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EXAMINATIONS
COUNCIL

Caribbean Secondary
Education Certificate®

SYLLABUS

CHEMISTRY

CXC 21/G/SYLL 13

Effective for examinations from May–June 2015



CSEC®

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NOTE TO TEACHERS AND LEARNERS

The Chemistry Syllabus (CXC 21/G/SYLL 13) was revised in 2016 for first examination in 2019.

Teaching is expected to commence on the revised syllabus in September 2017.

First Published in 1983
Revised in 1986, 1987, 1991, 1996, 2002 and 2016
Amended 2013
Revised 2017

PLEASE NOTE



This icon is used throughout the syllabus to represent key features which teachers and learners may find useful.

Chemistry Syllabus

◆ RATIONALE

The application of scientific principles and the conduct of relevant research are of significant importance in identifying, assessing and realising the potential of the resources of Caribbean territories. A good foundation in the sciences will help citizens of the Caribbean to respond to the challenges of a rapidly changing world using the scientific approach.

Chemistry is concerned with the physical and chemical properties of substances and the interaction of energy and matter. The study of Chemistry involves an investigation into chemical reactions and processes. The discipline seeks to explain and predict events at the atomic and molecular level. Through the principles of Chemistry, students will understand everyday life, nature and technology, and the significance of the well-being of man and the environment.

The CSEC Chemistry Syllabus is redesigned to allow students to work individually and with others in practical, field and interactive activities that are related to theoretical concepts in the course. It is expected that students will apply critical thinking, creativity and innovation, investigative and problem-solving skills, effectively communicate scientific information and appreciate the contribution that a study of chemistry makes to their understanding of the world. The syllabus places greater emphasis on the understanding and application of chemical concepts and principles and different learning styles and needs, so that students will develop twenty first century skills that will be of long-term value in an increasingly technological world, rather than focusing on large quantities of factual information. In addition, it encourages the use of various teaching and learning strategies while at the same time catering to multiple intelligences.

It contributes to the development of the Ideal Caribbean Person as articulated by the CARICOM Heads of Government in the following areas: respect for human life, awareness of the importance of living in harmony with the environment; demonstrates multiple literacies, independent and critical thinking and the innovative application of science and technology to problem solving. In keeping with the UNESCO Pillars of Learning, on completion of this course of study, students will learn to do, learn to be and learn to transform themselves and society.

◆ AIMS

This syllabus aims to:

1. appreciate and understand natural phenomena and the ways in which materials behave;
2. be aware of the power, impact and influence which Chemistry has in a modern scientific world and to emphasise that there is a responsibility that Chemistry be used for the good of the society and for the preservation of the environment;
3. appreciate, understand and use methods of science;

4. see the relevance of Chemistry to everyday life;
5. appreciate and understand the role of Chemistry in enabling materials to be used in the service of mankind, in the Caribbean and elsewhere;
6. understand basic chemical concepts in sufficient depth to provide an adequate foundation for specialisation;
7. develop the spirit of inquiry and to continue the search for new ways in which materials may be used in the service of mankind;
8. develop *creativity and innovation, communication, problem-solving* and critical thinking skills;
9. appreciate the inter-relationships among Chemistry, Biology, Physics, Mathematics and other subjects;
10. make use of chemical data, concepts, principles and terminology in communicating chemical information;
11. develop the ability to work independently and collaboratively with others when necessary;
12. appreciate the significance and limitations of science in relation to social and economic development;
13. integrate Information and Communication Technology (ICT) tools and skills into the teaching and learning of chemical concepts.

◆ CANDIDATE POPULATION

The syllabus is designed for students intending to pursue further studies in Science at the tertiary level as well as students whose formal study of the subject is unlikely to proceed further.

CANDIDATE REQUIREMENTS

1. Candidates should be exposed to at least three years of science at the secondary level, which should provide an introduction to basic scientific principles.
2. Candidates should be concurrently studying or have done:
 - (a) CSEC Mathematics or its equivalent;
 - (b) CSEC English A (English Language) or its equivalent.

It is assumed that students will be able to:

1. make calculations involving addition, subtraction, multiplication and division of quantities;
2. use significant figures, estimate orders of magnitude;

3. express fractions as percentages and vice versa;
4. use indices, transform decimal notation to powers of ten (standard form);
5. substitute values into equations;
6. manipulate formulae;
7. sketch curves (elementary), plot results graphically, select their own scales; determine gradients of curves and straight lines;
8. extrapolate and interpolate (from data);
9. perform simple operations involving ratio and proportion;
10. perform simple operations involving variation;
11. perform simple operations involving rates of change;
12. use pie charts, bar charts and histograms in representing data.

CLASS SIZE

It is recommended that practical classes accommodate a maximum of **twenty-five** students.

◆ SUGGESTED TIMETABLE ALLOCATION

It is recommended that a minimum of five 40-minute periods per week, including one double period, be allocated to the subject over a two-year period.

◆ ORGANISATION OF THE SYLLABUS

The syllabus is divided into three sections, namely:

SECTION A - Principles of Chemistry

SECTION B - Organic Chemistry

SECTION C - Inorganic Chemistry

◆ SUGGESTIONS FOR TEACHING THE SYLLABUS

It is recommended that Section A be taught first. However, in teaching each section, teachers need not follow the sequence given. SI units and IUPAC conversion of nomenclature should be used throughout.

*Teachers are strongly encouraged to use **inquiry-based** strategies to teach chemical concepts.*

Teachers should ensure that their lessons stimulate the students' curiosity and facilitate critical thinking and problem solving. This will help students view Chemistry as a dynamic and exciting investigative process. The provision of cooperative and collaborative activities is encouraged.

The general and specific objectives indicate the scope of the content including practical work that should be covered. However, unfamiliar situations may be presented as stimulus material in examination questions.

This syllabus caters to varying teaching and learning styles, with specific attention made to ensure the interrelatedness of concepts. The fourth column entitled, "Skills and Interrelationships" states which specific objectives are best suited for Observation, Recording and Reporting (ORR), Manipulation and Measurement (MM), Analysis and Interpretation (AI), and Planning and Designing (PD) skills. It also highlights connections between chemical concepts and fields of Biology, Physics, Mathematics and Agricultural Science. Whenever possible, a variety of teaching and learning strategies suitable to varying learning needs of students should be employed with special attention given to the identification of variables and the use of controls in chemical investigations. The need for repeated investigations and observations to arrive at meaningful conclusions should be emphasised.

In addition to developing a solid foundation of factual information, teachers are encouraged to emphasise the application of scientific concepts and principles and minimise memorisation and rote learning. In order to make the course as relevant as possible, every opportunity should be taken to help students make the connections between chemistry and their environment.

The role of the teacher is to facilitate students' learning accurate and unbiased information that will indirectly contribute to a more scientifically literate citizenry that is capable of making educated decisions regarding the world in which we live.

◆ CERTIFICATION AND DEFINITION OF PROFILES

The syllabus will be examined for General Proficiency certification.

In addition to the overall grade, there will be a profile report on the candidate's performance under the following headings:-

1. Knowledge and Comprehension;
2. Use of Knowledge;
3. Experimental Skills.

Knowledge and Comprehension (KC)

The ability to:

Knowledge

identify, remember, grasp the meaning of basic facts, concepts and principles;

Comprehension

select appropriate ideas, match, compare and cite examples of facts, concepts and principles in familiar situations.

Use of Knowledge (UK)

The ability to:

Application	use facts, concepts, principles and procedures in unfamiliar situations; transform data accurately and appropriately; use common characteristics as a basis for classification; use formulae accurately for computations;
Analysis and Interpretation	identify and recognise the component parts of a whole and interpret the relationships between those parts; identify causal factors and show how they interact with each other; infer, predict and draw conclusions; make necessary and accurate calculations and recognise the limitations and assumptions inherent in the collection and interpretation of data;
Synthesis	combine component parts to form a new meaningful whole; make predictions and solve problems;
Evaluation	make reasoned judgements and recommendations based on the value of ideas and information and their implications;
Environmental	show concern and awareness for the environment and the conservation of natural resources.

Experimental Skills (XS)

The ability to:

Observation/Recording/ Reporting	use the senses and extensions of them to perceive objects and events accurately; present a written report, drawing or other graphical representation, which is clear, concise, accurate and pertinent to the investigation; report and recheck unexpected results;
Drawing	make large, clear, labelled line representations of apparatus or models;
Manipulation/ Measurement	set up, use carefully and competently simple laboratory apparatus and measuring instruments; appropriately prepare materials for observation/investigation; master separation techniques; use materials economically;
Planning and Designing	develop hypotheses and devise means of carrying out investigations to test them; plan experimental procedures and operations in appropriate sequence; identify variables, state expected results, identify precautions and possible sources of error. It is expected that some of the planning and designing activities will be carried out <i>to help students develop this skill</i> . However, the reports of these activities are no longer plans and cannot be assessed as Planning and Design. They can be marked for other skills, for example, ORR.

◆ FORMAT OF THE EXAMINATIONS

Paper 01 (1 hour 15 minutes)	An objective test consisting of 60 multiple choice items.
Paper 02 (2 hours 30 minutes)	One compulsory data analysis question, two structured questions and three extended response questions.
Paper 03/1 School-Based Assessment (SBA)	School-Based Assessment will evaluate the achievement of the candidate in the Experimental Skills and Analysis and Interpretation involved in the laboratory and fieldwork. Candidates will be required to keep a separate practical workbook. CXC will require a sample of these for external moderation.
Paper 03/2 Assessment for Private Candidates only (2 hours and 10 minutes)	Alternate to the School-Based Assessment for private candidates. This paper will examine the same skills as those tested in Paper 03/1. The focus, therefore, will be on Experimental Skills and Use of Knowledge (Analysis and Interpretation).

NOTES ON THE EXAMINATIONS

1. The use of non-programmable calculators will be permitted in the examination. The use of a calculator to recall previously stored information during an examination is prohibited.
2. Copies of the Periodic Table will be provided if necessary.
3. SI units will be used on all examination papers.

WEIGHTING OF PAPERS AND PROFILES

The percentage weighting of the examination components and profiles is as follows:

Table 1- Percentage Weighting of Papers and Profiles

PROFILES	PAPER 01 Multiple Choice	PAPER 02 Structured and Data Analysis	PAPER 03 SBA	TOTAL RAW	TOTAL %
Knowledge and Comprehension	50	35	-	85	43
Use of Knowledge	10	55	10	75	37
Experimental Skills	-	10	30	40	20
TOTAL %	60	100	40	200	100

◆ REGULATIONS FOR PRIVATE CANDIDATES

Private candidates must be entered for examination through the Local Registrar in their respective territories and will be required to sit Papers 01, 02, and EITHER Paper 03/1 OR Paper 03/2.

Paper 03/2 is a practical examination designed for candidates whose work cannot be monitored by tutors in recognised educational institutions. The Paper will be of 2 hours and 10 minutes duration and will consist of three questions. Questions will test the Experimental Skills and Use of Knowledge (Analysis and Interpretation) profiles and will incorporate written exercises and practical activities.

◆ REGULATIONS FOR RESIT CANDIDATES

Resit candidates must complete Papers 01 and 02 and Paper 03 of the examination for the year for which they re-register.

SBA scores can be carried forward only ONCE and only during the year immediately following the first sitting. In order to assist candidates in making decisions about whether or not to reuse a moderated SBA score, the Council will continue to indicate on the preliminary results if a candidate's moderated SBA score is less than 50% in a particular subject.

Candidates re-using SBA scores should register as "Re-sit candidates" and must provide the previous candidate number when registering.

All resit candidates may enter through schools, recognised educational institutions, or the Local Registrar's Office.

◆ THE PRACTICAL APPROACH

The syllabus is designed to foster the use of inquiry-based learning through the application of the practical approach. Students will be guided to answer scientific (testable) questions by a process of making observations, asking questions, doing experiments and analysing and interpreting data. The CXC CSEC Chemistry syllabus focuses on the following skills.

1. Planning and Designing (PD)

Student's ability to:

- (a) *Ask questions: how, what, which, why or where. (Students must be guided by their teachers to ask scientific questions based on a stated problem).*

Sample Problem: It has been observed that galvanised roofs on beach houses corrode faster than those on houses inland.

Example: Why do galvanised roofs on beach houses corrode faster than those on houses inland?

- (b) *Construct a hypothesis; the hypothesis must be clear, concise and testable.*

Example: Iron rusts faster in the presence of salt water.

(c) *Design an experiment to test the hypothesis Experimental reports must include the following:*

- (i) *problem statement;*
- (ii) *aim;*
- (iii) *list of materials and apparatus to be used;*
- (iv) *clear and concise step by step procedure;*
- (v) *manipulated and responding variables;*
- (vi) *controlled variables;*
- (vii) *observations to be made or measurements to be taken;*
- (viii) *suggested display of results(for example, graphs tables;*
- (ix) *proposed use of results;*
- (x) *possible limitations, assumptions;*
- (xi) *precautions to be taken.*

2. Measurement and Manipulation (MM)

Student's ability to:

(a) *Handle scientific equipment competently.*

The list of equipment includes:

- (i) *Bunsen burner;*
- (ii) *measuring cylinder;*
- (iii) *beakers;*
- (iv) *thermometer;*
- (v) *ruler;*
- (vi) *stop watch/clock;*
- (vii) *balance;*
- (viii) *boiling tube;*
- (ix) *burette;*

- (x) pipette;
- (xi) conical flask;
- (xii) syringe;
- (xiii) voltmeter;
- (xiv) ammeter.

This list is not exhaustive.

- (b) Use appropriate apparatus.
- (c) Take accurate measurements.

3. Observation, Reporting and Recording (ORR)

(a) Recording

Student's ability to record observations and to collect and organise data. Observations and data may be recorded in the following format.

- (i) *Prose*
Written description of observations in the correct tense.
- (ii) *Table (Neatly enclosed)*
Numerical: physical quantities in heading, correct units stated in heading, symbols, decimal points.
Non-numerical: headings correct, details present.
- (iii) *Graph*
Axes labelled with units, correct scales, correct plotting, smooth curves/best fit lines.
- (iv) *Drawing of apparatus as set up for use.*

(b) Reporting

Student's ability to prepare a comprehensive written report on their assignments using the following format:

- (i) **Date** (date of experiment).
- (ii) **Aim** (what is the reason for doing the experiment).
- (iii) **Apparatus and Materials** (all equipment, chemicals and materials used in the experiment must be listed).
- (iv) **Method/Experimental Procedure** (step-by-step procedure written in the past tense, passive voice).

- (v) **Results and Observations** (see (a) above: Recording).
- (vi) **Discussion and Conclusion** (see 4: Analysis and Interpretation).

4. Analysis and Interpretation

Student's ability to:

- (a) *identify patterns and trends;*
- (b) *make accurate calculations;*
- (c) *identify limitations and sources of error;*
- (d) *make a conclusion to either support or refute the hypothesis;*
- (e) *compare actual results with expected results if they are different;*
- (f) *suggest alternative methods or modifications to existing methods;*
- (g) *analyse and interpret results and observations, and make conclusions.*

◆ SECTION A - PRINCIPLES OF CHEMISTRY

Section A is designed as an introduction to fundamental chemical concepts and principles. A study of the particulate nature of matter, structure, bonding, chemical properties and physical properties of elements, compounds and mixtures is included as well as certain quantitative properties. Comprehension of these concepts and principles will help students appreciate the importance of chemistry as it relates to the environment and the daily activities of man.

GENERAL OBJECTIVES

On completion of this Section, students should:

1. be aware that matter is made up of particles;
2. understand that different types of mixtures can be separated based on the properties of the components;
3. be familiar with the concept of the atom as the basic building block of matter;
4. appreciate that matter can be classified based on physical or chemical properties;
5. be aware of the different forces of attraction that exist between particles;
6. understand the mole as the unit for comparison of amounts of matter;
7. appreciate that properties of chemicals will affect their reactions;
8. assess the impact of certain materials on living systems and the environment;
9. be familiar with the composition of certain materials and develop the ability to make reasoned choices concerning their use;
10. understand that the rate at which a chemical reaction proceeds is dependent on a number of physical factors;
11. appreciate that energy changes occur during the course of a chemical reaction;
12. *appreciate the importance of chemistry to the environment.*

SECTION A - PRINCIPLES OF CHEMISTRY (cont'd)

SPECIFIC OBJECTIVES	CONTENT/ EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER- RELATIONSHIP
1. STATES OF MATTER			
Students should be able to:			
1.1 explain how evidence supports the particulate theory of matter;	<i>Evidence obtained from practical work involving processes, such as diffusion and osmosis. Use of salt or sugar to control garden pests and as a preservative.</i>	<i>Experiments of diffusion of ammonia and hydrogen chloride gases in cylindrical tube. Osmosis of Pawpaw (green) strips in a container of distilled water. Potassium manganate (VII) in water.</i>	<i>Biology- Osmosis, diffusion. Physics-Kinetic Theory. Skills: ORR; PD.</i>
1.2 distinguish among the three states of matter;	<i>Arrangement of particles, energy of particles, strength of forces of interaction. Consideration of physical characteristics of states. Example: Volume, density, compressibility.</i>		
1.3 explain the changes between the three states of matter in terms of energy and arrangement of particles.	<i>Consideration of freezing, melting, boiling, evaporation, sublimation, condensation; heating and cooling curves.</i>	<i>Heat the following ice, water, butter, Iodine (in a fume hood).</i>	<i>Physics - Specific latent heat. Skills: MM; AI; ORR.</i>
2. MIXTURES AND SEPARATIONS			
2.1 distinguish between pure substances and mixtures;	<i>Elements, compounds, atoms, molecules, fixed composition, properties, variable composition, variable properties.</i>	<i>Compare boiling point of pure water and sodium chloride solution.</i>	<i>Biology – Solutions in life processes. Skill: MM.</i>

SECTION A - PRINCIPLES OF CHEMISTRY (cont'd)

SPECIFIC OBJECTIVES	CONTENT/ EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER- RELATIONSHIP	
Students should be able to:				
2.2	<i>distinguish among solutions, suspensions and colloids;</i>	<i>Reference to particle sizes, passage of light, sedimentation.</i>	<i>Filtration, use of lamp light to view particles.</i>	<i>Skills: ORR, MM.</i>
2.3	<i>identify different types of solutions;</i>	<i>Types of solutions: solid in liquid, solid in solid, gas in liquid, liquid in liquid, gas in gas.</i>	<i>Observe examples of each type of solution.</i>	
2.4	<i>investigate the effect of temperature on solubility of solids in water;</i>	<i>Examples showing that a decrease in solubility with increasing temperature will not be required.</i>	<i>Determine the solubility of a solute in water, for example, potassium nitrate.</i>	<i>Biology – Transport system. Skills: AI; ORR; MM.</i>
2.5	<i>apply suitable separation techniques based on differences in properties of the components of mixtures;</i>	<i>Properties to be included: particle size, boiling point, crystalline structure, solubility and solute mobility in solvent. Include line drawing to represent the separation process. Refer to SO B1.2, B3.8, C5.8.</i>	<i>Use of simple filtration, simple and fractional distillation, paper chromatography, and the separating funnel.</i>	<i>Biology – Function of the kidney, digestive system. Skills: MM; ORR.</i>
2.6	<i>describe the extraction of sucrose from sugar cane.</i>	<i>A simple treatment of the following crushing, precipitation, filtration, vacuum distillation, crystallisation, centrifugation.</i>	<i>A field visit to a sugar producing plant.</i>	<i>Physics – Gas Laws, circular motion, Specific latent heat.</i>

SECTION A - PRINCIPLES OF CHEMISTRY (cont'd)

SPECIFIC OBJECTIVES	CONTENT/ EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER- RELATIONSHIP
Students should be able to:			
3. ATOMIC STRUCTURE			
3.1 describe with illustrations, the structure of atoms of atomic number 1 to 20;	<i>The atom as consisting of three basic particles: protons, neutrons and electrons arranged in shells. No consideration of orbitals is expected.</i>	<i>Make models.</i>	Physics-Particles in the atom.
3.2 state properties of electrons, protons and neutrons;	<i>Properties related to relative mass and relative charge only.</i>		
3.3 define atomic number and mass number;			Physics – Particles in the atom.
3.4 define relative atomic mass;	<i>Relative atomic mass based on carbon-12 isotope.</i>		
3.5 interpret notations of the form $\begin{array}{ccc} a & & c \\ & X & \\ b & & d \end{array}$	a – mass number; b – atomic number; c - charge; d - number of items in the entity; X – symbol of atom.		
3.6 define isotopy;	Isotopes as atoms with the same number of protons and different number of neutrons.		Physics- Radioactivity.
3.7 list uses of radioactive isotopes.	At least three uses of radioactive isotopes; for example, carbon dating, radiotherapy, tracers, pacemakers and energy generation.		Physics- Radioactivity.

