

Chapter 2

Gases

Quantitative Properties of Gases

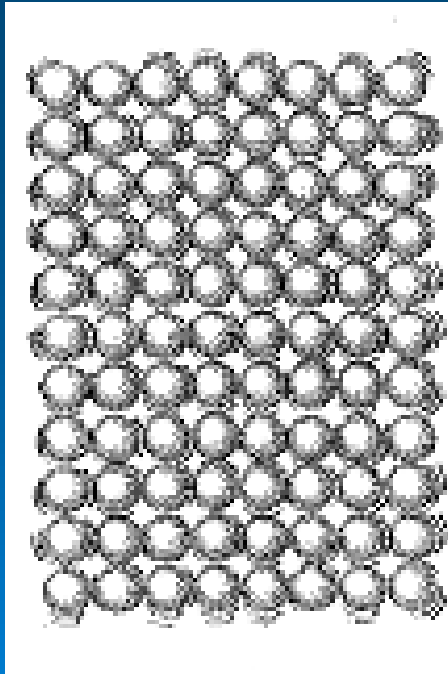
1. Amount (mass or moles)
2. Volume
3. Pressure
4. Temperature

Kinetic Molecular Theory: (Video)

- Smallest particles (atoms, ions or molecules) of a substance are in continuous motion
- As particles move around they collide with each other and objects they touch
- Energy of motion is called kinetic energy

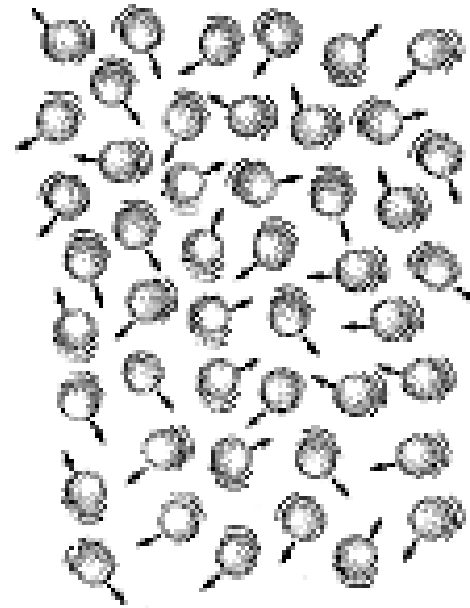
Three types of motion:

1. Translational - straight line
2. Rotational - spinning or turning
3. Vibrational - back-and-forth, oscillating & bond flexion



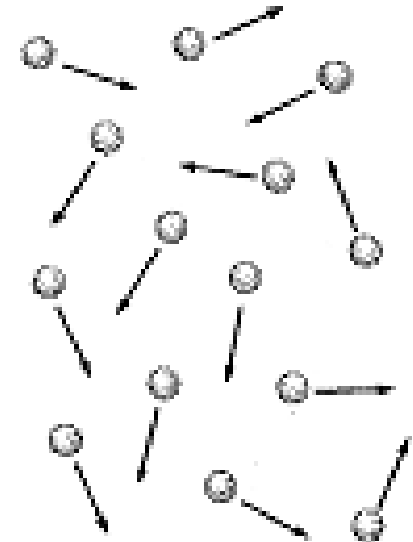
Solid

- Definite shape & volume
- Virtually incompressible
- Does not flow
- Mainly **vibrational** motion



Liquid

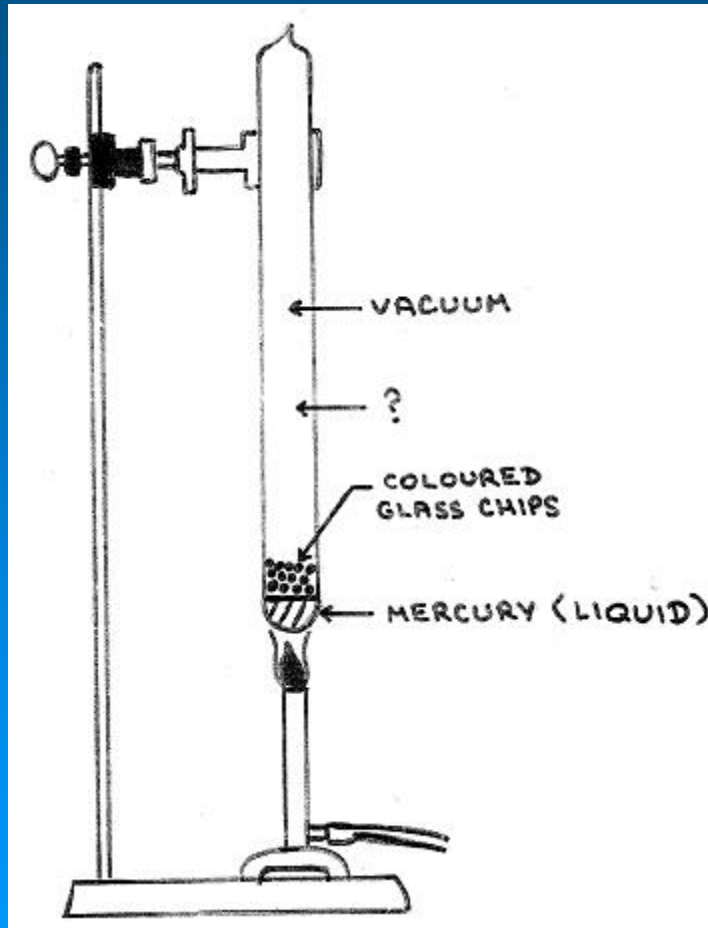
- Assumes container's shape
- Definite volume
- Virtually incompressible
- Flows readily
- **Vibrational** and **rotational**



