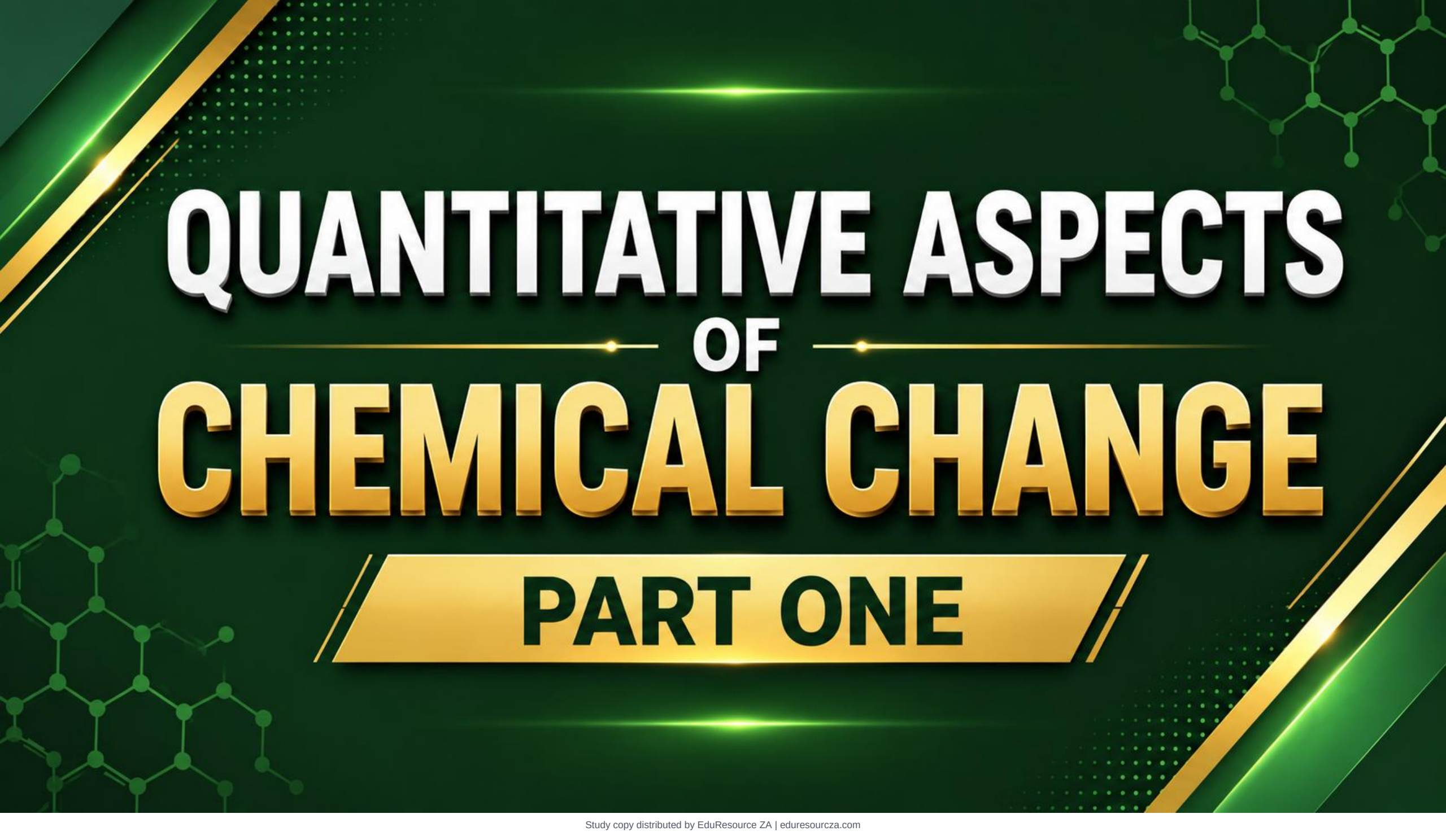
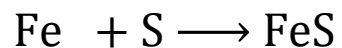




QUANTITATIVE ASPECTS OF CHEMICAL CHANGE

PART ONE

- ❑ An equation for a chemical reaction can provide us with a lot of useful information.
- ❑ It tells us what the reactants and the products are in the reaction, and it also tells us the ratio in which the reactants combine to form products.
- ❑ Consider the reaction below:

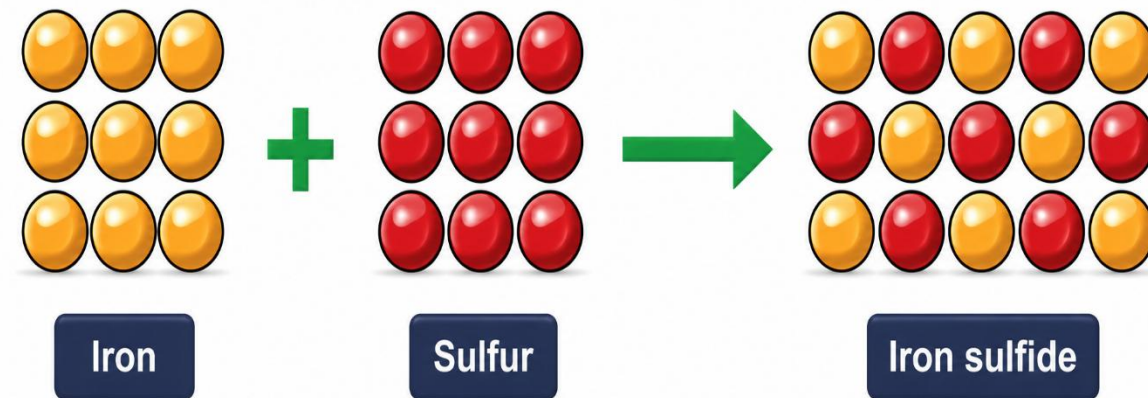


- ❑ In this reaction, every atom of iron (Fe) will react with a single atom of sulphur (S) to form one molecule of iron sulphide (FeS).

- ❑ However, what the equation does not tell us, **is the quantities or the amount of each substance that is involved.**

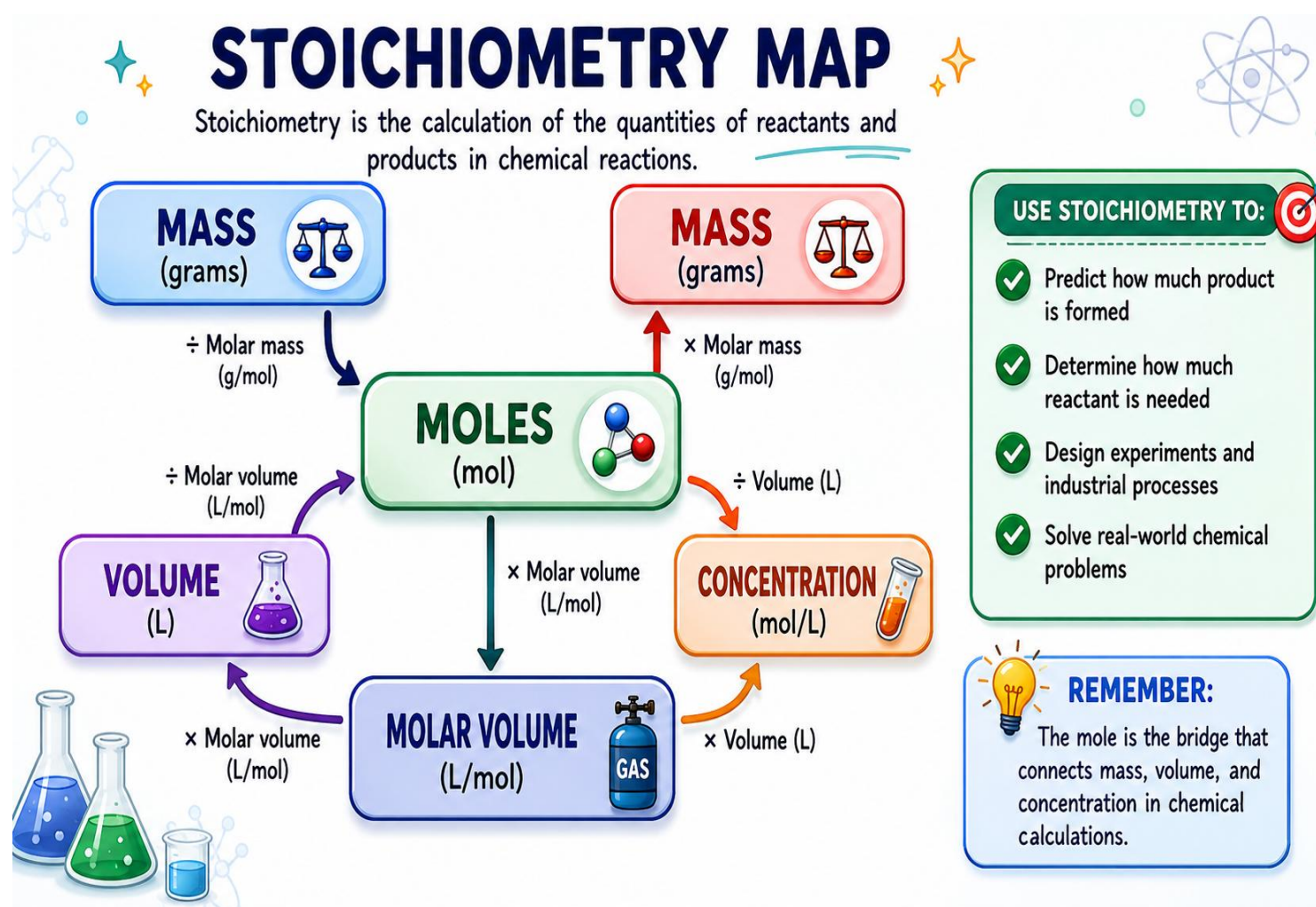
- ❑ So the questions to ponder on are:

- ❖ How will you know how many atoms of iron are in this sample?
- ❖ And how many atoms of sulphur will you need for the reaction to use up all the iron you have?
- ❖ Is there a way of knowing what mass of iron sulphide will be produced at the end of the reaction?



❖ Quantitative aspects of chemical change, also known as **stoichiometry**, involve using **balanced chemical equations** to calculate the amounts of reactants and products involved in a reaction.

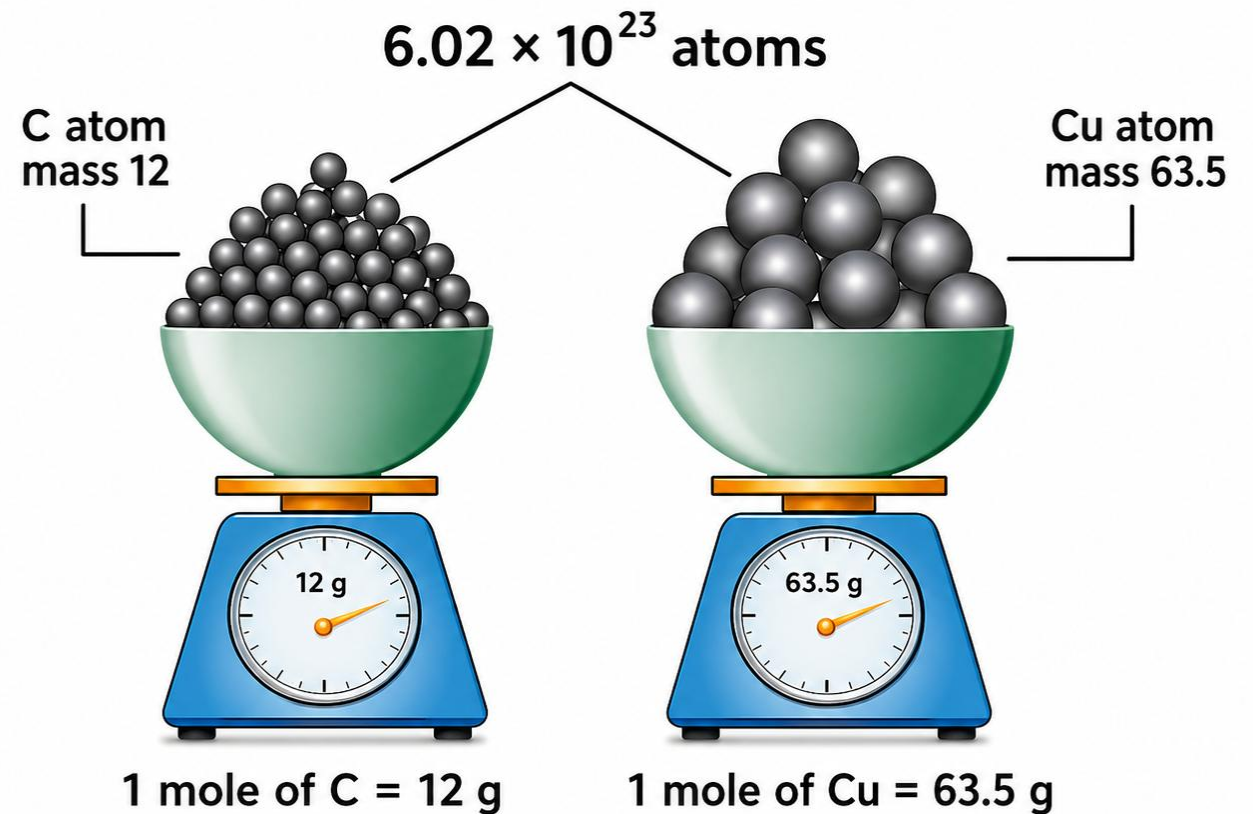
❖ This includes determining **mole ratios**, **molar masses**, and using these to **calculate masses, volumes, or concentrations** of substances



The Mole

- Chemical amounts are measured in moles
- **A mole is a unit of measurement used in chemistry to express the amount of a substance**
- The mole, symbol mol, is the SI unit of **amount of substance**
- **One mole is defined as the amount of substance having the same number of particles as there are atoms in 12 g carbon-12.**

Mole Concept



Conversion Between Moles and mass

- ☐ Moles and molar mass are fundamentally linked, allowing for conversions between the number of moles and the mass of a substance

$$\text{number of moles} = \frac{\text{mass of substance}}{\text{molar mass of substance}}$$

$$n = \frac{m}{M}$$

Where

n: number of moles(mol)

m: mass in grams

M: molar mass

$$n \text{ (moles)} = \frac{m \text{ (mass)}}{M \text{ (molar mass)}}$$

Example 1

Calculate the number of moles in each of the following samples:

(a) 21.62 g of boron (B)

(b) 54.94 g of manganese (Mn)

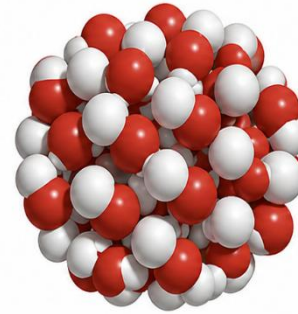
(c) 100.3 g of mercury (Hg)

Avogadro's number, N_A

- Chemical amounts are measured in moles
- The mole, symbol mol, is the SI unit of **amount of substance**
- One mole of a substance contains the same number of the stated particles
- This can be **atoms, molecules or ions**
- One mole contains 6.022×10^{23} particles; this number is known as the **Avogadro Number (N_A)**
- **Avogadro's number, N_A is the number of particles (atoms, molecules, formula-units) present in one mole**
- For example:
 - One mole of sodium (Na) contains 6.022×10^{23} atoms of sodium
 - One mole of hydrogen (H_2) contains 6.022×10^{23} molecules of hydrogen
 - One mole of sodium chloride (NaCl) contains 6.022×10^{23} formula units of sodium chloride

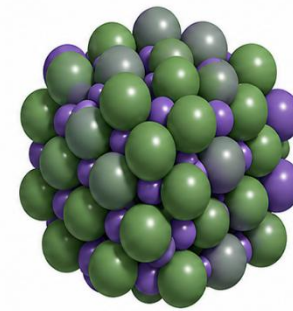
1 mole of any substance contains 6.022×10^{23} particles of that substance.

1 mole of H_2O



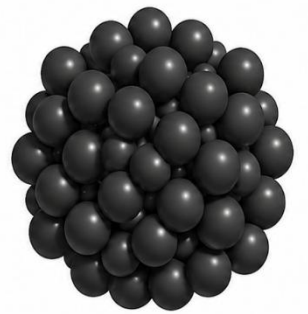
6.022×10^{23}
molecules

1 mole of NaCl



6.022×10^{23}
formula units

1 mole of C (atoms)



6.022×10^{23}
atoms

Conversion between Moles and Avogadro's Number

- To calculate the number of moles when given a specific number of particles, you divide the total number of particles by Avogadro's number.

$$\text{number of moles} = \frac{\text{number of particles}}{\text{Avogadro number}}$$

$$n = \frac{N}{N_A}$$

$$\text{Number of moles} = \frac{\text{Number of particles}}{\text{Avogadro number}}$$

In terms of letters

$$\begin{array}{c} n \\ \text{(number of moles)} \end{array} = \frac{N \text{ (number of particles)}}{N_A \text{ (Avogadro number)}}$$

Example 2

- How many particles are present in 2,5 mol of oxygen molecules?
- A sample contains $9,03 \times 10^{23}$ molecules of carbon dioxide. Calculate the number of moles.

