L-Università ta' Malta

MATSEC
Examinations Board

SEC 06 Syllabus

Chemistry

2025

Amended on 13th May 2022

Table of Contents

Introduction

This syllabus is based on the curriculum principles outlined in *The National Curriculum Framework for All* (NCF) which was translated into law in 2012 and designed using the *Learning Outcomes Framework* that identify what students should know and be able to achieve by the end of their compulsory education.

As a learning outcomes-based syllabus, it addresses the holistic development of all learners and advocates a quality education for all as part of a coherent strategy for lifelong learning. It ensures that all children can obtain the necessary skills and attitudes to be future active citizens and to succeed at work and in society irrespective of socio-economic, cultural, racial, ethnic, religious, gender and sexual status. This syllabus provides equitable opportunities for all learners to achieve educational outcomes at the end of their schooling, which will enable them to participate in lifelong and adult learning, reduce the high incidence of early school leaving and ensure that all learners attain key twenty-first century competences.

This programme also embeds learning outcomes related to cross-curricular themes, namely digital literacy; diversity; entrepreneurship creativity and innovation; sustainable development; learning to learn and cooperative learning and literacy. In this way students will be fully equipped with the skills, knowledge, attitudes and values needed to further; learning, work, life, and citizenship.

What is Chemistry?

Chemistry involves a dynamic and engaging study of the material world. It is a field of human endeavour based on the broad understanding of physical concepts and models, which are united by common procedural and intellectual processes. Chemistry and the work of chemists have a profound impact on the environment, quality of life and on social and cultural practices.

What does a study of Chemistry entail?

Chemistry is an experimental science and practical work is central in a teaching programme of the subject at this level. An investigative approach to teaching Chemistry highlights the study of key concepts of chemistry in real-world contexts. While a practical paper will not be set, it is nevertheless expected that students taking the examination would have direct experience of the laboratory and have carried out a reasonable number of experimental investigations.

Every opportunity should be taken to expose the students to the applications of Chemistry to everyday situations and to help students develop higher order thinking skills. To allow more time for an investigative approach to teaching chemistry and for the development of reasoning skills this syllabus has reduced the emphasis on factual knowledge and decreased the content that students are expected to recall.

The examination paper will test the knowledge and understanding of chemical facts and principles and the ability to apply these to everyday situations as well as to solve theoretical and practical chemical problems both qualitatively and quantitatively.

Finally, coursework has been extended to 30% of the final grade to reflect a wider range of skills and attitudes towards Chemistry.

How is Chemistry related to candidates' lives, to Malta, and to the world?

Since chemistry is fundamental to our world, it plays a role in everyone's lives and touches almost every aspect of our existence in some way. Chemistry is essential for meeting our basic needs of food, clothing, shelter, health, energy, as well as clean air, water, and soil. Chemical technologies enrich our quality of life in numerous ways by providing new solutions to problems in health, materials, and energy usage. Thus, studying chemistry is useful in preparing us for the real world.

This syllabus takes a learning outcomes approach and is based on five themes which put Chemistry at the centre of students' experience. The learning outcomes and assessment criteria have been written in a way that are student centred.

The aspirational programme learning outcomes for this subject are:

At the end of the programme, I can:

1. acquire a knowledge of basic chemical concepts and an understanding of chemical principles and patterns.
2. pursue my studies in chemistry or related subjects further.
3. appreciate that chemistry is a dynamic and evolving subject and that its principles and theories may change.
4. be aware of the importance of adopting the scientific method of investigation.
5. develop relevant practical skills whilst having due regard to correct and safe laboratory practice.
6. develop experimental and investigative competences.
7. develop abilities to:
   a. form hypotheses and design experiments to test these hypotheses;
   b. organize, interpret and evaluate chemical information in order to draw conclusions, make decisions and/or solve problems;
   c. communicate chemical knowledge and findings in appropriate ways.
8. apply the chemical knowledge and understanding to familiar and unfamiliar situations.
9. develop an appreciation of the environmental and technological applications of chemistry and related economic, ethical and social implications.

List of Subject Foci

1. Substances from the Earth: The Atmosphere.
2. Substances from the Earth: Aquatic environments.
3. Substances from the Earth: The Land.
4. Making New Materials: How fast? How far? How much?
5. Carbon compounds. Meeting our energy needs.

List of Learning Outcomes

At the end of the programme, I can:

LO 1. Demonstrate an understanding of how chemistry works and is communicated.

LO 2. Describe and explain the properties of gases that may be found in air and how to prepare them in the lab.

LO 3. Describe the solvent action of water including the impact of water hardness.

LO 4. Describe the chemical properties of acids, bases and salts.

LO 5. Describe the conduction of electricity through solutions and molten salts.

LO 6. Describe the major groups of the periodic table including their physical and chemical properties.

LO 7. Describe how substances dissolved in water can be identified and how their concentration can be measured.

LO 8. Describe how different rocks contain important substances, their extraction, chemical nature, responsible use and environmental impact.

LO 9. Describe how and why physical and chemical changes happen.

LO 10. Perform quantitative calculations.

LO 11. Investigate why and how chemical reactions proceed at different rates.

LO 12. Describe dynamic equilibria and the conditions needed to shift a reaction in equilibrium.

LO 13. Describe the chemical nature of crude oil and the substances obtained from it.

LO 14. Distinguish different homologous series and their physical and chemical properties.

LO 15. Describe the energy changes accompanying chemical changes.

Programme Level Descriptors

This syllabus sets out the content and assessment arrangements for the award of Secondary Education Certificate in **CHEMISTRY** at MQF Level 1, 2 or 3. Level 3 is the highest level which can be obtained for this qualification.

Table 1 overleaf refers to the qualification levels on the Malta Qualifications Framework (MQF) with minor modifications to reflect specific **CHEMISTRY** descriptors. These are generic statements that describe the depth and complexity of each MQF level of study and outline the knowledge, skills and competences required to achieve an award at Level 1, 2 or 3 in **CHEMISTRY**.