SECTION A - PRINCIPLES OF CHEMISTRY (cont'd)

SPECIFIC OBJECTIVES	CONTENT/ EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER- RELATIONSHIP	
Students should be able to:				
4. PERIODIC TABLE AND PERIODICITY				
4.1	<i>explain the basis for the arrangement of elements in the periodic table;</i>	<i>Mention historical development of the periodic table, for example, contributions from Mendeleev and Dobereiner. Classification based on atomic number, atomic structure. Arrangement in periods and groups.</i>	Physics-Structure of the atom.	
4.2	<i>explain trends in Group II;</i>	<i>Ease of ionisation, reactivity with oxygen, water, and dilute hydrochloric acid.</i>	<i>Reactions of magnesium and calcium with water, air, and dilute hydrochloric acid.</i>	<i>Skills: ORR; AI.</i>
4.3	<i>explain trends in Group VII;</i>	<i>Consideration of the following properties: physical state at room temperature, strength of oxidising power.</i>	<i>Carry out simple displacement reactions with chlorine, bromine and iodine. Observe the physical state of these elements.</i>	<i>Skills: ORR, AI.</i>
4.4	<i>identify trends in period 3;</i>	<i>Metallic to semi-metallic to non-metallic properties. Refer to SO A7.1.</i>		
4.5	<i>predict properties of unknown elements based on the position in periodic table.</i>	<i>Plan and design an investigation of the position of element X in the periodic table.</i>	<i>Skill: PD.</i>	

SECTION A - PRINCIPLES OF CHEMISTRY (cont'd)

SPECIFIC OBJECTIVES	CONTENT/ EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER- RELATIONSHIP
Students should be able to:			
5. STRUCTURE AND BONDING			
5.1	explain the formation of ionic and covalent bonds;	Draw dot and cross diagrams to show ionic and covalent bonding. Refer to SO B2.1.	
5.2	predict the likelihood of an atom forming an ionic or a covalent bond based on atomic structure;		
5.3	write formulae to represent ions, molecules and formula units;		
5.4	explain metallic bonding;	<i>Arrangement of cations and mobile electrons.</i> <i>Refer to SO C1.1.</i>	Physics-Particles in the atom.
5.5	<i>describe ionic crystals, simple molecular crystals and giant molecular crystals;</i>	Make diagrammatic representations of sodium chloride, graphite and diamond.	<i>Make models of sodium chloride, graphite and diamond.</i>
5.6	<i>distinguish between ionic and molecular solids;</i>	<i>Use melting point, solubility in water and organic solvents, and conductivity.</i>	Investigate melting point and solubility of solids and conductivity of resulting solutions. Physics – Electricity, specific latent heat. Biology – Life processes. <i>Skills: ORR; MM; AI.</i>
5.7	relate structure of sodium chloride, diamond and graphite to their properties and uses;	<i>Use melting point, solubility in water, conductivity, hardness and lubricating power.</i>	Physics - Electricity, latent heat. Biology - Solutions in life processes.
5.8	explain the term allotropy.	<i>Reference to the allotropes of carbon – diamond and graphite.</i>	

SECTION A - PRINCIPLES OF CHEMISTRY (cont'd)

SPECIFIC OBJECTIVES	CONTENT/ EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER- RELATIONSHIP
Students should be able to:			
6. MOLE CONCEPT			
6.1 define mole and molar mass;	<i>The mole as the amount of substance that contains 6.0×10^{23} (the Avogadro's constant) particles in that substance. Molar mass - mass of 1 mole of a substance in g mol^{-1}.</i>	<i>Observe and compare the masses of 1 mole of different substances.</i>	Physics-Kinetic Theory. Skills: MM, AI.
6.2 perform calculations involving the mole;	<i>Calculations from mass to moles and moles to mass and percentage composition by mass.</i> <i>Calculate relative molecular mass or relative formula mass given atomic masses.</i> <i>No definitions are required for the relative masses. Distinguish between molar mass and relative masses.</i>		
6.3 state Avogadro's Law;	<i>Calculations involving molar volumes. [rtp and stp].</i>		
6.4 state the Law of Conservation of Matter;			
6.5 write balanced equations;	<i>Use of both ionic and molecular equations (including state symbols) to represent chemical reactions referred to in the syllabus.</i>	<i>Use simple chemical reactions to illustrate.</i> <i>Refer to SO C1.1, C1.2, C6.1.</i>	Skills: ORR, AI.

SECTION A - PRINCIPLES OF CHEMISTRY (cont'd)

SPECIFIC OBJECTIVES	CONTENT/ EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER- RELATIONSHIP
Students should be able to:			
6.6	apply the mole concept to equations, both ionic and molecular;	Calculations involving masses and volumes. Refer to SO A7.11.	
6.7	define the term standard solution.	<i>Molar concentration and mass concentration.</i> <i>Refer to SO A7.11.</i>	<i>Prepare standard solutions.</i> <i>Skills: MM; AI.</i>
7.	ACIDS, BASES AND SALTS		
7.1	define acid, acid anhydride, base, alkali, salt, acidic, basic, amphoteric and neutral oxides;	Consideration of proton donor or acceptor and replaceable hydrogen. <i>Relate to basic and acidic oxides.</i> <i>Refer to SO A4.4.</i>	
7.2	relate acidity and alkalinity to the pH scale;	pH scale - No formal definition of pH required. Refer to SO C6.3.	Biology - Digestion, blood, enzyme activity. <i>Skill: ORR.</i>
7.3	discuss the strength of acids and alkalis on the basis of their completeness of ionisation;	Degree of ionisation linked to strength and the pH of the solution.	Use pH meter.
7.4	<i>investigate the reactions of non-oxidising acids;</i>	<i>Reactions of acids with metals, carbonates, hydrogen carbonates, bases.</i> <i>Refer to SO C1.2, C5.3.</i>	Biology – Use of antacids. <i>Skills: ORR; PD; AI.</i>

SECTION A - PRINCIPLES OF CHEMISTRY (cont'd)

SPECIFIC OBJECTIVES	CONTENT/ EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER- RELATIONSHIP
Students should be able to:			
7.5 list examples of acids in living systems;	<i>Vitamin C (ascorbic acid), methanoic acid (in ants), lactic acid (build-up in muscles). Neutralisation of Vitamin C with sodium hydrogen carbonate. Formula of Vitamin C not required. The treatment of ant stings, use of vinegar in food preservation due to low pH. Use of lime juice to remove rust stains.</i>	Plan, design and conduct an investigation to compare the vitamin C content of a named fruit juice before and after heating.	<i>Biology – Nutrition, respiration.</i> <i>Skills: PD; ORR, AI.</i>
7.6 investigate the reaction of bases with ammonium salts;	Refer to SO A 7.10, SO C5.2.		
7.7 identify an appropriate method of salt preparation based on the solubility of the salt;	A general knowledge of the solubility of sulfates, nitrates, chlorides, carbonates and bases. <i>Uses of salts in everyday life.</i>	Prepare insoluble salts by precipitation; prepare soluble salts by direct combination and by replacing hydrogen ions of an acid directly or indirectly by a metal or ammonium radical.	<i>Skills: MM; PD.</i>

SECTION A - PRINCIPLES OF CHEMISTRY (cont'd)

SPECIFIC OBJECTIVES	CONTENT/ EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER- RELATIONSHIP
Students should be able to:			
7.8 list the uses and dangers of salts;	<i>Refer to action of baking powder, calcium carbonate for the manufacture of cement. For food preservation: sodium chloride, sodium nitrite, sodium nitrate, sodium benzoate. For medical uses: plaster of Paris (calcium sulfate), Epsom salts (magnesium sulfate). Sodium nitrate is implicated in causing brain damage in infants and also suspected to be carcinogenic.</i>	<i>Use of universal indicator, pH meter reaction with carbonates.</i>	<i>Skills: ORR; PD.</i>
7.9 distinguish between acid salts and normal salts;	<i>Basicity of acids.</i>		
7.10 investigate neutralisation reactions using indicators and temperature changes;	<i>Use of colour change of indicators and temperature changes to determine neutralisation point. Refer to the action of toothpaste in neutralising acids in the mouth. For example, fluoride ions replacing hydroxide ions in the enamel of the tooth. Effect of adding lime to soil. Effect of adding lime and an ammonium fertiliser to soil at the same time. Refer to SO A 7.6, A11.3.</i>	<i>Carry out neutralisation reactions using indicators and thermometers.</i>	<i>Physics – Fundamental quantities and units. Skills: ORR; AI; PD; MM.</i>

SECTION A - PRINCIPLES OF CHEMISTRY (cont'd)

SPECIFIC OBJECTIVES	CONTENT/ EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER- RELATIONSHIP
Students should be able to:			
7.11 <i>perform calculations using volumetric analysis data.</i>	(a) <i>Number of moles reacting.</i> (b) <i>The mole ratio in which the reactants combine.</i> (c) <i>The molar concentration and mass concentration of reactants.</i>	<i>Acid-Base titrations.</i>	<i>Skills: MM, AI.</i>
<i>Refer to SO A6.6, A6.7.</i>			
8. OXIDATION – REDUCTION REACTIONS			
8.1 <i>investigate the action of common oxidising and reducing substances in everyday activities;</i>	<i>Action of bleach (stain removal, browning of cut fruits and rusting. Sodium sulfite or sulfur dioxide used as food preservatives.</i>		
8.2 <i>define oxidation and reduction;</i>	<i>Loss and gain of electrons and a change in oxidation number.</i>		
8.3 <i>deduce oxidation number from formulae;</i>			
8.4 <i>identify oxidation and reduction reactions including reactions at electrodes;</i>	<i>Refer to SO A9.8.</i>		<i>Skills: ORR; AI.</i>

SECTION A - PRINCIPLES OF CHEMISTRY (cont'd)

SPECIFIC OBJECTIVES	CONTENT/ EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER- RELATIONSHIP
Students should be able to:			
8.5 distinguish between oxidising and reducing agents;	Equations involving formulae for potassium chromate (VI), potassium manganate(VII) and household bleach are not required. Inclusion of at least one example of a substance, which can behave both as an oxidising and a reducing agent. Refer to SO B3.7, C6.3.	Perform reduction and oxidation reactions with potassium manganate (VII) iron (II) sulfate, potassium chromate (VI), hydrogen peroxide and potassium iodide. Concentrated hydrogen peroxide should be handled with care.	Skills: ORR; MM; AI; PD.
8.6 perform tests for oxidising and reducing agents.	Refer to SO C6.3.		Skills: ORR; AI; MM; PD.
9. ELECTROCHEMISTRY			
9.1 conduct investigations leading to the classification of substances as conductors or non-conductors;	Low voltage supplies only. Plastic and metals.		Physics – Current, electricity.
9.2 distinguish between metallic and electrolytic conduction;	Reference to mobile electrons in metals and mobile ions in solution.	Use simple circuits including plastic, metals or solutions.	Physics – Current, electricity. Skills: AI; MM; PD.
9.3 classify electrolytes as strong or weak based on their conductivity;	Use of acids, salts and alkalis as examples of electrolytes.		Physics – Current, electricity.
9.4 define electrolysis, cathode, anode, cation, anion;			Physics – Current, electricity.

SECTION A - PRINCIPLES OF CHEMISTRY (cont'd)

SPECIFIC OBJECTIVES	CONTENT/ EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER- RELATIONSHIP
Students should be able to:			
9.5	identify ions present in electrolytes;		
9.6	predict the electrode to which an ion will drift;		
9.7	predict chemical reactions making use of electrochemical series;	Consideration of gain or loss of electron and formation of cation.	
9.8	<i>discuss the electrolysis of certain substances;</i>	<p><i>Principles related to:</i></p> <p>(a) Concentration of electrolyte.</p> <p>(b) Type of electrode (active and inert).</p> <p><i>Position of ions in the electrochemical series with respect to the named substances. Refer to SO A8.4.</i></p>	<p>Carry out electrolysis of the following substances: dilute sulfuric acid, concentrated aqueous sodium chloride, dilute aqueous sodium chloride, aqueous copper(II)sulfate using carbon or platinum and copper electrodes. One fused halide, for example, lead (II) bromide, using inert electrodes. Draw simple line diagrams representing electrolytic cell.</p> <p>Physics – Current, electricity.</p> <p><i>Skills: ORR; AI.</i></p>
9.9	define the Faraday constant;	Approximate value of the Faraday constant as $96\,500\text{ C mol}^{-1}$ (coulombs per mole) of electrons.	Physics – Current, electricity.
9.10	<i>calculate the masses and volumes of substances liberated during electrolysis;</i>	<p>Quantity of electricity dependent on the current and time.</p> <p>$Q = It.$</p>	Physics – Current, electricity.

SECTION A - PRINCIPLES OF CHEMISTRY (cont'd)

SPECIFIC OBJECTIVES	CONTENT/ EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER- RELATIONSHIP
Students should be able to:			
9.11 describe industrial applications of electrolysis.	Reference to: (a) metallic extraction (based on position in electrochemical series); (b) purification; (c) electroplating; (d) anodising. Refer to SO C2.3.		Physics – Current electricity.
10. RATES OF REACTION			
10.1 define rate of reaction;	The change in concentration of reactant or product with time at a stated temperature.		
10.2 identify the factors which affect the rate of reaction;	Factors: (a) concentration; (b) temperature; (c) surface area; (d) presence or absence of a catalyst. The danger of explosive combustion of finely divided substances, for example, flour in flour mills. Consideration of the change in rate of reaction as the reaction proceeds.	Carry out exercises varying one factor at a time while maintaining the others constant, for example: (a) magnesium strips and dilute acid; (b) potassium iodide and hydrogen peroxide; (c) sodium thiosulfate and dilute acid; (d) marble chips and dilute hydrochloric acid.	Biology- Enzymes in biological systems. Skills: AI; ORR; PD; MM.
10.3 predict the effect of factors on rates of reaction from given data;			

SECTION A - PRINCIPLES OF CHEMISTRY (cont'd)

SPECIFIC OBJECTIVES	CONTENT/ EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER- RELATIONSHIP
Students should be able to:			
10.4	<i>interpret graphical representation of data obtained in studying rates of reaction.</i>	<i>Include graphs of (a) Concentration (volume; mass) vs. time; (b) Concentration Vs 1/t⁵ (c) rate vs time.</i>	
11.	ENERGETICS		
11.1	distinguish between exothermic and endothermic reactions;	Energy content of products and reactants. <i>Bond breaking being endothermic; bond forming being exothermic; temperature change in surroundings.</i> Use of ΔH notation.	Perform investigations to demonstrate endothermic and exothermic changes, for example, potassium nitrate and water, sodium hydroxide pellets and water. Physics-Thermal energy. <i>Skills: MM; AI; ORR.</i>
11.2	draw energy profile diagrams to illustrate endothermic and exothermic change;	Simple energy profile diagrams including energy barrier. Include the action of catalyst using energy profile diagrams.	Physics-Thermal energy.
11.3	calculate energy changes from experiments or from experimental data.	Reference to heat of solution and heat of neutralisation of strong acid and strong base. <i>Assumptions: density and specific heat capacity of pure water; negligible heat loss/gain from surroundings.</i> <i>Refer to SO A7.10.</i>	Physics - Thermal energy. <i>Skills: ORR; AI.</i>

SECTION A - PRINCIPLES OF CHEMISTRY (cont'd)

Suggested Teaching and Learning Activities

To facilitate students' attainment of the objectives of this Section, teachers are advised to engage students in the teaching and learning activities below. These activities are designed to promote inquiry-based learning and cater to students with various learning styles.

1. Take a trip to a sugar producing plant to understand the processes involved in the manufacture of sugar.
2. Look at a video clip on the processes involved in the manufacture of sugar from a sugar producing plant.
3. Create models of structures of atoms using everyday materials.
4. Use the internet to examine 3D structures of atoms.
5. Conduct research on the development of the Periodic Table and make group presentations.
6. Use of large Periodic Table chart to examine the elements.
7. Construct 3D models of sodium chloride, diamond and graphite using simple everyday materials.
8. Conduct research on the use of salts in everyday life, for example, preservatives, controlling pests, medicines.
9. Create posters showing the uses of radioactive isotopes and the dangers of radioisotopes.
10. Use role play to demonstrate the energy of particles in the different states of matter.
11. Use the internet to conceptualise and stir interest in understanding the mole concept.
12. Use role play to demonstrate/atoms in bonding.
13. Research, present and discuss acid-base reactions and oxidation-reduction reactions in everyday life.
14. Create pamphlets to alert the school community on the dangers of chemicals used in everyday life.
15. Students bring labels from home in order to stimulate discussions and analyse chemical information.
16. Use of video clips explaining the application of electrolysis in electroplating, anodising and purification.
17. Use of social networking (Facebook) to share and discuss information.

◆ SECTION B – ORGANIC CHEMISTRY

Section B involves the study of the sources and nature of the compounds of carbon. The classification of the carbon compounds in terms of some functional groups, their structures, physical and chemical properties and their uses should also be presented.

GENERAL OBJECTIVES

On completion of this Section, students should:

1. understand some of the processes involved in the formation of carbon compounds from natural sources;
2. relate bonding properties of carbon to simple organic compounds;
3. understand the patterns of reactions of the various homologous series of carbon compounds;
4. understand the general pattern involved in the nature and formation of polymers;
5. relate the properties of carbon compounds to their uses.

SPECIFIC OBJECTIVES	CONTENT/ EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER- RELATIONSHIP
1. SOURCES OF HYDROCARBON COMPOUNDS			
Students should be able to:			
1. 1 identify natural gas and petroleum as natural sources of hydrocarbons;			Physics-Forms of Energy. Biology-Ecology; Natural resources.
1. 2 list the main uses of at least three fractions obtained from the fractional distillation of petroleum;	Uses should include fuels, petrochemicals, lubricants. <i>Refer to SO A2.5.</i>		Physics-Forms of Energy. Biology-Ecology.
1. 3 describe cracking of petroleum fractions.	Thermal and catalytic cracking of alkanes.		

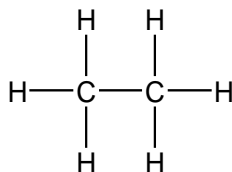
SECTION B – ORGANIC CHEMISTRY (cont'd)

SPECIFIC OBJECTIVES	CONTENT/ EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER- RELATIONSHIP
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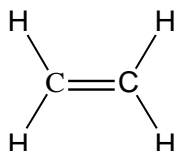
2. ORGANIC CHEMISTRY - AN INTRODUCTION

Students should be able to:

- 2.1 illustrate that carbon atoms can form single and double bonds, branched and unbranched chains and ring compounds;



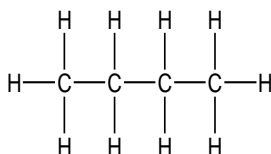
Illustrate various molecular structures using models.



