The First Step in Lab

PREPARING CHEMICAL SOLUTIONS

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PREFACE

Welcome to *The First Step in Lab: Preparing Chemical Solutions*. This guide is made just for you, whether you're new to science or about to start your first lab class. Inside, you'll find simple explanations, clear steps, pictures, and real lab examples to help you learn how to prepare chemical solutions with confidence.

You'll get to practice using lab tools, doing basic calculations, following safety rules, and preparing samples the right way. More than that, this book will help you understand why each step matters, not just how to do it.

Think of this guide as your lab buddy, here to help you through your first lab experiences and make learning fun and easy.

We hope you enjoy your journey into science and feel excited to explore, experiment, and learn by doing!

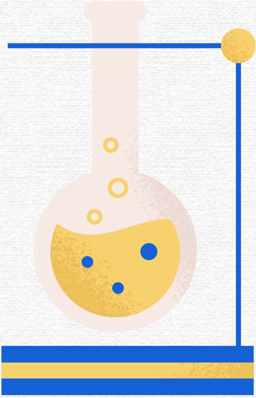


Table of Contents

LEARNING POINTS

1

Practice precautionary measures when preparing solutions

2

Calculate the amount of solute required

3

Prepare solutions from solid substance and concentrated solution using correct laboratory techniques

CHEMICAL SAFETY RULES IN THE LABORATORY

BEFORE USING CHEMICALS

📌 **Check the label** on all chemical bottles at least **twice** before using them.

📌 Ensure the label is **clear** and includes the correct **chemical name** and **concentration**.

🚫**DO NOT use** any chemical from an **unlabeled** container.

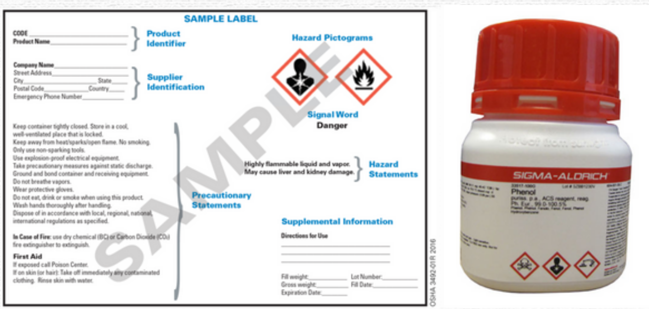


Figure 1: Sample label on chemical container

❌ PROHIBITIONS WHEN USING CHEMICALS

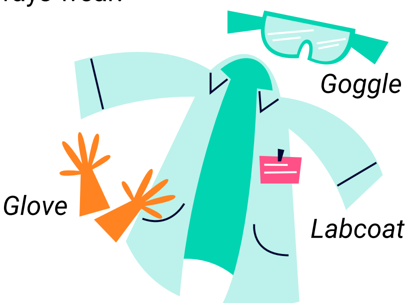
🚫 **DO NOT return** unused chemicals to the original container. This may cause **cross-contamination**.

🚫 **DO NOT touch, smell, or taste** chemicals directly.

🚫 **DO NOT handle solid chemicals with your hands**. Always use a spatula to transfer solid chemicals from their container.

⚠️ GENERAL SAFETY MEASURES

🧪 Always wear:



MATERIAL SAFETY DATA SHEET (MSDS)

What is an MSDS?

A Material Safety Data Sheet is a document that provides detailed information about a chemical substance, including its properties, potential hazards, safe handling practices, and emergency control measures.

It is essential in the laboratory to:

- Understand the risks associated with chemicals.
- Learn how to safely store and handle chemicals.
- Know what to do in case of spills, exposure, or accidents.
- Comply with legal and safety regulations.

Why is an MSDS Important?

Every laboratory must maintain updated MSDSs for all chemicals used on site. These documents are important for:

- Preventing accidents by providing safety guidelines
- Educating lab users about chemical properties
- Managing emergencies such as spills, fires, and exposure
- Guiding proper storage and disposal of chemicals
- Protecting health and the environment

In short, the MSDS is your safety reference guide for every chemical you handle.

SECTIONS IN MSDS

Section	Title	Description
1	Identification	Product name, recommended use, supplier details
2	Hazard(s) Identification	Chemical hazards, label elements, hazard classification
3	Composition / Ingredients	Chemical ingredients, concentration, CAS number
4	First-Aid Measures	Immediate steps in case of exposure (skin, eyes, inhalation, ingestion)
5	Fire-Fighting Measures	Extinguishing media, fire hazards, protective equipment
6	Accidental Release Measures	Spill response, cleanup, containment procedures
7	Handling and Storage	Safe handling tips, storage conditions
8	Exposure Controls / PPE	Exposure limits, personal protective equipment (PPE) needed

SECTIONS IN MSDS

Section	Title	Description
9	Physical and Chemical Properties	Appearance, odor, pH, boiling point, solubility, etc.
10	Stability and Reactivity	Reactivity hazards, conditions to avoid
11	Toxicological Information	Health effects and symptoms of exposure
12	Ecological Information	Impact on the environment (aquatic life, air, soil)
13	Disposal Considerations	Proper chemical waste disposal methods
14	Transport Information	Shipping classification and labeling requirements
15	Regulatory Information	Safety, health, and environmental regulations
16	Other Information	Date of preparation, reference sources