Knowledge involves the acquisition of basic, factual and theoretical information. Skills involve the application of the acquired knowledge and understanding to different contexts. Competences indicate sufficiency of knowledge and skills that enable someone to act in a wide variety of situations, such as whether one is competent to exercise skills with or without direct supervision, autonomy or responsibility.

MQF Level 1	MQF Level 2	MQF Level 3
Basic general **knowledge** of Chemistry. 1. Acquires basic general knowledge related to the immediate environment and expressed through a variety of simple tools and context as an entry point to lifelong learning; 2. Knows and understands the steps needed to complete simple tasks and activities in familiar environments; 3. Is aware and understands basic tasks and instructions; 4. Understands basic textbooks.	Basic factual **knowledge** of Chemistry. 1. Possesses good knowledge of Chemistry; 2. Is aware and interprets different types of information and ideas; 3. Understands facts and procedures in the application of basic tasks and instructions; 4. Selects and uses relevant knowledge to accomplish specific actions for self and others.	**Knowledge** of facts, principles, processes and general concepts in Chemistry. 1. Understands the relevancy of theoretical knowledge and information related to Chemistry; 2. Assesses, evaluates and interprets facts, establishing basic principles and concepts in Chemistry; 3. Understands facts and procedures in the application of more complex tasks and instructions; 4. Selects and uses relevant knowledge acquired on one's own initiative to accomplish specific actions for self and others.
Basic **skills** required to carry out simple tasks. 1. Has the ability to apply basic knowledge and carry out a limited range of simple tasks; 2. Has basic repetitive communication skills to complete well defined routine tasks and identifies whether actions have been accomplished; 3. Follows instructions and is aware of consequences of basic actions for self and others.	Basic cognitive and practical **skills** required to use relevant information in order to carry out tasks and to solve routine problems using simple rules and tools. 1. Has the ability to demonstrate a range of skills by carrying out a range of complex tasks within Chemistry; 2. Communicates basic information; 3. Ensures tasks are carried out effectively.	A range of cognitive and practical **skills** required to accomplish tasks and solve problems by selecting and applying basic methods, tools, materials and information. 1. Demonstrates a range of developed skills to carry out more than one complex task effectively and in unfamiliar and unpredictable contexts; 2. Communicates more complex information; 3. Solves basic problems by applying basic methods, tools, materials and information given in a restricted learning environment.

MQF Level 1	MQF Level 2	MQF Level 3
Work or study under direct supervision in a structured context. 1. Applies basic knowledge and skills to do simple, repetitive and familiar tasks; 2. Participates in and takes basic responsibility for the action of simple tasks; 3. Activities are carried out under guidance and within simple defined timeframes; 4. Acquires and applies basic key competences at this level.	Work or study under supervision with some autonomy. 1. Applies factual knowledge and practical skills to do some structured tasks; 2. Participates in and takes responsibility for assigned tasks. 3. Carries out activities under limited supervision and with limited responsibility in a quality-controlled context; 4. Acquires and applies basic key competences at this level.	Takes responsibility for completion of tasks in work or study and adapts own behaviour to circumstances in solving problems. 1. Applies knowledge and skills to do some tasks systematically; 2. Adapts own behaviour to circumstances in solving problems by participating pro-actively in structured learning environments; 3. Uses own initiative with established responsibility and autonomy, but is supervised in quality-controlled learning environments; 4. Acquires key competences at this level as a basis for lifelong learning.

Learning Outcomes and Assessment Criteria

Learning Outcome 1: **(Coursework and Controlled)**	**At the end of the programme, I can demonstrate an understanding of how chemistry works and is communicated. (*To be implemented in combination with coursework.*)**

Assessment Criteria (MQF 1)	Assessment Criteria (MQF 2)	Assessment Criteria (MQF 3)
1.1a State that scientific knowledge changes with new evidence/observations/experiments.	1.2a Distinguish between a fact, a hypothesis, and a theory.	1.3a Discuss briefly the meaning of science in terms of its healthy scepticism, aimed objectivity, and the value of physical (observable / measurable) evidence.
1.1b Discuss the importance of fair (objective) testing in science.		1.3b Evaluate an experiment in terms of its objectivity.
1.1c Identify variables in an experiment.		1.3c Identify dependent and independent variables.
1.1d Follow health and safety regulations.	1.2d State health and safety considerations.	1.3d Evaluate an experiment in terms of health and safety.
1.1e Carry out, with supervision, a written procedure for an experiment.	1.2e Carry out, with limited supervision, a written procedure for an experiment.	1.3e Carry out, with no direct supervision, a written procedure for an experiment.
1.1f Record observations/measurements in a given table.	1.2f Record observations/measurements appropriately.	1.3f Determine which observations/ measurements are to be measured for an experiment.
	1.2g Structure a laboratory report in sections.	1.3g Write a scientific report for an experiment carried out.
1.1h Label given diagrams.	1.2h Draw labelled diagrams from given apparatus.	1.3h Draw labelled diagrams of apparatus used during experiments.

Assessment Criteria (MQF 1)	Assessment Criteria (MQF 2)	Assessment Criteria (MQF 3)
1.1i Read values from simple graphical representations.	1.2i Interpret graphical representations containing single series of data.	1.3i Interpret multiple series of data plotted on the same axes.
1.1j Plot a single series of data on given axes.	1.2j Plot a single series of data.	1.3j Plot multiple series of data on the same axes.
	1.2k Interpret situations by sketching a graph.	1.3k Interpret situations by sketching graphs in relation to existing plotted graphs.
	1.2l Draw conclusions from an experiment.	1.3l Evaluate an experimental procedure and results by suggesting improvements.
	1.2m Plan an experiment to solve a given problem with supervision.	1.3m Plan an experiment to solve a given problem without direct supervision.
	1.2n Carry out an experiment to solve a given problem with supervision.	1.3n Carry out an experiment to solve a given problem without direct supervision.
1.1o Represent a chemical reaction using a word equation.	1.2o Represent a chemical reaction using a balanced chemical equation.	1.3o Represent a chemical reaction using a net ionic equation.

