

‘O’ Level Chemistry

Chapter 1 – Measurements in Chemistry

Measurements

- Four basic physical quantities measured in experiments:
 - Volume
 - Temperature
 - Mass
 - Time
- These measurements can also be made by **Data Logging**

Measurements in Chemistry Experiments

- **Volume of liquids**
 - SI unit: m^3
 - Other units: cm^3 , dm^3 ($1 \text{ dm}^3 = 1000 \text{ cm}^3$)

Apparatus	Use
Beaker / conical flask	For approximate volumes of 100 cm^3 or 250 cm^3
Measuring cylinder	For variable volumes accurate to nearest cm^3
Burette	For variable volumes accurate to nearest 0.1 cm^3 (follow the accuracy stated on the burette used)
Pipette (bulb pipette)	For fixed volumes accurate to nearest 0.1 cm^3 (follow the accuracy stated on the pipette used)

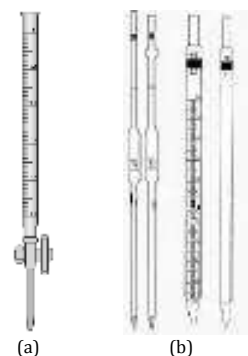


Fig. 1: (a) Burette and
(b) Pipettes

- **Volume of Gases**
 - Measured using a **gas syringe**.
 - Measures up to 100 cm^3 of gas on a graduated scale
- **Temperature**
 - SI unit: **Kelvin, K**
 - A more common unit: degree Celsius, $^{\circ}\text{C}$ (also called degree Centigrade)
 - $T (\text{in K}) = T (\text{in } ^{\circ}\text{C}) + 273$
 - Measured using a **mercury-in-glass** or **alcohol-in-glass thermometer** to the nearest $0.5 \text{ }^{\circ}\text{C}$ (or half of the smallest division).
- **Time**
 - SI unit: **second (s)**
 - Other units used: hour (h), minute (min)
 - Measured with a clock or **digital stopwatch**.

- Measurement to the nearest second is sufficient.

• Mass

- SI unit: **kilogram (kg)**
- Other common units: gram (g), milligram (mg), tonnes (1 ton = 1000 kg)
- Measured using **electronic 'top pan' balance** accurate to **nearest 0.001g** (accuracy also depends on the type of balance used) or beam balances

Writing measurements in Standard Form

- Very large or very small numbers are usually written in standard form
- Standard form: $A \times 10^n$ (where **A** is more than or equal to 1 and less than 10; **n** is an integer)
- For example, $0.00025 \text{ g} = 2.5 \times 10^{-4} \text{ g}$; $520\,000 \text{ cm}^3 = 5.2 \times 10^5 \text{ cm}^3$

Chemistry Experiments and the Apparatus used

• Heating a Flammable Liquid

- Flammable liquids (e.g. alcohols) will likely catch fire if heated in a boiling tube directly over a flame.
- Hence, these liquids are placed in a boiling tube and then warmed in a beaker of water (water bath) as shown in Fig. 2.



Fig. 2: Heating a flammable liquid

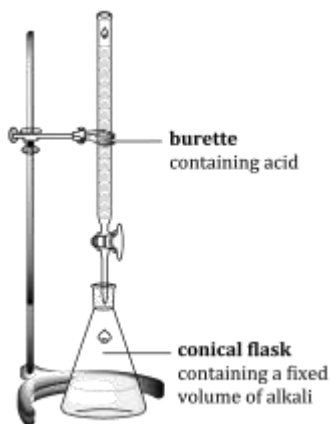


Fig. 3: Titration set-up

• Titration

- One solution is added to a known volume of another solution.
- Used during neutralisation reaction between acid and alkali.
- **Pipette**: to measure a very accurate fixed volume of a solution (e.g. alkali) into a conical flask.
- **Burette**: to contain a solution of acid and runs it into the conical flask. The volume of acid added to the alkali can then be read off from the burette.

• Collecting Gas from a Reaction

- To collect and measure the volume of gas produced over a period of time.
- Gas produced from the reaction of substances in a conical flask is collected in a **gas syringe**. (Fig. 4)
- This set up can also be used to measure the speed of a reaction.

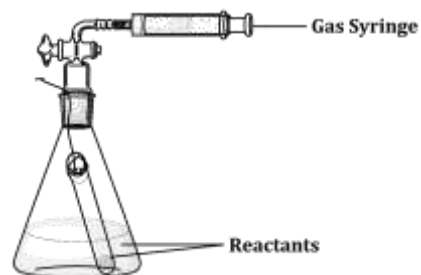


Fig. 4: Collecting gas from a reaction

- There are other methods of collecting gases (Fig. 5) and the method of collection depends on the properties of the gas (Fig. 6)

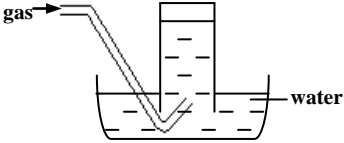

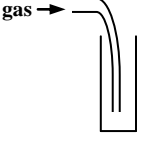
 <p>Displacement of water</p> <p>For gases that are insoluble or slightly soluble in water.</p>	 <p>Upward delivery</p> <p>For gases that are soluble in water but less dense than air.</p>	 <p>Downward delivery</p> <p>For gases that are soluble in water but denser than air.</p>
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Fig. 5: Other methods of collecting gases

Gas	Solubility in water	pH	Density with respect to air
Hydrogen	Insoluble	Neutral	Less dense
Oxygen	Insoluble	Neutral	Denser
Carbon dioxide	Slightly soluble	Acidic	Denser
Hydrogen chloride	Soluble	Acidic	Denser
Chlorine	Soluble	Acidic	Denser
Sulfur dioxide	Soluble	Acidic	Denser
Ammonia	Soluble	Alkaline	Less dense

Fig. 6: Table of properties of common gases

- **Drying agent** can be used to **remove moisture** in the gas collected. (Fig. 7)
- This is to obtain a **dry sample** and also a more accurate of volume collected.
- Examples of drying agents:
 - Concentrated sulphuric acid (not for alkaline gas, e.g. ammonia)
 - Calcium oxide (not for acidic gas, e.g. hydrogen chloride)
 - Calcium sulphate and calcium chloride

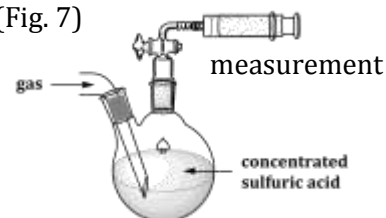


Fig. 7: Drying a gas by bubbling into concentrated sulfuric acid

• Change in Mass During a Reaction

- Instead of collecting the gas formed in a reaction, we can measure the decrease in mass. (Fig. 8)
- An **electronic balance** is used to measure the decrease in mass when the gas formed in a reaction escapes from the reaction flask.
- Useful to measure the speed of reaction.

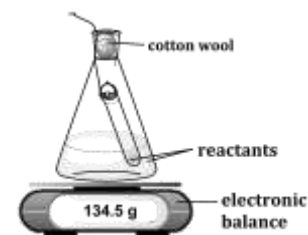


Fig. 8: Measuring change in mass during a reaction

• Data Logging

- To measure and record **variables that change over time** during an experiment.
- We can measure:
 - Temperature changes
 - Change in volume of gas produced
 - Change in mass during a reaction
 - Change in pH during a neutralisation reaction

- Main pieces of apparatus include: sensor (or probe), connector (or interface), computer and monitor (screen)
- Measurements can be displayed as **graphs** of variables against time on the monitor.

Summary