CHEMICAL HAZZARDS

Hazard Type	Symbol	Hazard Description	Recommended PPE
Flammable		Easily ignites; vapors may form explosive mixtures with air	◆ Flame-resistant lab coat ◆ Safety goggles ◆ Nitrile gloves ◆ Work in fume hood
Corrosive (Acids/Bases)		Destroys living tissue and metal surfaces	◆ Chemical-resistant gloves (nitrile/neoprene) ◆ Goggles or face shield ◆ Apron or lab coat
Toxic		Harmful/fatal if inhaled, ingested, or absorbed through skin	◆ Nitrile gloves ◆ Safety goggles ◆ Lab coat ◆ Respirator if fumes present ◆ Work in fume hood
Oxidizer		Causes or intensifies fire through release of oxygen	◆ Lab coat ◆ Safety goggles ◆ Nitrile gloves ◆ Store separately from flammables
Reactive (Unstable)		May explode or react violently with water, air, or other substances	◆ Face shield ◆ Heavy-duty gloves ◆ Lab coat ◆ Use blast shield if available
Water-Reactive		Reacts violently with water; may release toxic gas	◆ Dry environment ◆ Face shield ◆ Heavy gloves ◆ Use under fume hood
Compressed Gas		High pressure; may explode if damaged or overheated	◆ Safety goggles ◆ Lab coat ◆ Use proper cylinder support ◆ Keep caps on when not in use
Carcinogenic		May cause cancer upon repeated exposure	◆ Nitrile gloves ◆ Double-glove if needed ◆ Lab coat ◆ Fume hood ◆ Respirator if airborne
Irritant		Causes reversible inflammation (skin, eyes, respiratory)	◆ Nitrile gloves ◆ Goggles ◆ Lab coat
Cryogenic (e.g., Liquid Nitrogen)		Extreme cold; can cause burns or frostbite	◆ Cryogenic gloves ◆ Face shield ◆ Lab coat ◆ Insulated apron (optional)
Biological (Biohazards)		Infectious agents that may cause disease	◆ Lab coat ◆ Latex/nitrile gloves ◆ Eye protection ◆ Biosafety cabinet (if applicable)
Radiation (if applicable)		Ionizing or non-ionizing radiation from lab sources	◆ Lead apron (for ionizing radiation) ◆ Dosimeter badge ◆ Safety goggles

SAFE STORAGE FOR CHEMICALS

Storage for Chemicals

Proper storage of chemicals is vital in any laboratory to prevent accidents, chemical reactions, and health risks. This section outlines best practices to organize and store chemicals safely and systematically.

General Storage Rules

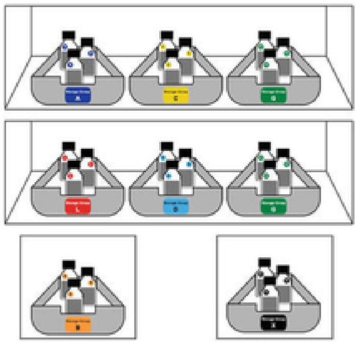
To ensure safety and compliance in the lab, always follow these universal chemical storage principles:

- Store chemicals by compatibility, not alphabetically
- Keep acids away from bases
- Flammables must be stored in a flammable cabinet
- Use secondary containment trays to prevent spills
- Store volatile chemicals in a well-ventilated area or fume hood
- Never store chemicals above eye level
- Use clearly labeled containers with waterproof ink
- Avoid direct sunlight, heat sources, and moisture

Chemical Storage and Segregation Guidelines

The following guidelines have been prepared to help you safely store your chemical reagents to avoid potential hazards that may arise if chemicals accidentally mix. This classification system should always be using in conjunction with the specific storage recommendations provided on the manufacturer's label and the Safety Datasheet. Particular attention should be paid to materials that require storage at specific temperature, humidity, or atmospheres.

Storage Group	Description
A	Compatible Organic Bases
B*	Compatible Pyrophoric and Water-Reactive Materials
C	Compatible Inorganic Bases
D	Compatible Organic Acids
E*	Compatible Oxidizers, Including Peroxides (Excluding Strong, Oxidizing Acids)
F	Compatible Inorganic Acids (Excluding Oxidizers or Combustible)
G	Not Intrinsically Reactive, Flammable, or Combustible
I	Compatible Strong Oxidizing Acids
K*	Compatible Stable Explosives (Excluding Oxidizing Explosives)
L	Non-reactive, Flammable and Combustible, Including Solvents
X*	Incompatible with ALL Other Storage Groups (Including Other X)



***Particular Storage Groups**

Storage Groups B, E, K, and X may have very specific storage requirements. Contact Chemical Safety for additional assistance for assessing the storage needs for these materials.