*Carbon atoms form four bonds.
Refer to SO A5.1.*

- 2.2 write formulae to represent simple organic compounds;

Structures to be represented by the condensed formulae $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$ and fully displayed (structural) formulae:



- 2.3 list the general characteristics of a homologous series;
- 2.4 write general and molecular formulae for members of a given homologous series;

Alkanes, alkenes, alcohols and alkanoic (carboxylic) acid.

SECTION B – ORGANIC CHEMISTRY (cont'd)

SPECIFIC OBJECTIVES	CONTENT/ EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER- RELATIONSHIP
Students should be able to:			
2.5	deduce <i>the</i> homologous series given the fully displayed and condensed formulae of compounds;		
2.6	write fully displayed structures and names of branched and unbranched alkanes and unbranched alkenes, alcohols, and alkanolic acid;	<i>IUPAC notation structure limited to compounds of up to 6 carbon atoms.</i>	Use molecular models.
2.7	define structural isomerism;		
2.8	write the fully displayed structures of isomers given their molecular formulae.	<i>Limited to structural isomerism for alkanes and alkenes up to 6 carbon atoms.</i>	
3.	REACTIONS OF CARBON COMPOUNDS		
3.1	describe the reactions of alkanes and alkenes;	<i>The chemical reactions considered should be: burning and halogenation of alkanes and alkenes; hydration and hydrogenation for alkenes. Equations and conditions for reactions are required.</i>	Demonstrate burning of appropriate hydrocarbons for example (hexane, hexene).
3.2	relate the characteristic reactions of alkanes and alkenes to their structures;	<i>Emphasis should be placed on the dominance of substitution in alkanes and addition in alkenes.</i>	Physics-Forms of energy. Biology - Ecology.

SECTION B – ORGANIC CHEMISTRY (cont'd)

SPECIFIC OBJECTIVES	CONTENT/ EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER- RELATIONSHIP	
Students should be able to:				
3.3	distinguish between alkanes and alkenes;	<i>Carbon-Carbon double bond (C=C) associated with unsaturation.</i>	Test for unsaturation (burning is not acceptable). Use bromine solution or acidified potassium manganate (VII).	<i>Skills: ORR; AI; PD.</i>
3.4	relate the properties of hydrocarbons to their uses;	Alkanes as fuels and solvents and alkenes as the starting material for a wide range of polymers (<i>for example, plastics</i>) <i>biogas production from decomposition of manure.</i> <i>Refer to SO B4.2.</i>		Physics - Energy. Biology - Ecology.
3.5	identify alcohols, acids and esters by their functional groups;	<i>Alcohol : R-OH,</i> <i>Acid: R-COOH,</i> <i>Ester: COO-R</i> <i>where R represents an alkyl group.</i>		
3.6	relate the properties of alcohols, acids and to their functional groups;	<i>The presence of hydroxyl (-OH) groups linked to solubility and volatility.</i>	Investigate solubility of alcohols and acids in water.	<i>Skills: ORR; AI.</i>
3.7	describe the reactions of ethanol;	<i>Combustion, reaction with sodium, dehydration. Oxidation by reaction with potassium chromate (VI), (KMnO₄). Reaction with organic acids to form esters. Equations and conditions for reactions are required.</i> Equations for the conversion to acid are not required. <i>Refer to SO A8.5.</i>	Demonstration of the principles of the breathalyser test, formation of esters and reaction of sodium with ethanol.	Physics - Forms of energy. Biology - Ecology.

SECTION B – ORGANIC CHEMISTRY (cont'd)

SPECIFIC OBJECTIVES	CONTENT/ EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER- RELATIONSHIP	
Students should be able to:				
3.8	describe the fermentation process by which ethanol is produced from carbohydrates;	<i>Fermentation of a suitable carbohydrate, for example, glucose. Equation is required. Reference to wine-making and rum manufacture.</i>	Prepare a sample of ethanol.	Biology - Aerobic and anaerobic respiration. <i>Skills: ORR; AI.</i>
	Draw line diagrams of the distillation process in the laboratory. Refer to SOA2.5.			
3.9	describe the reactions of ethanoic acid;	<i>Condensation reactions with alcohols (ester formation) Reactions with metals, oxides, hydroxides, and carbonates. Equations and conditions of reactions are required.</i>	Esterification with appropriate alcohols and carboxylic acids.	
3.10	explain hydrolysis of esters including saponification;	<i>Equation for hydrolysis of an ester. Include saponification of fats and oils.</i>	Preparation and hydrolysis of a suitable ester, for example, ethyl ethanoate. Preparation of a sample of soap.	<i>Skills: ORR; AI; MM.</i>
3.11	compare soapy and soapless detergents.	<i>Compare effect on hard and soft water, environmental impact. Refer to SO C5.5, C5.6, C5.7.</i>	A comparison of the effect of soaps and soapless detergents on hard water.	<i>Skills: ORR; AI.</i>
4.1	define polymers;	<i>Polymers as macromolecules produced from 50 or more monomers.</i>		

SECTION B – ORGANIC CHEMISTRY (cont'd)

SPECIFIC OBJECTIVES	CONTENT/ EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER- RELATIONSHIP
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Students should be able to:

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|-----|--|--|--|
| 4.2 | distinguish between addition and condensation as reactions in the formation of polymers; | <i>Addition – polyalkenes
Condensation –
polyamides
polyesters
polysaccharides.
The mechanism of
polymerization is NOT
required.
Refer to SO B3.4.</i> | |
| 4.3 | state at least one use of each of the following types of polymers. | <i>Polyalkene
Polyamide
Polyester
Polysaccharide.
A named example is
required in each case,
for example, polyvinyl
chloride (PVC) used in
pipe fittings.
Refer to SO C5.5.</i> | |

Suggested Teaching and Learning Activities

To facilitate students' attainment of the objectives of this Section, teachers are advised to engage students in the teaching and learning activities below. These activities are designed to promote inquiry-based learning and cater to students with various learning styles.

1. Take a trip to a petroleum industry and examine the chemical processes or view a video clip of the processes involved in the separation of crude oil.
2. Take a trip to observe the processes in the manufacture of alcohol.
3. Assess the impact of organic compounds used in everyday life on human health, society and the environment, for example, plastics, food additives, pharmaceuticals, detergents.
4. Propose a course of action to reduce the use of compounds that are harmful to human health and the environment.
5. Create models showing 3D structures of organic compounds.
6. Carry out a project to demonstrate the production of methane gas from manure/compost.
7. Invite a policeman to demonstrate the use of the breathalyser machine to test for alcohol.
8. View samples of each type of polymers.

◆ SECTION C – INORGANIC CHEMISTRY

Metals and non-metals are two types of elements which, based on their reactivity, can exist as free elements or in a combined state as compounds. The methods of extraction of metals and the laboratory preparation of some non-metals are investigated. A study of the physical properties, chemical properties and the uses of metals, non-metals and their compounds is integrally linked to their impact on living systems and the environment.

GENERAL OBJECTIVES

On completion of this Section, students should:

1. understand the features which characterise metals and non-metals;
2. understand the relationship between the method of extraction of a metal and its reactivity;
3. develop or determine an order of reactivity of the metals;
4. *be familiar with laboratory methods of preparation and collection of non-metals and their compounds;*
5. appreciate the relationship between metals and non-metals and their uses;
6. *understand the characteristics by which specific metals, non-metals and their ions can be identified;*
7. *appreciate that metals, non-metals and their compounds impact on the environment;*
8. appreciate that metals, non-metals and their compounds impact on living systems;
9. *appreciate the impact that man's activities have on the environment and apply the knowledge of chemistry for the good of society.*

SPECIFIC OBJECTIVES	CONTENT/ EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER- RELATIONSHIP
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1. CHARACTERISTICS OF METALS

Students should be able to:

1.1	describe the physical and chemical properties of metals;	Physical properties melting point, boiling point, conductivity, lustre, hardness, <i>density</i> . Chemical properties to include action of oxygen, water, dilute hydrochloric acid, dilute sulfuric acid. <i>Refer to SO A5.4.</i>	Physical examinations and reactions of various metals, including zinc, iron, sodium, calcium, magnesium, aluminium, copper. Reaction of acids with sodium and calcium should not be attempted.	Physics - Specific latent heat, current, electricity. <i>Skills: ORR; AI; MM.</i>
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SECTION C – INORGANIC CHEMISTRY (cont'd)

SPECIFIC OBJECTIVES	CONTENT/ EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER- RELATIONSHIP	
Students should be able to:				
1.2	describe the reactions of metallic oxides, hydroxides, nitrates and carbonates.	<i>Equations are required. Reaction with dilute acid, action of heat. Refer to SO A7.4, A6.5.</i>	The action of dilute sulfuric acid and hydrochloric acid on metallic oxides and hydroxides. The action of heat on nitrates, carbonates and hydroxides.	<i>Skills: ORR; AI; MM.</i>
2. REACTIVITY AND EXTRACTION OF METALS				
2.1	discuss the reactivity of metals;	<i>Reactivity based on displacement reactions, reactions with oxygen, relative ease of decomposition of their nitrates, carbonates, oxides and hydroxides.</i>	Refer to practical activities at SO C1.1 and 1.2.	Skills: ORR; AI; MM.
2.2	deduce the order of reactivity of metals based on experimental results or data supplied;		Refer to practical activities at SO C1.1, 2.2.	Skills: ORR; AI; MM; PD.
2.3	describe the extraction of aluminum and iron.	<i>Relate the principles underlying the extraction of a metal to its position in the electrochemical series; details of purification of the raw materials not required. Use of carbon or hydrogen in the extraction of iron.</i>		
3. USES OF METALS				
3.1	explain why metal alloys are often used in place of the metals;	<i>Consideration of aluminum alloys, steel and solder.</i>		

SECTION C – INORGANIC CHEMISTRY (cont'd)

SPECIFIC OBJECTIVES	CONTENT/ EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER- RELATIONSHIP
Students should be able to:			
3.2	relate the properties of the metals (aluminum, lead, iron) and their alloys to their uses.	<i>Consideration of aluminum alloys, steel and solder. Reference to the use of lead in batteries. Use of metal cans as storage containers.</i>	Physics – Current, electricity.
4.	IMPACT OF METALS ON LIVING SYSTEMS AND THE ENVIRONMENT		
4.1	investigate the conditions necessary for the corrosion of metals;	<i>Reference to iron and aluminum.</i>	Experiments with iron and aluminium under various conditions to show that air and water are necessary for corrosion.
4.2	explain the importance of metals and their compounds on living systems and environment;	<i>Organometallic compounds such as chlorophyll (containing magnesium) and haemoglobin, (containing iron). Importance of trace metals, for example, zinc.</i>	Biology - Transport, nutrition.

SPECIFIC OBJECTIVES	CONTENT/ EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER- RELATIONSHIP
4.3 discuss the harmful effect of metals and their compounds to living systems and the environment.	<i>Reference to toxicity of certain metals example: Lead (Lead compounds in car exhaust fumes, and paints, disposal of vehicular batteries), arsenic (for mining), cadmium (disposal of nickel-cadmium batteries), and mercury (disposal of thermometers in hospitals and labs, mercury content in fish). Problem of disposal of solid waste (metals).</i>		

SECTION C – INORGANIC CHEMISTRY (cont'd)

SPECIFIC OBJECTIVES	CONTENT/ EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER- RELATIONSHIP
Students should be able to:			
5. NON-METALS			
5.1 describe the physical and chemical properties of non-metals;	<i>Hydrogen, chlorine, oxygen, carbon, sulfur, nitrogen. Reactions with oxygen and metals, oxidising and reducing properties. Physical properties (melting point, boiling point, conductivity, luster, hardness, density).</i>	<i>Burning of sulfur and carbon conductivity of carbon and sulfur.</i>	Biology – Photosynthesis, nitrogen cycle, Physics – Specific latent heat, current electricity.
5.2 describe the laboratory preparation of gases;	<i>Preparation of O₂, CO₂, NH₃. Relate methods of drying and collection to the properties of gas (density, solubility and reaction with drying agents).</i> <i>Preparation of gases, line drawings of apparatus used. Refer to SO A7.6.</i>		<i>Skills: ORR; AI, MM.</i>
5.3 explain the use of gases based on their properties;	<i>Example: carbon dioxide in fire extinguishers, oxygen in hospitals and for welding. Refer to SO A7.4.</i>		
5.4 list uses of the non-metals: carbon, sulfur, phosphorus, chlorine, nitrogen, silicon and their compounds;	<i>Inclusion of insecticides, strengthening of plastics with fibre, jewellery, tyre manufacture, matches, phosphate and other fertilisers (NPK), bleaches, glass, ceramics.</i>		Biology - Nutrition; soils, fertilisers.

SECTION C – INORGANIC CHEMISTRY (cont'd)

SPECIFIC OBJECTIVES	CONTENT/ EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER- RELATIONSHIP
Students should be able to:			
5.5	discuss the harmful effects of non-metal on living systems and the environment;	<i>Pollution and role played by sulfur dioxide, carbon monoxide, hydrogen sulfide, oxide of nitrogen, carbon dioxide, chlorofluoro carbons, nitrates, phosphates, herbicides and pesticides; problem of disposal of solid waste (non-metal, example, plastics). Refer to SO B3.11, B4.3.</i>	<i>Biology - Ecology.</i>
5.6	relate the unique properties of water to its functions in living systems;	<i>Include density changes, solvent properties, specific heat capacity, volatility. Refer to SO B 3.11.</i>	<i>Physics-Specific heat capacity, density.</i>
5.7	discuss the consequences of the solvent properties of water;	<i>Hardness of water (temporary and permanent). Leaching. Refer to SO B 3.11.</i>	<i>Biology – Ecology.</i>
5.8	describe the methods used in the treatment of water for domestic purposes;	<i>Boiling, filtering, chlorinating, softening. Include equations for softening water. Refer to SO A2.5.</i>	<i>Biology – Role of decomposers.</i>

SECTION C – INORGANIC CHEMISTRY (cont'd)

SPECIFIC OBJECTIVES	CONTENT/ EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER- RELATIONSHIP
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Students should be able to:

5.9 *define Green Chemistry;*

Green Chemistry is the utilization of a set of principles that reduces or eliminates the use of generations of hazardous substances in the design, manufacture and application of chemical products.
Refer to SO C4.3, C5.5.

5.10 *outline the principles of Green Chemistry.*

In-depth study of the principles is not required.

6. QUALITATIVE ANALYSIS

6.1 identify cations - Pb^{2+} , Al^{3+} , Ca^{2+} , Zn^{2+} , Fe^{3+} , Fe^{2+} , NH_4^+ , Cu^{2+} ;

The following criteria to be used for identification;

(a) metallic ions - colour, solubility of the hydroxides in:

(i) aqueous sodium hydroxide refer to SO A7.1;

(ii) aqueous ammonia or a suitable confirmatory test.

Appropriate experimental activities based on criteria in "Content/Explanatory Notes".

Use of Potassium Iodide.

Use of potassium iodide identity of Pb^{2+} ions.

Skills: AI; ORR; PD.

SECTION C – INORGANIC CHEMISTRY (cont'd)

SPECIFIC OBJECTIVES	CONTENT/ EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER- RELATIONSHIP
Students should be able to:			
	(b) ammonium ion, evolution of ammonia gas after treatment with aqueous sodium hydroxide and warming. Ionic equations are required. Refer to SO A6.5.		
6.2 identify anions - CO_3^{2-} , SO_4^{2-} , SO_3^{2-} , NO_3^- , Br^- , I^- , Cl^- ;	The following criteria to be used for identification: (a) evolution and identification of gases produced when compounds containing the anions are: (i) heated strongly; (ii) treated with acid (dilute and concentrated); (b) <i>colour and solubility of the silver halide in aqueous ammonia or lead halide;</i> (c) colour of precipitate formed when anion reacts with a solution containing barium ions; (d) solubility of the precipitate formed in (c), in dilute acids.	Use criteria listed under "Content/ Explanatory Notes" to conduct simple experiments.	<i>Skills: ORR; AI; PD.</i>

SECTION C – INORGANIC CHEMISTRY (cont'd)

SPECIFIC OBJECTIVES	CONTENT/ EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER- RELATIONSHIP
Students should be able to:			
6.3	identify gases - H_2 , O_2 , CO_2 , NH_3 , SO_2 , Cl_2 , NO_2 , H_2O .	The following criteria to be used for identification: (a) colour; (b) odour; (c) reaction with a lighted or a glowing splint: (i) reaction with moist litmus paper; (ii) reaction with dry cobalt chloride paper/ <i>anhydrous copper(II) sulfate</i> ; (iii) reaction with acidified potassium manganate (VII) acidified potassium dichromate (VI); (iv) reaction with a glass rod dipped in concentrated aqueous ammonia or concentrated hydrochloric acid;	Standard laboratory tests for the gases. Biology - Photosynthesis, respiration. <i>Skills: ORR; AI; PD.</i>

SECTION C – INORGANIC CHEMISTRY (cont'd)

SPECIFIC OBJECTIVES	CONTENT/ EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER- RELATIONSHIP
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Students should be able to:

- (v) *hydroxide reactions with lime water/ aqueous calcium.*
Refer to SO A7.2, A8.5, A8.6.

Suggested Teaching and Learning Activities

To facilitate students' attainment of the objectives of this Section, teachers are advised to engage students in the teaching and learning activities below. These activities are designed to promote inquiry-based learning and cater to students with various learning styles.

- View video clips on the extraction of iron and aluminum.*
- Students display samples of alloys used at home.*
- Use of different forms of presentations by students to demonstrate an understanding of the dangers of metals and non-metals on living systems and the environment.*
- Use of group presentations and projects to explore "Green Chemistry".*
- View the following websites:*

<http://www.rsc.org/Education/Teachers/Resources/Practical>
<http://www.brainpop.com/science/>
<http://www.bbcscience.net>
<http://www.bbc.co.uk/schools/gscelutesize/chemistry/>
<http://portal.acs.org/portal/acs/corg>

◆ GUIDELINES FOR THE SCHOOL-BASED ASSESSMENT

RATIONALE

School-Based Assessment (SBA) is an integral part of student assessment in the course covered by this syllabus. It is intended to assist students in acquiring certain knowledge, skills and attitudes that are critical to the subject. The activities for the School-Based Assessment are linked to the “Suggested Practical Activities” and should form part of the learning activities to enable the student to achieve the objectives of the syllabus. *Students are encouraged to work in groups.*

During the course of study of the subject, students obtain marks for the competence they develop and demonstrate in undertaking their SBA assignments. These marks contribute to the final marks and grades that are awarded to students for their performance in the examination.

The guidelines provided in this syllabus for selecting appropriate tasks are intended to assist teachers and students in selecting assignments that are valid for the purpose of the SBA. These guidelines are also intended to assist teachers in awarding marks according to the degree of achievement in the SBA component of the course. In order to ensure that the scores awarded by teachers are not out of line with the CXC standards, the Council undertakes the moderation of a sample of SBA assignments marked by the teacher.

School-Based Assessment provides an opportunity to individualise a part of the curriculum to meet the needs of students. It facilitates feedback to the students at various stages of the experience. This helps to build the self-confidence of the students as they proceed with their studies. School-Based Assessment further facilitates the development of essential investigative and practical skills that allow the students to function more effectively in their chosen vocation and everyday life. School-Based Assessment therefore, makes a significant and unique contribution to the development of relevant skills of the students. It also provides an instrument for testing them and rewarding them for their achievements.