Gas

- Assumes container's shape and volume
- Highly compressible
- Flows readily
- **Vibrational**, **rotational** & **translational** motion

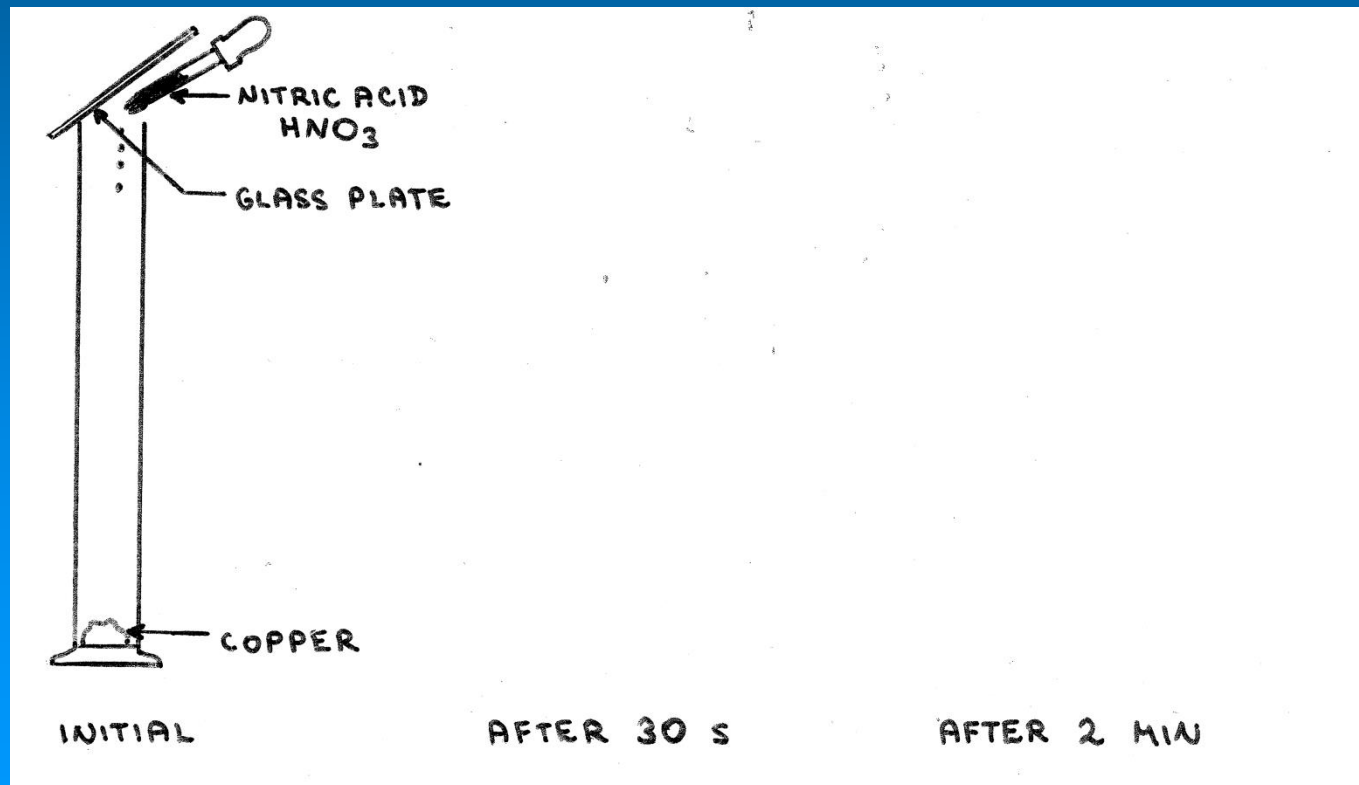
Particle Demonstration Tube:



Predict what will happen when the mercury is heated strongly.