Subject Focus:	Substances from the Earth: The Atmosphere
Learning Outcome 2: (Coursework and Controlled)	**At the end of the programme, I can describe and explain the properties of gases that may be found in air and how to prepare them in the lab.**

Assessment Criteria (MQF 1)	Assessment Criteria (MQF 2)	Assessment Criteria (MQF 3)
2.1a Identify the gases that make up the air naturally and those that may be added by humans. *(E.g. nitrogen, oxygen, carbon dioxide, water vapour, noble gases, carbon monoxide, sulfur dioxide, nitrogen oxides and ozone.)*	2.2a State the approximate percentage of nitrogen, oxygen, carbon dioxide and noble gases in dry, unpolluted air.	2.3a Determine experimentally the percentage oxygen in air.
2.1b Describe the properties of nitrogen, oxygen, carbon dioxide and noble gases.	2.2b Relate the properties of nitrogen, oxygen, carbon dioxide and noble gases to their uses.	
2.1c Distinguish between elements and compounds. *(E.g. using gases in air.)*	2.2c Explain the difference between elements and compounds.	
2.1d Use a periodic table to find information about elements. *(Including an online periodic table.)*	2.2d Use a periodic table to describe and/or model atoms showing differences between atoms. *(E.g. subatomic particles - protons, neutrons and electrons; atomic number, mass number, isotopes and relative atomic mass.)*	2.3d Calculate relative atomic mass from isotopic data.
	2.2e Determine the electron configuration of the first 18 elements of the periodic table.	

Assessment Criteria (MQF 1)	Assessment Criteria (MQF 2)	Assessment Criteria (MQF 3)
2.1f Distinguish between gases which are monoatomic and others which are diatomic. *(Limited to noble gases, H_2, N_2, O_2, F_2, and Cl_2.)*		
		2.3g Explain how covalent bonds are formed.
		2.3h Represent covalent bonds using dot and cross diagrams showing outer electron shells only. *(E.g. hydrogen, oxygen, nitrogen, chlorine, methane, water, carbon dioxide, ammonia and hydrogen chloride)*
		2.3i Explain the properties of covalent substances for simple molecules. *(Limited to melting and boiling points, non-conduction of electricity.)*
	2.2j Explain that gases have different diffusion rates depending on their atomic or molecular mass.	2.3j Explain why gases have different densities when measured under the same conditions of temperature and pressure.
	2.2k Prepare gases safely. *(Limited to carbon dioxide by reacting acid with carbonates, oxygen from hydrogen peroxide, and hydrogen by reacting an acid with an appropriate metal.)*	2.3k Prepare gases safely by selecting and assembling appropriate apparatus. *(Limited to carbon dioxide by reacting acid with carbonates, oxygen from hydrogen peroxide, and hydrogen by reacting an acid with an appropriate metal.)*

Assessment Criteria (MQF 1)	Assessment Criteria (MQF 2)	Assessment Criteria (MQF 3)
	2.2l Test the properties of gases following step by step instructions. *(Limited to carbon dioxide, hydrogen and oxygen)*	2.3l Test the properties of gases. *(Limited to carbon dioxide, hydrogen and oxygen)*
	2.2m Collect gases over water or in a gas syringe. *(Limited to carbon dioxide, oxygen and hydrogen)*	2.3m Collect gases by upward or downward delivery. *(Limited to carbon dioxide, oxygen and hydrogen. Reference to drying of gases is not required.)*
		2.3n Evaluate different collection methods for carbon dioxide, oxygen and hydrogen.
2.1o Relate the emission of the pollutants present in air to human activities. *(Limited to carbon dioxide, carbon monoxide and soot.)*	2.2o Describe how the amount of certain gases and particulates in the environment may increase due to combustion reactions. *(E.g. carbon dioxide due to complete combustion, carbon monoxide and soot due to incomplete combustion.)*	2.3o Explain how the amount of certain gases and particulates in the environment may increase due to combustion reactions and natural causes. *(E.g. carbon dioxide, carbon monoxide, sulfur dioxide, nitrogen oxides and soot.)*
	2.2p Identify carbon dioxide, sulfur dioxide and nitrogen dioxide as examples of acidic oxides.	2.3p Explain how some gases react with water to produce acidic solutions. *(E.g. acidic oxides such as carbon dioxide, nitrogen dioxide and sulfur dioxide.)*
	2.2q Identify water and carbon monoxide as examples of neutral oxides.	

Assessment Criteria (MQF 1)	Assessment Criteria (MQF 2)	Assessment Criteria (MQF 3)
2.1r Identify gases that contribute towards the greenhouse effect, ozone depletion and acid rain. *(Greenhouse gases: e.g. CO_2, CH_4 and water vapour.* *Ozone depletion: CFCs.* *Acid rain: e.g. SO_2 and NO_2.)*	2.2r Explain environmental effects of pollutants. *(Such as greenhouse gases, CFCs, SO_2, NO_2 and particulates which include smog, soot, dust and volcanic ash.)*	2.3r Interpret data regarding environmental effects of some pollutants. *(Such as global warming, acid rain, effect of CFCs on ozone and particulates which include smog, soot, dust and volcanic ash.)*
2.1s Identify methods for reducing emission of pollutants into the atmosphere. *(E.g. use of renewable sources of energy.)*	2.2s Describe methods for reducing emission of pollutants into the atmosphere. *(E.g. use of renewable sources of energy, banning or reduction of pollutants, better choice of non-renewable fuels.)*	2.3s Discuss methods for reducing emission of pollutants into the atmosphere. *(E.g. use of renewable sources of energy, catalytic converters and better choice of non-renewable fuels.)*

Subject Focus:	Substances from the Earth: Aquatic environments
Learning Outcome 3: (Coursework and Controlled)	At the end of the programme, I can describe the solvent action of water including the impact of water hardness.