PROCEDURES FOR CONDUCTING SBA

SBA assessments should be made in the context of normal practical coursework exercises. *It is expected that the exercises would provide authentic learning experiences.* Assessments should only be made after candidates have been taught the skills and given enough opportunity to develop them. **Sixteen** practicals over the two-year period would be considered the minimum number for candidates to develop their skills and on which to base realistic assessments. **These practicals MUST include all of the following:**

1. *separation techniques;*
2. *acids, bases and salts;*
3. *redox reactions and electrolysis;*
4. *qualitative analysis;*
5. *volumetric analysis;*
6. *rates of reaction;*
7. *energetics;*
8. *saturated and unsaturated hydrocarbons.*

Each skill must be assessed at **least three times** over the two-year period. Candidates should be encouraged to do corrections so that misconceptions will not persist. As the assessment of certain skills, especially those requiring on-the-spot observation or involve looking at several behaviours or criteria, teachers are advised to select not more than two skills to be assessed in any activity. The practical exercises selected to be used for assessment should make adequate demands on the candidates and the skills assessed should be appropriate for the exercises done. *Candidates are encouraged to work in groups.* For the assessment of written work, the practical selected should be one that can be completed in the time allotted for the class and **the report should be collected at the end of the period.**

Candidates who have not been assessed over the two-year period will be deemed absent from the whole examination. Under special circumstances, candidates who have not been assessed at all points may, at the discretion of CXC, have their marks pro-rated (adjusted proportionately).

1. In preparation for an SBA practical, the teacher should:

- (a) select tasks which must be chosen from the **eight (8)** topics on page 42 and should be related to a given syllabus objective. These tasks may be chosen from the “Suggested Practical Activities” and should fit in with the normal work being done in that class;
- (b) list the materials including quantities and equipment that will be needed for each student;
- (c) carry out the experiment beforehand, if possible, to ascertain the suitability of materials and the kind of results (observations, readings) which will be obtained, noting especially any unusual or unexpected results;
- (d) list the steps which will be required by the candidates in performing the experiment. From this it will be clear to the teacher how the candidates should be arranged in the laboratory, whether any sharing of equipment or materials is necessary, the skills which can be assessed from the practical, and the instructions to be given;
- (e) list the skills that may be assessed (for example, observation/recording/reporting, analysis and interpretation). **No more than two practical skills should be assessed from any one activity;**
- (f) select the skills to be assessed on this occasion. Skills other than those required for that year should also be included for teaching purposes;
- (g) work out the criteria for assessing each skill. This will form the basis of a mark scheme and a checklist.

2. The teacher should carry out the assessment and record the marks.

This is the most critical step in the assessment process. For a teacher to produce marks that are reliable, the marking must be consistent for all candidates and the marks should reflect the standard of performance at the level. The teacher must be able to justify the marks, and this occurs when there is a fixed set of conditions, factors or criteria for which the teacher looks. Marks should be submitted electronically to CXC on the SBA form provided. *The forms should be dispatched through the Local Registrar by the Moderator to reach CXC by 30 April in the year of the examination.*

ASSESSMENT OF PRACTICAL SKILLS

School-Based Assessment will assess skills under the profiles Experimental Skills and Use of Knowledge (Analysis and Interpretation only).

The assessment will be conducted during Terms 1 - 5 of the two-year period following the programme indicated in the Table below.

SBA SKILLS TO BE ASSESSED FOR CXC MODERATION


PROFILE	SKILLS	YEAR 1		YEAR 2		TOTAL		
		NO. OF TIMES SKILLS TO BE ASSESSED	MARKS	NO. OF TIMES SKILLS TO BE ASSESSED	MARKS	NO. OF TIMES SKILLS TO BE ASSESSED	MARKS	
XS	Manipulation/ Measurement	1	10	2	20	3	30	90 (30*)
	Observation/ Recording/ Reporting	1	10	2	20	3	30	
	Planning and Designing*	2	20	1	10	3	30	
UK	Analysis and Interpretation	2	20	1	20	3	40	40 (10*)
TOTAL		6	60	6	70	12	130	(40*)

***Weighted mark**

Investigative project to be done in Year 2.

The investigative project would be assessed for two skills, Planning and Design and Analysis and Interpretation.

Students who are pursuing two or more of the single science subjects (Biology, Chemistry, Physics) may opt to carry out ONE investigation* only from any of these subjects. Students are encouraged to work in groups.

[ONLY the marks for the investigation can be transferred across subjects.] 

Assessment of Investigation Skills

Proposal (Planning and Design)

The maximum marks available for the Proposal is

10 marks

The format for this part is shown below

Observation/Problem/Research question stated

Hypothesis

2 marks

Aim

1 mark

Materials and Apparatus

1 mark

Method

2 marks

Controlled variables

1 mark

Expected Results

2 marks

Assumptions, Precautions/ Limitations

1 mark

TOTAL

10 marks

Implementation (Analysis and Interpretation)

The maximum marks available for the Implementation is

20 marks

The format for this part is shown below.

Method

1 mark

Results

4 marks

Discussion

5 marks

Limitation

3 marks

Reflection

5 marks

Conclusion

2 marks

TOTAL

20 marks

REPORTING FORMAT OF INVESTIGATION

PART A THE PROPOSAL (Planning and Design)

Statement of the Problem – Can be an observation, a problem

Hypothesis

Aim – Should be related to the hypothesis

Materials and Apparatus

Method – Should also include variables

Assumptions/Precautions

Expected Results

PART B THE IMPLEMENTATION (Analysis and Interpretation)

Method - Linked to Part A (change of tense)

Results

Discussion – Explanations/Interpretations/Trends

Limitations

Reflections

Conclusion

CRITERIA FOR ASSESSING INVESTIGATIVE SKILLS

A. PLANNING AND DESIGN

HYPOTHESIS		2
- Clearly stated	1	
- Testable	1	
AIM		1
- Related to hypothesis	1	
MATERIALS AND APPARATUS		1
- Appropriate materials and apparatus	1	
METHOD		2
- Suitable	1	
- At least one manipulated or responding variable	1	
CONTROLLED VARIABLE		1
-Controlled variable stated	1	
EXPECTED RESULTS		2
- Reasonable	1	
- Link with method	1	
ASSUMPTIONS/PRECAUTIONS/POSSIBLE SOURCES OF ERRORS		1
- Any one stated	1	

TOTAL		(10)
B. ANALYSIS AND INTERPRETATION		
METHOD		1
Linked to Proposal, Change of tense		
RESULTS		4
- <i>Correct formulae and equations:</i>	2	
<i>Accurate (2)</i>		
<i>Acceptable (1)</i>		
- <i>Accuracy of data:</i>	2	
<i>Accurate (2)</i>		
<i>Acceptable (1)</i>		
DISCUSSION		5
- <i>Explanation</i>	2	
<i>Development of points:</i>		
<i>Thorough (2)</i>		
<i>Partial(1)</i>		
- <i>Interpretation</i>	2	
<i>Fully supported by data (2)</i>		
<i>Partially supported by data (1)</i>		
- <i>Trends</i>	1	
<i>Stated</i>		
LIMITATIONS		3
-Sources of error identified	1	
-Precautions stated	1	
-Limitation stated	1	
REFLECTIONS		5
- <i>Relevance between the experiment and real life</i>	1	
<i>(Self, Society or Environment)</i>		
- <i>Impact of knowledge gain from experiment on self</i>	1	
- <i>Justification for any adjustment made during experiment</i>	1	
- <i>Communication of information</i>	2	
<i>(Use of appropriate scientific language, grammar and clarity of expression all of the time (2); some of the time (1))</i>		
CONCLUSION		2
- <i>Stated</i>	1	
- <i>Related to the aim</i>	1	
TOTAL		(20)

EXAMPLAR OF INVESTIGATIVE PRACTICAL

EXEMPLAR 1

Part A THE PROPOSAL

Observation

Whenever an uncovered carbonated beverage is left exposed at room temperature the beverage goes 'flat' (that is, loses its fizz) within a few hours but when an uncovered carbonated beverage is stored in a refrigerator it remains fizzy for much longer.

Hypothesis: The higher the temperature of an uncovered carbonated drink the faster the drink will lose carbon dioxide gas.

Aim: To determine if increasing the temperature causes an uncovered carbonated beverage to lose carbon dioxide gas at a higher rate.

Materials/Apparatus: A sealed bottle of a carbonated beverage, cold water, 3 boiling tubes, 3 delivery tubes with rubber bungs, three test tube racks, a 60 °C water bath, an ice- bath, 3 thermometers, three measuring cylinder, three retort stands with clamps, 3 graduated syringes and a timing device.

Method

1. All apparatus will be cleaned and dried before beginning the experiment.
2. Label each boiling tube as follows: R- for room temperature, C- for cold and H- for hot. Measure 20 cm³ of the carbonated beverage and pour slowly into each boiling tube.
3. Leave the uncovered boiling tube labeled R on the counter at room temperature. Place the uncovered tube labeled C into an ice-bath and the uncovered tube labeled H into a 60°C water bath. Record the temperature of each beverage in a table and leave each tube undisturbed for 30 minutes.
4. After the 30 minutes has passed for each beverage, securely fit the tube with a rubber bung and delivery tube. Keep the shaking of the tube to a minimum during this set-up process. The open end of the delivery tube will be attached to a graduated syringe and the boiling tube shaken for two minutes. Record the volume reached by the gas in a suitable table. Repeat the same procedure for each tube.

Precaution: Carbonated beverage was poured slowly down the sides of the boiling tube to minimise loss of gas.

Expected Results

It is expected that the carbonated beverage labeled H will produce the least volume of gas, beverage R will produce more gas than H but less than C and beverage C will produce the highest volume of gas.

PART B- THE IMPLEMENTATION

Introduction

Whenever an uncovered carbonated beverage is left exposed at room temperature the beverage goes 'flat' (that is, loses its fizz) within a few hours but when an uncovered carbonated beverage is stored in a refrigerator it remains fizzy for much longer.

The gas responsible for the fizz of a carbonated drink is carbon dioxide and the lower the carbon dioxide content of a drink the 'flatter' the drink will be.

In this experiment the relationship between the temperature and the carbon dioxide content of a carbonated drink will be explored so as to offer an explanation to the observation made.

Method

1. All apparatus was cleaned and dried before beginning the experiment.
2. Each boiling tube was labeled as follows: R- for room temperature, C- for cold and H- for hot.
3. 20 cm³ of the carbonated beverage was measured and poured slowly into each boiling tube.
4. The uncovered boiling tube labeled R was left on the counter at room temperature, the uncovered tube labeled C was placed into an ice-bath and the uncovered tube labeled H was placed into a 60°C water bath. The temperature of each beverage was recorded in a table and each tube was left undisturbed for 30 minutes.
5. After 30 minutes had passed for each beverage, the tube was securely fitted with a rubber bung and delivery tube. Shaking of the tube was kept to a minimum during this set-up process. The open end of the delivery tube was attached to a graduated syringe and the boiling tube was shaken for two minutes. The volume reached by the gas was recorded in a suitable table. The same procedure was repeated for each tube.

Results

TABLE SHOWING THE VOLUME OF CARBON DIOXIDE GAS COLLECTED AT VARIOUS TEMPERATURES

Boiling Tube	Temperature (°C)	Volume of CO ₂ gas (cm ³)
R	30	
H	60	
C	2	

Discussion

From this experiment, it was determined that as the temperature increased the carbon dioxide content of the drink decreased. The drink which was kept at the highest temperature lost the most gas in the allotted time period.

When a carbonated drink is left uncovered, the decrease in pressure causes the gas particles to leave the solution at the surface faster. Also, increasing the temperature gives the gas particles more kinetic energy and increases the rate at which these particles leave the drink's surface. Particles

possess more kinetic energy at higher temperatures than at lower temperatures. Hence, more gaseous particles will leave the surface of a drink at room temperature than at a lower temperature. Therefore it is clear that when the carbonated drink was left at room temperature the loss of CO₂ would have occurred more readily than if the same drink was kept in a refrigerator and as a result the drink at room temperature would become flat much sooner than one stored at colder temperatures.

Limitations

Every effort was made to reduce experimental error as much as possible. Shaking of the beverage during measuring was minimised and the temperatures were monitored strictly. However, the following situations may have contributed to experimental error:

1. Loss of gas as an undetermined amount of gas was lost during the pouring of the beverage into the measuring cylinder.
2. Loss of gas occurred during the assembling of the delivery tube to the graduated syringe.

Reflections

Whenever an uncovered carbonated beverage is left exposed at room temperature, the beverage goes flat (it loses its fizz) within a few hours but when an uncovered carbonated beverage is stored in a refrigerator it remains fizzy for much longer.

From the experiment, I have learnt that the reason carbonated drinks go flat faster at room temperature is because of the higher temperature which gives the gas particles enough energy to leave the drink's surface faster. Therefore, based on scientific fact it is better to store a carbonated drink at low temperatures as this will preserve its CO₂ content for much longer.

This experiment was carried out as designed in the plan.

Conclusion

Increasing the temperature of an uncovered carbonated drink causes the drink to lose carbon dioxide faster.

Exemplar 2

Part A THE PROPOSAL

Observation

While on a field trip to the local Botanical Gardens, an observation was made that all the rocks in the river which flowed through this garden had shiny, rusty-brown surfaces. The villagers claim that the water flowing through the gardens contains iron compounds and that the rocks had these compounds deposited from the water on their surfaces.

Hypothesis: The rusty brown solid on the rock surfaces is a compound of iron.

Aim: To determine if the deposit on the surfaces of the river rocks is a compound of iron.

Materials/Apparatus: A sample of the rock from the river bed, a sample of rock from the river shore, knife, test tube and test tube rack, 2 M H₂SO₄ solution, sodium hydroxide solution, measuring cylinder and a test pipette.

Method

1. All apparatus will be cleaned and dried before beginning the experiment.
2. The knife will be used to remove some of the deposit from the surface of the river rock. The deposit will be placed into a test tube. 4 cm³ of acid will be added to the test tube and the tube will be shaken. The mixture will be decanted to isolate any undissolved particles. To the filtrate, sodium hydroxide solution will be added dropwise until in excess. Repeat the experiment using the sample of rock from the river shore.
3. All observations will be recorded and tabulated.

Assumption: There is enough iron compound in the rock deposit to react with the acid.

Expected Results

It is expected that if an iron compound is present, the iron compound from the deposit will react in the acid to give a pale yellow solution. When the solution is tested with the sodium hydroxide dropwise, a rusty-brown precipitate will form which will be insoluble in excess.

PART B - THE IMPLEMENTATION

Introduction

While on a field trip to the local Botanical Gardens, an observation was made that all the rocks in the river which flowed through this garden had shiny, rusty-brown surfaces. The villagers claim that the water flowing through the gardens contains compounds of iron and that the rocks had iron compounds deposited from the water on their surfaces.

Fe³⁺ ions which are present in iron compounds will precipitate out as iron (III) oxide which is rusty brown in colour. This compound coats the rocks, making them appear as shiny rusty brown surfaces.

It is suspected that the water contains iron (III) ions which will form a rusty brown deposit. The purpose of this experiment is to determine if this is the case.

Method

All pieces of apparatus were cleaned and dried before beginning the experiment.

The knife was used to remove some of the deposit from the surface of the river rock. The deposit was placed into a test tube. 4 cm³ of acid was added to the test tube and the tube was shaken to dissolve as much of the deposit as possible. The mixture was filtered to isolate any undissolved particles. To the filtrate, sodium hydroxide solution was added dropwise until in excess.

All observations were recorded and tabulated.

Results

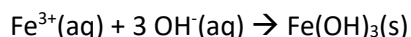
TABLE SHOWING THE OBSERVATIONS WHEN SODIUM HYDROXIDE SOLUTION WAS ADDED DROPWISE AND IN EXCESS

OBSERVATION WITH DILUTE NaOH (aq)	
Dropwise	Excess
A rusty-brown precipitate formed.	The rusty-brown precipitate remained insoluble.

Discussion

Mineral water is obtained from a mineral spring and contains various minerals such as salts and even compounds of sulfur. Other compounds found in mineral water are iron compounds, the levels of which may vary depending on the time of year and the pH of the water. During certain times of the year the river water becomes more acidic and this causes an increase in the amount of iron salts from the soil dissolved in the river water. Some of those salts can then precipitate onto the river rocks and change the regular appearance of the rocks' surfaces.

The rusty brown solid is likely to be iron(III) oxide which reacts with the sulfuric acid forming a soluble iron(III) salt which is a pale yellow solution. By performing qualitative analysis on a sample of the deposit it was determined that the rusty-brown deposit on the rock contained iron(III) ions due to the presence of an iron(III) salt. Iron(III) salt solutions form the rusty-brown, insoluble iron (III) hydroxide precipitate with sodium hydroxide solution. As shown by the equation below:



Limitations

The reaction between the iron compound and the acid produced a small amount of iron (III) ion solution. Iron compounds will react with sulfuric acid to form soluble salts which can then be tested using aqueous sodium hydroxide. If small amounts of the iron (III) ions are produced in the reaction between the acid and the deposit, then the resulting solution may not have sufficient iron(III) ions to produce a visible precipitate with sodium hydroxide.

Reflections

Mineral springs produce water which contains a number of dissolved salts, one of which is a compound of iron. The rusty brown deposits on the rocks are likely to be iron(III) oxide which will react with acids to produce iron(III) ion solutions.

It is believed that mineral water has medicinal properties because of the presence of some compounds such as compounds of iron.

Knowledge of the iron content of water allows decisions to be made as to the benefits of using this water for health purposes.

It was decided that filtration would replace decantation as suggested in the proposal to ensure that the suspended particles were completely removed.

Conclusion

Iron compounds were found to be deposited on the river rocks. . The results of the test support the villagers' claims. Iron compounds are indeed present in the river water.

RECORD KEEPING

Each candidate is required to keep a practical workbook containing all practicals done over the two-year period prior to the examination. Those assessed for CXC will be used to determine the standard of marking by the teacher. **A mark scheme must be provided for each practical assessed for CXC.** All practicals should be dated and an index made by the candidates of the practicals done. Those assessed for CXC should be clearly indicated along with the marks awarded for each skill. **This must include the identity of unknowns and expected readings.**

Candidates' workbooks should be durable and neatness should be encouraged. The pages should be numbered and all exercises should be dated. The workbook should contain a contents page providing the following information concerning the practicals:

1. page number;
2. date;
3. aim of practical;
4. an indication using an asterisk, of which practicals were assessed for CXC;
5. the skills assessed.

A possible format is given below:

Page No.	Date	Aim of Practical	Skills Assessed
8	2013-10-02	Separation of mixtures- oils and water, dyes in screened methyl orange, ammonium chloride and sodium chloride	
*9	2013-10-23	To observe the effect of heat on nitrates	Man./Meas.

Note: The asterisk (*) indicates practical assessed for CXC.

A breakdown of the skills assessed and the marks awarded should be given at the end of the report for each SBA practical (for example):

Manipulation and Measurement (mm)	6/10
Observation, Recording, Reporting (ORR)	8/10

CXC will require a sample of practical workbooks for moderation. Teachers are reminded that **the marks awarded for each practical skill should be in the candidate's workbook** and that accuracy in recording marks on CXC mark sheets is essential.

Additional workbooks may be requested. The school should therefore retain all other practical workbooks until at least three (3) months after the publication of examination results. Candidates' workbooks should show evidence of conducting test some of the experiments, which they have planned and designed.

Moderation of School-Based Assessment

The reliability (consistency) of the marks awarded by teachers on the School-Based Assessment is an important characteristic of high quality assessment. To assist in this process, the Council undertakes on-site moderation of the School-Based Assessment conducted by visiting external Moderators.

*The Moderator will make a first visit in Term 3 of Year 1. Teachers must make available to the Moderator **ALL** Assessment Sheets (Record of Marks, Mark Schemes and the proposal for the Investigation).*

*During the Term 2 of Year 2, the Moderator will make a second visit. Teachers must make available to the Moderator **ALL** Assessment Sheets (Record of Marks, Mark Schemes and the report on the Investigation). **Teachers are NOT required to submit to CXC samples of candidates' work, unless specifically requested to do so by the Council BUT will be required to submit the candidates' marks electronically.***

The Moderator will remark the skills, and investigation reports for a sample of five candidates, who are selected using the guidelines listed below.

