solution required (L)	Concentration required (M)	Molar mass of solute	Grams of Solutes	Notice	Stock	Container
0.05N KMnO4	3L	1	0.01	158.04	1.580		3 Dark bottle-1000mL	Beaker-600mL
0.05N H2C2O4	1L	1	0.025		0.000		1 duran-1000mL	Beaker-600mL
Unknown H2C2O4	1L	1			0.000		1 duran-1000mL	Beaker-600mL
Unknown FeSO4 in H2SO4	1L = 300mL H2SO4 3M + 700mL H2O	1	0.025	278.03	6.951	Let's say that the conc. is 0.025	1 duran-1000mL	Beaker-600mL
Chemical	**Amount (mL) for 2 classes (14 groups)**	**Volume of solution required (mL)**	**Concentration required (M, %)**	**Molarity of starting or Percent of starting**	**Volume of Solutes**	**Notice**	**Stock**	**Container**
6N H2SO4	**3L**	**2000**	**3**	**18**	**333.333**		**1 duran-2000mL + 1 duran-1000mL**	**Beaker-600mL**

EXPERIMENT 4

Chemical	Amount (mL) for 2 classes (14 groups)	Volume of solution required (L)	Concentration required (M)	Molar mass of solute	Grams of Solutes	Stock	Container	Notice
Methyl Violet	50	0.1			Put untill can't be disslove	1 dropper bottle	1 dropper bottle	
0.5M K2CrO4	50	0.1	0.5		0	1 dropper bottle	1 dropper bottle	
0.1M AgNO3	50	0.1	0.1		0	2 dropper bottle	2 dropper bottle	Dark bottle
6M NaOH	100	0.25	6	40	60	1 Bottle	4 dropper bottle	
0.05M CaCl2	150	0.5	0.05		0		Beaker	
0.1M Na2C2O4	50	0.1	0.1		0		Beaker	
0.1M H2C2O4	50	0.1	0.1		0		Beaker	
0.1M CoCl2	50	0.1	0.1		0		Beaker	
0.01M FeCl3	200	0.5	0.01		0		Beaker	
0.01M KSCN	200	0.5	0.01		0		Beaker	
Chemical	**Amount (mL) for 2 classes (14 groups)**	**Volume of solution required (mL)**	**Concentration required (M, %)**	**Molarity of starting or Percent of starting**	**Volume of Solutes**	**Stock**	**Container**	**Notice**
6M HCl	**100**	**500**	**6**	**12**	**250**		**Beaker & Pasteur dropper**	**Fume hood**
6M NH4OH	**50**	**100**	**6**	**14.8**	**40.541**		**Beaker & Pasteur dropper**	**Fume hood**
Concentrated HCl							**Beaker & Pasteur dropper**	**Fume hood**

EXPERIMENT 5

Chemical	Amount (mL) for 2 classes (14 groups)	Volume of solution required (L)	Concentration required (M)	Molar mass of solute	Grams of Solutes	Stock	Container	Notice
0.20 M KI	2000mL	2	0.2		0	2 Duran - 1L	Beaker	Dark bottle
0.005 M $Na_2S_2O_3$	800mL	1	0.005		0	Duran - 1L	Beaker	Dark bottle
0.01 M $KMnO_4$	50mL	0.2	0.01	158.04	0.31608	Bottle	Beaker	Dark bottle
0.10 M $(NH_4)_2S_2O_8$	2000mL	2	0.1		0	Duran - 2L	Beaker	
0.33 M $H_2C_2O_4$	500mL	0.5	0.33		0	Bottle	Beaker	