Assessment Criteria (MQF 1)	Assessment Criteria (MQF 2)	Assessment Criteria (MQF 3)
3.1a Identify sources of potable water and their management in Malta.	3.2a Present ideas that water is a very precious resource in the world and a potential source of conflict.	3.3a Relate ideas based on research about why water is a very precious resource in the world and a potential source of conflict.
3.1b Identify physical properties of pure water.	3.2b State criteria of purity for water. (*Limited to melting point, boiling point and conductivity.*)	
3.1c Describe how salt is produced in Malta from sea water. *(By evaporation and crystallisation.)*	3.2c Explain how salt is produced in other countries from rock salt. *(By solution, filtration, evaporation and crystallisation.)*	3.3c Produce crystals of salt from rock salt.
		3.3d Compare size of crystals obtained from slow and fast crystallisation methods.
3.1e Explain that sea water contains dissolved charged ions that form crystals on evaporation.	3.2e Identify which elements form positive ions and which form negative ions in relation to their position in the periodic table.	3.3e Explain how ionic bonds lead to giant ionic structures. *(Structure limited to sodium chloride. Drawing of structure is not expected.)*
		3.3f Explain the properties of ionic compounds. *(Limited to solubility, melting/boiling points and electrical conductivity in different states.)*

Assessment Criteria (MQF 1)	Assessment Criteria (MQF 2)	Assessment Criteria (MQF 3)
		3.3g Draw dot and cross diagrams to represent ionic binary compounds showing all electron shells. *(Limited to the first 18 elements.)*
	3.2h Work out the formulae of ionic compounds from the charge on the ions. *(Metal ions limited to groups 1 and 2, aluminium, zinc, lead(II), silver, copper(II) and iron(II and III).* *Non-metal ions limited to groups 6 and 7. Polyatomic ions limited to carbonate, hydrogencarbonate, nitrate, sulfate, hydroxide and ammonium.)*	3.3h Work out the formulae of ionic compounds from the charge on the ions. *(Limited to copper(I), nitrite, sulfite, and phosphate.)*
3.1i Distinguish between solute, solvent, and solution.	3.2i Distinguish between dilute, concentrated, and saturated solutions.	
3.1j Distinguish between soluble and insoluble substances.	3.2j Predict solubility of salts in water using the solubility rules.	3.3j Interpret solubility curves of salts/gases in water.
3.1k Distinguish between hard and soft water using simple chemical tests. *(E.g. Lathering of soap.)*	3.2k Explain the difference between hard and soft water.	3.3k Investigate the differences between hard and soft water. *(Using soap solution, boiling water, and evaporation.)*

Assessment Criteria (MQF 1)	Assessment Criteria (MQF 2)	Assessment Criteria (MQF 3)
3.1l Describe the risks and benefits of hard water including issues of health and economics. *(E.g. the need of calcium by the body, clogging of hot water pipes and limescale on electric heating elements.)*	3.2l Explain, using chemical reactions, where hardness, both temporary and permanent, and limescale come from. *(With reference to groundwater.)*	
3.1m Explain why water softening is important in hard water areas by referring to the local scenario.	3.2m Explain, using chemical equations where appropriate, the effectiveness of different methods for removing water hardness. *(Using ion exchange resin, boiling water, distillation and addition of washing soda.)*	
3.1n Name desalination techniques that can be used to create demineralised water from seawater. *(Limited to distillation and reverse osmosis.)*	3.2n Describe how simple distillation and reverse osmosis are used to produce demineralised water from impure water.	3.3n Evaluate desalination techniques that can be used to produce demineralised water from seawater. *(Limited to distillation and reverse osmosis.)*

Subject Focus:	**Substances from the Earth: Aquatic environments**
Learning Outcome 4: **(Coursework and Controlled)**	**At the end of the programme, I can describe the chemical properties of acids, bases and salts.**

Assessment Criteria (MQF 1)	Assessment Criteria (MQF 2)	Assessment Criteria (MQF 3)
4.1a Use indicators and the pH scale to distinguish between acidic, alkaline and neutral solutions. *(E.g. Using litmus, universal indicator, phenolphthalein and methyl orange indicators.)*	4.2a Classify a substance as acid, base or alkali.	4.3a Explain the difference between strong and weak acids/alkalis.
	4.2b Identify basic oxides by their reaction with acids and the metal's position in the periodic table.	4.3b Identify amphoteric oxides by their reaction with acids and alkalis as well as the metal's position in the periodic table. *(Chemical equations for their reactions with alkalis are not required.)*
	4.2c Represent reactions of non-oxidising acids with bases/alkalis, carbonates/ hydrogencarbonates, and fairly reactive metals, using chemical equations.	4.3c Represent reactions of non-oxidising acids with bases/alkalis, carbonates/ hydrogencarbonates, fairly reactive metals and sulfites, using net ionic equations.
	4.2d Represent the reaction of an alkali with an ammonium salt using chemical equations.	4.3d Represent the reaction of an alkali with an ammonium salt using net ionic equations.
	4.2e Represent the precipitation of an insoluble salt using chemical equations.	4.3e Represent the precipitation of an insoluble salt using net ionic equations.
	4.2f Apply acid-base concepts to the real world. *(E.g. In terms of solutions to environmental issues such as acid rain, neutralisation of acid soils and excess stomach acidity.)*	4.3f Investigate acid-base concepts in real life applications.

Assessment Criteria (MQF 1)	Assessment Criteria (MQF 2)	Assessment Criteria (MQF 3)
	4.2g Describe a suitable method to make and obtain a pure dry sample of an insoluble salt from named starting substances.	4.3g Describe a suitable method to make and obtain a pure dry sample of a soluble/insoluble salt from different starting substances. *(Limited to metal with acid, carbonate with acid, base with acid, alkali with acid, and precipitation reactions.)*

Subject Focus:	**Substances from the Earth: Aquatic environments**
Learning Outcome 5: **(Coursework and Controlled)**	**At the end of the programme, I can describe the conduction of electricity through solutions and molten salts.**

Assessment Criteria (MQF 1)	Assessment Criteria (MQF 2)	Assessment Criteria (MQF 3)
5.1a Give examples of conductors and non-conductors (insulators), electrolytes and non-electrolytes.	5.2a Define conductors and non-conductors (insulators), electrolytes and non-electrolytes of electricity.	
5.1b State whether solid/molten ionic and covalent substances conduct electricity when connected to a DC circuit.	5.2b Describe how conductive solid/molten ionic and covalent substances conduct electricity.	5.3b Compare what happens when electricity is applied to solid/molten ionic and covalent substances.
	5.2c Explain what happens when electricity is applied to molten ionic salts.	5.3c Explain what happens when electricity is applied to solutions of salts. *(E.g. Electrolysis of dilute sulfuric acid, electrolysis of copper(II) sulfate solution using inert and active electrodes and electrolysis of concentrated sodium chloride solution.)*
		5.3d Describe electrolysis using half equations.
		5.3e Interpret electrolytic half equations in terms of oxidation and reduction.