CHEMICAL SEGREGATION CHART

Use this basic compatibility table to determine which chemical groups can be stored together. A YES means they can be stored in the same area; NO means they must be separated

Chemical Group	Flammables	Acids	Bases	Oxidizers	Toxics	Water-Reactive
Flammables	✅	❌	❌	❌	✅	❌
Acids	❌	✅	❌	❌	✅	❌
Bases (Alkalis)	❌	❌	✅	❌	✅	❌
Oxidizers	❌	❌	❌	✅	❌	❌
Toxics	✅	✅	✅	❌	✅	❌
Water-Reactive	❌	❌	❌	❌	❌	✅

CHEMICAL SPILL SAFETY STEPS

Chemical spills can happen even in the most careful labs. Knowing how to respond quickly and safely can prevent injuries, contamination, and equipment damage.

What to Do If You Spill Chemicals:

1. **Let others know and leave if needed**
    - Tell people nearby.
    - Leave the area if the spill is big, dangerous, or smells strong.
2. **Wear safety gear**
    - Put on gloves, goggles, lab coat, and face shield if needed.
    - Use a respirator if there are harmful vapors (only if trained).
3. **Stop the spill from spreading**
    - Use things like spill pads, sand, or paper towels.
    - For acid spills, use baking soda. For base spills, use citric acid.
4. **Clean it up**
    - Use a chemical spill kit.
    - Pick up the mess with a dustpan or tongs.
    - Put everything in a bag marked for hazardous waste.
5. **Throw waste away the right way**
    - Follow the rules for chemical waste.
    - Tell your supervisor and write down what happened.

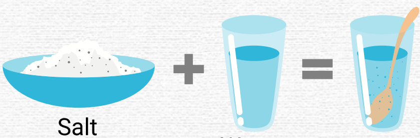
WHAT IS SOLUTION?

A solution is a type of homogeneous mixture — meaning the components are mixed so well that you can't tell them apart. It forms when a solute (the substance being dissolved) is evenly distributed throughout a solvent (the substance doing the dissolving).

In simple terms:

Solute + Solvent ⟶ Solution

Example:



Salt (solute) + Water (solvent) = Salt Water (solution)

When you stir salt into water, the salt breaks down into tiny particles that are invisible to the naked eye. The mixture looks like plain water, but it now contains dissolved salt — this is a solution.

Tip: Water is called the "universal solvent" because it dissolves more substances than any other liquid.

Purpose of Solution Preparation:

- To dissolve solid solutes in water to produce a solution.
- To dilute a highly concentrated stock solution.

TYPES OF SOLUTION

Solutions can be grouped based on the physical states of the solute and the solvent. For example, a diving tank with helium and oxygen is a gas-in-gas solution; oxygen dissolved in water for fish to breathe is a gas-in-liquid solution; alcohol mixed with water in hand sanitizer is a liquid-in-liquid solution; and steel, made of carbon and iron, is a solid-in-solid solution. Table below shows the common types of solutions along with their solutes and solvents.

Types of Solution	Solute	Solvent	Example
Solid in Liquid	Solid	Liquid	Saline solution
Liquid in Liquid	Liquid	Liquid	Vinegar
Gas in Liquid	Gas	Liquid	Carbonated drink
Gas in Gas	Gas	Gas	Air
Solid in Solid	Solid	Solid	Brass

Remember: A solution isn't always a liquid— it can also exist as a solid or a gas, as long as the mixture is uniform throughout (homogeneous).

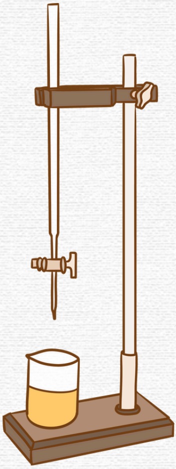
WHAT IS A STANDARD SOLUTION?

A standard solution is a solution where the concentration is known exactly. This is important because in experiments, we need to:

- Compare results
- Calculate unknown concentrations
- Make sure the reactions happen correctly

Why this matters?
In chemistry, we often need to measure or react unknown substances. To do that, we use a standard solution with a known concentration, like a reference point, to find the values we don't know.

Example:
If you want to find out how strong an acid is, you can titrate it with a standard solution of a base with a known concentration. This helps you calculate the unknown acid's concentration.



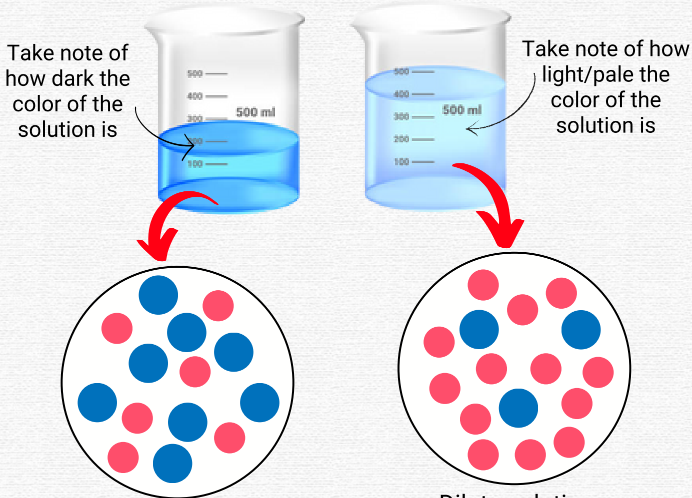
WHAT IS CONCENTRATION?