Chemical	Amount (mL) for 2 classes (14 groups)	Volume of solution required (mL)	Concentration required (M, %)	Molarity of starting or Percent of starting	Volume of Solutes	Stock	Container	Notice
3% H2O2	500mL	1000	3	30	100	Duran - 1L	Beaker	Prepare every 2 classe
3M H2SO4	**500mL**	**1000**	**3**	**18**	166.67	**Duran - 1L**	**Beaker**	**Fume hood**
Chemical					**Grams of Solutes**	**Stock**	**Container**	**Notice**
Starch					Put untill can't be disslove	Beaker	Beaker + Dropper	Heat as using it
MnCl2						1 weighting bottle & spoon	1 weighting bottle & spoon	
MnO2						1 weighting bottle & spoon	1 weighting bottle & spoon	
NaCl						1 weighting bottle & spoon	1 weighting bottle & spoon	
CaCl2						1 weighting bottle & spoon	1 weighting bottle & spoon	
Zn						1 weighting bottle & spoon	1 weighting bottle & spoon	
KNO3						1 weighting bottle & spoon	1 weighting bottle & spoon	
Fe(NO3)3						1 weighting bottle & spoon	1 weighting bottle & spoon	

2. Equipment

- **EXPERIMENT 1**

No.	Name	Number
1	Test tube	10x7
2	Test tube rack	7
3	Tray	7
4	Alcohol lamp	2
5	Loop wired	2
6	Distilled water bottle	7

- **EXPERIMENT 2**

No.	Name	Number
1	Beaker 250-mL	7
2	Beaker 100-mL	7
3	Beaker 50-mL	14
4	Erlenmeyer flask	21
5	Graduated Cylinder 100-mL	7
6	Stirring rod	7
7	Graduated Pipette 10-mL	7
8	Pipette pump	7
9	pH meter	7
10	Distilled water bottle	7
11	Dropper	4x2
12	Volumetric flask 100-mL	1
13	Volumetric flask 50-mL	1

- **EXPERIMENT 3**

No.	Name	Number
1	Thermometer	7
2	Funnel (small)	7
3	Distilled water bottle	7
4	Burette	7
5	Pipette 10-mL	7
6	Pipette pump	7
7	Erlenmeyer flask-250mL	14
8	Beaker 250mL	7
9	Beaker 100mL	7
10	Cylinder 50-mL	9

- **EXPERIMENT 4**

No.	Name	Number
1	Test tube	98
2	Test tube rack	7
3	Beaker 250-mL	7
4	Beaker 100-mL	7
5	Beaker 50-mL	7
6	Stirring rod	7
7	Cylinder 50-mL	7
8	Graduated pipette 10-mL	7
9	Pipette pump	7
10	Distilled water bottle	7
11	Ice bath	2
12	Water bath	2