Subject Focus:	**Substances from the Earth: Aquatic environments**
Learning Outcome 6: **(Controlled only)**	**At the end of the programme, I can describe the major groups of the periodic table including their physical and chemical properties.**

Assessment Criteria (MQF 1)	Assessment Criteria (MQF 2)	Assessment Criteria (MQF 3)
6.1a Name the groups of the periodic table. *(Limited to alkali metals, alkaline earth metals, transition metals, halogens and noble gases.)*	6.2a Distinguish between metals and non-metals in terms of their physical properties.	
6.1b List common uses of halogens. *(E.g. Bleaching and antibacterial action of chlorine in water and antiseptic properties of iodine.)*	6.2b Describe the trends in physical and chemical properties of group 7 elements. *(Limited to state and colours of halogens at room temperature and reactions of halogens with hydrogen.)*	6.3b Investigate displacement reactions of halogen/halide mixtures to construct a reactivity series of non-metals. *(Limited to chlorine, bromine and iodine. Represent reactions using balanced chemical equations and net ionic equations.)*
		6.3c Interpret displacement reactions in terms of oxidation and reduction.
	6.2d Describe trends in physical and chemical properties of group 1 metals. *(Limited to;* *Physical properties: melting/boiling points and hardness.* *Chemical properties: reactions of metals with water to form alkalis and with oxygen to form simple oxides.)*	6.3d Compare trends in reactivity found in groups 1 and 7 using atomic structures to explain the variation of reactivity within a group.

Subject Focus:	**Substances from the Earth: Aquatic environments**
Learning Outcome 7: **(Coursework and Controlled)**	**At the end of the programme, I can describe how substances dissolved in water can be identified and how their concentration can be measured.**

Assessment Criteria (MQF 1)	Assessment Criteria (MQF 2)	Assessment Criteria (MQF 3)
7.1a Use paper chromatography to identify the components of a coloured mixture. *(Solvent limited to water.)*	7.2a Perform paper chromatography. *(Solvents limited to water and ethanol.)*	7.3a Interpret chromatograms.
	7.2b Identify gases from descriptions of chemical tests. *(Limited to water vapour, oxygen, hydrogen, carbon dioxide, chlorine and ammonia.)*	7.3b Perform chemical tests to identify gases. *(Limited to water vapour, oxygen, hydrogen, carbon dioxide, chlorine and ammonia.)*
7.1c Identify cations present in salts/solutions using flame tests. *(Limited to identification of Li^+, Na^+, K^+, and Ca^{2+} ions)*	7.2c Identify cations present in solutions. *(Limited to identification of Mg^{2+}, Ca^{2+}, NH_4^+, Cu^{2+}, Fe^{2+}, and Fe^{3+} with sodium hydroxide solution.)*	7.3c Identify cations present in solutions. *(Limited to identification of:* • *Al^{3+}, Pb^{2+} with sodium hydroxide solution;* • *Pb^{2+} with KI solution.)*
	7.2d Identify anions present in solutions. *(Limited to identification of:* • *Cl^-, Br^-, I^- with acidified $AgNO_3$ solution;* • *CO_3^{2-} with dilute acid and identifying CO_2)*	7.3d Identify anions present in solutions. *(Limited to identification of:* • *SO_3^{2-} and SO_4^{2-} with acidified $BaCl_2$ solution;* • *NO_3^- by reduction with aluminium and alkali.)*
	7.2e Represent reactions for cations and anions using chemical equations.	7.3e Represent reactions for cations and anions using net ionic equations. *(Except the test for nitrate ions.)*

Assessment Criteria (MQF 1)	Assessment Criteria (MQF 2)	Assessment Criteria (MQF 3)
		7.3f Perform calculations involving moles and molar concentrations. *(Do not use the formula:* $\frac{MaVa}{mole\ ratio\ (a)}=\frac{MbVb}{mole\ ratio\ (b)}$ *)*
	7.2g Prepare a standard solution using step by step instructions. *(Limited to sodium carbonate.)*	7.3g Prepare a standard solution. *(Limited to sodium carbonate.)*
	7.2h Conduct an acid/base titration using step by step instructions. *(Limited to hydrochloric acid, sulfuric acid, with sodium hydroxide, potassium hydroxide and sodium carbonate.)*	7.3h Conduct an acid/base titration to determine the concentration of a given solution. *(E.g. hydrochloric acid, sulfuric acid, nitric acid, ethanoic acid with sodium hydroxide, potassium hydroxide and sodium carbonate.)*
		7.3i Calculate the concentration/volume of a solution taking part in a reaction.

Subject Focus:	Substances from the Earth: The Land
Learning Outcome 8: (Coursework and Controlled)	**At the end of the programme, I can describe how different rocks contain important substances, their extraction, chemical nature, responsible use and environmental impact.**

Assessment Criteria (MQF 1)	Assessment Criteria (MQF 2)	Assessment Criteria (MQF 3)
8.1a State uses of limestone.	8.2a Describe the use of limestone in industry. *(Including the manufacture of quicklime and slaked lime. As an aggregate in construction.)*	
	8.2b Investigate simple physical properties of substances used in buildings and relate them to their use. *(E.g. density, heat and electrical conductivity of limestone, concrete, wood, steel and aluminium.)*	8.3b Investigate the chemical properties of substances used in buildings and relate them to their use. *(Limited to action of acids and water on limestone, concrete, wood, steel and aluminium)*
	8.2c Describe the economic and environmental impact of open quarrying of stone.	8.3c Debate the economic and environmental impact of open quarrying of stone.
8.1d Identify metals that are found free in nature or that are extracted from certain minerals found in rocks. *(Limited to iron from haematite and aluminium from bauxite as well as the very few metals found as elements in the ground e.g. gold and platinum.)*		8.3d Describe the essential chemical reactions in the industrial extraction of metals. *(Limited to aluminium from bauxite and iron in the blast furnace. Drawing of diagrams, technical details and conditions are not required.)*
	8.2e Describe typical properties of transition elements/compounds.	