Concentration refers to the amount of solute (the substance being dissolved) present in a specific volume of solution.

It tells us how "strong" or "weak" a solution is.

The more solute dissolved in the solution, the higher the concentration.

The less solute present, the lower the concentration.



Concentrated solution (High concentration)

Dilute solution (Low concentration)

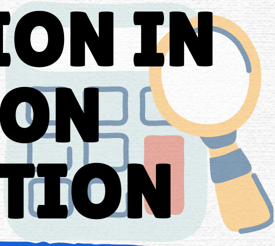
Concentration is commonly expressed in these units:.

- mol/L or Molar (M) – moles of solute per liter of solution
- mmol/L – millimoles of solute per liter
- N (Normality) – used for acids and bases, based on reactive units
- % w/v – mass of solute per volume of solution
- % w/w – mass of solute per mass of solution
- % v/v – volume of solute per volume of solution

Why is it important?

Understanding the concentration of a solution is super important especially in science experiments where we need to be accurate and consistent.

CALCULATION IN SOLUTION PREPARATION



CALCULATING MASS GIVEN MOLARITY AND VOLUME

Molarity is the number of moles of solute dissolved in one liter of a solution.

$$\text{Molarity (M)} = \frac{\text{moles of solute (mol)}}{\text{volume of solution (L)}}$$

If the molarity and the total volume of solution is given, we must first calculate the number of moles of solute.

$$\text{Moles of solute} = \text{Molarity} \times \text{Volume of solution}$$

Then, by multiplying the moles of solute with the solute's molar mass, we can determine the amount of solute required in grams.

$$\text{Mass of solute (g)} = \text{moles of solute (mol)} \times \text{molar mass of solute (g/mol)}$$

Example 1

How many grams of NaCl are required to make 500.0 mL of a 0.6 M NaCl solution?

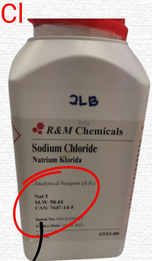
Answer:

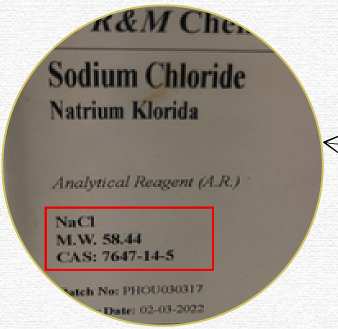
Step 1: Find moles of NaCl

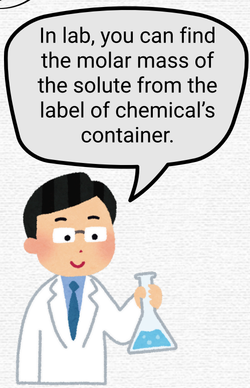
Moles of NaCl = Molarity (M) × Volume of solution (L)
= 0.6 mol/L × 0.5 L
= 0.3 mol

Step 2: Determine molar mass of NaCl

Molar mass of NaCl = 22.99 + 35.45
= 58.44 g/mol







Step 3: Calculate the mass of NaCl

Mass of NaCl required
= moles of solute × molar mass
= 0.3 mol × 58.44 g/mol
= 17.53 grams

Example 2

Prepare 200 mL of a 0.5 M barium chloride dihydrate ($BaCl_2 \cdot 2H_2O$) solution.Calculate the mass of $BaCl_2 \cdot 2H_2O$ required.
(Molar mass of $BaCl_2 \cdot 2H_2O$ = 244.26 g/mol)

Answer:

Step 1: Convert the volume mL to L

$$\text{Volume} = 200 \text{ mL} \times \frac{1L}{1000\ mL}$$
$$= 0.2\ L$$

Step 1: Find moles of $BaCl_2 \cdot 2H_2O$

Moles of $BaCl_2 \cdot 2H_2O$
= Molarity (M) × Volume of solution (L)
= 0.5 mol/L × 0.2 L
= 0.1 mol

Step 3: Calculate the mass of $BaCl_2 \cdot 2H_2O$

Mass of $BaCl_2 \cdot 2H_2O$ required
= moles of solute × molar mass
= 0.1 mol × 244.26 g/mol
= 24.43 grams

CALCULATING MASS GIVEN PERCENTAGE

When building up a certain amount of solution of a set percent by mass, you may need to calculate the mass of the solute to use. In this situation, mass percent can be beneficial as a converter. The mass percent can be expressed as:

$$\%w/w = \frac{\text{weight of solute (g)}}{\text{weight of solution (g)}} \times 100\%$$

Each mass must be expressed in the same units to determine the proper concentration.

The mass/volume percent, which measures the mass or weight of the solute in grammes (e.g., in grammes) and the volume of the solution, is another sort of percentage concentration (e.g., in mL).

$$\%w/v = \frac{\text{mass of solute (g)}}{\text{volume of solution (mL)}} \times 100\%$$

Example 3

What is the mass of NaCl needed to prepare 100 grams of a 20%w/w NaCl solution?

