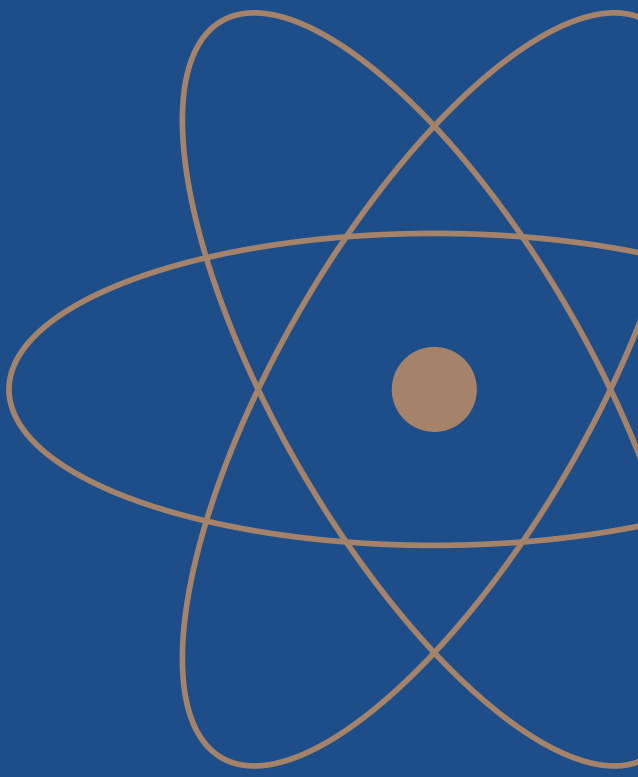
EXAM READY CHEMISTRY

Exam Ready Chemistry

GRADE 10

Study Guide, Worked Examples and Practice Tests for the Grade 10 Examination



- ✓ 6 units with clear key ideas, worked examples and “Watch out!” boxes
- ✓ 175 worked examples and 280+ practice questions at three levels
- ✓ 120 unit-quiz questions and 3 full mock exams (60 MCQ each)
- ✓ Diagnostic test · Key Facts Sheet · Top 20 Mistakes · teacher notes

Follows the units and order of the Ethiopian Grade 10 Chemistry textbook

ERMIAS WEDAJE TEGBARU

Exam Ready Chemistry

Grade 10 · Study Guide, Worked Examples and Practice Tests

By Ermias Wedaje Tegbaru
Civil engineer and author, Addis Ababa
First edition, 2026

© 2026 Ermias Wedaje Tegbaru. All rights reserved. This book is licensed to its reader for personal study on the Exam Ready Ethiopia website. It may not be copied, photographed, shared or sold, in whole or in part, without the author's written permission.

This is an independent study guide. It follows the units and order of the Ethiopian Grade 10 Chemistry student textbook, but it is not published or endorsed by the Ministry of Education. All explanations, examples and questions are original. Keep your textbook and your teacher's notes beside this book.

The answers were calculated and checked before printing, but no book is free of errors. If you find a mistake or disagree with an answer, please tell the author on Telegram (@Ermias_Wedaje) and it will be reviewed for the next edition.

How to Use This Book

Each unit follows the same pattern, so you always know where to look.

Key ideas
The rules and facts of the section, short and clear.

Worked examples
Step-by-step solutions. Cover the solution and try first.

⚠ Watch out!
The mistakes students make most often, and the right way.

Practice
Level 1 Basic · Level 2 Standard · Level 3 Challenge.

Unit quiz
20 multiple-choice questions in the style of the national examination.

For the Teacher
Timing, starters, misconceptions, activities and assessment.

For students

- Begin with the Diagnostic Test. It shows which units need the most work.
- Read the key ideas, then study each example with the solution covered.
- Do Level 1 and Level 2 practice for every section; try Level 3 when you are ready.
- Take each quiz in 30 minutes, mark it, and redo every question you got wrong.
- In the last weeks, learn the Key Facts Sheet and the Top 20 Mistakes page, and sit the three mock exams. Their answer keys show which unit each question comes from.

For teachers

- Each unit follows the textbook sections, so the book can sit beside your lessons.
- The “For the Teacher” page gives timing, starters, misconceptions and activities.
- The quizzes and mock exams can be used as class tests; every answer has a short reason.

For parents

- Ask your child to explain one worked example to you each day. Teaching is the best way to learn.
- Look at the quiz score after each unit, and celebrate progress, not only high marks.

