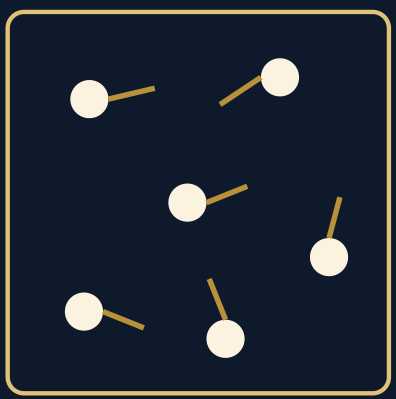
KECUDO

HIGH SCHOOL CHEMISTRY

Gases & Solutions

Class 4 · Concepts, Labs & Structures



PREMIUM
IV
EDITION

2026 EDITION · STUDENT SERIES

About this book

Welcome to **High School Chemistry, Class 4: Gases & Solutions**. Most chemistry happens in air or in water. Here you will learn the laws that predict how gases behave, and how to describe, make and use solutions.

How each chapter works

- **Depth dots** show the level: Foundation ●○○, Core ●●○, Advanced ●●●.
- **Concepts** with worked examples and figures drawn from real data.
- **Kecudo Lab** boxes: one hands-on experiment per chapter.
- **Try it** questions with answers, plus a 25-question scored self-assessment at the end.

Our running example

Kecudo Chem Co. inflates the airbag from Class 3 using the ideal gas law, makes a copper(II) sulfate solution from Sample K's blue crystals, and dilutes it for testing. Kecudo Salt Co. explains road salt, and Kecudo Water Co. tracks the oxygen fish need.

Data sources

Gas constant and standard pressure from NIST/CODATA; composition of dry air from NOAA and standard references; solubility data from the CRC Handbook of Chemistry and Physics; dissolved-oxygen saturation values from USGS tables. Kecudo company names and Sample K are fictional teaching examples.

> **Safety & use.** Educational content only. Perform experiments only with a qualified teacher, proper safety equipment and your school's safety rules. Steps marked “teacher demonstration” or “teacher-supervised” are not for students alone.

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FOUNDATION

Chapter 1

States of Matter & Kinetic Molecular Theory

The **kinetic molecular theory** (KMT) says all matter is made of particles in constant random motion. How fast they move, and how strongly they attract, decides whether a substance is a solid, liquid or gas.

The five ideas of KMT for gases

1. Gases are made of tiny particles far apart; the particles themselves take up almost no volume.
2. Particles move constantly, randomly and in straight lines.
3. Collisions are **elastic**: no energy is lost overall.
4. There are no attractions or repulsions between gas particles (an *ideal* gas).
5. Average kinetic energy is proportional to the **kelvin temperature**.

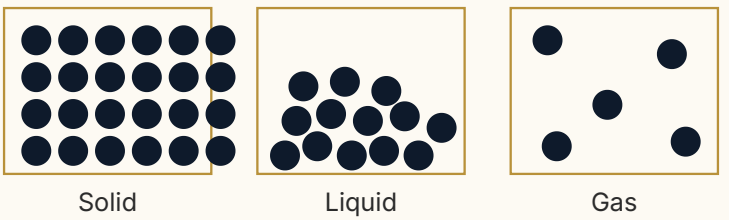


FIG 1.1 · Particle arrangement in the three states



FIG 1.2 · Average (rms) speed of gas molecules at 25 °C (m/s)

Source: calculated: √(3RT ÷ M).

Comparing the states

	Solid	Liquid	Gas
Shape	Fixed	Takes container's shape	Fills container
Volume	Fixed	Fixed	Fills container
Compressible?	No	Barely	Easily
Particle motion	Vibrate in place	Slide past each other	Fly freely
Attractions	Strong	Medium	Almost none

Changes of state

solid › melting → › liquid › vaporisation → › gas

Reverse: condensation (gas → liquid), freezing (liquid → solid). Solid straight to gas is **sublimation** (dry ice); gas straight to solid is **deposition** (frost).

> **Real vs ideal gases:** real gases behave almost ideally at normal conditions. They deviate at very high pressure (particles crowd together, so their volume matters) and very low temperature (attractions start to matter, and the gas condenses).

⚗ Kecudo Lab · Food Colouring in Hot and Cold Water

Add one drop of food colouring to a beaker of ice water and one of hot tap water at the same moment. Time how long the colour takes to spread evenly.

Analysis: use KMT to explain the difference. (Faster particles in hot water mix the dye sooner.)

✎ Try it

1. Which state is easiest to compress?
2. Dry ice turning to gas is called…
3. What does temperature measure in KMT?

Answers: **1.** gas · **2.** sublimation · **3.** average kinetic energy of particles

FOUNDATION

Chapter 2

Temperature & Pressure

Every gas law uses two measurements: **temperature** (how fast particles move) and **pressure** (how hard they hit the walls). Both have units you must get right.