Answer:

$$\%w/w = \frac{\text{weight of solute (g)}}{\text{weight of solution (g)}} \times 100\%$$

$$20\%w/w = \frac{\text{mass of solute}}{100\text{ g}} \times 100\%$$

$$0.20 = \frac{\text{mass of solute}}{100\text{ g}}$$

mass of NaCl = 0.20 × 100 g

= 20 g

Therefore, mass of solvent

= 100 g – 20 g

= 80 g of H_2O

Example 4

Calculate is the mass of NaCl needed to make 500 mL of a 2%w/v NaCl solution.

Answer:

$$\%w/v = \frac{\text{mass of solute (g)}}{\text{volume of solution (mL)}} \times 100\%$$

$$2\%w/v = \frac{\text{mass of solute}}{500\ \text{mL}} \times 100\%$$

$$0.02 = \frac{\text{mass of solute}}{500\ \text{mL}}$$

mass of NaCl = 10 g

Reminder: A small mistake in measurement can lead to incorrect results in experiments. Always double-check your calculations and measurements!

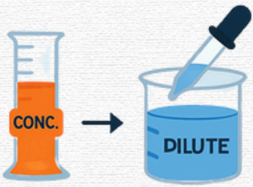
CALCULATING VOLUME OF CONCENTRATED SOLUTION GIVEN MOLARITY AND VOLUME

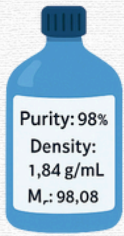
Some acids and chemicals, like HCl, H_2SO_4, HNO_3, CH_3COOH, NH_4OH and organic chemicals like formalin and ethanol are usually found in liquid form, not solid.

These are supplied as concentrated solutions in bottles.

To prepare a dilute solution, we do not weigh these liquids. Instead, we:

- Measure the volume of the concentrated liquid using a measuring cylinder or pipette.
- Add water to dilute it to the required concentration.





To find out how much concentrated solution to use, look at the bottle label for these 3 things:

- Percentage purity (how pure the chemical is)
- Density (g/mL)
- Relative molecular mass (Mr)

Table 1 shows the molecular weight (M.W.), density (S.G.), and concentration (%) of several commonly used concentrated acids and organic chemicals such as sulphuric acid, hydrochloric acid, nitric acid, ethanoic acid, ammonium hydroxide, and formaldehyde.

Table 1: Properties of Common Concentrated Acids and Chemicals

Type of Acid	M.W.	S.G.	Concentration
Concentrated sulphuric acid.	98	1.84	97%
Concentrated hydrochloric acid.	36.46	1.19	37%
Concentrated nitric acid.	63	1.42	72%
Concentrated ethanoic acid.	60	1.048	99.5%
Concentrated ammonium hydroxide	17	0.91	25%
Formaldehyde	30	1.075	37%

Calculating Formula:

$$\text{Volume of concentrated solution required (cm}^3\text{)} = \frac{\text{Mass of 1 mol of substance (g)}}{\text{Density of concentated solution (S.G)} \times \text{Percentage of concentrated solution (\%)}} \times \text{Volume of dillute solution (dm}^3\text{)} \times \text{Concentration of dilute solution (M)}$$

*Note : 1 dm^3 ≡ 1 L ≡ 1000 ml ≡ 1000 cm^3

Example 5

You need to prepare 100.0 mL of a 1 M HCl solution. What is the volume of HCl required?

Answer:

Step 1: Find the molecular weight, density and percentage assay

From the bottle's label,

Molecular weight of HCl = 36.46 g/mol

Density of HCl = 1.19 g/cm^3

Percentage assay of HCl = 37%

Figure 2: Bottle's label for HCl

Step 2: Calculate the volume of concentrated solution required

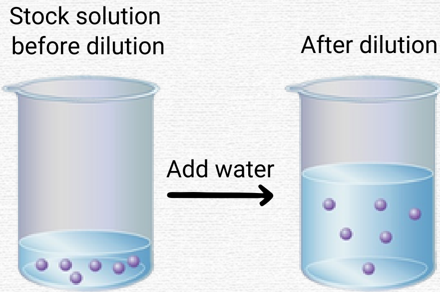
$$\text{Volume of HCl required} = \frac{36.46}{1.19 \times 0.37} \times 0.1 \times 1$$

$$= 8.28 \text{ cm}^3$$

Tip: Be sure the units in the unit conversion cancel correctly. You may need to convert units within the metric system if necessary

DILUTION

The process of dilution involves taking a solution with a known concentration and preparing a second solution that has a lower concentration.



The two beakers contain the same number of moles of solute

The calculation can be performed using the formula:

$$M_1V_1=M_2V_2$$

where:

M1 = initial concentration of the solution (mol/L)
V1 = volume of the initial solution used (mL or L)
M2 = desired concentration of the solution (mol/L)
V2 = desired final volume of the solution (mL or L)

Example 6

You have a 6.0 M solution of hydrochloric acid (HCl) and you are required to make 300.0 mL of 2.0 M HCl. How much water and how much 6.0 M HCl should you use to make 300.0 mL of 2.0 M HCl?