Molar volume of gases

- ❖ Molar volume is the volume occupied by one mole of a substance.
- ❖ **Avogadro's Law states that one mole of any gas occupies the same volume at the same temperature and pressure.**

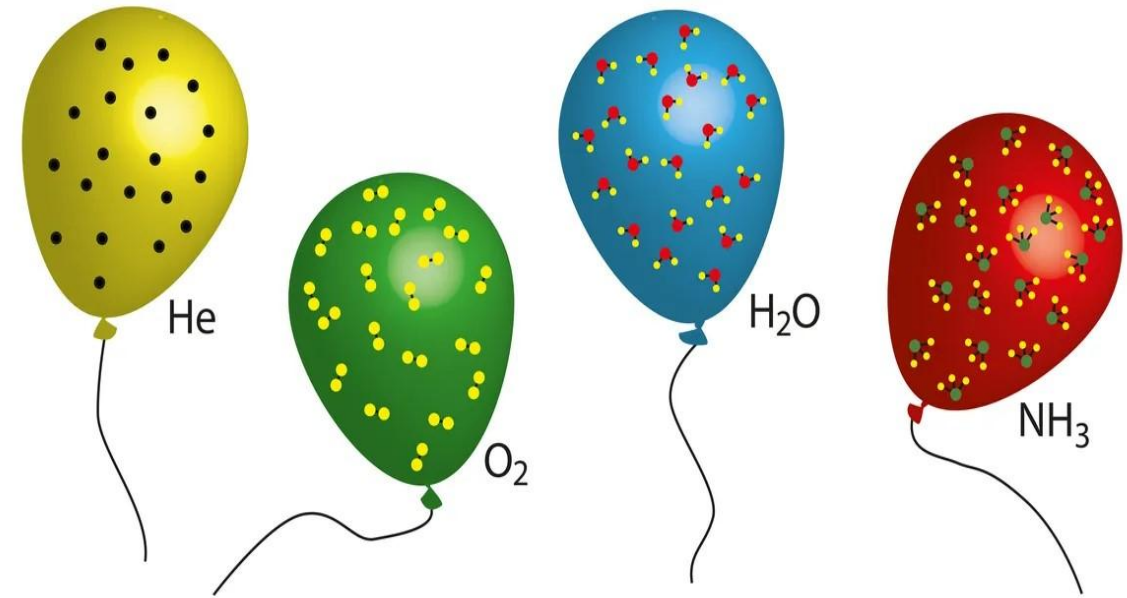
Standard Temperature and Pressure (STP)

- ❑ Standard Temperature and Pressure (STP) refers to a specific set of conditions (temperature and pressure) used for comparing the properties of gases.

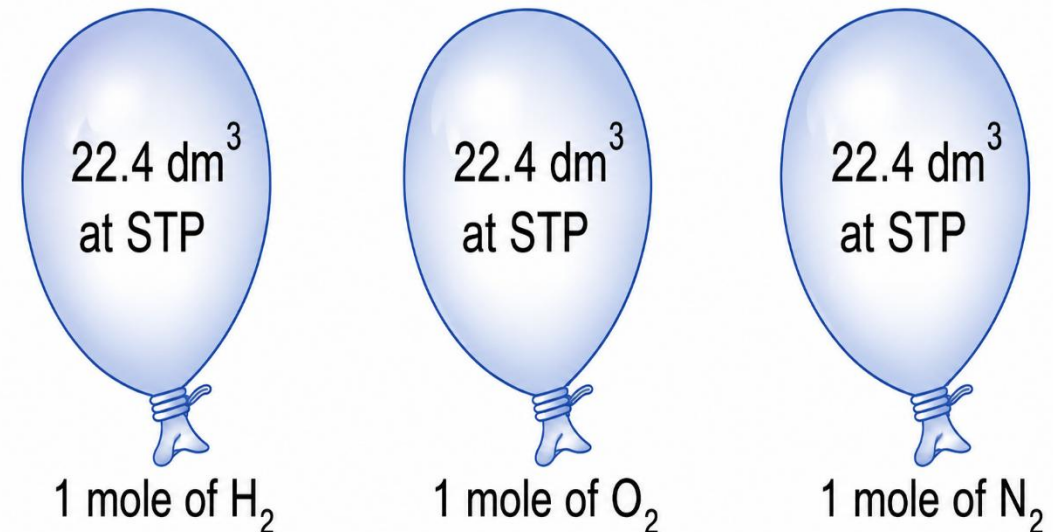
The conditions are:

- ❑ **Temperature of 0°C (273 K)**
- ❑ **Pressure of 1 atmosphere or (101,3 kPa)**

Note: The molar volume (V_m) for 1 mole of any gas is **22,4 dm³** at STP



Avogadro's hypothesis: same volumes of gases present same number of particles



Conversions Between Moles and Gas Volume

- At Standard Temperature and Pressure (STP), one mole of any ideal gas occupies a volume of $22,4\text{dm}^3$.

- This relationship is expressed by the formula

$$\text{number of moles} = \frac{\text{Volume of gas produced}}{\text{molar volume}}$$

$$n = \frac{V}{V_m}$$

Where

n: number of moles(mol)

V: volume of gas in dm^3

V_m : molar volume dm^3

$$\text{Number of moles of a gas (n)} = \frac{\text{Volume of the gas at STP}}{\text{Molar volume of the gas}}$$

Example 3

Carbon reacts with oxygen to form carbon dioxide, according to the equation

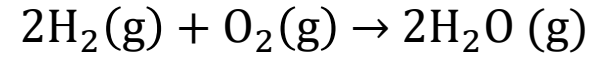


$5,75\text{dm}^3$ of oxygen at STP reacts

- How many moles of oxygen reacted?
- How many moles of carbon dioxide will be formed?
- What volume of carbon dioxide will be formed at STP?

Example 4

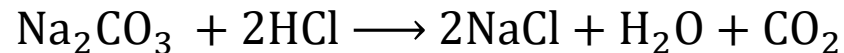
Hydrogen and oxygen react according to the equation



- a. What volume of oxygen will react with 4,0dm³ of hydrogen at STP?
- b. What volume of water vapor will be produced?

2017 November Paper 2 Q 6.2

Study the balanced chemical equation of the reaction between sodium carbonate (Na_2CO_3) and hydrochloric acid (HCl) and answer the questions that follow



In a reaction, 10,6 g of sodium carbonate reacts completely with excess hydrochloric acid.

6.2.1 Calculate the molar mass of sodium carbonate. (2)

6.2.2 Calculate the initial number of moles of sodium carbonate. (2)

6.2.3 Calculate the mass of CO_2 produced during this reaction. (4)

6.2.4 Calculate the mass of sodium chloride produced if $4,87\text{dm}^3$ of carbon dioxide was produced at STP. (6)

Concentration of solutions

- ❑ In chemistry, the concentration of a solution is the quantity of a **solute** that is contained in a particular quantity of **solvent** or solution.
- ❑ A solvent is a substance, usually a liquid, that can dissolve other substances, known as solutes, to form a solution.
- ❑ The most **common example** of a solvent is **water**.
- ❑ A solute is a substance that dissolves in a solvent to form a solution. It is the substance that gets dissolved, and it's typically present in a smaller amount compared to the solvent
- ❑ **In a solution**, the **solvent** is the substance present in the **larger amount**

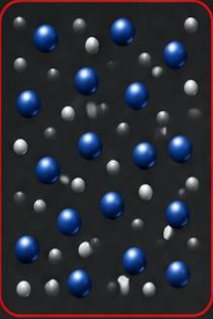


- A solution can be prepared in **different concentration** according to the amount of **solute dissolved in it**.
- The terms “concentrated ” and “dilute” are used to describe solutions .
- **Solutions that contain relativity large amount of solute are called concentrated and relatively small amount of solute are called dilute**
- A higher concentration means there are more moles of solute within the same volume of solution
- **Concentration is defined as the amount of solute per litre of solution.**

CONCENTRATED AND DILUTE SOLUTIONS

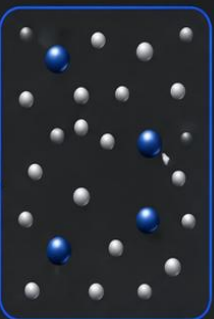
Solutions that contain relatively large amount of solute are called **concentrated** and relatively small amount of solute are called **dilute**.