Contents

Start	Diagnostic Test · Where Should I Start?	5
Unit 1	Chemical Reactions and Stoichiometry	7
Unit 2	Solutions	23
Unit 3	Important Inorganic Compounds	39
Unit 4	Energy Changes and Electrochemistry	55
Unit 5	Metals and Nonmetals	68
Unit 6	Hydrocarbons and Their Natural Sources	84
Reference	Key Facts Sheet	100
Reference	Top 20 Mistakes to Avoid	101
Reference	Exam Strategy	102
	Mock Examination 1	103
	Mock Examination 2	107
	Mock Examination 3	111
	Answers to the Mock Examinations	115

Page numbers are the numbers shown at the foot of each page (and in the online reader).

Diagnostic Test · Where Should I Start?

14 questions · 15 minutes. Take this test before you start the book. There are two questions on each unit. Your score only shows you where to spend your time.

1. The law of conservation of mass was proposed by
   A. Mendeleev B. Dalton C. Lavoisier D. Avogadro
2. Balanced: $N_2 + 3\ H_2 \rightarrow 2\ NH_3$. How many moles of NH_3 form from 6 mol of H_2?
   A. 6 B. 4 C. 9 D. 2
3. Which of the following is a homogeneous mixture?
   A. smoke B. muddy water C. brass D. milk
4. Whipped cream is a colloid of
   A. gas in liquid B. solid in liquid
   C. liquid in liquid D. liquid in gas
5. Which oxide is acidic?
   A. ZnO B. MgO C. SO_2 D. CO
6. Which is a neutral oxide?
   A. P_4O_{10} B. NO C. NO_2 D. CaO
7. In an exothermic reaction the products have
   A. the same enthalpy as the reactants B. no enthalpy
   C. lower enthalpy than the reactants D. higher enthalpy than the reactants
8. The heat needed to warm 100 g of water by 5 K ($c = 4.18\ J\ g^{-1}\ K^{-1}$) is
   A. 418 J B. 2.09 J C. 2090 J D. 20.9 J
9. Which metal is liquid at room temperature?
   A. mercury B. lead C. sodium D. iron
10. The reaction of sodium with water gives
    A. NaOH and O_2 B. NaOH and H_2 C. Na_2O and H_2 D. Na and H_2O_2
11. Which element does every organic compound contain?
    A. nitrogen B. oxygen C. carbon D. sulfur
12. The formula of the alkane with 9 carbon atoms is
    A. C_9H_{16} B. C_9H_{20} C. C_9H_{22} D. C_9H_{18}
13. The molar mass of $Al_2(SO_4)_3$ (Al 27, S 32, O 16) is
    A. 150 g/mol B. 278 g/mol C. 342 g/mol D. 315 g/mol
14. The mass of Fe obtained from 320 kg of Fe_2O_3 (Fe 56, O 16) is
    A. 112 kg B. 448 kg C. 320 kg D. 224 kg

Unit 1 · Chemical Reactions and Stoichiometry

By the end of this unit you will be able to:

- write and balance chemical equations and state the law of conservation of mass
- classify reactions as combination, decomposition, single displacement or double displacement
- assign oxidation numbers and identify oxidation, reduction, oxidising and reducing agents
- use the mole, molar mass and Avogadro's number, and find empirical and molecular formulae
- solve mass–mass, mass–volume and volume–volume stoichiometry problems
- find the limiting reactant and the percentage yield

Before you start — check yourself. (a) How many atoms of oxygen are in 2 H_2O? (b) What is the atomic mass of carbon? (c) Name the reactants in $H_2 + Cl_2 \rightarrow 2\ HCl$. (d) What happens to the total mass in a chemical reaction?
Answers: (a) 2 (b) 12 (c) hydrogen and chlorine (d) it stays the same

Key words: balanced equation · oxidation number · oxidising agent · reducing agent · mole · molar mass · empirical formula · stoichiometry · limiting reactant · percentage yield

How this unit is examined

Question types that appear again and again in Ethiopian model examinations:

- Chemical equations and balancing
- Types of chemical reactions
- Oxidation and reduction reactions
- The mole, molar mass and chemical formulas
- Stoichiometry
- Limiting reactant and percentage yield

1.1 Chemical Equations and Balancing

Key ideas

- A **chemical equation** uses formulas and symbols to show a reaction: **reactants → products**. State symbols: (s), (l), (g), (aq).
- **Law of conservation of mass:** the total mass of reactants equals the total mass of products, so the number of atoms of each element must be the same on both sides.
- **To balance:** (1) write the correct formulas; (2) count atoms on each side; (3) change **coefficients** only, never subscripts; (4) balance the elements that appear in one compound first, and O and H last; (5) check and use the smallest whole numbers.
- A balanced equation also shows the **ratio of moles** (and of gas volumes) of the substances.