Assessment Criteria (MQF 1)	Assessment Criteria (MQF 2)	Assessment Criteria (MQF 3)
		8.3f Interpret the extraction of metals as examples of redox reactions. *(In terms of loss or gain of oxygen/hydrogen, loss or gain of electrons and change in oxidation numbers. Oxidation numbers limited to binary compounds.)*
8.1g Describe methods that prevent rusting.	8.2g Investigate the conditions needed for iron to rust.	8.3g Investigate the effectiveness of various rust prevention techniques in different situations.
	8.2h Relate metals' position in the reactivity series to their ease of corrosion and extraction. *(Metals limited to potassium, sodium, calcium, magnesium, aluminium, zinc, iron, lead, copper, silver, gold and platinum.)*	
	8.2i Determine metals' position in the reactivity series from their reactions with water/steam and hydrochloric acid. *(Metals limited to potassium, sodium, calcium, magnesium, aluminium, zinc, iron, lead, and copper. Represent reactions using balanced chemical equations.)*	8.3i Determine the position of an unknown metal (e.g. tin) with respect to other metals in the reactivity series from their reactions with water/steam and hydrochloric acid. *(Other metals limited to potassium, sodium, calcium, magnesium, aluminium, zinc, iron, lead, and copper. Represent reactions using balanced chemical equations. Oxidizing/reducing agents.)*
		8.3j Determine metals' position in the reactivity series from displacement reactions. *(Metals limited to calcium, magnesium, aluminium, zinc, iron, lead, and copper.* *Represent reactions using balanced chemical equations and net ionic equations.)*

Assessment Criteria (MQF 1)	Assessment Criteria (MQF 2)	Assessment Criteria (MQF 3)
		8.3k Use the reactivity series of metals to predict the best method of metal extraction by reduction with carbon or electrolysis.
8.1l Identify diamond, graphite, graphene and carbon nanotubes from given molecular diagrams.	8.2l Explain that diamond, graphite, and carbon nanotubes are allotropes.	8.3l Relate the structure of diamond, graphite, graphene and carbon nanotubes to their properties and uses.
	8.2m Discuss the environmental issues surrounding the mining of metals.	8.3m Evaluate the economic and environmental impact of the extraction of metals. *(Limited to aluminium and iron.)*
	8.2n Describe the best course of action when considering the finite nature of many metals. *(Reduce, reuse, recycle)*	8.3n Evaluate the best course of action when considering the finite nature of many metals. *(Reduce, reuse, recycle)*

Subject Focus:	**Making New Substances: How fast? How far? How much?**
Learning Outcome 9: **(Controlled only)**	**At the end of the programme, I can describe how and why physical and chemical changes happen.**

Assessment Criteria (MQF 1)	Assessment Criteria (MQF 2)	Assessment Criteria (MQF 3)
	9.2a Explain that some substances are useful in their native state and that other substances need to be changed by chemical reactions to be more useful.	
9.1b Name the changes that take place when chemical reactions occur.	9.2b Compare chemical reactions with physical changes.	
	9.2c Describe using diagrams, the arrangement, movement of particles, and forces of attraction between particles in the three states of matter. *(Forces of attraction limited to strong and weak forces.)*	9.3c Interpret the physical properties (*E.g. compressibility, ease of flow, shape*) of the three states of matter in terms of the kinetic theory.
9.1d Name the six changes of state. *(Melting, freezing, evaporation/boiling, condensation, sublimation and deposition.)*	9.2d Interpret the shape of heating/cooling curves. *(Without reference to the kinetic theory.)*	9.3d Explain energy changes accompanying changes of state using the kinetic theory of matter.
	9.2e Explain that when chemical reactions happen mass is conserved.	

Subject Focus:	Making New Substances: How fast? How far? How much?
Learning Outcome 10: (Controlled only)	At the end of the programme, I can perform quantitative calculations.

Assessment Criteria (MQF 1)	Assessment Criteria (MQF 2)	Assessment Criteria (MQF 3)
	10.2a Calculate relative formula mass or relative molecular mass of a compound from relative atomic masses.	
	10.2b Work out percentage by mass calculations. *(E.g. Percentage by mass of an element in a compound and the value of xH_2O in a hydrated compound.)*	
		10.3c Calculate the formula of reacting masses from experiment and relate empirical and molecular formulae of simple substances.
		10.3d Calculate the amount of products formed from given amount of one reactant in a reaction and vice versa. *(In moles, number of particles, masses, and volumes of gases at STP. Concept of limiting reagent will not be assessed. Use of Avogadro's constant and Avogadro's law.)*
		10.3e Calculate the theoretical and percentage yield of product for a given reaction.

Subject Focus:	Making New Substances: How fast? How far? How much?
Learning Outcome 11: (Coursework and Controlled)	At the end of the programme, I can investigate why and how chemical reactions proceed at different rates.

Assessment Criteria (MQF 1)	Assessment Criteria (MQF 2)	Assessment Criteria (MQF 3)
	11.2a State that rate of reaction is the increase in amount of product or decrease in amount of reactant with time.	
	11.2b Perform experiments to measure the rate of a reaction. *(E.g. Between an acid and different metals; between limestone and acid; precipitation reactions such as the reaction of thiosulfate with an acid. No chemical equation required for the latter.)*	11.2b Investigate methods to follow the rate of a reaction. *(E.g. Between an acid and different metals; between limestone and acid; precipitation reactions such as the reaction of thiosulfate with an acid.)*
11.1c Identify conditions that may affect the rate of a given reaction. *(Limited to state of subdivision of reactants, and temperature.)*	11.2c Identify conditions that may affect the rate of a given reaction. *(Limited to concentration, catalyst, light, and pressure in gases.)*	
	11.2d Investigate how the rate of reaction may be affected by surface area of reactants/catalysts.	11.3d Investigate how the rate of reaction may be affected by various factors. *(E.g. Surface area of reactants, concentration of reactants, temperature, light and the use of a catalyst.)*
	11.2e Plot a single series of data using experimental results	11.3e Plot multiple series of data using experimental results.