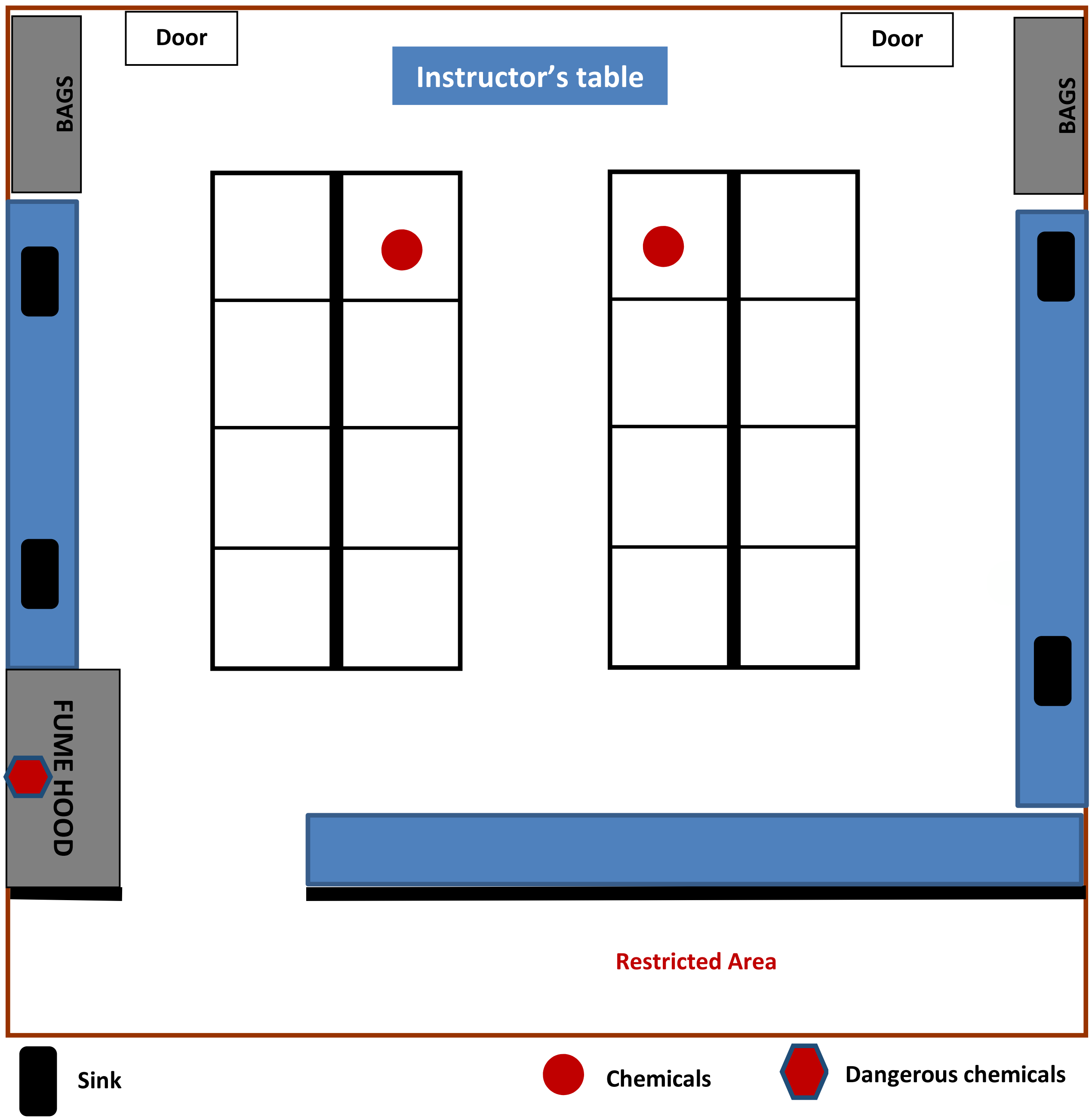
- **EXPERIMENT 5**

No.	Name	Number
1	Test tube	154
2	Test tube rack	9
3	Stirring rod	7
4	Distilled water bottle	7
5	Beaker 250-mL	7
6	Beaker 100-mL	7
7	Graduated Pipette 10-mL	7
8	Pipette pump	7
9	Distilled water bottle	7
10	Water bath	2

APPENDIX B

LAB STRUCTURE

Location: La. 502



MATERIAL SAFETY DATA SHEETS (MSDS)

The table below provides general information about chemicals used in the lab manual. The toxicity section is established based on The Fire Diamond (*) and Material Safety Data Sheet (also known as MSDS).

Figure: Image of simple Fire Diamond

(*) The Fire Diamond, NFPA Diamond, is set of the standard established by National Fire Protection Association to determine the different levels of flammability (red), health hazards (blue), instability (yellow) on scale of 4 and special hazards (white) of each compound. The details of each factor are introduced as table .....

Table x : The details of fire diamond information

Level	**Flammability (Flashpoint)**	**Health hazards**	**Instability**	**Symbol**	**Special hazards**
4	Below 23°C	Deadly	May explode at normal condition	**OXY**	Have characteristics of oxidizers
3	Below 37°C	Extreme dangerous	May explode with presence of shock or heat	**~~W~~**	React violently or explosively with water
2	Between 37°C and 93°C	Hazardous	May undergo violent chemical change	**SA**	Be simple asphyxiants, which cause lack of oxygen in oxygenation of blood
1	Above 93°C	Slightly hazardous	May become slightly unstable with presence of heat, pressure and water	**COR - ALK**	Corrosive; strong acid or base, alkaline
0	Will not burn	Safe	Stay strongly stable under different conditions		