Example 1.1 — Balance a combustion

Balance: $C_3H_8 + O_2 \rightarrow CO_2 + H_2O$.

Solution. C: 3 CO_2; H: 4 H_2O; O on the right = 6 + 4 = 10, so 5 O_2. **$C_3H_8 + 5\ O_2 \rightarrow 3\ CO_2 + 4\ H_2O$.**

Example 1.2 — Balance a metal–acid reaction

Balance: $Al + H_2SO_4 \rightarrow Al_2(SO_4)_3 + H_2$.

Solution. 2 Al, 3 SO_4, so 3 H_2SO_4 and 3 H_2: **$2\ Al + 3\ H_2SO_4 \rightarrow Al_2(SO_4)_3 + 3\ H_2$.**

Example 1.3 — Word to formula equation

Write a balanced equation: sodium reacts with water to give sodium hydroxide and hydrogen.

Solution. $Na + H_2O \rightarrow NaOH + H_2$; balance H: **$2\ Na + 2\ H_2O \rightarrow 2\ NaOH + H_2$.**

Example 1.4 — Exam Booster · Conservation of mass

10 g of calcium carbonate decomposes into 5.6 g of calcium oxide and carbon dioxide. What mass of CO_2 forms?

Solution. 10 − 5.6 = **4.4 g**.

Example 1.5 — Exam Booster · Balance with a polyatomic ion

Balance: $Ca(OH)_2 + H_3PO_4 \rightarrow Ca_3(PO_4)_2 + H_2O$.

Solution. 3 Ca, 2 PO_4: **$3\ Ca(OH)_2 + 2\ H_3PO_4 \rightarrow Ca_3(PO_4)_2 + 6\ H_2O$.**

⚠ Watch out!

× Wrong	✓ Right
Change the subscript to balance ($H_2O \rightarrow H_2O_2$).	Subscripts define the substance; only change coefficients.
The equation is balanced if the elements are the same on both sides.	The **number of atoms** of each element must be equal.
Balance O and H first.	Balance O and H last, because they appear in many substances.

Practice 1.1

Level 1 — Basic

1. State the law of conservation of mass.
2. Balance: $H_2 + O_2 \rightarrow H_2O$.
3. What do (s), (l), (g) and (aq) mean?

Level 2 — Standard

4. Balance: $N_2 + H_2 \rightarrow NH_3$.
5. Balance: $Fe + O_2 \rightarrow Fe_2O_3$.
6. Balance: $KClO_3 \rightarrow KCl + O_2$.

Level 3 — Challenge

7. Balance: $C_2H_6 + O_2 \rightarrow CO_2 + H_2O$.
8. Balance: $Al(OH)_3 + H_2SO_4 \rightarrow Al_2(SO_4)_3 + H_2O$.

1.2 Types of Chemical Reactions

Key ideas

- **Combination (synthesis):** A + B → AB. Example: $2\ Mg + O_2 \rightarrow 2\ MgO$.
- **Decomposition:** AB → A + B (heat, light or electricity). Example: $2\ H_2O_2 \rightarrow 2\ H_2O + O_2$; $CaCO_3 \rightarrow CaO + CO_2$.
- **Single displacement:** A + BC → AC + B. A more reactive metal displaces a less reactive one (or hydrogen) from a compound. Example: $Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$.
- **Double displacement:** AB + CD → AD + CB. Ions exchange partners; a precipitate, gas or water forms. Example: $AgNO_3 + NaCl \rightarrow AgCl\downarrow + NaNO_3$. **Neutralisation** (acid + base → salt + water) is a double displacement reaction.
- **Reactivity series (high to low):** K, Na, Ca, Mg, Al, Zn, Fe, Pb, (H), Cu, Ag, Au. A metal displaces those **below** it.

Example 1.6 — Classify

Classify: (a) $2\ Na + Cl_2 \rightarrow 2\ NaCl$; (b) $2\ KClO_3 \rightarrow 2\ KCl + 3\ O_2$; (c) $Fe + CuSO_4 \rightarrow FeSO_4 + Cu$; (d) $BaCl_2 + Na_2SO_4 \rightarrow BaSO_4 + 2\ NaCl$.

