

EXAMINATIONS COUNCIL OF ZAMBIA

ASSESSMENT SCHEME

CHEMISTRY — 4014

Examination for Certificate of Secondary Education Ordinary Level

Form 1 – 4

Aligned to the CDC Chemistry Syllabus, Secondary Education Ordinary Level, Form 1–4 (2024)

1. Construct

Applies chemistry concepts and scientific skills in solving real-life problems.

2. Elements of Construct (EoC)

The Chemistry examination will be based on the following six (6) Elements of Construct:

EoC 1 Classifies substances and interprets the physical and chemical changes of the substances for suitable application in life

- Classifies substances according to their nature, properties and their application in real life.
- Investigates and interprets the physical and chemical changes of substances.

EoC 2 Analyses and identifies chemical composition of substances for scientific decision making

- Uses a variety of analytical procedures, methods and techniques involved in identifying the chemical composition of substances in solid, liquid or gaseous form in order to solve real-life problems.

EoC 3 Evaluates industrial chemical processes and suggests alternative methods of production that are sustainable and environmentally safe

- Investigates and evaluates the conditions employed in industrial chemical processes and how these processes impact on the environment.
- Generates alternative methods of production that are sustainable and environmentally friendly.

EoC 4 Applies Chemistry principles and mathematical operations to determine quantities of either reactants or products from quantitative (balanced) chemical equations in real-life situations or for solving problems

- Applies mathematical manipulations to interpret stoichiometric ratios from balanced chemical equations.
- Determines stoichiometric quantities of reactants and their products from balanced chemical equations.

EoC 5 Investigates quantities involving industrial processes

- Determines theoretical yields in various industrial chemical processes as applied by chemists in everyday life.
- Develops more efficient ways of increasing yields.

EoC 6 Applies Chemistry principles in everyday life

- Designs and develops solutions, products and services using acquired scientific knowledge and skills for local and global real-life situations.

3. Test Design

The Chemistry examination will consist of two components: Component 1, School Based Assessment (SBA), set and scored by teachers at school level; and Component 2, the Final Examination, centrally set and marked by the Examinations Council of Zambia (ECZ) at the end of Form 4. The weighting of SBA and the Final Examination is 30% and 70% respectively, in line with the assessment policy stated in the CDC Chemistry Syllabus (2024).

Summary of the Test Design

Component	Code	Level	Duration	No. of Items/Tasks	Marks	Weighting
School Based Assessment – Component 1	4014/1	Form 2	1 year	6	100	
		Form 3	1 year	6	100	30%
Final Examination – Component 2	4014/2	Form 4	2 hours 30 minutes	6	80	70%

Distribution of Marks across Elements of Construct — Final Examination

EoC 1	EoC 2	EoC 3	EoC 4	EoC 5	EoC 6	Total
13	13	13	14	13	14	80

3.1 Structure

3.1.1 School Based Assessment – Component 1

SBA will be conducted during the course of teaching and learning from Form 2 to Form 3 and will be based on all six (6) Elements of Construct. The component will comprise a total of twelve (12) tasks — six (6) at Form 2 and six (6) at Form 3 — giving a total of 200 marks. Tasks will take the form of class tests, assignments, practical work, research/projects (individual or group) and end-of-term/end-of-year tests, and will be scenario-based, presenting real-life problems for learners to solve using chemistry concepts and skills. Tasks assessing experimental skills may use materials and specimens unfamiliar to learners, requiring them to follow instructions, make observations, record data, draw diagrams, and apply concepts to arrive at conclusions.

3.1.2 Final Examination – Component 2

The Final Examination will consist of six (6) compulsory items, one drawn from each of the six Elements of Construct. Each item will present a real-life scenario followed by a set of structured tasks. Candidates will answer all six items. The paper will be written in Form 4, will last 2 hours 30 minutes, and will carry a total of 80 marks.

3.2 Test Content

3.2.1 Types of Tasks and Items

- School Based Assessment – Component 1: objective and subjective tasks drawn from real-life situations, including assignments, presentations, class exercises, practical activities, quizzes, tests, and a subject-specific project.

- Final Examination – Component 2: semi-structured items (requiring words, numbers, symbols, equations, definitions, comparisons or calculations) and essay-type items (requiring extended prose responses), all scenario-based.

3.2.2 Syllabus Coverage

Both components are based on the CDC Chemistry Syllabus, Secondary Education Ordinary Level, Form 1–4 (2024), covering: Introduction to Chemistry, Matter, Elements/Compounds/Mixtures, and Atomic Structure (Form 1); Bonding, Chemical Reactions, Chemical Kinetics, Redox Reactions, and Acids/Bases/Salts (Form 2); Stoichiometry and the Mole Concept, Thermochemistry, Equilibrium, Electricity and Chemistry, and Periodicity (Form 3); and Metallurgy, Non-Metals, Organic Chemistry, and Environmental Chemistry (Form 4). Items assess the key competences of analytical thinking, critical thinking, problem solving, communication, collaboration, creativity and innovation, and environmental sustainability.

3.2.3 Level of Difficulty

SBA task difficulty ranges from Remembering to Creating (Revised Bloom's Taxonomy); Final Examination items range from Understanding to Evaluating. Difficulty is determined by: the complexity of the real-life scenario; the depth of subject knowledge and skill required; the number and complexity of cognitive processes needed to generate a response; the degree of abstract and critical thinking required; and the extent to which a candidate must devise their own strategy rather than follow an explicit procedure.