Answer:

$$M_1V_1 = M_2V_2$$

$$(6.0\ M)\ (V_1) = (2.0\ M)\ (300.0\ mL)$$

$$V_1 = \frac{(2.0\ M)(300\ mL)}{6.0\ M}$$

$$V_1 = 100\ mL$$

If the desired solution is made with 100.0 mL of 6.0 M HCl, the amount of distilled water required to dilute the solution to the correct molarity and volume is:

$$300.0\ mL - 100.0\ mL = 200.0\ mL$$

Hence, to make 300.0 mL of 2.0 M HCl, you will need 100.0 mL of 6.0 M HCl and 200.0 mL of distilled water.

Example 7

Prepare 250 mL of a 0.1 M solution from a 1 M hydrochloric acid (HCl) stock solution. Calculate the volume of stock solution needed.

Answer:

$$M_1V_1 = M_2V_2$$

$$(1M)V_1 = (0.1M)(250mL)$$

$$V_1 = \frac{0.1 \times 250}{1}$$

$$= 25 \text{ mL}$$

LEARNING CHECK 1

1. Calculate the mass of potassium chloride (KCl) needed to prepare 500 mL of a 0.2 M solution. (Molar mass of KCl = 74.55 g/mol)
2. How many grams of glucose ($C_6H_{12}O_6$) are required to prepare 250 mL of a 0.5 M solution? (Molar mass of glucose = 180.16 g/mol)
3. How much of a 1.0 M HCl stock solution is needed to prepare 100 mL of 0.2 M HCl solution?
4. You have a 2.0 M NaOH stock solution. What volume of this stock is required to make 250 mL of 0.5 M NaOH solution?
5. A student needs 300 mL of 0.1 M sulfuric acid (H_2SO_4) from a 1.5 M stock solution. Calculate the volume of stock needed and the volume of water to be added.

• Answer

Question 1:
M = 0.2 mol/L
V = 500 mL = 0.500 L
Molar mass = 74.55 g/mol
mass = 0.2 × 0.500 × 74.55 = **7.455 g**

Question 2:
M = 0.5 mol/L
V = 250 mL = 0.250 L
Molar mass = 180.16 g/mol
mass = 0.5 × 0.250 × 180.16 = **22.52 g**

Question 3:
M_1 = 1.0 M
M_2 = 0.2 M
V_2 = 100 mL
V_1 = ?
$V_1 = (M_2 \times V_2) / M_1$ = (0.2 × 100) / 1.0 = **20 mL**

Question 4:
M_1 = 2.0 M
M_2 = 0.5 M
V_2 = 250 mL
V_1 = ?
V_1 = (0.5 × 250) / 2.0 = **62.5 mL**

Question 5:
M_1 = 1.5 M
M_2 = 0.1 M
V_2 = 300 mL
V_1 = ?
V_1 = (0.1 × 300) / 1.5 = **20 mL**
Water to add = 300 mL − 20 mL = **280 mL**

COMMON LAB TOOLS FOR SOLUTIONS

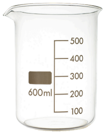
Before making any solution, always get your lab tools ready. The type of tool you use depends on how exact your measurement needs to be.

IMPORTANT

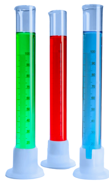
Before using any glassware, make sure it is clean, rinsed with distilled water, and dry (unless stated otherwise).

Dirty or contaminated glassware can affect the accuracy of your results. Rinsing with distilled water helps remove any leftover chemicals or residues that may interfere with your solution.

LAB TOOLS AND THEIR USES



Beaker
Used for mixing and heating. Not good for exact measurements.



Graduated Cylinder
Better than a beaker for measuring liquid, but still not very exact.

Dropping Pipette (Dropper)
Adds liquid drop by drop. Good for small amounts but not precise.

Volumetric Flask
Used to make a solution with an exact volume. Very accurate.

Pipette
Used to move a specific amount of liquid. Very accurate, especially the volumetric pipette.

Glass Rod
Used to stir or mix solutions manually.

Magnetic Stirrer
Used to mix solutions evenly using a small magnetic bar.

Funnel
Helps to pour liquids into containers (like volumetric flasks) without spilling.

Tip:

- **Use beakers and graduated cylinders when you don't need to be very precise.**
- **Use pipettes and volumetric flasks when you need exact measurements.**

Using a Balance to Measure Mass by Taring

A balance is used to determine the mass of an object. The most commonly used type is the electronic balance.

Steps to measure mass using the taring method:

1. Press ON to turn on the balance.
2. Place a clean and dry container (e.g., weighing boat, weighing paper, or beaker) on the balance pan.
3. Press TARE to zero the balance. It should display 0.00 g.
4. Add the substance into the container until the required mass is reached.

PREPARING A STANDARD SOLUTION FROM A SOLID

STEPS TO PREPARE A STANDARD SOLUTION FROM A SOLID

- Calculate the required mass of solute based on the desired molarity and volume. Accurately weigh the solid using an electronic balance and transfer it into a clean beaker.

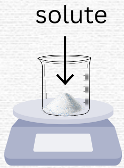
- Dissolve the solid in a small amount of distilled or deionized water. Stir the mixture using a glass rod until the solid is completely dissolved.

- Pour the solution into a volumetric flask using a funnel to avoid spillage.