1. *Candidates' total marks on the SBA are arranged in descending order (highest to lowest).*
2. *The sample comprises the work of the candidates scoring the:*
 - (a) *highest Total mark;*
 - (b) *middle Total mark;*
 - (c) *lowest Total mark;*
 - (d) *mark midway between the highest and middle Total mark;*
 - (e) *mark midway between the middle and lowest Total mark.*
3. *The candidates selected above may be required to demonstrate some practical skills.*

Teachers' marks may be adjusted as a result of the moderation and feedback will be provided by the Moderator to the teachers.

*The Moderator may re-mark the assignments of additional candidates. Where the total number of candidates is five or fewer, the Moderator will remark **ALL**.*

On the first visit, the Moderator will re-mark a sample of the Year 1 candidates. A copy of this report must be retained by the teacher, and be made available to the Moderator during Term 2 of Year 2.

The Moderator will submit the Assessment Sheets, moderation of SBA Sample and the moderation reports to the Local Registrar by April 30 of the year of the examination. A copy of the Assessment Sheets and candidates' work must be retained by the school for three months after the examination results are published by CXC.

School-Based Assessment Record Sheets are available online via the CXC's website www.cxc.org.

All School-Based Assessment Record of marks must be submitted online using the SBA data capture module of the Online Registration System (ORS).

EXAMPLE OF A POSSIBLE SBA PRACTICAL

Aim: Finding the end of a neutralisation reaction by measuring temperature changes.

Apparatus: 2 mol dm⁻³ sodium hydroxide solution.
2 mol dm⁻³ hydrochloric acid solution.
Thermometer (0-110°C, 1°C gradations).
Styrofoam cup.
25 cm³ or 20 cm³ pipette. (Measuring cylinder can be used if pipettes are unavailable)
Burette (Test tube calibrated to measure 5 cm³ or syringe or any other suitable measuring container).

Procedure:

1. Pipette 25 cm³ of the sodium hydroxide solution into the Styrofoam cup. Measure and record the temperature of this solution.
2. Fill the burette to the 0 mark with the acid and deliver 5 cm³ of acid into the alkali all at once. Stir with the thermometer and record the highest temperature reached. WITHOUT DELAY, add a second 5 cm³ of the acid, stir and record the highest temperature reached. Repeat the procedure until a total of 40 cm³ of acid has been added.
3. Record your readings in an appropriate table.

Activities:

1. Plot a graph of total volume of acid added (x-axis) against the temperature (y-axis) and draw two best-fit lines.
2. Account for the shape of the graph you have obtained.
3. Use your graph to determine the total volume of acid needed to neutralise exactly 25 cm³ of alkali.
4. Determine likely sources of error in this procedure for determining the end-point of a neutralisation reaction.
5. Write the ionic equation for the neutralisation reaction.

MARK SCHEME

Skills assessed: Observation/Recording/Reporting, Analysis and Interpretation.

Temperature change during neutralisation

1. Observation/Recording/Reporting

Table

- | | | |
|-----|------------------------|---|
| (a) | Neatly enclosed table. | 1 |
| (b) | Headings with units. | 1 |

- | | | |
|-----|--|----------|
| (c) | Data written correctly to a consistent number of decimal places. | 1 |
| (d) | Graph. | |
| | (i) Labelling of axes with units | 2 |
| | (ii) Selecting a suitable scale for x and y axes. | 2 |
| | (iii) Plotting accurately. | 2 |
| | (iv) Drawing best fit intersecting lines. | <u>1</u> |

10 Marks

2. Analysis and Interpretation

- | | | |
|-----|--|----------|
| (a) | Deducing that for the portion of the graph sloping upwards: | |
| | (i) reaction is incomplete; | 1 |
| | (ii) amount of heat given off increases as more reactant (acid) is available. | 1 |
| (b) | Deducing that for the portion of graph sloping downwards: | |
| | (i) reaction is complete; | 1 |
| | (ii) temperature falls as more reactant is added. | 1 |
| (c) | Deducing that reaction is complete when highest temperature is reached, hence peak in graph. | 1 |
| (d) | Reading off volume of acid corresponding to highest temperature reached. | 2 |
| (e) | Two likely sources of error (for example, heat loss to surroundings, incomplete transfer of acid). | 2 |
| (f) | Ionic equation | <u>1</u> |
| | $H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O(l) + \text{heat.}$ | |

10 Marks

Manipulation and Measurement

Aim: To investigate how the solubility of potassium nitrate crystals varies with temperature.

Apparatus and Materials: Boiling tube, test tube holder, Bunsen burner, glass rod, measuring cylinder, thermometer, matches, potassium nitrate, distilled water, tap water, ice.

- Procedure:
- Place 5 g of KNO_3 crystals into a boiling tube.
 - Using a measuring cylinder, pour 3.0 cm^3 of distilled water into the KNO_3 .
 - Heat the contents of the boiling tube carefully over Bunsen flame while stirring until all the solid dissolves.
 - Remove the boiling tube carefully from the flame. Place the thermometer in the boiling tube. Allow the boiling tube to cool and record the temperature at which the crystals first appear.

5. Add to the contents of the boiling tube a further 3.0 cm³ of distilled water and repeat the above procedure, noting the temperature at which crystals first appear.
6. Repeat the procedure adding a further 3.0 cm³ portions of water to obtain a total volume of 15 cm³.

Results: Record the results in a table with the following headings (include appropriate units).

Volume of H ₂ O Added to 5 g KNO ₃	Temperature at Which Crystals Appear	Mass of KNO ₃ dissolved in 100 g of H ₂ O (Solubility)
---	---	---

Analysis of Results:

Calculate the solubility of KNO₃ at for each volume of water using the equation below.

3.0 cm³ of H₂O dissolves 5 g of KNO₃

100 cm³ of H₂O dissolves $5 \times 100 = 166.6$ g

Plot graph of temperature at which crystals form (x-axis) vs solubility in 100 g of water (y-axis) and draw the best-fit curve.

Use your graph to determine:

1. the solubility of KNO₃ at 45°C;
2. the mass of KNO₃ that would crystallise when a solution of KNO₃ cools from 65°C to 35°C.

Discussion:

Define solubility.

Account for the shape of the graph you have obtained.

MARK SCHEME

NB. This lab may be assessed for ORR and AI.

Skill Assessed: Manipulation and Measurement

- | | | |
|-----|--|---|
| (a) | Correct use of balance (scale). | 1 |
| (b) | Placing measuring cylinder on flat surface. | 1 |
| (c) | Taking reading at eye level. | 1 |
| (d) | Correctly lighting Bunsen burner.
(closing air hole, striking match, turning on gas, lighting burner,
opening air hole, adjusting gas to control height of flame). | 4 |
| (e) | Carefully heating contents of boiling tube with
stirring by holding tube away from self and others. | 1 |
| (f) | Holding thermometer upright for reading. | 1 |
| (g) | Making sure that the bulb of the thermometer
is submerged and not touching the walls of the container. | 1 |

10 Marks

Planning and Design

Problem:

In a café, sugar is provided in a single package cube. Each customer is given one package per order. Each cube contains 5 g of sugar. The manager notices that there is sugar left in the bottom of many of the used iced tea cups but not in the bottom of the hot tea cups.

Propose an hypothesis to explain this observation. Plan and design an experiment to test this hypothesis.

Skills Assessed: Planning and Design

Hypothesis:	Clearly stated with ONE variable, testable.	2
Aim:	Related to hypothesis and problem statement, method to be used specified	2
Apparatus and Materials:	All essential ones stated.	2
Procedure:	Logical sequence of steps, written in present or future tense, workable or feasible to test hypothesis.	3
Variables:	(Manipulated, controlled and responding): Clearly stated or implied	2
Data to be collected:	Observations, measurements or qualitative data which will prove or disprove hypothesis.	2
Treatment/ Interpretation of data:	Shows link between how data to be collected proves or disproves hypothesis.	

Assumptions, Limitations, Precautions.

20 marks (scale to 10)

Conversion of marks to the 11-point scale

The 11-point scale ranges from 0 to 10 thus the maximum mark for each skill at any assessment point is 10. Always marking out of 10 or multiples of 10 makes conversion easy but this is not necessary, as this may be readily calculated. Conversion of the scale can be done for each assessment but this is not the only possibility. The raw marks out of the totals used must be recorded and these marks totalled for each skill and the conversion done only when their submission to CXC is required.

The following hypothetical result for the assessment of a student on a particular skill may be used as an example. If the marks obtained for observation/recording/reporting are:

5/7, 4/6, 5/5, 7/9, 6/8

The total marks are out of a possible 35 marks. This may be converted by calculations as follows:

$$\frac{27}{35} \times 10 = 7.71 \text{ (approximately)}$$
$$= 8 \text{ for CXC purposes.}$$



VALIDITY AND RELIABILITY OF TEACHERS' MARKS

The reliability of marks awarded is a significant factor in SBA and has far-reaching implications for the candidate's final grade. Teachers are asked to note the following:

1. The criteria for assessing a skill should be clearly identified. A mark scheme must be submitted with the sample of books sent for moderation. Failure to do this could result in the candidates being unavoidably penalised.
2. The relationship between the SBA marks in the practical workbooks and those submitted to CXC on the SBA forms must be clearly shown. It is important that the marks awarded reflect the degree of mastery of the skills assessed.
3. Workbooks should contain all practical work and those exercises used for SBA marks should be clearly identified. At least eight exercises should be undertaken.
4. The standard of marking must be consistent, hence the need for a mark scheme.
5. Collaboration among teachers especially in the same centre is urged to minimise the discrepancy in the standard of assessment among teachers.

STRATEGIES FOR ASSESSING THE PLANNING AND DESIGN SKILL

The Planning and Designing skill is intended to test students' ability to develop hypotheses and devise means of carrying out investigations to test them, plan experimental procedures and operations in appropriate sequence, identify variables, state expected results and identify precautions and possible sources of error. It is expected that some activities related to the planning and designing skill will be carried out. However, the reports of these activities are no longer plans and cannot be assessed as planning and design (PD). They can be marked for other skills, for example, observation, recording and reporting (ORR).

The assessing of Planning and Designing is not intended to test the students' research ability but rather their ability to use known procedures in a novel situation, or to make a novel use of a known procedure. Developing this skill to a good standard requires an understanding of the concepts involved. It requires much practice before it is assessed.

The following steps are recommended to ensure that this important skill is developed by students and properly tested by the teacher (See Guidelines for the School-Based Assessment for further details):

1. The problem selected should preferably be one which allows for different feasible routes to a solution, and should give opportunities for resourcefulness.
2. Less than full instructions should be given for typical experiments. The fewer the Instructions the greater the test of the student's ability to plan and design.
3. Allow candidates to plan the sequence of steps in the identification of unknown substances. For example, candidates could be given test tubes of substances labelled A, B, C and so on, and be required to decide from a separate list of the names of the substances (not given in the correct order) the identity of each one using only the substances given in the test tubes, or a given set of reagents.

They should be required to prepare a clear logical plan of the procedure before carrying out the investigation. This should include a list of requirements, precautions necessary, and the significance of each step proposed. They should then be required to explain how the results will be interpreted, including the relevant equations.

CARIBBEAN EXAMINATIONS COUNCIL

SCHOOL-BASED ASSESSMENT IN CHEMISTRY

NAME OF SCHOOL: _____ SCHOOL CODE: _____ YEAR OF FINAL EXAMINATION: _____

NAME OF TEACHER: _____ TERRITORY: _____

REGISTRATION NUMBER	CANDIDATES NAME	YEAR 1				TOTAL	YEAR 2				TOTAL	TOTAL		COMMENTS			
		XS MM	XS ORR	XS PD	UK AI		Year 1	XS MM	XS ORR	XS PD		UK AI	Year 2		PROFILE		OVERALL
		P3 (10)	P3 (10)	P3 (20)	P2 (20)		60	P3 (20)	P3 (20)	P3 (10)		P2 (20)	70		P3 (90)	P2 (40)	

TEACHER'S SIGNATURE: _____

PRINCIPAL'S NAME: _____

DATE: _____

PRINCIPAL'S SIGNATURE: _____



◆ LIST OF SUGGESTED CHEMICALS

1. Aluminium foil.
2. Aluminium powder.
3. Aluminium Ammonium Sulfate.
4. Aqueous Ammonia, 3 mol dm^{-3} .
5. Ammonium Chloride or Ammonium Carbonate.
6. *Ammonium Nitrate*.
7. Barium Chloride or Barium Nitrate 0.25 mol dm^{-3} .
8. Bromine.
9. Calcium.
10. Calcium Carbonate, (powdered or precipitated).
11. Calcium Chloride, anhydrous.
12. Calcium Hydroxide saturated solution (filtered).
13. Calcium Nitrate.
14. Charcoal powder.
15. Copper (turnings or powder).
16. Copper, thick wire or strips.
17. Copper (II) Carbonate.
18. Copper (II) Nitrate.
19. Copper (II) Oxide.
20. Copper (II) Sulfate.
21. Ethanoic (acetic) Acid.
22. *Hydrochloric Acid 2 mol dm^{-3} , 6 mol dm^{-3}* .

LIST OF SUGGESTED CHEMICALS (cont'd)

23. Hydrogen Peroxide, 20 volume.
24. *Distilled water.*
25. Iodine (resublimed).
26. Iodine solution.
27. Iron nails.
28. Iron (II) Ammonium Sulfate.
29. Iron (II) Sulfide.
30. Iron (III) Chloride.
31. Lead foil.
32. Lead (II) Bromide or Lead(II)Iodide .
33. Lead Ethanoate.
34. Lead (II) Nitrate.
35. Lead (II) Oxide.
36. Litmus paper, blue and red.
37. Magnesium ribbon.
38. Manganese (IV) Oxide.
39. Marble chips.
40. Methyl orange or screened methyl orange.
41. Nitric Acid 2 dm^{-3} .
42. Phenolphthalein.
43. Potassium Bromide or Sodium Bromide.
44. Potassium Carbonate.

LIST OF SUGGESTED CHEMICALS (cont'd)

45. Potassium Iodide 0.5 mol dm^{-3} .
46. Potassium Nitrate.
47. Potassium Permanganate (manganate (VII)).
48. Silver Nitrate 0.1 mol dm^{-3} .
49. Sodium.
50. Sodium Carbonate.
51. Sodium Carbonate hydrated (washing soda).
52. Sodium Chloride.
53. Sodium Hydrogen Carbonate.
54. Sodium Hydroxide 2 mol dm^{-3} , pellets.
55. Sodium Sulfate.
56. Sodium Sulfite.
57. Sodium Thiosulfate.
58. Steel wool.
59. Sulfuric Acid 3 mol dm^{-3} , 6 mol dm^{-3}
60. Universal indicator paper.
61. Universal indicator solution.
62. Zinc granulated or powdered.
63. Zinc Carbonate.
64. Zinc Oxide.
65. Zinc Nitrate.
66. Zinc Sulfate.
67. Ethanol.
68. *Sulfur powder.*

◆ SUGGESTED EQUIPMENT LIST

1. Balance ($\pm 0.1\text{g}$).
2. Beakers (100 cm^3 , 250 cm^3 , 400 cm^3).
3. Boiling tubes.
4. Bunsen burners.
5. Burettes (50 cm^3).
6. Burette brushes.
7. Burette clamps or clips.
8. Capillary tubes (melting point tubes).
9. Conical flasks (250 cm^3).
10. Crucible tongs.
11. Distillation apparatus (*simple and fractional*)
12. Dropper or teat pipettes.
13. Evaporating dishes.
14. Filter funnels.
15. Filter paper.
16. First Aid kit (1 per lab.).
17. *Fire Extinguisher (1 per lab)*
18. Gas syringes (100 cm^3).
19. Glass rods.
20. Glass tubing.
21. Measuring cylinders (20 cm^3 , 100 cm^3) (1000 cm^3 for teachers use only).
22. *Pipette fillers.*
23. Pipettes (25 cm^3 , 20 cm^3).
24. Reagent bottles.

SUGGESTED EQUIPMENT LIST (cont'd)

25. Retort stands.
26. Rubber tubing.
27. Separating funnel.
28. Simple electrolysis apparatus (electrodes, cells, wire).
29. Spatulas.
30. Stoppers or Bungs.
31. Test tubes (125 mm x 15 mm).
32. Test tube brushes.
33. Test tube holder.
34. Test tube racks.
35. Thermometers (1° C grad.).
36. Tripods.
37. Volumetric flasks (250 cm³, 1dm³, 2dm³, - for teacher's use).
38. Wash bottles.
39. Watch glasses.
40. Wire gauzes.
41. Delivery tubes.
42. Boss heads.
43. Crucibles.
44. Stop watches.
45. Gas jars.
46. Splints.
47. Pneumatic trough.
48. *Beehive shelf.*

◆ RESOURCES

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◆ GLOSSARY

WORD/TERM	DEFINITION/MEANINGS	NOTES
annotate	add a brief note to a label	{simple phrase of a few words}
apply	use knowledge and principles to solve problems	{make inferences and conclusions; UK}
assess	present reasons for the importance of particular structures, relationships or processes	{compare the advantages and disadvantages or the merits and demerits of a particular structure, relationship or process; UK}
calculate	arrive at the solution to numerical problem	{steps should be shown; units must be included; UK}
cite	quote or refer to	{KC}
classify	divide into groups according to observable characteristics	{UK}
comment	state opinion or view with supporting reasons	{UK}
compare	state similarities and differences	{an explanation of the significance of each similarity and difference stated may be required for comparisons which are other than structural; UK}
construct	use a specific format to make or draw a graph, histogram, pie chart or other representation using data or material provided or drawn from practical investigations, build (for example, a model) draw scale diagram	{such representation should normally bear a title, appropriate headings and legend; UK}
deduce	make a logical connection between two or more pieces of information; use data to arrive at a conclusion	{UK}
define	state concisely the meaning of a word or term	{this should include the defining equation or formula where relevant; KC}
demonstrate	show, direct attention to...	{KC}
derive	to deduce, determine or extract from data by a set of logical steps some relationship, formula or result	{this relationship etc. may be general or specific; KC}

WORD/TERM	DEFINITION/MEANINGS	NOTES
describe	provide detailed factual information on the appearance or arrangement of a specific structure or the sequence of a specific process	{descriptions may be in words, drawings or diagrams or any appropriate combination. Drawings or diagrams should be annotated to show appropriate detail where necessary; KC}
determine	find the value of a physical quality	{UK}
design	plan and present, with appropriate practical detail	{where hypotheses are stated or when tests are to be conducted, possible outcomes should be clearly stated the way in which data will be analyzed and presented; XS}
develop	expand or elaborate on an idea or argument with supporting reasons	{KC/UK}
differentiate or distinguish (between or among)	state or explain briefly those differences between or among items which can be used to define the items or place them into separate categories	{KC}
discuss	present reasoned argument; consider points both for an against; explain the relative merits of a case	{UK}
draw	make a line representation of apparatus which shows accurate relationship between the parts	{A diagram is a simplified representation showing the relationship between components; KC/UK}
estimate	make an approximate quantitative judgement	{UK}
evaluate	weigh evidence and make judgements based on given criteria	{the use of logical supporting reasons for a particular point of view is more important than the view held; usually both sides of an argument should be considered; UK}
explain	give reasons, based on recall, to account for	{KC}
find	locate a feature or obtain as from a graph	{UK}
formulate	devise a hypothesis	{UK}
identify	name or point out specific components or features	{KC}

WORD/TERM	DEFINITION/MEANINGS	NOTES
illustrate	show clearly by using appropriate examples or diagrams, sketches	{KC/UK}
investigate	use simple systematic procedures to observe, record data and draw logical conclusions	{XS}
label	add names to identify structures or parts indicated by pointers	{KC}
list	itemise without detail	{KC}
measure	take accurate quantitative readings using appropriate instruments	{XS}
name	give only the name of	{no additional information is required; KC}
note	write down observations	{XS}
observe	pay attention to details which characterise reaction or change taking place; to examine and note scientifically	{observations may involve all the senses or extensions of them but would normally exclude the sense of taste; XS}
plan	prepare to conduct an exercise	{XS}
predict	use information provided to arrive at a likely conclusion or suggestion possible outcome	{UK}
record	write an accurate description of the full range of observations made during a given procedure	{this includes the values for any variable being investigated; where appropriate, recorded data may be depicted in graphs, histograms or tables; XS}
relate	show connections between; explain how one set of facts or data depend on others or are determined by them	{UK}
sketch	Make a simple freehand diagram showing relevant proportions and any important details	{KC}
state	provide factual information in concise terms omitting explanations	{KC}

WORD/TERM	DEFINITION/MEANINGS	NOTES
suggest	offer an explanation deduced from information provided or previous knowledge. (... an hypothesis; provide a generalisation which offers a likely explanation for a set of data or observations.)	{no correct or incorrect solution is presumed but suggestions must be acceptable within the limits of scientific knowledge; UK}
test	to find out following set procedures	{XS}

KEY TO ABBREVIATIONS

- KC - Knowledge and Comprehension
- UK - Use of Knowledge
- XS - Experimental Skills

Western Zone Office
12 June 2013

CARIBBEAN EXAMINATIONS COUNCIL®

**Caribbean Secondary Education Certificate
(CSEC)®**



CHEMISTRY

Specimen Papers and Mark Schemes/Keys

Specimen Papers:	Paper 01 Paper 02 Paper 03/2
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Mark Schemes/Keys:	Paper 02 Paper 03/2
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FORM 01212010/SPEC 2012**CARIBBEAN EXAMINATIONS COUNCIL****CARIBBEAN SECONDARY EDUCATION CERTIFICATE®
EXAMINATION****CHEMISTRY****SPECIMEN PAPER****Paper 01 – General Proficiency***1 hour 15 minutes***READ THE FOLLOWING INSTRUCTIONS CAREFULLY.**

1. This paper consists of 60 items. You will have one hour and 15 minutes to answer them.
2. In addition to this test booklet, you should have an answer sheet.
3. Each item in this test has four suggested answers, lettered (A), (B), (C) and (D). Read each item you are about to answer and decide which choice is best.
4. On your answer sheet, find the number which corresponds to your item and shade the space having the same letter as the answer you have chosen. Look at the sample item below.