Distribution of Marks by Cognitive Level — Final Examination

Remembering	Understanding	Applying	Analysing	Evaluating	Creating	Marks
0	20	25	25	10	0	80

4. Scoring Criteria

4.1 School Based Assessment – Component 1

- SBA will be marked at school level by the subject teacher using scoring guides/rubrics provided in the School Based Assessment Guidelines for the Examination for Certificate of Secondary Education Ordinary Level.
- Scoring will measure the correctness of responses as well as the application of scientific skills — observation, data interpretation, problem solving, communication, and use of scientific procedures.
- Raw SBA marks for each of the two years (Form 2 and Form 3) will be submitted to ECZ, which will compute the appropriate weighting.

4.2 Final Examination – Component 2

- The Final Examination will be marked centrally by examiners engaged by ECZ, using an official scoring guide.
- A coordination meeting will be held before marking begins to harmonise the scoring guide and agree on acceptable alternative responses.
- Method marks will be allocated for correct working in calculations; an accuracy mark will be allocated for the correct final answer, including correct units.
- Marks will be allocated for correctly balanced equations, correct state symbols, and correctly drawn/labelled diagrams where required.
- Omission of essential working in a calculation, even where the final numerical answer is correct, may result in loss of marks.

5. Notes and Guidelines

- Candidates must sit both components in order to be graded; ECZ does not process partial marks.
- Non-programmable, silent scientific calculators are permitted in the Final Examination.
- Candidates will be expected to use 3.14, 3.142, or the calculator value of π , and Avogadro's constant as $6.0 \times 10^{23} \text{ mol}^{-1}$, unless otherwise stated.
- Relative atomic masses will be provided on the question paper where required.
- State symbols (s), (l), (g), (aq) must be written in lower case on the same line as the chemical species, not as subscripts.
- Cell phones, programmable calculators, and other unauthorised electronic devices are not permitted in the examination room.
- Practical/experimental SBA tasks must be supervised and scored progressively by the subject teacher, not assessed only on a finished product.

6. Exemplar Test Items

The following exemplar items illustrate the type, format, scenario-based design, and level of difficulty expected for the Final Examination. One item is provided for each Element of Construct, spanning topics across Forms 1–4 as prescribed in the syllabus.

Item 1 — EoC 1: Classifies substances and interprets physical and chemical changes

Element of Construct: EoC 1

Form Level / Topic: Form 1 — Matter; Elements, Compounds and Mixtures; Criteria of Purity; Purification and Separation Techniques

Specific Competence: Classify substances into elements, compounds and mixtures; separate mixtures using appropriate techniques; determine purity of a substance.

Key Competences: Analytical thinking, problem solving, environmental sustainability, communication.

Scenario

A community borehole in a rural area of Zambia has started producing water that looks cloudy and tastes slightly salty. A sample brought to the school laboratory is found to contain fine sand particles, dissolved common salt (sodium chloride), and a small amount of dissolved plant matter. As the school's young chemist, you have been asked by the Parent-Teacher Association to investigate the sample and recommend a way of making the water safe and clear for drinking.

Tasks

- (a) Classify sand, dissolved sodium chloride, and the borehole water sample itself as an element, a compound or a mixture, giving a reason for each classification. [4]
- (b) Describe, stage by stage, how you would separate the borehole water sample into its pure components, naming the separation technique used at each stage. [5]
- (c) State two criteria of purity you would use to confirm that the water collected after purification is pure. [2]
- (d) Using an example from the scenario, distinguish between a physical change and a chemical change. [2]

Model Answers / Marking Points

- (a) Sand — compound (silicon dioxide), made of two elements chemically combined; sodium chloride — compound, made of sodium and chlorine chemically combined; the borehole water sample — mixture, since sand, salt and plant matter are only physically combined and not chemically bonded, and can be separated by physical means. [1 mark each, max 4]
- (b) Filtration to remove the insoluble sand and plant debris from the salt solution; the filtrate (salt solution) is then purified by simple distillation, which evaporates the water and condenses it separately from the dissolved salt, leaving pure water as the distillate. [Filtration named and explained – 2; distillation named and explained – 3]
- (c) A pure substance has a sharp, fixed melting/boiling point (pure water boils at exactly 100 °C at standard pressure); a pure substance shows no residue and has a constant, definite composition. [Any two, 1 mark each]
- (d) A physical change (e.g. water evaporating during distillation) does not produce a new substance and is usually reversible; a chemical change (e.g. bleach reacting with the plant matter to destroy microbes) produces a new substance with different properties and is generally not easily reversible. [1 mark each contrast]

[Total: 13 marks]

Item 2 — EoC 2: Analyses and identifies chemical composition

Element of Construct: EoC 2

Form Level / Topic: Form 1/2 — Atomic Structure (Isotopes); Acids, Bases and Salts (Qualitative Analysis)

Specific Competence: Identify cations and anions present in a salt using qualitative tests; determine the relative atomic mass of an element from isotopic abundances.

Key Competences: Analytical thinking, critical thinking, problem solving, communication.

Scenario

A trader in Kasumbalesa has received several unlabelled sacks of white crystalline fertiliser from a supplier and does not know whether they contain ammonium sulphate. As the laboratory technician at the nearby agricultural research station, you are asked to test a sample dissolved in water to confirm the cation and anion present, and to help the station's report writer explain how the relative atomic mass of nitrogen (used in calculating the fertiliser's nitrogen content) is obtained from its isotopes.

Tasks

[Total: 16 marks]