Temperature: always use kelvin

K = °C + 273.15 (usually 273 is close enough)

Point	°C	K
Absolute zero	−273.15	0
Water freezes	0	273.15
Room temperature	25	298.15
Water boils (1 atm)	100	373.15

At **absolute zero** particles would have the minimum possible energy. The kelvin scale starts there, so it has no negative numbers — and doubling the kelvin temperature really does double the average kinetic energy.

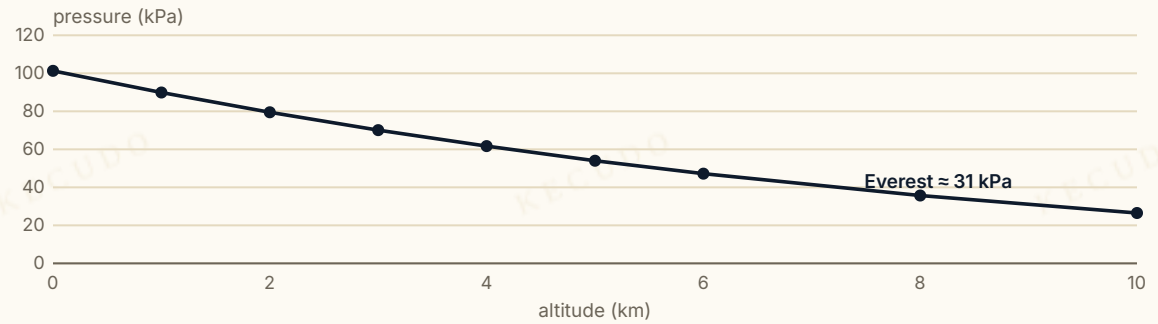


FIG 2.1 · Air pressure vs. altitude (kPa)

Source: U.S. Standard Atmosphere (1976).

FOUNDATION

Chapter 3

Boyle's Law

In 1662 Robert Boyle found that, at constant temperature, **the pressure and volume of a gas are inversely proportional**: squeeze a gas into half the space and its pressure doubles.

$$P_1V_1 = P_2V_2 \quad \text{(constant T and amount of gas)}$$

KMT explanation: in a smaller volume the same particles hit the walls more often, so the pressure rises.

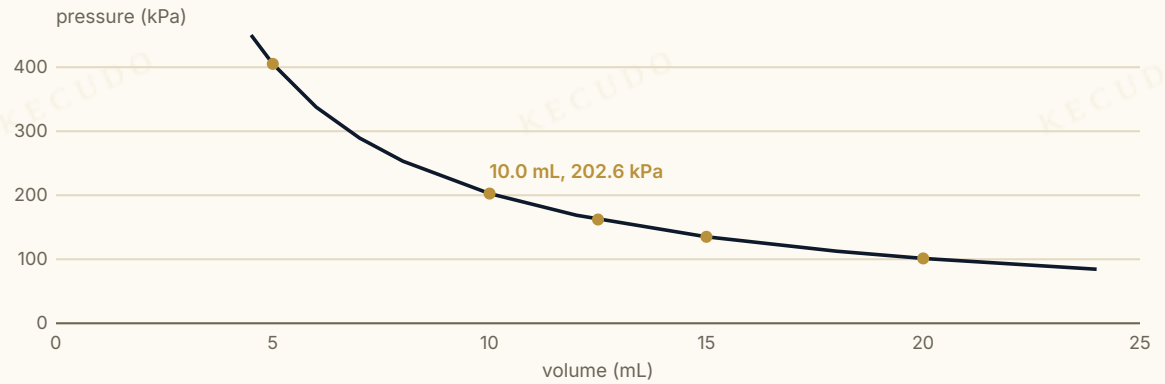


FIG 3.1 · Pressure vs. volume for air in a sealed syringe (P × V stays constant)

Source: Calculated from $P_1V_1 = P_2V_2$, starting at 101.3 kPa and 20.0 mL.

SELF-ASSESSMENT

Part A · Basics

Choose one answer per question. Your choice locks, and your score updates at the top of the screen.

A1. In KMT, temperature measures the...

A. Size of particles	B. Average kinetic energy of particles
C. Number of particles	D. Pressure

A2. Which unit must temperature be in for gas laws?

A. °C	B. °F
C. Kelvin	D. Any unit

A3. Boyle's law relates...

A. Pressure and volume	B. Volume and temperature
C. Pressure and temperature	D. Moles and volume

A4. In salt water, the solvent is...

A. Salt	B. Sodium
C. Chloride	D. Water

A5. Molarity is moles of solute per...

A. kg of solvent	B. Litre of solvent
C. Litre of solution	D. 100 g of water

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Thank you for learning with Kecudo.

Next in the series

Class 5 — Energy, Reaction Rates & Equilibrium

Heat & calorimetry · enthalpy · collision theory · catalysts · Le Chatelier's principle

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