Chemical formula	Chemical name	Physical properties	Hazardous Chracteristics
CH_3COOH	Acetic Acid, Glacial Chemical	**MW:** 60.05 g/mole **BP:** 118.1°C (244.6°F) **MP:** 16.6°C (61.9°F) **Odour:** Pungent, vinegar-like, sour (Strong) **Physical state:** Liquid **Colour:** colourless **Taste:** Vinegar, sour	Hazardous in case of skin contact (irritant), ingestion, and inhalation at high concentration. Protective clothing and equipment are required.
HCl	Hydrochloric Acid		
$H_2C_2O_4$	Oxalic Acid		
H_2SO_4	Sulfuric Acid		
KOH	Potassium Hydroxide		
NaOH	Sodium Hydroxide		
NH_4OH	Ammonium Hydroxide		
$AgNO_3$ (*)	Silver Nitrate		
KNO_3	Potassium Nitrate		
$NaNO_3$	Sodium Nitrate		
$Al_2(SO_4)_3$	Aluminum Sulfate		
$CuSO_4$	Copper (II) Sulfate		
$FeSO_4$ (*)	Iron (II) Sulfate		
$BaCl_2$	Barium Chloride		
$CaCl_2$	Calcium Chloride		
$FeCl_3$	Iron (III) Chloride		
KCl	Potassium Chloride		
LiCl	Lithium Chloride		
$MnCl_2$	Manganese (II)		

	Chloride
NaCl	Sodium Chloride
NH_4Cl	Ammonium Chloride
CH_3COONa	Sodium Acetate
K_2CrO_4	Potassium Chromate
$K_2Cr_2O_7$ (*)	Potassium Dichromate
$K_4[Fe(CN)_6]$ (*)	Potassium Ferrocyanide
KI (*)	Potassium Iodine
$KMnO_4$ (*)	Potassium Permanganate
KSCN	Potassium Thiocyanate
$Na_2C_2O_4$	Sodium Oxalate
Na_2SO_3	Sodium Sulfite
$Na_2S_2O_3$	Sodium Thiosulfate
MnO_2	Manganese Dioxide
H_2O_2	Hydrogen Peroxide
C_2H_5OH	Ethanol
$(C_6H_{10}O_5)n$	Starch
$C_{24}H_{28}N_3Cl$	Methyl Violet
Zn	Zinc

Acetic acid MSDS

Molecular Weight: 60.05 g/mole

Physical state and appearance: Liquid

Odor: Pungent, vinegar-like, sour (Strong)

Taste: Vinegar, sour (Strong)

Color: Colorless. Clear (Light)

Storage: Store in a segregated and approved area. Keep container in a cool, well-ventilated area. Keep container tightly closed and sealed until ready for use. Avoid all possible sources of ignition (spark or flame)

Waste Disposal: Waste must be disposed of in accordance with federal, state and local environmental control regulations

Precautions: Keep away from heat. Keep away from sources of ignition. Ground all equipment containing material. Do not ingest. Do not breathe gas/fumes/ vapor/spray. Never add water to this product. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as oxidizing agents, reduci ng agents, metals, acids, alkalis.

Special Remarks on Reactivity: Reacts violently with strong oxidizing agents, acetaldehyde, and acetic anhydride. Material can react with metals, strong bases, amines, carbonates, hydroxides, phosphates, many oxides,cyanides, sulfides, chromic acid, nitric acid, hydrogen peroxide, carbonates. ammonium nitrate, ammonium thiosulfate, chlorine trifluoride, chlorosulfonic acid, perchloric acid, permanganates, xylene, oleum, potassium hydroxide, sodium hydroxide, phosphorus isocyanate, ethylenediamine, ethylene imine.

Protective Equipment: Gloves (impervious). Synthetic apron. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate. Splash goggles.

First Aid Measures

Immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Cover the irritated skin with an emollient. Cold water may be used. Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.

Application:

The application of acetic acid is diverse. It is easily seen in real life that acetic acid appears as vinager in daily life. It is mainly used in food dressing in many diluted forms such as apple vinager, ketchup, mayonnaise and mustard.

Besides, it also plays important roles as solvent in many industries like dye material industry, cosmetic industry, cleaning industry and so on.

Acetic acid works on ear infection treatment.

Figure: Some brand names of acetic acid products in the market

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