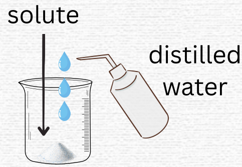
- Rinse the beaker and glass rod with a small volume of distilled water, and pour the rinsing into the volumetric flask to ensure all solute is transferred. Rinse the funnel with distilled water and remove it.

- Add distilled water gradually using a wash bottle until the bottom of the meniscus reaches the calibration mark on the neck of the volumetric flask.

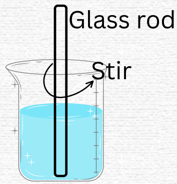
- Stopper the flask and invert it several times to mix thoroughly and obtain a homogeneous solution.



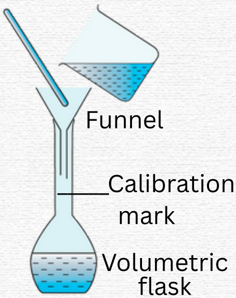
(a) Weight accurately the amount of solid required (solute)



(b) Dissolve the solid in a small amount of distilled or deionized water.

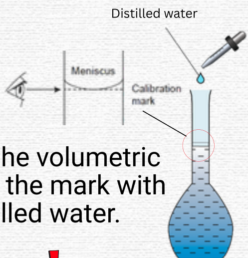


(c) Stir the solution. Ensure all the solid has dissolved.



(d) Transfer the solution into volumetric flask

(e) Rinse the funnel with distilled water to ensure all solute enters the flask.



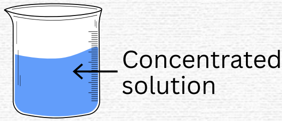
(f) Fill the volumetric flask to the mark with distilled water.

(g) Close the flask with a stopper and invert several times to mix well

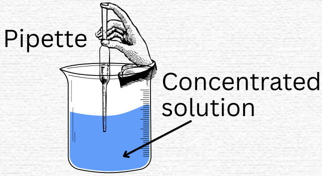
PREPARING A SOLUTION FROM CONCENTRATED SOLUTION

STEPS TO PREPARE A SOLUTION FROM CONCENTRATED SOLUTION

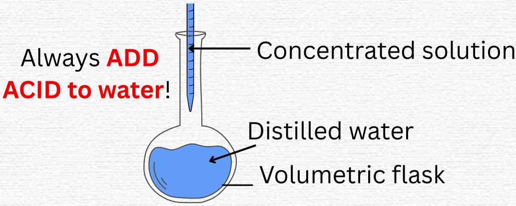
- Calculate the required volume of concentrated solution needed by applying the dilution equation:
- Measure the required volume of concentrated solution and carefully transfer it to a container.
- Pour distilled water into a volumetric flask to an appropriate level (depending on the final volume needed).
- Slowly add the measured concentrated acid to the flask with distilled water. Add it along the side of the flask to ensure proper mixing.
- Perform this step under a fume hood and wear appropriate personal protective equipment (e.g., gloves).
- Allow the solution to cool if needed.
- Top up with distilled water to the desired volume (indicated by the meniscus), then cap the flask and mix thoroughly by inverting it several times.



(a) Pour a small amount of the concentrated solution into a beaker

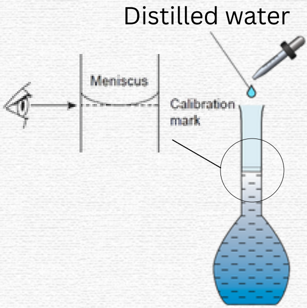


(b) Use a pipette to measure the required volume (V1)

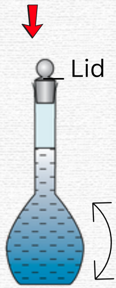


(c) Transfer the measured volume of concentrated solution into a volumetric flask containing about half full of distilled water.

Reminder: Always add acid to water, not the other way around.



(d) Add distilled water until the solution reaches the calibration mark



(e) Close the flask with a stopper and invert it several times to mix thoroughly

Safety Tip:

- **Concentrated solutions are highly corrosive. If spilled on skin or clothing, rinse immediately with plenty of water and seek medical help if needed.**
- **Always perform the entire procedure inside a fume hood to avoid inhaling harmful vapors. Ensure the fume hood sash is at a safe height.**

TROUBLESHOOTING GUIDE

COMMON MISTAKES IN SOLUTION PREPARATION

Even the most careful students make mistakes in the lab! Here's a quick guide to help you spot and fix common errors when preparing chemical solutions.

IMPORTANT

TIP: If you make a mistake, don't panic. Pause, check what went wrong, and restart safely. Accuracy takes practice.

MISTAKE	WHAT WENT WRONG?	HOW TO FIX OR AVOID IT
Overshooting the volume in a volumetric flask	You added too much liquid, going past the calibration mark.	❌ You can't "undo" this. Discard the solution and start again. Add liquid slowly near the mark.