Assessment Criteria (MQF 1)	Assessment Criteria (MQF 2)	Assessment Criteria (MQF 3)
	11.2f Interpret results obtained from experimental data related to rates of reactions.	11.3f Plot graphs using experimental data related to rates of reaction.
		11.3g Use the kinetic and collision theories to explain how factors such as state of subdivision, concentration, temperature and pressure affect the rate of a reaction.

Subject Focus:	Making New Substances: How fast? How far? How much?
Learning Outcome 12: (Controlled only)	At the end of the programme, I can describe dynamic equilibria and the conditions needed to shift a reaction in equilibrium.

Assessment Criteria (MQF 1)	Assessment Criteria (MQF 2)	Assessment Criteria (MQF 3)
	12.2a Classify reactions as acid-base, combustion, thermal decomposition and precipitation.	12.3a Classify reactions as displacement and/or redox.
12.1b Describe changes of state as an example of a reversible change.	12.2b Describe reversible changes such as hydration of copper(II) sulfate and thermal dissociation of ammonium chloride.	
12.1c Use the appropriate symbol to represent a reversible change.		12.3c Explain how some chemical reactions in closed conditions do not go to completion but reach dynamic equilibrium.
		12.3d Explain how changing temperature or pressure affects the position of equilibrium in a reversible reaction.
		12.3e Explain how in the Haber process the best yield of ammonia is obtained by applying compromised conditions with respect to temperature and pressure and the use of a catalyst. (*Values for pressure (200 atm.) and temperature (450 °C) will be given.*)
	12.2f Identify needs for chemical products such as ammonia and substances produced from it. *(Limited to fertilizers.)*	12.3f Discuss the environmental issues related to the use and misuse of chemical products such as ammonia and substances produced from it. *(Limited to fertilizer and explosives.)*

Subject Focus:	**Carbon compounds. Meeting our energy needs.**
Learning Outcome 13: **(Controlled only)**	**At the end of the programme, I can describe the chemical nature of crude oil and the substances obtained from it.**

Assessment Criteria (MQF 1)	Assessment Criteria (MQF 2)	Assessment Criteria (MQF 3)
13.1a Identify crude oil as an example of fossil fuels.	13.2a Describe the importance of crude oil as a source of energy for transport and production of electricity as well as feedstock for chemical production.	13.3a Evaluate the importance of crude oil as a source of energy for transport and production of electricity as well as feedstock for chemical production.
		13.3b Present an argument demonstrating that crude oil is a crucial raw material and that control of crude oil in the world is a possible source of conflict.
	13.2c Describe the risks and benefits of the transport of fuels to and storage on an island and the use of crude oil as a finite fuel.	13.3c Evaluate the risks and benefits of the transport of fuels to and storage on an island and the use of crude oil as a finite fuel.
13.1d State that crude oil consists of a mixture of hydrocarbons.	13.2d Describe the uses of fractions obtained from crude oil. *(Students should be able to list the following fractions in this order: refinery gases, gasoline/petrol, naphtha, kerosene, diesel oil, fuel oil and residue. Details of carbon chain length and fraction temperatures are not required.)*	13.3d Describe how crude oil is separated by fractional distillation.
13.1e Distinguish between miscible and immiscible liquids.	13.2e Separate immiscible liquids using a separating funnel.	

Assessment Criteria (MQF 1)	Assessment Criteria (MQF 2)	Assessment Criteria (MQF 3)
13.1f Describe the problems of high sulfur content in fossil fuels.	13.2f Discuss the importance of desulfurisation of fuels.	
	13.2g Describe how the use of fuels contributes to pollution. *(Such as pollution and/or global warming by liberating particulates, carbon monoxide and carbon dioxide.)*	13.3g Explain how the use of fuels contributes to pollution. *(Such as pollution and/or global warming by liberating particulates, carbon monoxide, carbon dioxide, nitrogen oxides and sulfur dioxide into the atmosphere.)*
		13.3h Interpret data on the use of fossil fuels and the gases generated.

Subject Focus:	Carbon compounds. Meeting our energy needs.
Learning Outcome 14: (Controlled only)	At the end of the programme, I can distinguish different homologous series and their physical and chemical properties.

Assessment Criteria (MQF 1)	Assessment Criteria (MQF 2)	Assessment Criteria (MQF 3)
	14.2a Explain why carbon is a special element that can form many different compounds that are natural and/or synthetic.	
		14.3b Use the terms homologous series, empirical formula, molecular formula, structural formula, displayed formula, general formula and functional group. *(For homologous series: alkanes, alkenes, alkynes, alcohols, carboxylic acids.)*
	14.2c Identify the homologous series of given simple organic molecules from their names and/or displayed formulae. *(Limited to the first 5 straight chain members of alkanes, alkenes, alkynes, alcohols, and carboxylic acids.)*	14.3c Draw structures of simple organic molecules from their names and vice-versa. *(Limited to the first 5 straight chain members of alkanes, alkenes, alkynes, alcohols, and carboxylic acids where the functional group (if applicable) is on the first carbon atom.)*
	14.2d Identify isomers from displayed formulae of alkanes. (*Limited to alkanes with 4 and 5 carbon atoms. No naming of branched hydrocarbons is required.*)	14.3d Draw isomers of alkanes from their molecular formulae. (*Limited to alkanes with 4 and 5 carbon atoms. No naming of branched hydrocarbons is required.*)