Solution. (a) **combination**; (b) **decomposition**; (c) **single displacement**; (d) **double displacement** ($BaSO_4$ is the precipitate).

Example 1.7 — Will it react?

Will copper displace zinc from $ZnSO_4$ solution?

Solution. No. Cu is below Zn in the reactivity series, so it cannot displace zinc.

Example 1.8 — Predict the products

Complete and balance: Mg + HCl → ?

Solution. Mg is above hydrogen: **$Mg + 2\ HCl \rightarrow MgCl_2 + H_2$**.

Unit 3 · Important Inorganic Compounds

By the end of this unit you will be able to:

- classify oxides as acidic, basic, amphoteric, neutral and peroxides and write their reactions
- describe the properties, preparation and uses of acids and bases and the Arrhenius definitions
- calculate pH, pOH, $[H^+]$ and $[OH^-]$ using $K_w = 10^{-14}$
- classify salts as normal, acidic and basic and describe hygroscopic, deliquescent and efflorescent salts
- prepare salts by neutralisation, metal–acid, precipitation and direct combination
- describe plant nutrients, fertilizers and pesticides

Before you start — check yourself. (a) Name the products when an acid reacts with a base. (b) What is the pH of pure water at 25 °C? (c) Write the formula of sodium chloride. (d) What colour does blue litmus turn in acid?
Answers: (a) a salt and water (b) 7 (c) NaCl (d) red

Key words: oxide · amphoteric · acid · base · pH · neutralisation · salt · deliquescent · fertilizer · indicator

How this unit is examined

Question types that appear again and again in Ethiopian model examinations:

- Oxides
- Acids
- pH, pOH and the ionisation of water
- Bases
- Salts
- Plant nutrients, fertilizers and pesticides

Unit 5 · Metals and Nonmetals

By the end of this unit you will be able to:

- compare the physical and chemical properties of metals and nonmetals
- use the reactivity series to predict reactions and choose a method of extraction
- describe the extraction of aluminium, iron and copper and the making of steel
- describe the production and properties of nitrogen, oxygen and phosphorus
- describe the production of sulfur, sulfuric acid by the Contact process, and chlorine
- state the uses of important metals and nonmetals

Before you start — check yourself. (a) Name two properties of metals. (b) Which gas makes up about 78% of air? (c) Name the process in which a solid ore is heated in air. (d) What is an alloy?
Answers: (a) conduct heat and electricity; shiny (b) nitrogen (c) roasting (d) a mixture of a metal with another element

Key words: ore · reactivity series · blast furnace · slag · alloy · allotrope · fractional distillation · Frasch process · Contact process · brine

How this unit is examined

Question types that appear again and again in Ethiopian model examinations:

- General properties of metals and the reactivity series
- Extraction of metals and aluminium
- Iron and steel
- Copper
- Nitrogen, oxygen and phosphorus
- Sulfur and chlorine

Unit 6 · Hydrocarbons and Their Natural Sources

By the end of this unit you will be able to:

- describe organic chemistry, functional groups and homologous series
- name alkanes, alkenes and alkynes and draw their isomers
- describe the properties and reactions of alkanes (combustion, substitution)
- describe the properties and reactions of alkenes and alkynes (addition, tests)
- describe benzene and aromatic hydrocarbons
- describe crude oil, its fractional distillation, cracking, natural gas and coal

Before you start — check yourself. (a) How many bonds does a carbon atom form? (b) Name the gas CH_4. (c) What is formed when a hydrocarbon burns completely? (d) Name the process of separating liquids by boiling point.
Answers: (a) four (b) methane (c) carbon dioxide and water (d) fractional distillation

Key words: organic compound · functional group · homologous series · alkane · alkene · alkyne · isomer · addition reaction · cracking · crude oil

How this unit is examined

Question types that appear again and again in Ethiopian model examinations:

- Introduction to organic chemistry
- Alkanes
- Alkenes
- Alkynes
- Aromatic hydrocarbons: benzene
- Natural sources of hydrocarbons

Key Facts Sheet

Learn these by heart. Cover the right-hand side and say each fact from memory.

