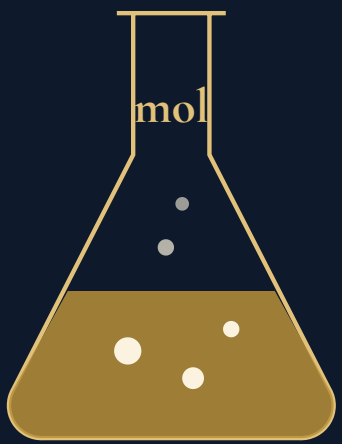
KECUDO

HIGH SCHOOL CHEMISTRY

The Mole & Reactions

Class 3 · Concepts, Labs & Structures



PREMIUM
III
EDITION

2026 EDITION · STUDENT SERIES

About this book

Welcome to **High School Chemistry, Class 3: The Mole & Chemical Reactions**. Atoms are far too small to count one by one, so chemists count them by weighing. With the mole and a balanced equation, you can predict exactly how much product any reaction will make.

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. weighs Sample K (53.6 g of copper) to count its atoms, turns it into silver crystals in a single-replacement reaction, and calculates the yield. Kecudo Bakery returns with baking soda and vinegar to show limiting reactants.

Data sources

IUPAC standard atomic weights (H 1.008, C 12.011, N 14.007, O 15.999, Na 22.990, S 32.06, Cu 63.546, Ag 107.87); CODATA Avogadro constant; solubility rules and activity series from standard references (CRC Handbook). Lab-group yield data are fictional teaching examples. 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

Counting by Weighing: The Mole

A single drop of water holds about 1.7×10^{21} molecules — far too many to count. So chemists use a counting unit, like a "dozen" but enormous: the **mole**.

$$1 \text{ mole (mol)} = 6.022 \times 10^{23} \text{ particles} \quad (\text{Avogadro's number, } N_A)$$

Counting unit	How many	Used for
pair	2	shoes
dozen	12	eggs
ream	500	sheets of paper
mole	6.022×10^{23}	atoms, molecules, ions

"Particles" means whatever the substance is made of: **atoms** for elements (Cu), **molecules** for covalent compounds (H_2O), **formula units** for ionic compounds (NaCl).

The number was chosen so that **1 mole of an element weighs its atomic mass in grams**. Carbon's atomic mass is 12.011 u, so one mole of carbon atoms has a mass of 12.011 g.

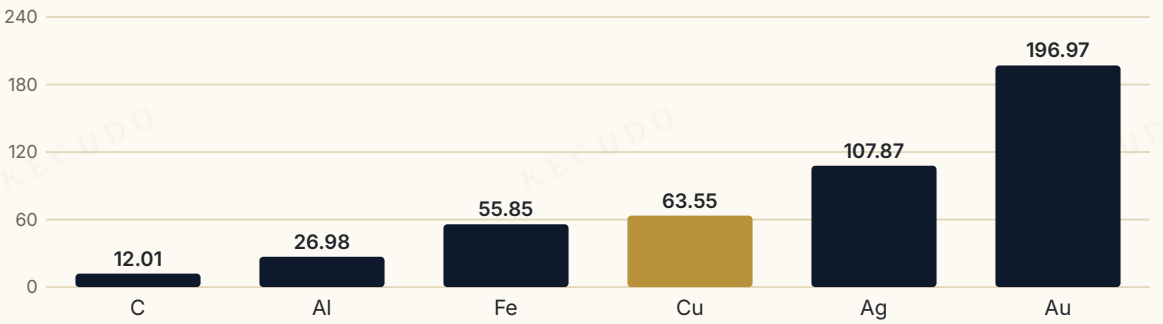


FIG 1.1 · Mass of one mole of atoms of each element (g)

Source: IUPAC standard atomic weights.

Each bar holds the **same number** of atoms — 6.022×10^{23} — but gold atoms are heavier, so a mole of gold weighs more. Same count, different mass: just like a dozen eggs vs. a dozen watermelons.

> **How big is N_A?** If you counted one atom per second, it would take about 1.9×10^{16} years to count one mole — over a million times the age of the universe.

⚗ Kecudo Lab · Counting by Weighing

Find the mass of 10 dried beans, 10 paperclips and 10 rice grains. Then, without counting, use mass to scoop out exactly 200 of each. Count to check.

Link: chemists do exactly this, using atomic mass instead of the mass of 10 beans.

✎ Try it

1. How many atoms are in 2.5 mol of iron?
2. Mass of 1 mol of copper atoms?
3. How many atoms in 12.0 g of carbon?

Answers: **1.** 1.51×10^{24} · **2.** 63.55 g · **3.** 6.02×10^{23}

FOUNDATION

Chapter 2

Molar Mass

The **molar mass** (M) of a substance is the mass of one mole of it, in grams per mole (g/mol). For a compound, add up the atomic masses of every atom in the formula.

Worked example — water, H_2O

Element	Atoms	Atomic mass	Subtotal (g/mol)
H	2	1.008	2.016
O	1	15.999	15.999
Molar mass of H_2O			**18.02**

Worked example — copper(II) sulfate pentahydrate (Sample K's blue crystals)

Part	Count	Mass each	Subtotal (g/mol)
Cu	1	63.546	63.546
S	1	32.06	32.06
O (in sulfate)	4	15.999	63.996
$CuSO_4$			**159.60**
H_2O (water of hydration)	5	18.015	90.075
$CuSO_4 \cdot 5H_2O$			**249.68**

Source: IUPAC standard atomic weights.

●○○ FOUNDATION

Chapter 3

Mole Conversions

The mole is the **hub** of chemical calculations. Every conversion between mass and number of particles passes through moles.

Mass (g) › ÷ molar mass → Moles ← × molar mass › × 6.022×10^{23} → Particles

FIG 3.1 · The mole map: always go through moles

To go from…	…to	Do this
grams	moles	divide by molar mass
moles	grams	multiply by molar mass
moles	particles	multiply by 6.022×10^{23}
particles	moles	divide by 6.022×10^{23}

Worked example — how many atoms in Sample K?

$$53.6\ \text{g Cu} \times \frac{1\ \text{mol}}{63.546\ \text{g}} = 0.843\ \text{mol Cu}$$

$$0.843\ \text{mol} \times \frac{6.022 \times 10^{23}\ \text{atoms}}{1\ \text{mol}} = 5.08 \times 10^{23}\ \text{atoms}$$

SELF-ASSESSMENT

Part A · Basics

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

A1. One mole contains how many particles?

A. 6.022×10^{23}	B. 6.022×10^{-23}
C. 1000	D. 12

A2. In a balanced equation you may change…

A. Subscripts	B. Coefficients
C. Formulas	D. States of matter

A3. Which type is $2Mg + O_2 \rightarrow 2MgO$?

A. Decomposition	B. Combustion only
C. Synthesis	D. Double replacement

A4. The limiting reactant is the one that…

A. Has the largest mass	B. Is a gas
C. Is left over	D. Runs out first

A5. “(aq)” after a formula means…

A. Dissolved in water	B. Aqueous solid
C. Gas	D. Pure liquid

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Thank you for learning with Kecudo.

Next in the series

Class 4 — Gases & Solutions

Kinetic molecular theory · the gas laws · molarity & dilution · solubility curves

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