MISTAKE	WHAT WENT WRONG?	HOW TO FIX OR AVOID IT
Forgetting to tare the balance	You weighed the container and the substance without zeroing first.	Always press the TARE button after placing the empty container to get an accurate mass of the solute.
Not mixing the solution properly	Solute isn't evenly distributed, causing inaccurate concentration.	After topping to the mark, invert the flask at least 10 times or use a magnetic stirrer.
Using dirty or wet glassware	Contamination or dilution affects your result.	Make sure all glassware is clean and dry, unless instructed to rinse with the solution.
Using the wrong measuring tool	Less accurate measurements lead to errors in concentration.	Use volumetric flasks and pipettes for precision. Avoid beakers and cylinders for exact volumes.
Adding water to acid (instead of acid to water)	Dangerous exothermic reaction may splash acid.	Always add acid to water slowly, never the other way around. Use a fume hood when needed.

LABELLING YOUR SOLUTIONS

After you have completed the preparations for the solution, you must consider how it will be identified in the future. The following information should be clearly labelled on your solutions:

1. Identity of contents
2. Concentration
3. Date of preparation

The label must be securely attached to the container and written in ink that is not water soluble.

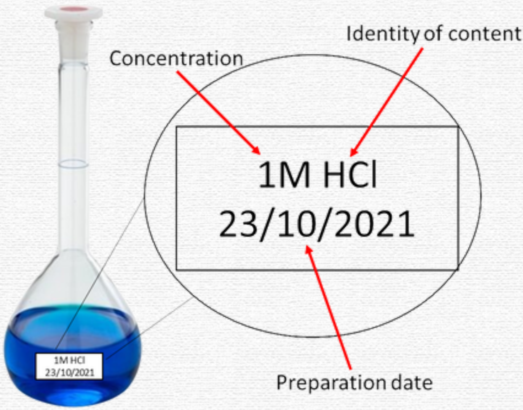


Figure 3: Labelling solutions

LEARNING CHECK 2

Question1:

Fill in the blanks:

1. When preparing a diluted acid solution, always add ______ to ______.
2. Use a ______ to measure small volumes of concentrated acid.
3. Final volume in a volumetric flask should be adjusted using ______.

Question 2:

Match the item to its purpose:

Equipment	Purpose
a. Volumetric flask	
b. Pipette/dropper	
c. Beaker	
d. Funnel	

Options:

1. To transfer small volumes
2. To make up a solution to volume
3. To roughly mix chemicals
4. To avoid spills while pouring

Question 3:

Write **T (True)** or **F (False)** next to each statement.

1. It is safe to mix acid and water outside the fume hood. ______
2. Always add acid to water, not the other way around. ______
3. You don't need gloves when working with dilute acids. ______
4. A volumetric flask is used for accurate volume measurements. ______

• Answer

Question 1:

1. acid, water
2. pipette
3. distilled water

Question 2:

a. To make up a solution to volume

b. To transfer small volumes

c. To roughly mix chemicals

d. To avoid spills while pouring

Question 3:

1. F
2. T
3. F
4. T

CHEMICAL WASTE DISPOSAL

Proper disposal of chemical waste is essential to ensure safety, environmental protection, and compliance with laboratory regulations. Improper disposal can lead to chemical reactions, contamination, and legal penalties

- **Avoid disposing of hazardous chemicals in regular trash bins.**
- **Do not pour chemicals down sinks, onto the ground, or into storm drains.**

Chemical waste in the lab can be grouped into five main categories:

TYPE OF WASTE	DESCRIPTION	EXAMPLES
Organic solvents	Flammable and volatile compounds	Ethanol, acetone, chloroform
Inorganic acids & bases	Corrosive liquids that must be neutralized or stored properly	HCl, NaOH, H_2SO_4
Heavy metal waste	Toxic metals that can accumulate in living organisms	Lead (Pb), mercury (Hg), chromium (Cr)
Halogenated waste	Organic compounds containing halogens (F, Cl, Br, I)	Dichloromethane, chloroform
Biological or reactive	Biohazardous or highly reactive materials	Pathogenic samples, peroxides

LABELING AND SEGREGATING WASTE

Proper labeling and segregation is key to safe chemical waste handling

IMPORTANT

Segregation Tips:

- **Use separate containers for:**
  - **Halogenated vs. non-halogenated solvents**
  - **Acids vs. bases**
  - **Organics vs. inorganics**
  - **Metals vs. non-metals**
- **Keep containers:**
  - **Closed at all times**
  - **In secondary containment trays**
  - **Labeled clearly and stored away from incompatible materials**

Labeling Rules

- Use pre-labeled chemical waste tags (or design your own
- Label must include:
    - Waste contents (full chemical names, not formulas)
    - Concentration (if known)
    - Date
    - Laboratory / instructor
    - Hazard classification (e.g., flammable, corrosive)

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The First Step in Lab

Preparing Chemical Solutions

Start Your Chemistry Lab Journey with Confidence

The First Step in Lab: Preparing Chemical Solutions is the perfect beginner's guide for students, lab assistants, and anyone new to chemistry. Learn the basics of preparing chemical solutions with easy-to-follow steps, real-life tips, and safety guidelines.

You'll learn how to:

✅ Read chemical labels
✅ Use the right lab tools
✅ Prepare and dilute solutions
✅ Handle chemicals safely
✅ Avoid common mistakes

Build your confidence and skills—one solution at a time!

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