CONCENTRATED SOLUTION



Contains a relatively **large amount** of solute.
Darker color

DILUTE SOLUTION



Contains a relatively **small amount** of solute.
Lighter color

 = Solute particles |  = Solvent particles

Conversions Between Moles and Concentration

- ❑ The relationship between moles and concentration is defined by the formula:

$$\text{concentration} = \frac{\text{number of moles}}{\text{volume}}$$

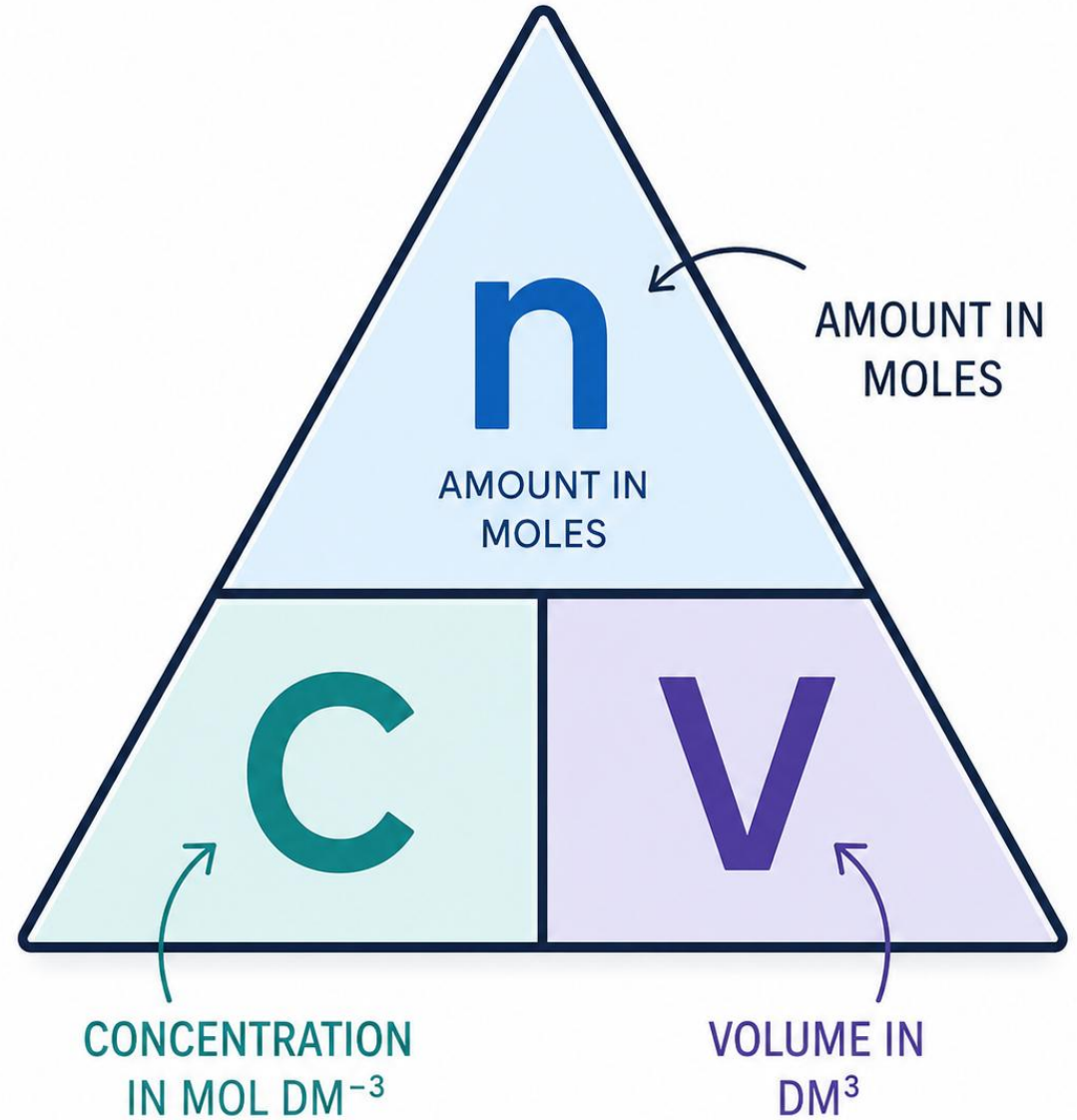
$$c = \frac{n}{v}$$

Where:

c: concentration of the solution in mol dm^{-3}

n: number of moles

v: volume in dm^3



A Standard Solution

- ❑ A standard solution is defined as a solution of precisely known concentration
- ❑ It is used in chemistry for analysis and calibration.
- ❑ It is prepared by accurately weighing a **known amount of a substance (the solute)** and **dissolving it in a specific volume of solvent**



Preparation of the standard solution

Dissolving as solid

1. Calculate what mass of solid is needed to make the required volume and concentration of solution.
2. Measure out the mass of solid using an electronic scale.
3. Add the solid in half of the required volume of distilled water in a volumetric flask.
4. Shake the flask carefully until all the solute (solid) has dissolved.
5. Add more distilled water to fill up to the required volume.

To calculate the exact concentration of the prepared solution, use the mass that was recorded on the scale and the formula:

$$c = \frac{m}{MV}$$

c: concentration of the prepared solution

m: mass of the solid

M: molar mass of the solid

V: volume of the solution

Preparation of a Solution of Known Concentration Using a **Solid Solute**



Key Point: Accurate measurement, complete dissolution, and proper meniscus alignment ensure a solution of known concentration.

Example 5

45 g of NaOH is dissolved in water and made up to a volume of 250 cm^3 . Calculate the concentration of the solution.

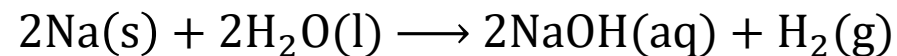
Example 6

What mass of HCl would have to be placed in a beaker and made up to a volume of 375 cm^3 if the concentration is to be $0,2 \text{ mol dm}^{-3}$?

PAST EXAM PAPERS

2016 November Paper 2 Q 9

The reaction between sodium and water is represented by the following balanced chemical equation:



During the reaction 10 g of sodium reacts with 2dm³ water to produce hydrogen gas at STP.

9.1 Write down the values of temperature and pressure at STP. (2)

9.2 Calculate the following:

9.2.1 Mass (in gram) of hydrogen gas produced (5)

9.2.2 Volume (in dm³) of hydrogen gas produced at STP (3)

9.2.3 Mass (in gram) of NaOH produced (4)

9.2.4 Concentration of the sodium hydroxide solution (3)

2015 November Paper 2 Q 6.1

Sodium thiosulphate, $\text{Na}_2\text{S}_2\text{O}_3(\text{s})$, reacts with 200 cm^3 of a hydrochloric acid solution, $\text{HCl}(\text{aq})$, of concentration $0,2 \text{ mol dm}^{-3}$ according to the following balanced equation:



- 6.1.1 Define the term *concentration of a solution*. (2)
- 6.1.2 Calculate the number of moles of $\text{HCl}(\text{aq})$ added to the sodium thiosulphate. (3)
- 6.1.3 Calculate the volume of $\text{SO}_2(\text{g})$ that will be formed if the reaction takes place at STP. (3)

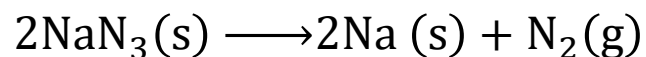
2020 Eastern Cape November Paper 2 Q 6.2 and Q 6.3

6.2 Learners prepare a solution of sodium hydroxide (NaOH) in water by placing 8 g of sodium hydroxide (NaOH) in a volumetric flask and adding water to produce 250 cm³ of solution after stirring.