Sample Item

The SI unit of length is the

- (A) metre
(B) newton
(C) second
(D) kilogram

Sample Answer

The best answer to this item is “metre”, so answer space (A) has been shaded.

5. If you want to change your answer, erase it completely before you fill in your new choice.
6. When you are told to begin, turn the page and work as quickly and as carefully as you can. If you cannot answer an item, omit it and go on to the next one. You can return to the omitted item later. Your score will be the total number of correct answers.
7. You may do any rough work in this booklet.
8. Figures are not necessarily drawn to scale.
9. The use of silent electronic calculators is allowed.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

Items 1 - 2 refer to the table below which presents two physical properties of four substances at room temperature (28 °C) . In answering the items, each of the options below may be used once or not at all.

Substance	Melting Point (°C)	Boiling Point (°C)
P	-285	-183
Q	800	1400
R	190	180
S	-20	350

- (A) P only
- (B) R only
- (C) P and S only
- (D) Q and R only

Which substance(s)

1. will have fast moving particles?
2. will be solid(s)?
3. At a stage in the process of extracting sucrose from sugar cane, *lime* is added to the sucrose solution in order to
 - (A) lower the pH of the solution
 - (B) raise the pH of the solution
 - (C) stop the sucrose changing into sugars
 - (D) increase the percentage of sugar that would crystallize out

4. A mixture of copper(II) chloride solution and copper(II) oxide could BEST be separated by

- (A) distilling the mixture
- (B) heating the mixture and condensing
- (C) shaking with excess water and then filtering
- (D) shaking with excess water followed by fractional distillation

5. Which of the following halogens is a liquid at room temperature?

- (A) Bromine
- (B) Fluorine
- (C) Chlorine
- (D) Iodine

6. Which of the following compounds does NOT consist of individual molecules?

- (A) Ethane
- (B) Ethanol
- (C) Hydrogen chloride
- (D) Sodium chloride

7. Which of the following salts are soluble in water?

- I. Ammonium carbonate
- II. Barium sulfate
- III. Lead nitrate

- (A) I and II only
- (B) I and III only
- (C) II and III only
- (D) I, II and III

8. The ionic equation between zinc and sulfuric acid can BEST be represented by

- (A) $\text{Zn(s)} + 2\text{H}^+(\text{aq}) \rightarrow \text{Zn}^{2+}(\text{aq}) + \text{H}_2(\text{g})$
- (B) $\text{Zn(s)} + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow \text{ZnSO}_4(\text{aq}) + \text{H}_2(\text{g})$
- (C) $\text{Zn(s)} + \text{H}_2\text{SO}_4 \rightarrow \text{Zn}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) + \text{H}_2(\text{g})$
- (D) $\text{Zn(s)} + 2\text{H}^+(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \rightarrow \text{Zn}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) + \text{H}_2(\text{g})$

9. In which of the following compounds does manganese have an oxidation number of +7?
- (A) MnO
 - (B) MnO₂
 - (C) Mn₂O₃
 - (D) KMnO₄

Items 10 - 12 refer to the following information.

A compound when treated with aqueous sodium hydroxide and warmed gives off a colourless gas which turns moist red litmus paper blue.

10. The gas given off is
- (A) ammonia
 - (B) sulfur dioxide
 - (C) nitrogen dioxide
 - (D) hydrogen sulfide
11. The aqueous sodium hydroxide is acting as
- (A) a base
 - (B) an acid
 - (C) a catalyst
 - (D) a reducing agent
12. The compound is MOST LIKELY
- (A) iron(III) oxide
 - (B) sodium nitrate
 - (C) ammonium nitrate
 - (D) aluminium hydroxide
13. Which of the following can act as oxidising agents?
- I. Metallic ions
 - II. Metallic atoms
 - III. Non-metallic atoms
- (A) I only
 - (B) II only
 - (C) I and III only
 - (D) II and III only

14. In the electrolysis of concentrated copper(II) chloride solution using carbon electrodes, the substance formed at the anode is
- (A) carbon
 - (B) copper
 - (C) oxygen
 - (D) chlorine

15. Which of the following substances will NOT conduct electricity?
- (A) Solid calcium
 - (B) Molten calcium
 - (C) Solid calcium chloride
 - (D) A solution of calcium chloride in water

16. Which of the following statements about isotopes is NOT true?
- (A) Diseases can be diagnosed and treated using radioisotopes.
 - (B) The age of archaeological specimens can be determined using C-12 dating.
 - (C) In artificial pacemakers, plutonium-238 is used in the thermoelectric batteries.
 - (D) Nuclear power stations use the fission of uranium-235 as a source of energy.

17. Which of the properties below will decrease down the group F, Cl, Br, and I?
- I. Atomic radius
 - II. Electronegativity
 - III. Oxidising power
- (A) I only
 - (B) I and II only
 - (C) II and III only
 - (D) I, II and III

18. The layer-like arrangement of graphite and the weak bonds between the layers determine that graphite is

(A) colourless and transmit light
(B) very hard with a high density
(C) greasy and used as a lubricant
(D) a good conductor of electricity

19. Which of the following copper(II) compounds is LEAST suitable for preparing copper(II) sulfate by reacting with dilute sulfuric acid?

(A) Oxide
(B) Chloride
(C) Carbonate
(D) Hydroxide

20. Which of the following statements would be correct if diamond and graphite are allotropes?

I Both can be represented by the symbol C.
II Both have a relative atomic mass equal to that of carbon.
III They have similar physical properties.

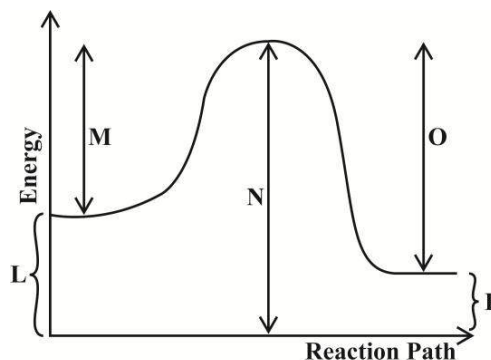
(A) I and II only
(B) I and III only
(C) II and III only
(D) I, II and III

21. Which of the following bonds can be formed by an atom of hydrogen?

I. An ionic bond by losing an electron
II. An ionic bond by gaining an electron
III. A covalent bond by sharing a pair of electrons

(A) I and II only
(B) I and III only
(C) II and III only
(D) I, II and III

Items 22 - 24 refer to the following energy-profile diagram.



22. Which letter in the diagram denotes the energy necessary for the reaction to take place?

(A) L
(B) M
(C) N
(D) O

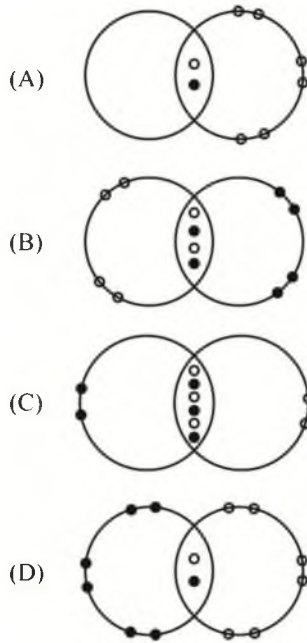
23. Which of the following equations is correct for ΔH (enthalpy change)?

(A) $\Delta H = P - L$
(B) $\Delta H = O - M$
(C) $\Delta H = L - M$
(D) $\Delta H = M - N$

24. Which of the following statements about the forward reaction is NOT true?

(A) ΔH is negative.
(B) The reaction is exothermic.
(C) The energy content of the product is greater than that of the reactant.
(D) The energy necessary for the reverse reaction is greater than that for the forward reaction.

25. Which of the following diagrams BEST illustrates bonding of nitrogen?



26. Oxygen, ${}^{16}_8\text{O}$, occurs before neon, ${}^{20}_{10}\text{Ne}$, in the periodic table because oxygen

- (A) is a better oxidising agent than neon
(B) has fewer protons on its atom than neon
(C) reacts with metals more readily than neon
(D) has a smaller relative atomic mass than neon

Items 27 - 30 refer to the following information.

A piece of calcium is added to some distilled water in a container and the following observations are recorded.

- The reaction is rapid.
- Bubbles of gas evolve.
- A white suspension forms.
- Temperature increases.

27. The gas evolved would be expected to

- (A) relight a glowing splint
(B) decolourize acidified aqueous potassium manganate(VII)
(C) give a 'pop' with a lighted splint
(D) turn acidified aqueous potassium dichromate green

28. Calcium forms a white suspension in water because its

- (A) hydroxide is slightly soluble
(B) carbonate is insoluble
(C) oxide is slightly soluble
(D) sulfate is insoluble

29. A sample of the suspension is filtered and the pH of the filtrate determined. The expected pH of the filtrate should be approximately

- (A) 3
(B) 5
(C) 7
(D) 10

30. The increase in temperature shows that

- (A) bonds in the products are formed
(B) bonds in the reactants are broken
(C) the products contain less energy than the reactants
(D) the reactants contain less energy than the products

31. Which of the following quantities of acid can exactly neutralise 40 cm³ of 2.0 mol dm⁻³ sodium hydroxide?

- I. 10 cm³ of 2.0 mol dm⁻³ hydrochloric acid
- II. 10 cm³ of 4.0 mol dm⁻³ sulfuric acid
- III. 20 cm³ of 4.0 mol dm⁻³ nitric acid

- (A) I only
- (B) II only
- (C) I and II only
- (D) II and III only

32. Epsom salts (magnesium sulfate) is widely used. Which of the following statements are true of this salt?

- I. It relaxes the muscles.
- II. It sedates the nervous system.
- III. It is used as a supplement for plant growth.

- (A) I and II only
- (B) I and III only
- (C) II and III only
- (D) I, II and III

33. Which of the following acids is important for healing wounds?

- (A) Lactic
- (B) Ascorbic
- (C) Ethanoic
- (D) Methanoic

34. Which of the following classifications is correct?

	BASIC OXIDE	ACIDIC OXIDE	NEUTRAL OXIDE
(A)	Sodium oxide	aluminium oxide	water
(B)	Sodium oxide	carbon dioxide	sulfur (IV) oxide
(C)	Sulfur(IV) oxide	calcium oxide	carbon monoxide
(D)	Copper(II) oxide	carbon dioxide	carbon monoxide

Items **35 – 38** refer to the following options.

- (A) Propene
- (B) Methane
- (C) Bitumen
- (D) Medicinal paraffin

Match EACH item below with one of the options above. Each may be used once, more than once or not at all.

- 35. Is a major constituent of natural gas.
- 36. Is the residue in the fractional distillation of petroleum.
- 37. Requires the least oxygen per mole for complete combustion.
- 38. Is used in making plastics.

39. An organic compound X has a relative molecular mass between 40 and 50. On shaking it with bromine, the mixture quickly turns colourless. From this information, X could be

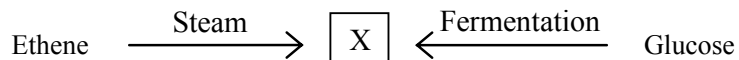
- (A) C₂H₄
- (B) C₃H₆
- (C) CH₃CO₂H
- (D) C₂H₅OH

40. Ethanol may be used as a fuel because it

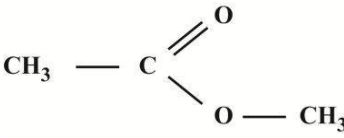
- (A) is easily converted to ethane
- (B) is easily converted to carbon
- (C) has a low heat of formation
- (D) has a high heat of combustion

41. Unsaturated compounds show addition reactions but saturated compounds do not because
- (A) saturated compounds contain double bonds
 - (B) unsaturated compounds contain multiple bonds
 - (C) unsaturated compounds contain single C-C bonds only
 - (D) saturated compounds are much more reactive than unsaturated compounds

42. The diagram below shows some reactions.



What is the product X?

- (A) Carbon
 - (B) Ethane
 - (C) Ethanol
 - (D) Carbon dioxide
-
43. What is the name of the following compound?
- 
44. Which of the following substances is a well-known polyamide?
- (A) Nylon
 - (B) Plastic
 - (C) Bakelite
 - (D) Polystyrene
- (A) Ethyl ethanoate
 - (B) Ethyl methanoate
 - (C) Methyl ethanoate
 - (D) Methyl propanoate
45. Which of the following equations represents a condensation reaction?
- (A) $\text{CH}_3\text{CH}_2\text{CH}_3 + \text{Br}_2 \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{Br} + \text{HBr}$
 - (B) $\text{CH}_3\text{CH}=\text{CH}_2 + \text{HBr} \rightarrow \text{CH}_3-\text{CH}_2-\text{CH}_2\text{Br}$
 - (C) $\text{CH}_3\text{CH}_2\text{COOH} + \text{NaOH} \rightarrow \text{CH}_3\text{CH}_2\text{COONa} + \text{H}_2\text{O}$
 - (D) $\text{CH}_3\text{COOH} + \text{CH}_3\text{CH}_2\text{OH} \rightarrow \text{CH}_3\text{COOCH}_2\text{CH}_3 + \text{H}_2\text{O}$

46. Which of the following names is correct for the compound whose formula is $\text{H}_3\text{C}-\text{CH}_2-\text{CH}_2-\text{CH}_2\text{OH}$?
- (A) n-propanol
(B) n-butanol
(C) 2-propanol
(D) 2-butanol
47. Addition of hydrochloric acid to a solution of metallic nitrate gives a white precipitate which is insoluble in water but soluble in aqueous ammonia. The metallic nitrate is **LIKELY** to be
- (A) silver nitrate
(B) lead(II) nitrate
(C) barium nitrate
(D) zinc nitrate
48. A colourless gas with a pungent odour turns blue litmus paper red and turns filter paper dipped in acidified potassium dichromate from orange to green.
- This gas is
- (A) ammonia
(B) chlorine
(C) sulfur dioxide
(D) nitrogen dioxide
49. Cryolite is important in the extraction process because it
- (A) functions as the electrolyte
(B) reacts with oxygen
(C) protects the carbon anode
(D) lowers the melting point of the electrolyte
50. During electrolysis the carbon anode tends to
- (A) react with the cryolite
(B) be oxidised by oxygen
(C) dissolve in the electrolyte
(D) be oxidised by fluorine from cryolite
51. Which of the following materials is used for the cathode?
- (A) Iron
(B) Carbon
(C) Copper
(D) Mercury
-
52. A white metallic hydroxide, X, undergoes no colour change when heated. It dissolves in both dilute sulfuric acid and sodium hydroxide solutions. The metallic hydroxide is **MOST** likely
- (A) $\text{Al}(\text{OH})_3$
(B) $\text{Zn}(\text{OH})_2$
(C) $\text{Pb}(\text{OH})_2$
(D) $\text{Ca}(\text{OH})_2$
53. Which of the following elements is **MOST** electropositive?
- (A) Zinc
(B) Calcium
(C) Aluminium
(D) Magnesium
54. To positively identify sulfur dioxide gas, a strip of paper is soaked in an aqueous solution of
- (A) blue litmus
(B) iron(II) sulfate
(C) lead(II) ethanoate
(D) potassium dichromate(VI)

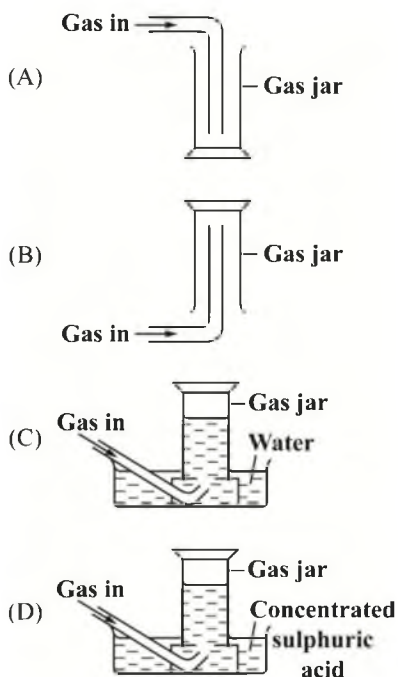
55. Which of the following substances can cause temporary hardness of water?

- (A) Calcium carbonate
- (B) Magnesium carbonate
- (C) Calcium hydrogen carbonate
- (D) Sodium hydrogen carbonate

56. Which of the following reactions is likely to take place MOST readily?

- (A) $\text{Zn(s)} + \text{Pb(NO}_3)_2(\text{aq}) \rightarrow \text{Zn(NO}_3)_2(\text{aq}) + \text{Pb(s)}$
- (B) $\text{Zn(s)} + \text{Fe(NO}_3)_2(\text{aq}) \rightarrow \text{Zn(NO}_3)_2(\text{aq}) + \text{Fe(s)}$
- (C) $\text{Zn(s)} + \text{Cu(NO}_3)_2(\text{aq}) \rightarrow \text{Zn(NO}_3)_2(\text{aq}) + \text{Cu(s)}$
- (D) $\text{Zn(s)} + 2\text{AgNO}_3(\text{aq}) \rightarrow \text{Zn(NO}_3)_2(\text{aq}) + 2\text{Ag(s)}$

Items 57 – 58 refer to the following diagrams which illustrate four methods of collecting gases. Choose the diagram, (A), (B), (C) or (D), which corresponds to each item. Each diagram may be used once, more than once or not at all.



Which of the above methods is suitable for collecting

- 57. moist oxygen?
- 58. carbon dioxide?

Item 59 – 60 refer to the following information.

A solution of iron(II) sulfate is added until in excess to a solution of barium nitrate. The precipitate produced is filtered off and water is added to the residue in the filter paper.