Diffusion :

The process by which a substance spreads spontaneously in all directions from an area of high concentration to an area of lower concentration of the substance.



Given this definition and the particle theory, predict what will happen when NO_2 gas is produced.

Experiment: Number of moles and the volume of a gas

Purpose: The purpose of the experiment is to determine the relationship between the number of moles of H₂ gas produced in a reaction and the volume of H₂ gas.

Hypothesis:

The reaction is $\text{Mg}_{(s)} + 2\text{HCl}_{(aq)} \rightarrow \text{MgCl}_{2(aq)} + \text{H}_{2(g)}$

The independent variable is the _____.

The dependent variable is the _____.

The controlled variables are _____, _____, and _____.

As the number of moles of H₂ gas produced increases, the volume of H₂ gas produced will _____.

Procedure: *Write a summary (pg. 12) - don't copy word for word*

Diagram: *Look at the apparatus - label the diagram*

Data: Volume-gas moles relationship

Reaction	Volume of HCl consumed (mL) (\pm _____)	Volume of water (mL) (\pm _____)	Moles of H ₂ (g) produced (n)	Volume of H ₂ gas produced (mL) (\pm _____)	Volume of H ₂ gas (mL) Class Average
A	1.0	9.0	0.0005		
B	2.0	8.0	0.0010		
C	3.0	7.0	0.0015		

Analysis : Graph two lines

1. Your values of H₂ volume (3 data points)
2. Average volumes of H₂ from the class data (3 data points)

Conclusion:

As the number of moles of H₂ gas increases, the volume of H₂ gas _____ . This is a (direct/indirect) relationship.

The data (supports /does not support) the hypothesis.

Error Analysis

- Sources of error (2)
- How errors influence the results
- How can we correct for this error

Moles of Gas vs. Volume of a Gas

As the moles of a gas increase, the volume of the gas increases provided that the temperature and pressure of the gas remains constant.

In this lab ...

The independent variable was the moles of H₂ gas.

The dependent variable was the volume of H₂ gas.

The controlled variables were the temperature and pressure of the gas.

Introduction to Pressure

Mass = amount of matter (g)

Weight = the force that matter exerts due to gravity,
Newtons (N)

Pressure = the force (or weight) exerted on a given
surface area, Pascals (Pa)

$$1 \text{ Pascal} = 1 \text{ Newton/m}^2 \quad \text{or} \quad 1 \text{ Pa} = 1 \text{ N/m}^2$$

Activity: What pressure do you exert on the ground below your feet?

Step 1: *Calculate your weight in Newtons.*

Weight = Force = 120.0 lbs

$\frac{454 \text{ g}}{1 \text{ lb}} = \frac{\text{m}}{120.0 \text{ lb}}$ m = _____ g

_____ g \div 1000 = _____ kg

Multiply the answer by 9.8 m/s^2 to account for the force of gravity on the body.

_____ kg \times 9.8 m/s^2

= _____ $\text{kg}\cdot\text{m/s}^2$

= _____ N

= _____ N \leftarrow correct number of significant figures

Step 2: *What is the contact surface area that your body makes with the ground?*

Take off your right shoe and place your right foot on a piece of graph paper on the floor. Taking turns, your partner can trace the outline of your foot on the graph paper. Then count the number of square centimeters (surface area) of your foot. Multiply this value by _____ because you have _____.

Surface area = _____ cm² ÷ _____ = _____ m²

Step 3: *Calculate the pressure you exert on the ground below your feet?*

Pressure (Pa) = Weight (N) ÷ surface area (m²)

Pressure (kPa) = Pressure (Pa) ÷ 1000

Experiment: The Volume and External Pressure of a Gas

(Formal Lab Write-up – typed or hand written)

Problem: What effect does an increase in external pressure have on the volume of a gas?

Hypothesis: As the external pressure increases, the volume of a gas will _____ because _____.

Procedure: *Look at the syringe set in the wood block. How can you place 1, then 2 and then 3 bricks on top? Does it make any difference how you position the bricks? Discuss and write, with your partner, a procedure*

Diagram: *Look at the apparatus – label the diagram*

Data: *In a table (**Observations only**)*

Analysis: ***Pressure calculations***

Graph of your data (Volume (mL) vs. Pressure (kPa))

When the pressure doubles the volume _____.

When the pressure halves, the volume _____.

Conclusion: As the external pressure increases, the volume of a gas _____ provided the quantity of gas and the temperature remain constant. This is a (direct /indirect) relationship.

The data (supports /does not support) the hypothesis.

This is called _____ Law.

Error Analysis

- Sources of error
- How errors influence the results
- How can we correct for this error