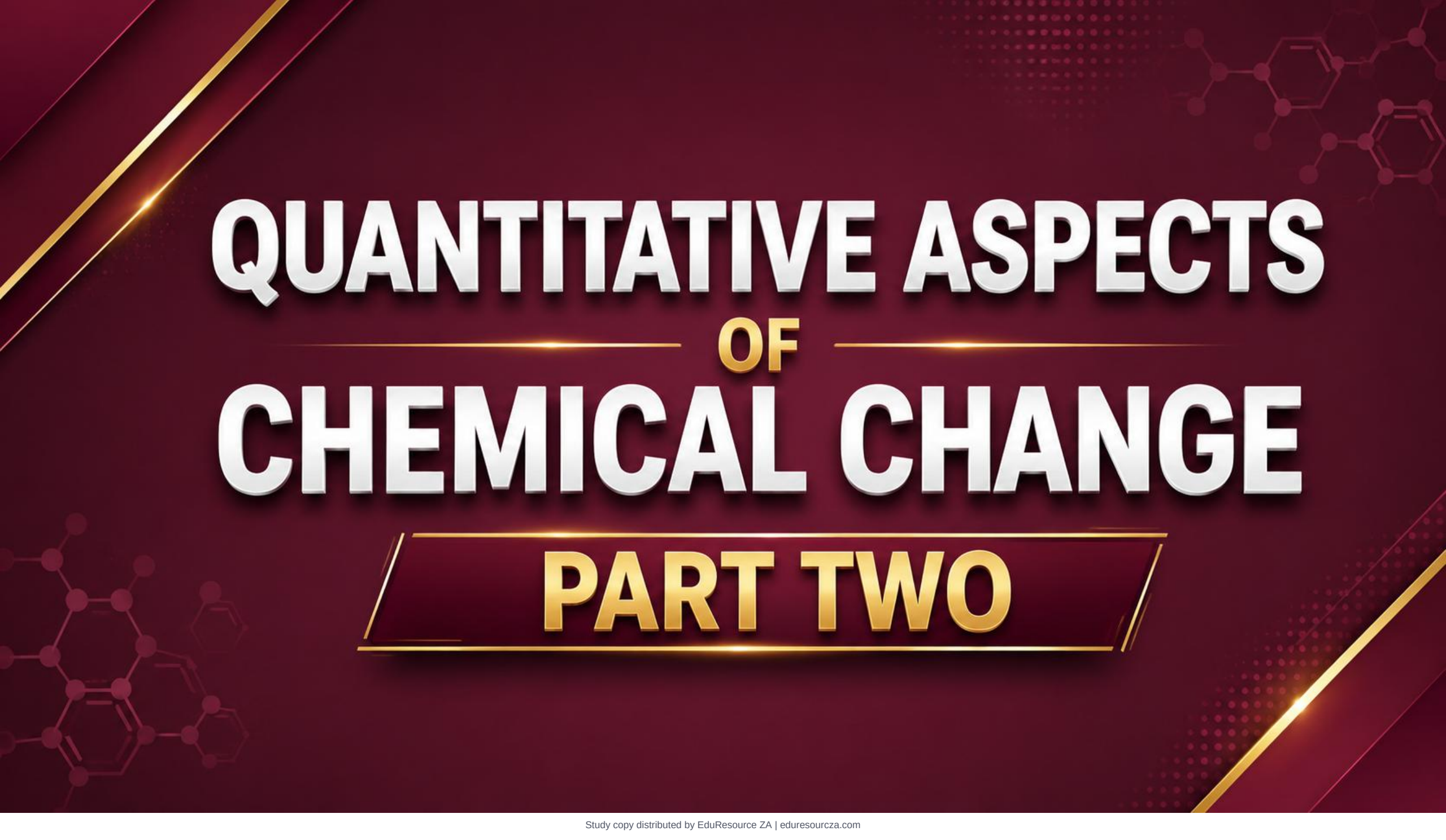
6.2.1 Define *concentration* in words. (2)

6.2.2 Calculate the concentration of the sodium hydroxide (NaOH) solution. (4)

6.3 Sodium azide (NaN₃) is used in car airbags. For the airbag to inflate the following reaction must take place:



Calculate the volume of nitrogen gas (N₂) that would be produced at STP if 55 g of sodium azide reacts completely. (5)

The background is a dark maroon color with faint, stylized chemical structures (benzene rings and molecular chains) scattered across it. There are also diagonal gold lines and a dotted pattern in the corners.

QUANTITATIVE ASPECTS OF CHEMICAL CHANGE

PART TWO

Empirical Formula

- The empirical formula of a chemical compound is a simple expression of the relative number of each type of atom in that compound.
- **An empirical formula is the simplest whole-number ratio of elements in a compound.**
- The compound ethanoic acid for example, has the molecular formula CH_3COOH or simply $\text{C}_2\text{H}_4\text{O}_2$.
- In one molecule of ethanoic acid ($\text{C}_2\text{H}_4\text{O}_2$), there are two carbon atoms, four hydrogen atoms and two oxygen atoms.
- The ratio of atoms in the compound is 2: 4: 2, which can be simplified to 1: 2: 1.
- Therefore, the empirical formula for this compound is CH_2O .
- The empirical formula **contains the smallest whole number ratio of the elements that make up a compound**

What is the empirical formula of acetic acid ($\text{C}_2\text{H}_4\text{O}_2$)?



Empirical formula – lowest whole-number ratio of elements in a compound



GCF = 2

$$\text{C: } 2 \div 2 = 1 \quad | \quad \text{H: } 4 \div 2 = 2 \quad | \quad \text{O: } 2 \div 2 = 1$$



Molecular Formula

- A **molecular formula** is a chemical representation that shows the exact number and types of atoms present in a single molecule of a compound. It uses standard chemical symbols and numerical subscripts (e.g H₂O) to detail exactly what the substance is made of
- Unlike empirical formulas, which only show the simplest whole-number ratio of atoms, **the molecular formula of a chemical compound gives the actual number of atoms of each element found in a molecule of that compound.**
- While it tells you exactly what atoms are present, it does not reveal how those atoms are arranged, their spatial geometry, or how they are bonded

 COMPOUND	 MOLECULAR FORMULA	 EMPIRICAL FORMULA
 Ethane	C₂H₆	CH₃
 Propene	C₃H₆	CH₂
 Glucose	C₆H₁₂O₆	CH₂O
 Phosphorus pentoxide	P₄O₁₀	P₂O₅
 Hydrogen peroxide	H₂O₂	HO
 Ethanol	C₂H₆O	C₂H₆O

2017 November Paper 2 Q 7.4

Determine the empirical formula of butane gas if it consists of 82,76% carbon and 17,24% hydrogen. (4)

2019 Eastern Cape Exemplar Paper 2 Q 7.1

The chemical composition of a particular compound is:

11,79% Carbon

69,57% Chlorine

18,64% Fluorine

The molar mass of the compound is 204 g mol^{-1} .

Determine, by calculations, the molecular formula of the compound. (7)

2016 November Paper 2 Q 8.1

8.1 The empirical formula of a certain compound is to be determined. On analysis of a sample of the compound it was found to contain 40% C, 6,6% H and 53,3% O.

8.1.1 Define the term *empirical formula*. (2)

8.1.2 Determine the empirical formula of the compound.

Show ALL calculations. (5)

8.1.3 If the molecular mass of the compound is 60 g mol^{-1} , calculate the molecular formula of the compound. (3)

2023 Eastern Cape Exemplar Paper 2 Q 5.2

A compound with a molar mass of 162 g mol^{-1} has the following mass composition

44,4% C	6,21% H	39,5% S	9,86% O
---------	---------	---------	---------

Determine the molecular formula of the compound. (7)

2016 November Paper 2 Q 5.3

5.1 Define the term *concentration*. (2)

5.2 Eight (8) grams of $\text{Na}_2\text{S}_2\text{O}_3$ is dissolved in water to prepare 500 cm^3 of solution. Calculate the concentration of the $\text{Na}_2\text{S}_2\text{O}_3$ solution. (3)

5.3 A 10 g sample of a compound contains 2,66 g of potassium, 3,54 g of chromium and 3,81 g of oxygen.

5.3.1 Define the term *empirical formula*. (2)

5.3.2 Determine the empirical formula of this compound. (7)

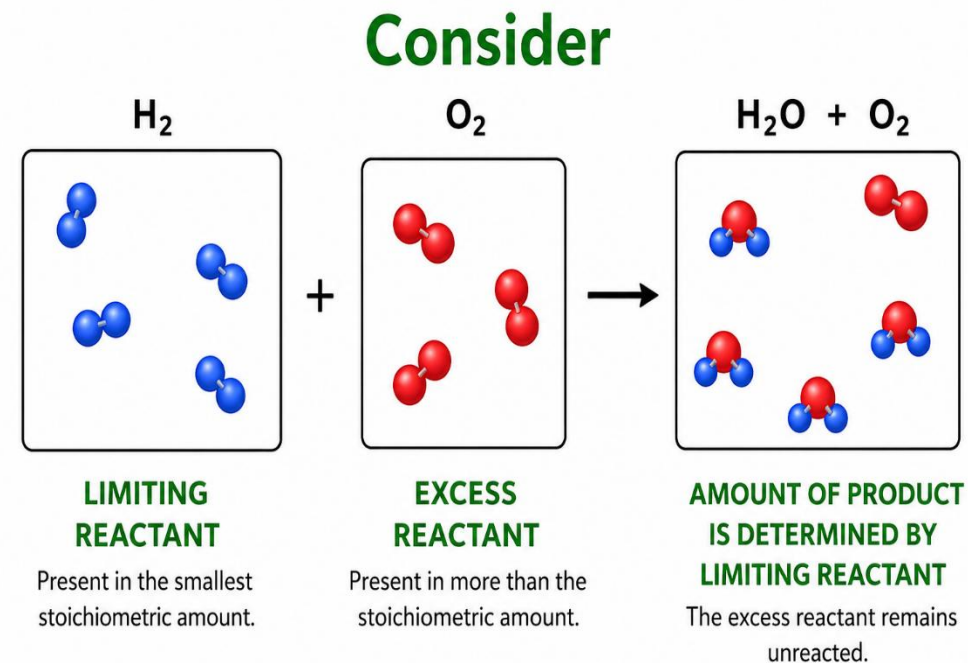
Chemical reaction

- ❑ A chemical reaction is the processes where one or more substances(reactants) change into one or more new substances (products).
- ❑ The substances that go into a chemical reaction are called the **reactants**
- ❑ Atoms in the reactants rearrange to form new molecular structures.
- ❑ The substances produced at the end of the reaction are known as the **products**.
- ❑ Chemical reactions occur when chemical bonds between atoms are **formed or broken**.
- ❑ Chemical changes are generally permanent, meaning the original substances cannot be easily recovered.