59. The colour of the precipitate produced is

- (A) green
- (B) white
- (C) orange
- (D) yellow

60. With which of the following solutions would the filtrate produce a precipitate?

- I. Barium chloride
- II. Aqueous ammonia
- III. Sodium hydroxide

- (A) I and II only
- (B) I and III only
- (C) II and III only
- (D) I, II and III

END OF TEST

IF YOU FINISH BEFORE TIME IS CALLED, CHECK YOUR WORK FIRST

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EXAMINATION

CHEMISTRY

SPECIMEN PAPER

Paper 02 – General Proficiency

2 hours 30 minutes

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This paper consists of SIX compulsory questions.
2. Write your answers in THIS booklet.
3. For Section A, write your answer to EACH question in the space provided after each part of the question.
4. For Section B, write your answers in the spaces provided at the end of the entire question.
5. The use of silent, non-programmable calculators is allowed.
6. Return this booklet at the end of the examination.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

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SECTION A

Answer ALL Questions.

Write your answers in the spaces provided for each part of the question.

Do NOT spend more than 30 minutes on Question 1.

1. (a) Steve knows that hydrogen peroxide decomposes to produce oxygen and water, and that catalysts can be used to speed up this reaction.

Steve conducted a series of experiments to investigate the effect of the mass of catalyst on the rate of decomposition of hydrogen peroxide. For each experiment, he combined a different mass of the catalyst, manganese dioxide (MnO_2), with 50 cm^3 of 0.8 mol dm^{-3} hydrogen peroxide solution and measured the volume of oxygen produced. He then calculated the rate of the reaction for each quantity of catalyst used and recorded the information in Table 1.

TABLE 1: RATE OF REACTION BY MASS OF MANGANESE DIOXIDE

Mass of Manganese Dioxide (g)	Rate of Reaction ($10^{-3} \text{ g O}_2 \text{ s}^{-1}$)
0.7	0.6
1.0	1.3
2.0	2.5
3.0	3.8
4.0	5.0

- (i) Define the term 'rate of reaction'.

(1 mark)

- (ii) Write a **balanced** chemical equation to show the decomposition of hydrogen peroxide.

(2 marks)

- (iii) Use the axes in Figure 1 on page 3 to plot a graph showing rate of reaction versus mass of manganese dioxide.

(3 marks)

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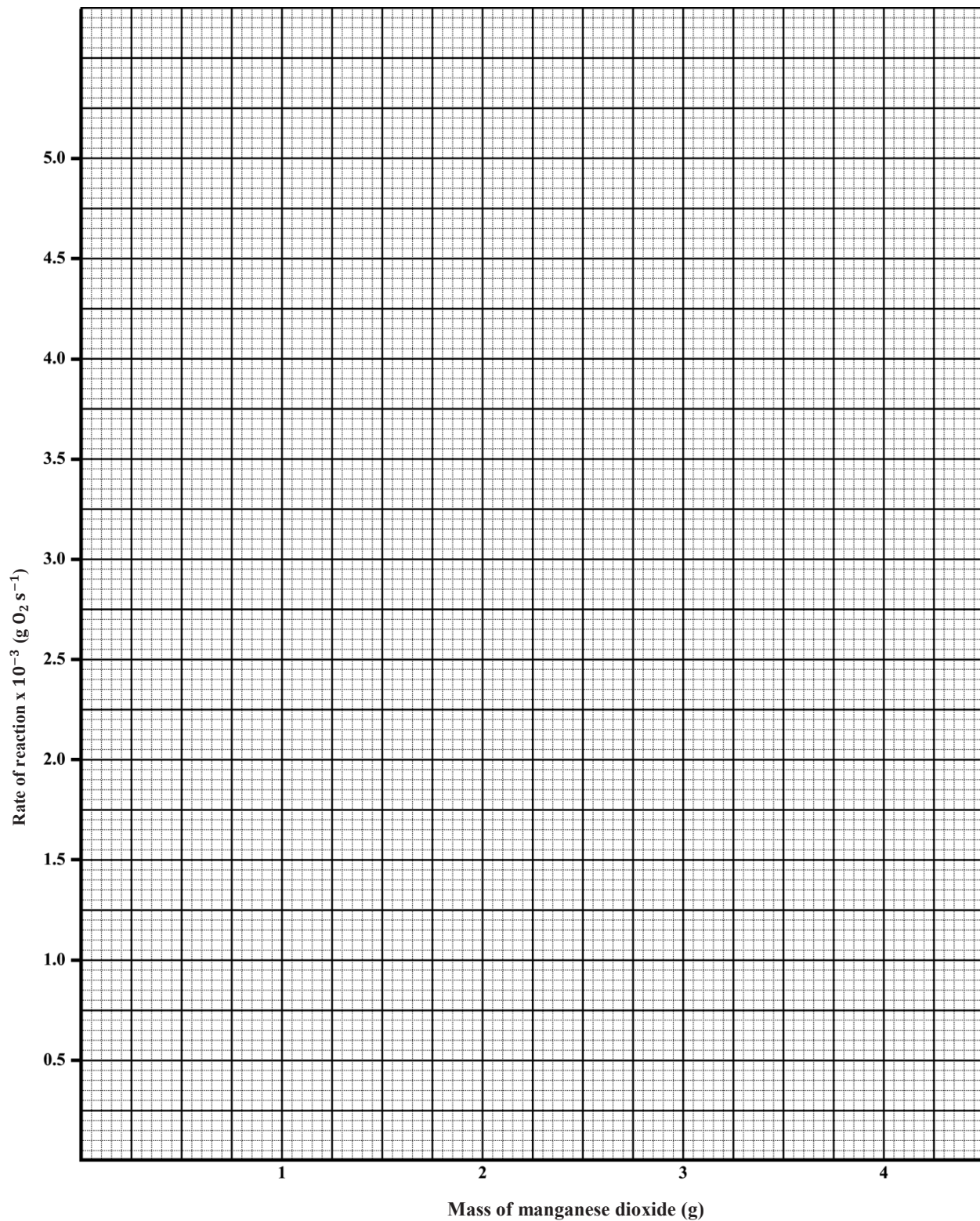


Figure 1. Rate of reaction versus mass of manganese dioxide

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- (iv) From the graph, describe the relationship between the rate of reaction and the mass of the catalyst.

(2 marks)

- (v) Explain how the catalyst affects the rate of the reaction as described in (a)(iv).

(2 marks)

- (vi) From the graph, determine the mass of oxygen produced after 10 s using 3.5 g of the catalyst.

2 marks)

- (vii) Draw a diagram of the apparatus that Steve should use for conducting this experiment and collecting the gas.

(3 marks)

- (viii) Steve conducted another experiment to compare the rate of decomposition of 0.3 mol dm^{-3} hydrogen peroxide using the same amounts of MnO_2 . On the same axes in Figure 1, sketch a graph to show how the rate of production of oxygen compares with that from Experiment 1.

(2 marks)

- (b) Tara needed to identify an unknown compound, X. She carried out a number of tests on an aqueous solution of X and recorded some of her results in Table 2. Complete Table 2 by inserting the missing inferences.

TABLE 2: OBSERVATIONS AND INFERENCES

Test	Observation	Inference
To a sample of Solution X, aqueous ammonia was added until in excess.	Light blue precipitate is soluble in excess to produce deep blue solution.	(1 mark)
Powdered zinc was added to a sample of Solution X.	A red/brown solid is produced and the blue liquid gets paler.	Ionic equation is required. (3 marks)

- (c) Tara has a sample of sodium chloride which became contaminated by a small amount of sand and iodine crystals. List the steps that Tara should perform to remove the iodine and sand from the mixture in order to obtain pure sodium chloride.

(4 marks)

Total 25 marks

2. (a) Study Table 3 which presents a portion of the periodic table with Q, R, T, W and X representing some elements, and answer the questions which follow.

TABLE 3: REPRESENTATION OF THE PERIODIC TABLE

I	II	III	IV	V	VI	VII	VIII
${}^3\text{Li}$							${}_{20}\text{Ne}$
	X				Q	R	
W	${}_{20}\text{Ca}$						T

- (i) Identify an alkaline-earth metal.

_____ (1 mark)

- (ii) Which of the elements shown has the HIGHEST atomic number?

_____ (1 mark)

- (iii) Which element will form ions with oxidation number of -2 ?

_____ (1 mark)

- (iv) R reacts with W to form a compound.

- a) What type of bonding takes place when R reacts with W?

_____ (1 mark)

- b) Draw a dot and cross diagram to show the bonding between R and W.

(3 marks)

- (v) R reacts vigorously with water to form a solution. A gas is evolved.
- a) What would you observe when the solution is tested with red or blue litmus paper?

(1 mark)

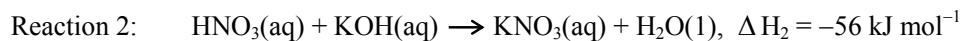
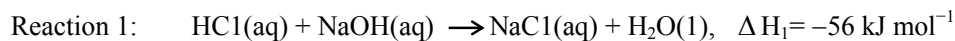
- b) Describe a suitable test to identify the gas evolved in (a) (v) .

(2 marks)

- (b) (i) Define the term 'heat of neutralization'.

(2 marks)

The equations below represent the reactions between strong acids and strong alkalis.



- (ii) Write an ionic equation to represent ONE of the reactions.

(2 marks)

- (iii) The values ΔH_1 and ΔH_2 are approximately the same. Suggest a reason for this.

(1 mark)

Total 15 marks

3. Pentane and pentene are two hydrocarbons.

(a) (i) Write the name of the homologous series for:

Pentane _____

Pentene _____

(2 marks)

(ii) Draw the FULLY displayed unbranched structure of pentane.

(2 marks)

(iii) Write a **balanced** chemical equation to show the conversion of pentene to pentane.

_____ (2 marks)

(b) (i) Define the term 'structural isomerism'.

(2 marks)

(ii) Draw a FULLY displayed structure of **another** isomer with the SAME molecular formula as pentane.

(2 marks)

(iii) State the name of the isomer in (b) (ii).

_____ (1 mark)

GO ON TO THE NEXT PAGE

- (c) (i) What chemical tests may be used to distinguish between pentane and pentene?

Reagents _____

Observations _____

_____ (2 marks)

- (ii) State ONE use of:

Pentane _____

Pentene _____

(2 marks)

Total 15 marks

SECTION B

Answer ALL questions in this section.

Write your answers in the spaces provided at the end of the question.

4. (a) Figure 2 shows some reactions of dilute sulfuric acid. Use the figure to answer the questions which follow.

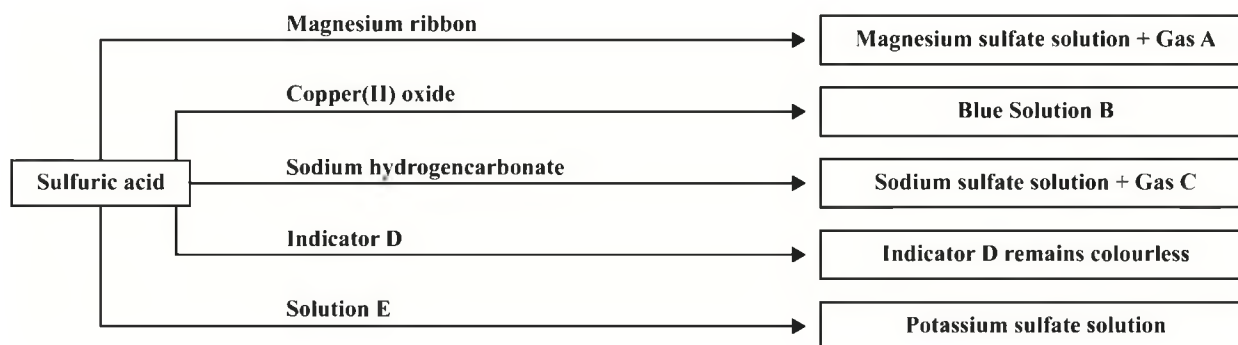
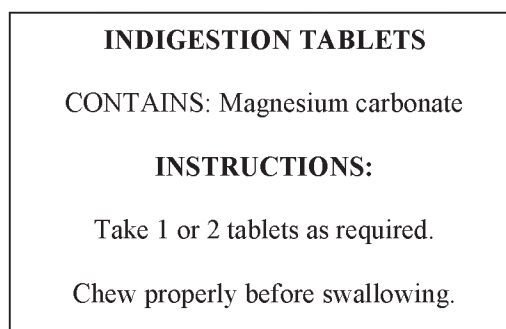


Figure 2. Some reactions of dilute sulfuric acid.

Identify EACH substance labeled A, B, C, D and E respectively.

(5 marks)

- (b) Some people suffer from indigestion when their stomach produces excess acid. The label on a household brand of indigestion tablet is shown below.



- (i) Magnesium carbonate is insoluble in water. Magnesium carbonate is mixed with water and strips of blue litmus paper are dipped into the mixture. What colour change is observed in the litmus paper?
(1 mark)
- (ii) Explain why the instructions suggest that the tablets be chewed before swallowing?
(2 marks)
- (iii) The acid present in the stomach is hydrochloric acid. Write a balanced equation for the reaction taking place in the stomach when the tablet is swallowed.
(2 marks)

GO ON TO THE NEXT PAGE

(iv) Name this type of reaction. **(1 mark)**

(v) A gas is produced from the reaction in 4(b)(iii). How can you test for this gas in the laboratory? **(2 marks)**

(c) Car batteries contain strong sulfuric acid. In treating a spillage from a car battery, washing soda is added to the affected area. Write an ionic equation to show the reaction of washing soda with sulfuric acid. **(2 marks)**

Total 15 marks

Write the answer to Question 4 here.

(a)

(i) Gas A _____

(ii) Solution B _____

(iii) Gas C _____

(iv) Indicator D _____

(v) Solution E _____

5. Iron can be extracted from its ore by reduction.

- (a) (i) Define 'reducing agent' in terms of oxidation number. **(2 marks)**
- (ii) Name a reducing agent that could be used to extract iron from its ore. **(1 mark)**
- (iii) Write a **balanced** chemical equation to show the reduction of iron ore with the reducing agent you have named in 5(a)(ii). **(2 marks)**
- (b) Compounds containing iron(II) ions can act as reducing agents.
- (i) What would be observed when iron(II) ions react with hydrogen peroxide. **(2 marks)**
- (ii) Write an ionic half equation to show iron(II) ions acting as reducing agents. **(2 marks)**
- (iii) With reference to oxidation numbers, explain why the equation below is a redox reaction.
$$\text{Fe(s)} + \text{CuSO}_4(\text{aq}) \rightarrow \text{Cu(s)} + \text{FeSO}_4(\text{aq})$$
 (3 marks)
- (iv) What colour change would you expect to see in the reaction above? **(1 mark)**
- (c) Describe ONE harmful effect on the body of EACH of the following
- (i) Lack of iron **(1 mark)**
- (ii) Carbon monoxide **(1 mark)**

Total 15 marks

Write the answer to Question 5 here.

GO ON TO THE NEXT PAGE

6. (a) Water has been shown to have unique properties which relate to many of its uses in living systems.
- (i) Draw a dot and cross diagram to show the bonding in the water molecule. **(2 marks)**
 - (ii) State THREE properties of water which can be considered **unique**. **(3 marks)**
 - (iii) Relate ONE of the properties you have stated in 6(a)(ii) to the structure and bonding of water molecules. **(2 marks)**
- (b) “The properties of water contribute to the problem of water pollution”.
- (i) State TWO reasons to support this statement. **(2 marks)**
 - (ii) List THREE **major** sources of water pollution. **(3 marks)**
 - (iii) The use of natural cleaners is one method of reducing water pollution and is considered one way of applying the principles of ‘Green Chemistry’. Explain why this is one way of applying ‘Green Chemistry’. **(3 marks)**

Total 15 marks

Write the answer to Question 6 here.

GO ON TO THE NEXT PAGE

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EXAMINATION**

CHEMISTRY

SPECIMEN PAPER

Paper 032 – General Proficiency

2 hours 10 minutes

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. Answer ALL questions on this paper.
2. Use your answer booklet when responding to the questions. For EACH question, write your answer in the space indicated and return the answer booklet at the end of the examination.
3. You may use a silent, non-programmable calculator to answer the questions.
4. You are advised to take some time to read through the paper and plan your answers.

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1. (a) M is a 0.07 mol dm^{-3} sodium hydroxide solution. P is a solution made by diluting 100 cm^3 of vinegar to 1000 cm^3 with distilled water.

Titrate 25 cm^3 portions of M with P using the indicator provided. These results will be used to determine the concentration of ethanoic acid in the vinegar before dilution.

- (i) Record your titration (burette) readings in Table 1.

TABLE 1: TITRATION READINGS

Burette Reading	Titration Number			
	1	2	3	
Final Reading (cm^3)				
Initial reading (cm^3)				
Volume of P used (cm^3)				

(8 marks)

- (ii) Describe the colour change of the indicator at the end point.

_____ **(1 mark)**

- (iii) Record the volume of P to be used in calculation.

_____ **(1 mark)**

- (iv) Write an equation for the reaction between ethanoic acid and sodium hydroxide.

_____ **(2 marks)**

- (v) Calculate the number of moles of sodium hydroxide in 25 cm^3 of Solution M.

(1 mark)

- (vi) Calculate the number of moles of ethanoic acid in the volume of Solution P used.

(1 mark)

GO ON TO THE NEXT PAGE

(vii) Calculate the concentration, in mol dm^{-3} , of ethanoic acid in Solution P.

(2 marks)

(viii) Calculate the concentration, in mol dm^{-3} , of the original vinegar (before dilution).

(1 mark)

(b) You are provided with TWO solutions labelled R and S, and a solid T. Perform the following tests on R, S and T and record your observations in Table 2.

TABLE 2: TESTS AND OBSERVATIONS

Test	Observations		
	R	S	T
(i) In a test tube, add approximately 4 cm^3 of water to a spatula full of solid T and swirl the tube until there is no further change. To separate portions of R, S and the mixture of T obtained in (i), carry out tests (ii) – (iv).			(1 mark)
(ii) Add aqueous ammonia gradually until in excess.	(2 marks)	(2 marks)	(2 marks)
(iii) Add a few drops of aqueous potassium iodide.	(1 mark)	(1 mark)	

Total 26 marks

2. The data collected from an experiment to compare the effect of temperature on the solubility of two salts, Z and Q, are presented in Table 3.

TABLE 3: SOLUBILITIES OF Z AND Q AT VARIOUS TEMPERATURES

Temperature (°C)		0	20	40	60	80
Solubility (g per 100 g water)	Z	18	10	8	4	2
	Q	8	25	48	64	85

- (a) Using the graph paper provided on page 5, plot the data for the solubilities of Z and Q given in Table 3. Use 2 cm to represent 10 °C and 1 cm to represent 10g/100g of water. **(6 marks)**

- (b) Describe the effect of increasing temperature on the solubilities of Z and Q respectively.