Unit 1 · Reactions and stoichiometry

Balance with coefficients, never subscripts

$n = m/M$; $N_A = 6.022 \times 10^{23}$; 22.4 L/mol at STP

Oxidation = loss of e^- ; reduction = gain (OIL RIG)

% yield = actual/theoretical × 100

Limiting reactant: smallest (mol ÷ coefficient)

Empirical formula: moles → smallest whole-number ratio

Unit 2 · Solutions

Molarity M = mol/L of solution

Molality m = mol/kg of solvent

$M_1V_1 = M_2V_2$

Mass % = solute/solution × 100 ; ppm = $\times 10^6$

Henry: $S \propto P$ (gas)

Like dissolves like

Unit 3 · Inorganic compounds

Non-metal oxide: acidic ; metal oxide: basic

Amphoteric: Al_2O_3, ZnO ; neutral: CO, NO

$pH = -\log[H^+]$; $pH + pOH = 14$

$K_w = [H^+][OH^-] = 10^{-14}$

Acid + base → salt + water

N, P, K = primary plant nutrients

Unit 4 · Energy and electrochemistry

Exothermic $\Delta H < 0$; endothermic $\Delta H > 0$

$q = m\,c\,\Delta T$; $c(\text{water}) = 4.18\ J\ g^{-1}\ K^{-1}$

Anode: oxidation ; cathode: reduction

Galvanic: chemical → electrical ; electrolytic: reverse

Brine: H_2 at cathode, Cl_2 at anode, NaOH left

Plating: object = cathode

Unit 5 · Metals and nonmetals

K Na Ca Mg Al Zn Fe Pb H Cu Ag Au

Al: Hall–Héroult, cryolite, 950 °C

Fe: ore + coke + limestone ; $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

Cu: roast $CuFeS_2$, refine electrolytically

S: Frasch ; H_2SO_4: Contact (V_2O_5, 450 °C)

Cl_2: electrolysis of brine

Unit 6 · Hydrocarbons

Alkane C_nH_{2n+2} ; alkene C_nH_{2n} ; alkyne C_nH_{2n-2}

Alkanes: substitution ; alkenes/alkynes: addition

Br_2 water test for C=C or C≡C

C_4H_{10}: 2 isomers ; C_5H_{12}: 3 isomers

Benzene C_6H_6: substitution only

Crude oil: fractional distillation, then cracking

Mock Examination 1

60 multiple-choice questions · 90 minutes · one mark each. A scientific calculator is allowed. Circle one answer. Mark with the answer key at the back and use the unit number to see where to revise.

1. The law of conservation of mass was proposed by

   A. Mendeleev B. Dalton C. Lavoisier D. Avogadro

2. In a balanced equation the coefficients tell us the

   A. number of atoms in a molecule B. masses in grams
   C. mole ratio of the substances D. colour of the products

3. The coefficient of H_2O when $C_2H_6 + O_2 \rightarrow CO_2 + H_2O$ is balanced with whole numbers ($C_2H_6 = 2$) is

   A. 3 B. 4 C. 6 D. 7

4. Balanced: $N_2 + 3\ H_2 \rightarrow 2\ NH_3$. How many moles of NH_3 form from 6 mol of H_2?

   A. 6 B. 4 C. 9 D. 2

5. $2\ Mg + O_2 \rightarrow 2\ MgO$ is a

   A. single displacement reaction B. double displacement reaction
   C. combination reaction D. decomposition reaction

6. Which equation represents a double displacement reaction?

   A. $BaCl_2 + Na_2SO_4 \rightarrow BaSO_4 + 2\ NaCl$ B. $2\ H_2O \rightarrow 2\ H_2 + O_2$
   C. $C + O_2 \rightarrow CO_2$ D. $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$

7. Which metal will displace copper from copper(II) sulfate solution?

   A. mercury B. gold C. silver D. zinc

8. The oxidation number of chromium in $K_2Cr_2O_7$ is

   A. +3 B. +12 C. +7 D. +6

9. In the reaction $CuO + H_2 \rightarrow Cu + H_2O$ the reducing agent is

   A. Cu B. H_2O C. H_2 D. CuO

10. A substance that is reduced in a reaction is called the

    A. solvent B. reducing agent
    C. oxidising agent D. catalyst

11. Which of the following is a homogeneous mixture?

    A. smoke B. muddy water C. brass D. milk

12. Particles of a suspension are

    A. smaller than 1 nm B. larger than 1000 nm
    C. between 1 and 1000 nm D. single atoms

13. The scattering of light by a colloid is called the

    A. Brownian effect B. Doppler effect
    C. Raman effect D. Tyndall effect