Limiting and excess reagent

- ❖ In a reaction, **the substance that is totally consumed** when the chemical reaction is complete is known as a **limiting reagent**.
- ❖ It is the reactant in a chemical reaction that limits the amount of product that can be formed.
- ❖ The reaction reaches **completion** when all the **limiting reactant is consumed**.
- ❖ The **reactant that remains when the limiting reagents has been used up** is known as the **excess reactant**



The **limiting reactant** is completely consumed first and determines the maximum amount of product that can be formed.



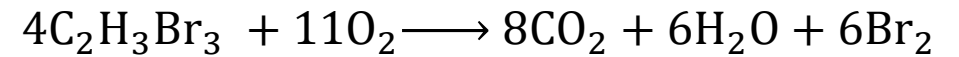
Finding the limiting reagent

Find the limiting reagent by looking at the number of moles of each reactant.

- ☐ Determine the balanced chemical equation for the chemical reaction.
- ☐ Convert all given information into moles (most likely, through the use of molar mass as a conversion factor).
- ☐ Calculate the mole ratio from the given information.
- ☐ **Compare the required ratio to the actual ratio.**
- ☐ **If the actual ratio is greater than the required ratio, then the denominator is the limiting reagent**
- ☐ **If the actual ratio is less than the required ratio, then the numerator is the limiting reagent**

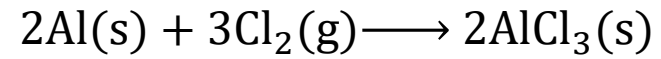
Example 6

What is the limiting reagent if 76.4 grams of $\text{C}_2\text{H}_3\text{Br}_3$ were reacted with 49.1 grams of O_2 ? The equation is shown below:



Example 7

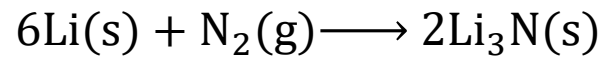
A 2,80 g sample of Al(s) reacts with a 4,15 g sample of $\text{Cl}_2(\text{g})$ according to the equation shown below. Which one is the limiting reagent?



2019 Eastern Cape Exemplar Paper 2 Q 7.2

When heated, lithium reacts with nitrogen to form lithium nitride.

The balanced equation:



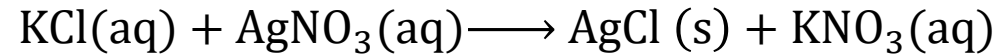
12,3 g of lithium is heated with 33,6 g of N_2 .

7.2.1 Define the term *limiting reagent*. (2)

7.2.2 Determine by calculation which substance is the limiting reagent. (6)

2023 Gauteng November Paper 2 Q 6.1

6.1 If a solution of silver nitrate (AgNO_3) is mixed with solution of potassium chloride (KCl), a precipitate of AgCl is produced according to the following reaction:



55 cm^3 of a potassium chloride solution with a concentration of $0,25 \text{ mol dm}^{-3}$ is added to 70 cm^3 of a silver nitrate solution with a concentration of $0,15 \text{ mol dm}^{-3}$.

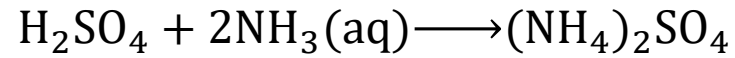
6.1.1 What is meant by limiting reagent? (2)

6.1.2 Determine which substance is the limiting reagent. (5)

6.1.3 What mass of AgCl has precipitated? (4)

2020 Eastern Cape November Paper 2 Q 7

The fertiliser ammonium sulphate $((\text{NH}_4)_2\text{SO}_4)$ is produced from the reaction of sulphuric acid (H_2SO_4) and ammonia (NH_3) according to the balanced equation:



2 kg of sulphuric acid and 58,82 moles of ammonia are available to produce the fertiliser.

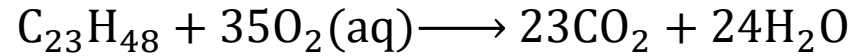
7.1 Define the term *limiting reagent*. (2)

7.2 Calculate the maximum mass of ammonium sulphate that can be produced by the reaction. (7)

2019 KwaZulu Natal September Paper 2 Q 8.1-8.2

Candle wax burns in oxygen to form carbon dioxide and water

according to the following balanced equation:



In one such reaction, $4,816 \times 10^{22}$ molecules of candlewax reacts with 3 moles of oxygen

8.1 Define a limiting reagent (2)

8.2 Determine whether the candle wax or oxygen is the limiting reagent. (4)

2016 November Paper 2 Q 6

Learners made a mini volcano in a science laboratory by adding sodium bicarbonate to ethanoic acid. They added 100 ml of a $0,2 \text{ mol dm}^{-3}$ ethanoic acid solution to 10 g of NaHCO_3 to start the reaction of the volcano.

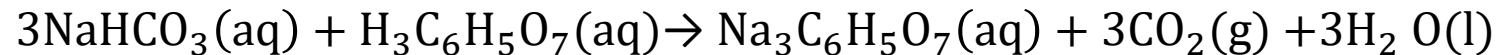
The balanced equation for this reaction is:



- 6.1 Define the term *limiting reagent*. (2)
- 6.2 Determine the limiting reagent in this reaction. (6)
- 6.3 Calculate the mass of the other substance in excess. (3)
- 6.4 Calculate the volume of CO_2 produced at STP. (4)

2015 November Paper 2 Q 5

The fizz produced when an antacid dissolves in water is caused by the reaction between sodium hydrogen carbonate (NaHCO_3) and citric acid ($\text{H}_3\text{C}_6\text{H}_5\text{O}_7$) The balanced equation for the reaction is:



5.1 Write down the FORMULA of the substance that causes the fizz when the antacid dissolves in water. (1)

A certain antacid contains 1,8 g of $\text{H}_3\text{C}_6\text{H}_5\text{O}_7$ and 3,36 g of NaHCO_3 . The antacid is dissolved in 100 cm^3 distilled water in a beaker.

5.2 Define *1 mole of a substance*. (2)

5.3 Calculate the number of moles of NaHCO_3 in the antacid. (3)

5.4 Determine, using calculations, which substance is the limiting reagent. (4)

5.5 Calculate the mass of the reactant in excess. (3)

5.6 Calculate the mass decrease of the beaker contents on completion of the reaction. (3)

QUANTITATIVE ASPECTS OF CHEMICAL CHANGE

PART THREE

Percentage composition of a compound

- ❑ A chemical compound is the combination of **two or more elements**.
- ❑ If you are studying a chemical compound, you may want to find the percent composition of a certain element within that chemical compound.
- ❑ **Percentage composition tells you by mass what percent of each element is present in a compound.**
- ❑ Percentage composition is **the mass of each atom present in a compound expressed as a percentage of the total mass of the compound.**
- ❑ The sum of percentages of each element in a compound should be 100.
- ❑ The equation for percent composition is:

$$\% \text{ composition} = \frac{\text{mass of element}}{\text{molecular mass}} \times 100$$

Steps in calculating percentage compositions

- Find the molar mass of all the elements in the compound in grams per mole.
- Find the molecular mass of the entire compound.
- Use the formula to calculate the percentage of each element

Percentage Composition



$$\text{Mass \% element} = \frac{\text{mass of element}}{\text{total mass of compound}} \times 100$$

Example 8

What is the percent composition of each element in H_2SO_4 ?

Example 9

What is the percent composition of each element in Na_2CO_3 ?