(2 marks)

From your graph, determine

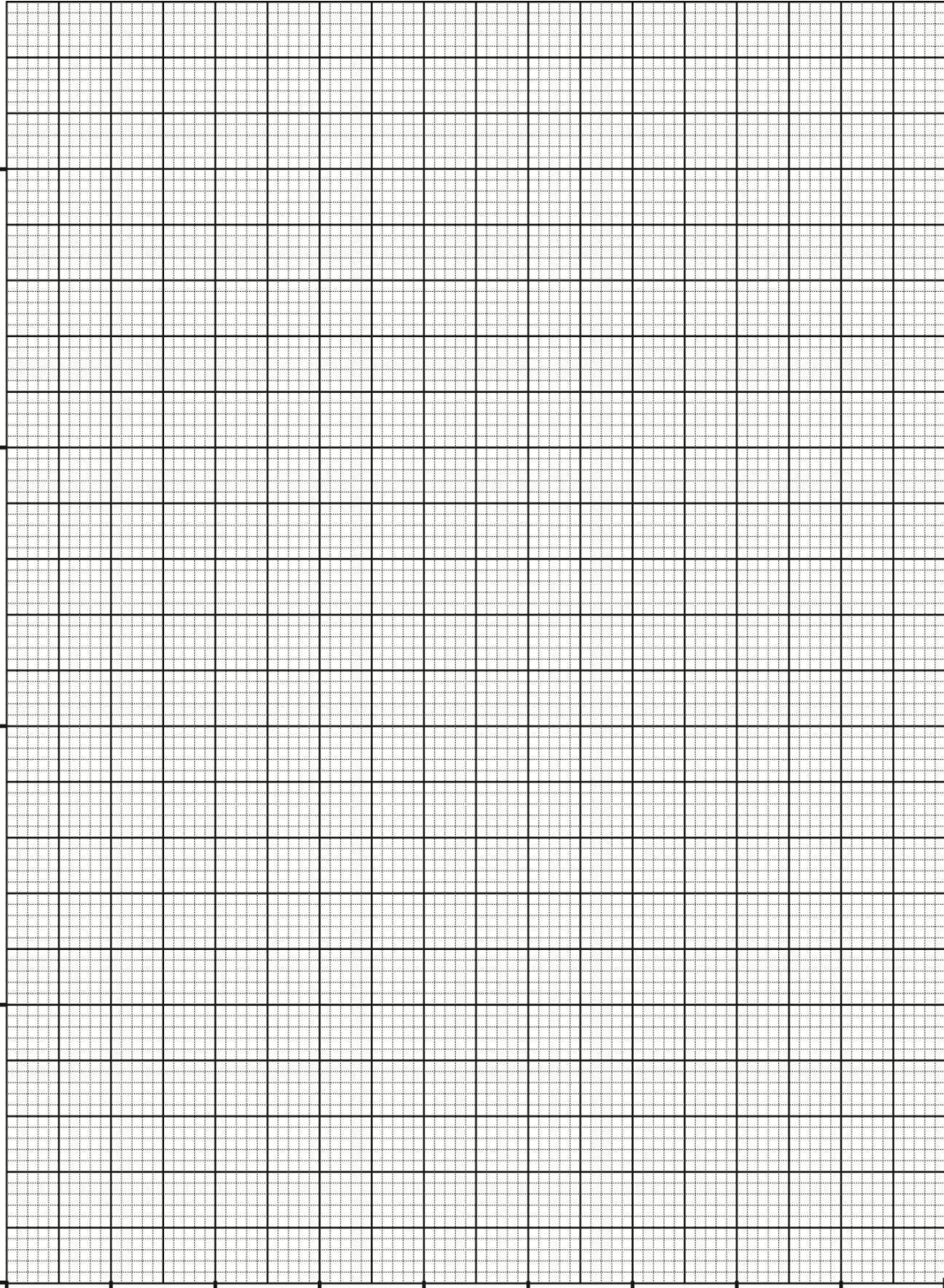
- (c) which salt is more soluble at 10 °C

(1 mark)

- (d) the temperature at which the solubility of Z and the solubility of Q are equal.

(1 mark)

Total 10 marks



3. Garcia conducted an experiment to compare the rate of reaction between iron and magnesium with dilute hydrochloric acid. The rate of reaction was determined by comparing the rate of formation of the gaseous product when the two metals react with dilute acid.

(a) Describe a possible procedure that Garcia might have used for successfully conducting this experiment. In your response you should:

(i) State the manipulated (independent) and control variables.

Manipulated (Independent) variable - _____

Control variable - _____

(2 marks)

(ii) Outline the steps Garcia would take in carrying out this experiment.

(3 marks)

(iii) Draw a diagram to show how the apparatus would be arranged for conducting the experiment.

(3 marks)

- (iv) Sketch a graph to show how the rate of reaction between the two metals would differ.

(2 marks)

- (b) Describe a confirmatory test for the gaseous product of the reaction.

(2 marks)

Total 10 marks

END OF TEST

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Item	Specific Objective	Key
1	A 1.3	A
2	A 1.3	D
3	A 2.6	B
4	A 2.5	C
5	A 4.3	A
6	A 5.2	D
7	A 7.7	B
8	A 6.5	A
9	A 8.3	D
10	C 5.2	A
11	A 7.6	A
12	C 5.2	C
13	A 8.5	C
14	A 9.8	D
15	A 9.2	C
16	A 3.7	B
17	A 4.3	C
18	A 5.7	C
19	A 7.7	B
20	A 5.8	A
21	A 5.2	D
22	A 11.2	B
23	A 11.1	A
24	A 11.1	C
25	A 5.1	C
26	A 4.1	B
27	C 6.3	C
28	C 1.1	A
29	A 7.2	D
30	A 11.1	C

Item	Specific Objective	Key
31	A 7.11	D
32	A 7.8	D
33	A 7.5	B
34	A 7.1	D
35	B 1.1	B
36	B 1.2	C
37	B 3.1	B
38	B 4.3	A
39	B 3.3	B
40	B 3.7	D
41	B 3.3	B
42	B 3.8	C
43	B 3.10	C
44	B 4.3	A
45	B 3.9	D
46	B 2.6	B
47	C 6.2	A
48	C 6.3	C
49	C 2.3	D
50	C 2.3	B
51	C 2.3	B
52	C 1.2	A
53	C 2.1	B
54	C 6.3	D
55	C 5.7	C
56	C 2.1	D
57	C 5.2	C
58	C 5.2	A
59	C 6.2	B
60	C 6.1	D

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C A R I B B E A N E X A M I N A T I O N C O U N C I L

CARIBBEAN SECONDARY EDUCATION CERTIFICATE®

CHEMISTRY

PAPER 02 - MARK SCHEME

SPECIMEN

CHEMISTRY
PAPER 02 - GENERAL PROFICIENCY
MARK SCHEME

Question 1

Specific objectives: A2.5, 6.5, 6.6, 10.1, 10.3, 10.4,; C2.1, 5.2, 6.1

- (a) (i) The rate of change in concentration of reactant or product with time.
- (ii) $2\text{H}_2\text{O}_2(\text{aq}) \rightarrow \text{O}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l})$
- (iii) 4-5 points correctly plotted 2XS
2-3 points correctly plotted 1XS
Straight line 1xs
- (iv) The reate of production of oxygen increases with the mass of catalyst. The rate of production of oxygen is directly proportional to the mass of catalyst used.
- (v) The catalyst lowers the activation energy of the reaction causing more molecules to participate in the reaction per unit time.
- (vi) Reading from graph = $4.4 \times 10^{-3} \text{ g s}^{-1}$ 1UK
Mass of O_2 after 10 s = $10 \times 4.4 \times 10^{-3}$ 1 UK
- (vii) Airtight apparatus; gas collected over water, graduated collection device
- (viii) Straight line going through origin; smaller slope than in first plot.

(b) .

Test	Observation	Inference
To a sample of Solution X, aqueous ammonia was added until in excess	Light blue precipitate soluble in excess to produce deep blue solution	Cu^{2+} ions are present (1UK)
Powdered zinc was added to a sample of Solution X	A red/brown solid is produced and the blue liquid gets paler	Copper metal produced $\text{Cu}^{2+}(\text{aq}) + \text{Zn}(\text{s}) \rightarrow \text{Cu}(\text{s}) + \text{Zn}^{2+}(\text{aq})$ (3UK) Ionic equation is required.

- (c) 1. Warm gently and the iodine sublimes. (1)
2. Add water to the remaining mixture and mix. (1)
3. Filter to remove the sand. (1)
4. Heat to remove the water and leave the salt. (1)

4XS

Total 25 marks

KC	UK	XS
1	2	3
2	2	3
2	2	3
	2	4
		4
3	12	10

CHEMISTRY
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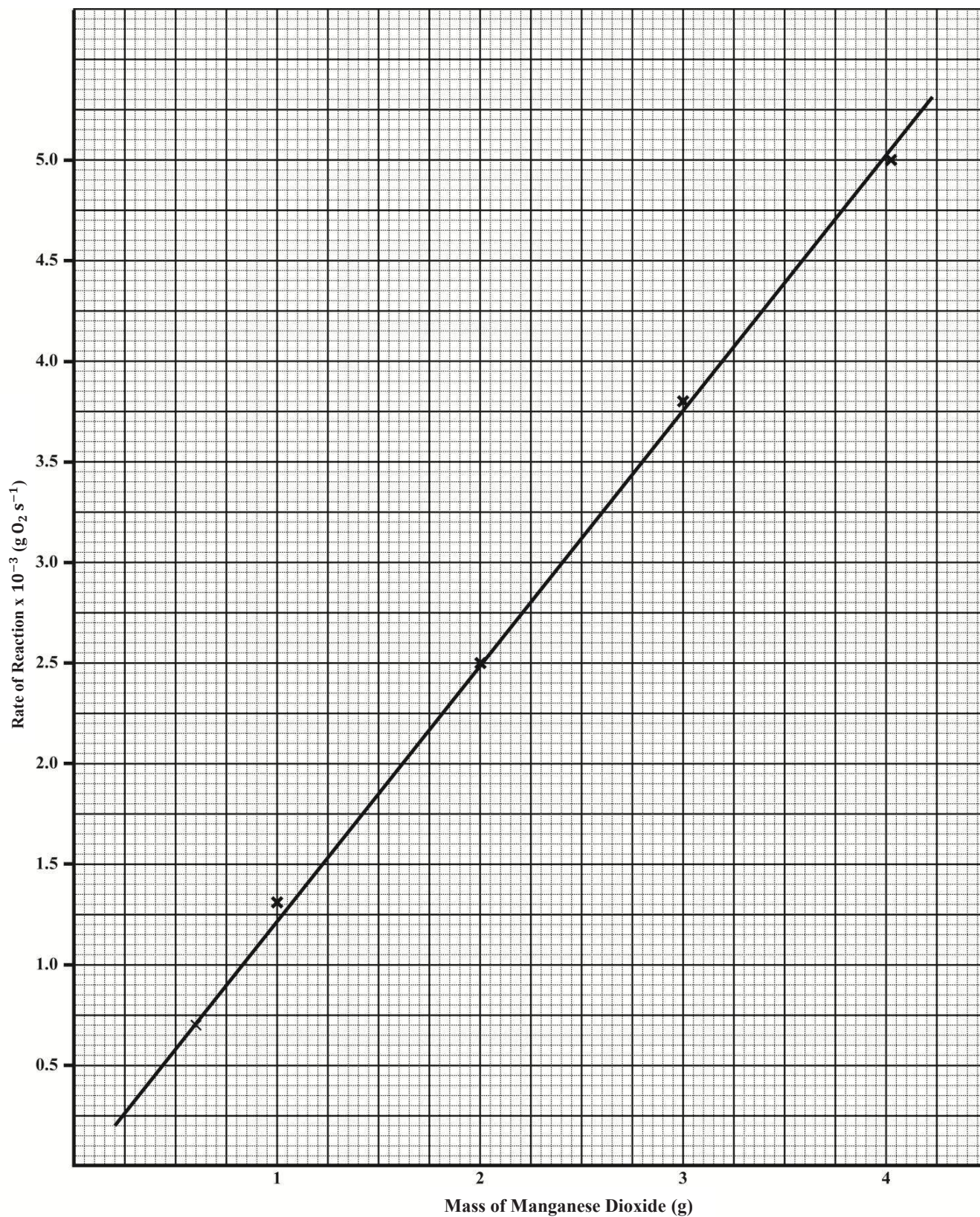


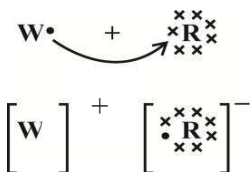
Figure 1. Rate of reaction versus mass of manganese dioxide

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MARK SCHEME

Question 2.

Specific objectives: A4.1, 4.5, 5.1, C1.1, 6.3, A 11.3, 6.5

- (a) (i) X
(ii) T
(iii) Q
(iv) a) Electrovalent or ionic bonding



- (v) (a) Red litmus turns blue, blue litmus unchanged.
(b) Hold a lighted splint in gas. The flame goes out with a 'pop' sound - hydrogen.
- (b) (i) The heat of neutralization is the energy change per mole of H₂O formed during the neutralization of an acid by a base.
(ii) H⁺(aq) + OH⁻(aq) → H₂O (l)
(iii) ΔH₁ and ΔH₂ are the same because in each case, one mole of water is formed.

KC	UK
1	
1	
1	
	1
	3
	1
2	
2	
	2
	1
Total 15 marks	7
	8

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MARK SCHEME

Question 4

Specific Objectives: A7.4, 7.10, 7.5, 7.1, 6.3, 6.5

- (a) (i) Hydrogen or H₂
 (ii) Copper sulfate or Cu SO₄
 (iii) Carbon dioxide or CO₂
 (iv) Phenolphthalein
 (ii) Potassium hydroxide or KOH
- (b) (i) Red litmus to blue
 (ii) Chewing: to increase surface area
 For faster reaction
 (iii) MgCO₃ + 2HCl → MgCl₂ + CO₂ + H₂O Balance (1)
 (iv) Neutralisation reaction
 (v) CO₂ turns lime water(1) cloudy(1).
- (c) 2H⁺(aq) + CO₃²⁻ → CO₂(g) + H₂O(l) Balanced (1)

KC	UK
1	
1	
1	
1	
1	
	1
	2
	2
1	
	2
	2
6	9

Total 15 marks

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MARK SCHEME

Question 5

Specific Objectives: A8.4, 8.5; C2.3, 4.2, 5.5

- (a) (i) A reducing agent undergoes an increase in oxidation number
- (ii) Carbon monoxide
- (iii) $\text{Fe}_2\text{O}_3 + 3\text{CO} \rightarrow 2\text{Fe} + 3\text{CO}_2$
- (b) (i) The pale green solution becomes reddish brown/yellow
- (ii) $\text{Fe}^{2+} \rightarrow \text{Fe}^{3+} + \text{e}^-$
- OR
- $\text{Fe}^2 - \text{e}^- \rightarrow \text{Fe}^{3+}$
- (iii) $\text{Fe}^0 + \text{Cu}^{2+} \text{SO}_4^{2-} \rightarrow \text{Cu}^0 + \text{Fe}^{2+} \text{SO}_4^{2-}$
There is a change in oxidation state for Fe and/or Cu
- (iv) Blue solution to green solution
- (c) (i) Lack of iron will affect the formation of haemoglobin which is essential for oxygen transport OR will cause anaemia.
- (ii) Carbon monoxide combines with haemoglobin resulting in death.

KC	UK
2	
1	
	2
2	
	2
	2
1	
	1
	1
	1
6	9

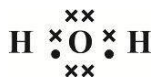
TOTAL 15 marks

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MARK SCHEME

Question 6

Specific Objectives: C5.6, 5.7, 5.9, 5.10

- (a) (i) Dot and Cross Diagram



- (ii)
- Universal solvent
 - High specific heat capacity
 - High melting and boiling point
 - Low volatility
 - Density decreases when cooled below 4°C
(Any 3, Or any other reasonable answer)
- (iii) Universal solvent:
- Water polar so can dissolve a range of substances
 - High melting/boiling point (low volatility):
Intermolecular forces (H-bonding) strong so lots of energy required to cause the change in state
 - Density changes: Below 4°C, presence of H-bonds prevents molecules from coming close together.
(Or any other reasonable answer.)
- (b) (i) Water universal solvent(1) so will dissolve many pollutants.(1)
- (ii) Sources of water pollution: Farm run-off, sewage, household waste, industrial waste.
Any three or any other reasonable answer
- (iii) Green Chemistry:
- A proactive approach to pollution prevention.
 - 'It involves designing chemical products and processes that reduce or eliminate the use and/or generation of hazardous substances'.
(www.beyondbenign.org;24/04/2012)
 - Natural cleaners produce less waste/ produce non-toxic waste/ are biodegradable/ breakdown into harmless substances/ are less harmful thus reducing the chances of chemical accidents.
(Any other reasonable answer.)

KC	UK
	2
3	
	2
	2
3	
	1
	1
	1
Total 15 marks	6
	9

01212032/SPECIMEN/MS/2012

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SPECIMEN

CHEMISTRY
PAPER 032 – GENERAL PROFICIENCY
MARK SCHEME

Paper 3/2 – Question 1

Specific Objectives: A7.1, 7.2, 7.3, 7.4

		UK	XS																				
(a)	(i)	3 sets of entries/volumes – 3 x 1 mark Accuracy +/- 0.1 cm ³ 5 mks +/- 0.2 cm ³ 4mks +/- 0.3 cm ³ 3 mks +/- 0.4 cm ³ 2 mks +/- 0.5 cm ³ 1 mk		8																			
	(ii)	Correct indicator colour Phenolphthalein - pink to colourless Methyl orange - yellow to pink		1																			
	(iii)	Correct volume of P based on burette readings	1																				
	(iv)	NaOH + CH ₃ COOH → CH ₃ COONa + H ₂ O	2																				
	(v)	No. moles NaOH = (0.07 / 1000) x 25 = 0.00175 mol	1																				
	(vi)	No. moles acid = No. moles NaOH = 0.00175 mol	1																				
	(vii)	Let the volume of P used = y cm ³ y cm ³ contains 0.00175 mol acid 1000 cm ³ contains (0.00175/y) x 1000 mol = z	2																				
	(viii)	Concentration of original vinegar = z x 10	1																				
(b)		<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th rowspan="2">Test</th> <th colspan="3">Observations</th> </tr> <tr> <th>R</th> <th>S</th> <th>T</th> </tr> </thead> <tbody> <tr> <td>(i) Given</td> <td style="background-color: #cccccc;"></td> <td style="background-color: #cccccc;"></td> <td>Pale blue solution formed. (1 mark)</td> </tr> <tr> <td>(ii) Given</td> <td>White ppt. soluble in XS (2 marks)</td> <td>White ppt. insoluble in XS (2 marks)</td> <td>Blue ppt. insoluble in XS (2 marks)</td> </tr> <tr> <td>(iii) Given</td> <td>No visible change (1 mark)</td> <td>Bright yellow Ppt. (1 mark)</td> <td style="background-color: #cccccc;"></td> </tr> </tbody> </table>	Test	Observations			R	S	T	(i) Given			Pale blue solution formed. (1 mark)	(ii) Given	White ppt. soluble in XS (2 marks)	White ppt. insoluble in XS (2 marks)	Blue ppt. insoluble in XS (2 marks)	(iii) Given	No visible change (1 mark)	Bright yellow Ppt. (1 mark)			9
	Test	Observations																					
		R	S	T																			
	(i) Given			Pale blue solution formed. (1 mark)																			
(ii) Given	White ppt. soluble in XS (2 marks)	White ppt. insoluble in XS (2 marks)	Blue ppt. insoluble in XS (2 marks)																				
(iii) Given	No visible change (1 mark)	Bright yellow Ppt. (1 mark)																					
Total 26 marks		8	18																				

CHEMISTRY
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MARK SCHEME

Question 2**Specific Objectives: B7.1, 7.2, 7.3**

		UK	XS
(a)	Axes – correct labels (2) Suitable Scale (1) Accuracy of Plot: 8 – 10 points accurately plotted - (3). 5 – 7 points accurately plotted - (2). 2 - 4 points accurately plotted - (1).		6
(b)	Increasing temperature causes solubility of Z to decrease and that of Q to increase .	2	
(c)	Correct reading based on candidate's graph	1	
(d)	Correct reading based on candidate's graph	1	
Total 10 marks		4	6

Question 3**Specific Objectives: A 5.2, 5.3**

		UK	XS
(a)	(i)	Manipulated and control variables will be dependent on the procedure used for conducting the reaction. Award one mark for each.	2
	(ii)	Steps for conducting expt. <u>Clear and logical sequence of steps(1) that will yield gaseous product (1)and will allow for comparison of rates.(1)</u> Award maximum of 1 mark if the procedure will allow for formation of gaseous product but will not allow for comparison of reaction rates.	3
	(iii)	Diagram should be airtight, allow for collection of gas and should show reactants added together.	3
	(iv)	Sketch graph – Axes labeled and rate of Mg greater than for Zn	2
(b)	Test for hydrogen. Use a lighted splint. Splint goes out with a “pop”.		2
Total 12 marks			12



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