2015 November Paper 2 Q 6.2

Menthol, the substance we can smell in mentholated cough drops, is composed of carbon (C), hydrogen (H) and oxygen (O). During combustion of a 9,984 g sample of menthol, it is found that 28,160 g of $\text{CO}_2(\text{g})$ and 11,520 g of $\text{H}_2\text{O}(\text{g})$ is produced.

Calculate the mass of carbon (C) in the CO_2 . (4)

Percentage yield

- ❖ Chemical reactions in the real world do not always go exactly as planned on paper.
- ❖ During an experiment, many things will contribute to the formation of **less product than would be predicted**.
- ❖ Besides spills and other experimental errors, there are often losses due to an incomplete reaction, undesirable side reactions, etc.
- ❖ Chemists need a measurement that indicates how successful a reaction has been.
- ❖ **This measurement is called the percentage yield.**
- ❖ To compute the percent yield, it is first necessary to determine **how much of the product should be formed based on stoichiometry**.
- ❖ This is called the **theoretical yield, the maximum amount of product that could be formed from the given amounts of reactants**.

- ❖ The **actual yield** is the amount of product that is formed when the reaction is carried out in the laboratory.
- ❖ **The actual yield is defined as the quantity physically obtained from a chemical reaction**
- ❖ The theoretical yield is defined as **the calculated yield of a product in a chemical reaction**.
- ❖ The **percent yield** is the ratio of the actual yield to the theoretical yield, expressed as a percentage

Percent Yield

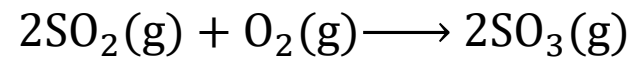
$$\text{percent yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100\%$$

Actual yield is the amount of product obtained from lab data.

Theoretical yield is the amount of product obtained from stoichiometry.

2022 Eastern Cape November Paper 2 Q 7.3

The formation of sulphur trioxide (SO_3) is represented by the following balanced equation.



During the above reaction 10 g of O_2 (oxygen) reacts completely with sulphur dioxide (SO_2).

Calculate the:

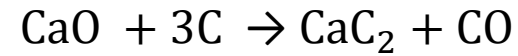
7.3.1 Number of moles of O_2 that reacted (3)

7.3.2 Theoretical yield of SO_3 (4)

7.3.3 Percentage yield if 40 g of SO_3 is produced at the end of the reaction (3)

2016 KwaZulu Natal June Common Paper 2 Q 5.2

Calcium carbide, CaC_2 , is produced industrially according to the reaction:

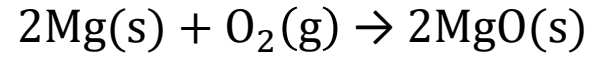


In a reaction, 1,5 kg of carbon was reacted with calcium oxide and 2,42 kg of calcium carbide was produced.

Calculate the percentage yield of calcium carbide. (8)

2018 KwaZulu Natal June Common Paper Q 6.2

Magnesium burns in oxygen to form magnesium oxide according to the following balance equation



The percentage yield of the reaction is 75%

Calculate the mass of magnesium that must be burnt in excess of oxygen to produce 20 g of magnesium oxide. (6)

Percentage purity

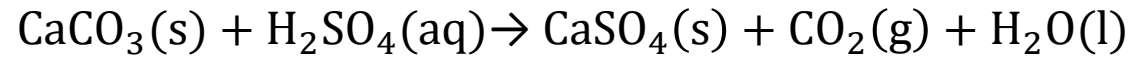
- ❑ Percentage purity refers to the proportion of a specific chemical compound or element present in an impure sample
- ❑ We can quantify how pure a sample is by its **percentage purity**.
- ❑ Percentage purity is defined as **the percentage of pure compound in an impure sample**
- ❑ It indicates the amount of pure and impure substance present in a sample.
- ❑ It is given by the equation:

$$\% \text{ purity} = \frac{\text{mass of pure compound in sample}}{\text{total mass of impure sample}} \times 100$$



2020 Eastern Cape November Paper 2 Q 8.3

40 g of IMPURE calcium carbonate reacts with a 200 cm³ of a dilute sulphuric acid with a concentration of 1,5 moldm⁻³. All the calcium carbonate and sulphuric acid react completely leaving the impurities unreacted at the completion of the reaction.



Calculate the percentage purity of the calcium carbonate. (6)

2023 Gauteng November Paper 2 Q 6.2

Mary heats 50 g of CaCO_3 that reacts according to the following reaction:



She collects the formed CO_2 gas.

6.2.1 Determine the number of moles of the CaCO_3 . (3)

6.2.2 She obtains only 18,2 g CO_2 gas. Determine the percentage purity of the CaCO_3 . (5)

6.2.3 Calculate the mass of CO_2 gas that Mary could collect if CaCO_3 was only 70% pure. (5)

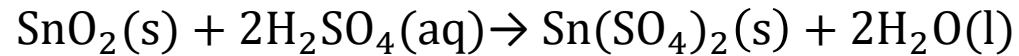
2018 KwaZulu Natal June Common Test Q 6.1

An impure sample containing tin oxide (SnO_2) is used to determine how much tin oxide it contains.

The sample weights 4,5g

Excess sulphuric acid is added to the sample and tin (IV) sulfate forms.

The equation for the reaction is:



The mass of tin sulphate produced is 4.9 g

Calculate the percentage purity of this sample. (6)

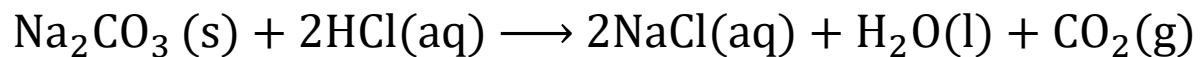


PAST EXAM PAPERS



2022 Gauteng November Paper 2 Q 5

A brisk effervescence is seen when diluted hydrochloric acid (HCl) reacts with sodium carbonate (Na_2CO_3). The balanced equation for the reaction is:



5.1 Write down the FORMULA of the substance that causes the brisk effervescence that is seen. (1)

5.2 In a reaction, 10,6 g of sodium carbonate reacts completely with excess hydrochloric acid.

5.2.1 Define *one mole of a substance*. (2)

5.2.2 Which substance is the limiting reagent?

Give a reason for your answer. (2)

5.2.3 Calculate the mass of CO_2 produced during this reaction. (5)

5.2.4 Calculate the mass of sodium chloride produced if $4,87 \text{ dm}^3$ of carbon dioxide is produced at STP. (5)

5.3 The empirical formula of a gas is NO_2 . Exactly 46 g of this occupies $11,2 \text{ dm}^3$ at STP.

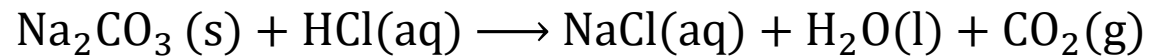
5.3.1 State Avogadro's Law that you will use with this information. (2)

5.3.2 Find the molecular formula of this compound. (3)

2018 November Paper 2 Q 6

In an experiment, a learner added 1,5 g of sodium carbonate (Na_2CO_3) to hydrochloric acid (HCl). A volume of 306 cm^3 of carbon dioxide gas was formed and collected under standard pressure at room temperature. Take the molar gas volume at room temperature (V_m) as $24,45 \text{ dm}^3$.

The unbalanced equation for the reaction is:



6.1.1 Define the term *one mole of a substance*. (2)

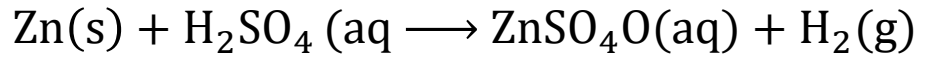
6.1.2 Balance the equation for the reaction. (2)

6.1.3 Calculate the mass of sodium carbonate that reacted. (7)

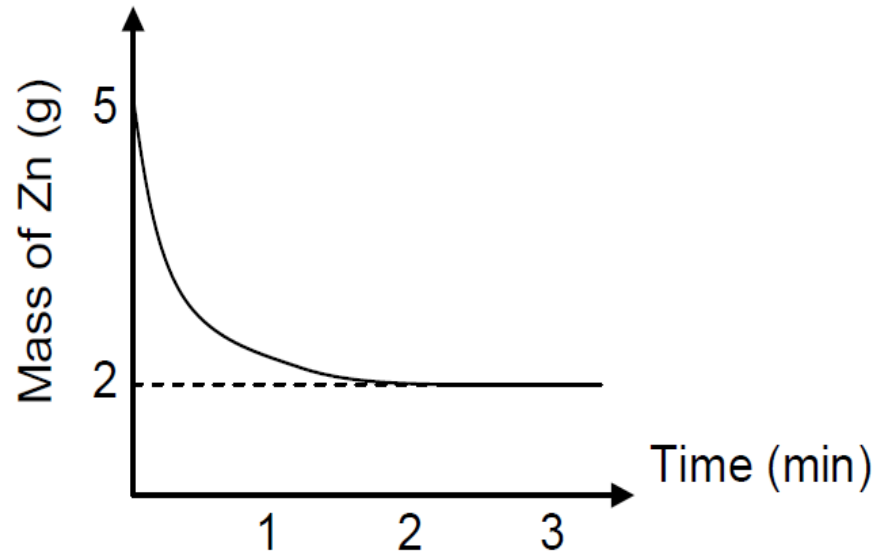
6.1.4 Calculate the percentage of sodium carbonate in excess. (2)

CONTINUED.....

6.2 Zinc reacts with sulphuric acid according to the reaction below.



The mass of zinc is recorded during the experiment and is shown on the graph below. The reaction stops after 2 minutes.



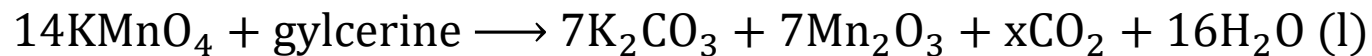
6.2.1 Name the substance that is the limiting reagent. (1)

6.2.2 Calculate the initial concentration of the sulphuric acid if 50 cm³ of the acid was used. (5)

2019 November Paper 2 Q 6

Potassium permanganate, KMnO_4 , burns with a bright flame when a few drops of glycerine are added to it.

The incomplete equation for the reaction is:



6.1.1 Define the term *molar mass*. (2)

6.1.2 The composition of glycerine is as follows:

39,13% carbon; 8,7% hydrogen; 52,17% oxygen

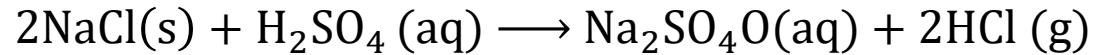
Determine the EMPIRICAL formula of glycerine.
Show ALL calculations. (6)

6.1.3 Write down the value of x in the equation above if the MOLECULAR formula of glycerine is $\text{C}_3\text{H}_8\text{O}_3$ (1)

6.1.4 Calculate the mass of $7\text{Mn}_2\text{O}_3$ that can be prepared if 18 g of KMnO_4 reacts with excess glycerine. (4)

CONTINUED...

6.2 The balanced equation for the reaction of sodium chloride, NaCl, with sulphuric acid, H_2SO_4 , is as follows:



During a reaction, 1,5 g of an impure sample of sodium chloride reacts with 100 cm³ sulphuric acid of concentration 0,1 mol·dm⁻³ at room temperature.

6.2.1 Define the term *concentration*. (2)

6.2.2 Calculate the number of moles of sulphuric acid used in the reaction above. (3)

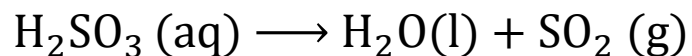
On completion of the reaction it is found that 460 cm³ of HCl gas has formed.

6.2.3 Calculate the percentage purity of the sodium chloride.

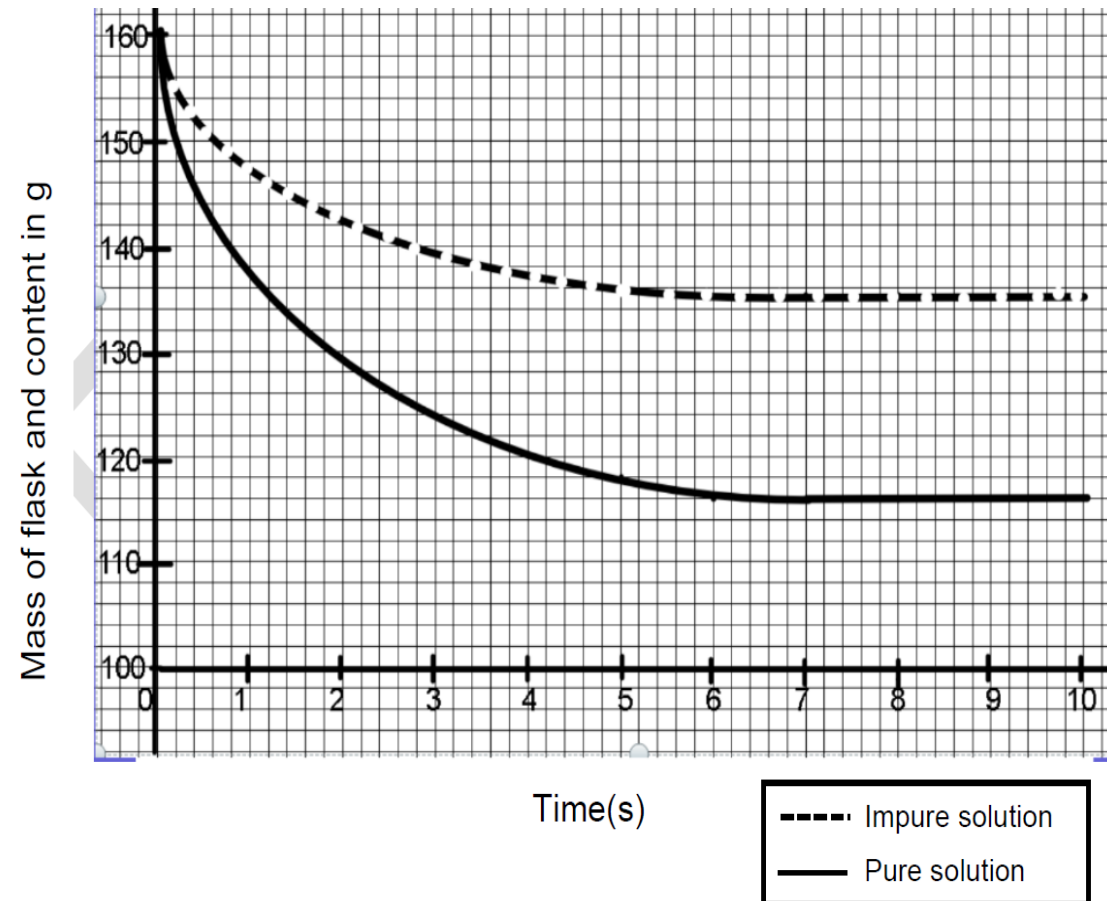
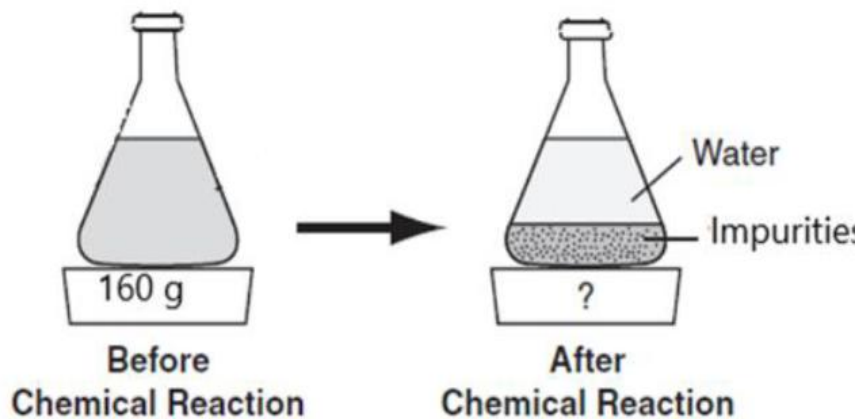
Use 24,45 dm³ as the molar gas volume (V_m) at room temperature. (6)

2021 Gauteng November Paper 2 Q 5.1-5.4

Sulphur dioxide has a pungent, irritating odour, similar to the smell of a just-struck match. Although its chief uses are in the preparation of sulphuric acid, sulphur trioxide and sulphites, sulphur dioxide is also used as a disinfectant, a refrigerant, a reducing agent, a bleach, and a food preservative, especially in dried fruits. The balanced equation of the decomposition of sulphurous acid, H_2SO_3 is:



Two samples H_2SO_3 with equal mass of which one is pure, and one is impure, are placed in open containers on a balancing scale, as shown in the diagram below:



5.1 Explain why the mass of the flask with its contents decreases. (2)

5.2 At which time did the reaction of the pure H_2SO_3 stop? (2)

The graph below shows the results obtained and the graph becomes parallel to the x-axis when the reaction is complete.

CONTINUED.....

5.3 Calculate the change in the mass of the pure sample
 H_2SO_3 . (3)

5.4 Calculate the percentage yield of the impure sample of
 H_2SO_3 . (4)