Assessment Criteria (MQF 1)	Assessment Criteria (MQF 2)	Assessment Criteria (MQF 3)
	14.2e Describe how long chain alkanes can be converted to smaller, more useful ones. *(Limited to thermal cracking only. Specific cracking temperatures are not required.)*	14.3e Identify possible alkanes and alkenes that can be obtained from thermal cracking of long chain alkanes.
		14.3f Compare the strength of intramolecular bonding (covalent) and intermolecular forces (weak forces of attraction) in alkanes and use these to explain the trends in properties of alkanes such as boiling points and melting points.
14.1g Name common alkanes that are used as fuels.	14.2g Relate the production of carbon dioxide/carbon monoxide with complete/incomplete combustion of hydrocarbons.	14.3g Describe the main chemical reactions of alkanes. *(Limited to cracking, combustion and halogenation (monosubstitution).*
		14.3h Link the saturated nature of alkanes to their lack of reactivity.
	14.2i Describe a test to distinguish between saturated and unsaturated hydrocarbons.	14.3i Describe addition reactions of ethene. *(E.g. bromination, hydration and hydrogenation. Details of reaction conditions are not required.)*
		14.3j Link the reactivity of alkenes and alkynes to unsaturation.
	14.2k Describe how certain organic substances, other than fuels, can contribute to environmental problems. *(Limited to non-biodegradable plastics; the ongoing effect of CFCs on ozone depletion and their replacement.)*	

Assessment Criteria (MQF 1)	Assessment Criteria (MQF 2)	Assessment Criteria (MQF 3)
14.1l Describe some important uses of ethanol. *(E.g. Solvent, fuel and alcoholic drinks.)*	14.2l Describe how ethanol can be produced through fermentation and hydration of ethene.	14.3l Evaluate the advantages and disadvantages of fermentation and hydration of ethene.
		14.3m Describe how ethanol can be oxidised to ethanoic acid using acidified potassium dichromate and by aerial oxidation. *(Chemical equations are not required.)*
14.1n List uses of polyethene, PTFE and PVC.	14.2n Discuss how applying a strategy of "reduce, reuse, recycle" can alleviate environmental problems caused by organic substances.	14.3n Model the production of polymers from alkenes and other unsaturated monomers by addition polymerisation. *(Limited to polyethene, PTFE and PVC.)*
		14.3o Construct the reaction between a carboxylic acid and an alcohol to form an ester. *(Limited to ethyl ethanoate.)*
		14.3p Identify the ester functional group in a displayed formula.

Subject Focus:	**Carbon compounds from the Earth. Meeting our energy needs.**
Learning Outcome 15: **(Coursework and controlled)**	**At the end of the programme, I can describe the energy changes accompanying chemical changes.**

Assessment Criteria (MQF 1)	Assessment Criteria (MQF 2)	Assessment Criteria (MQF 3)
15.1a Identify chemical reactions that are exothermic or endothermic.	15.2a Draw energy level diagrams to represent exothermic and endothermic reactions including activation energy.	15.3a Explain energy level diagrams in terms of bond energies. (*Calculations are not required.*)
	15.2b Carry out experiments to compare energy released by different food samples.	15.3b Determine the heat of combustion of different food samples (in kJ g^{-1}).
		15.3c Carry out experiments to determine the change in heat (in kJ mol^{-1}). *(Limited to combustion of safe liquid fuels and neutralisation of an acid with an alkali.)*

Scheme of Assessment

General Notes

- All learning outcomes form part of a subject focus, except for Learning Outcome 1 which should be implemented when carrying out coursework activities.
- Some assessment criteria include further information in brackets and italics. Note that "limited to" implies that only those examples listed will be examined while "e.g." means that apart from the examples listed, other related instances may be examined.
- Throughout this programme, chemical reactions should be represented by balanced chemical equations. States of substances including solids, liquids, gases, and aqueous solutions, should be represented by (s), (l), (g), and (aq) respectively.
- Net ionic equations are only expected for assessment criteria where they are specified.
- Questions will be set in English and must be answered in English.
- Electronic calculators may be used in any part of the examination.
- The Periodic Table complete with atomic numbers, relative atomic masses and full names, will be provided with all controlled papers.
- The Reactivity Series will also be provided in all controlled papers.
- The order of discharge at electrodes, a list of polyatomic ions and their charges as well as solubility rules will be given in separate tables in controlled papers for Level 1-2 only.
- The following 'Useful Data' will be provided in all controlled papers:
    - Avogadro constant = 6.02×10^{23}
    - Specific heat capacity of water = 4.2 J g^{-1} $^{o}C^{-1}$
    - The molar volume for gases = 22.4 dm^3 at STP
    - STP conditions = 0 ^{o}C and 10^5 Pa/1 atm.
- The minimum mathematical requirements are:
    - The ability to perform simple arithmetic processes such as addition, subtraction, multiplication and division of quantities expressed in decimal form, as fractions, or in index notation;
    - The ability to calculate volumes; simple percentage calculations; calculations involving ratios and proportion;
    - The ability to use and interpret simple graphs, carry out extrapolations and interpolations and measure gradients.

School Candidates

The assessment consists of 2 parts:

Coursework: 30% of the total marks; comprising 5 assignments of equal weighting i.e. 6% each; set during the three-year course programme.

Coursework can be pegged at either of two categories:

- A coursework at MQF level categories 1-2 must identify assessment criteria from these two MQF levels. The ACs are to be weighted within the assignment's scheme of work and marking scheme at a ratio of 40% at Level 1 and 60% at Level 2.
- A coursework at MQF level categories 1-2-3 must identify assessment criteria from each of Levels 1, 2, and 3. These ACs are to be weighted within the assignment's scheme of work and marking scheme at a ratio of 30% at each of Levels 1 and 2 and 40% at Level 3.

The mark for assignments at level categories 1-2 presented for a qualification at level categories 2-3 is to be recalculated to 60% of the original mark. The mark stands in all other cases.

Controlled Assessment: 70% of the total marks; comprising of a two-hour written exam; set at the end of the programme and differentiated between two tiers:

a. MQF levels 1 and 2;
b. MQF levels 2 and 3.

Candidates can obtain a level higher than Level 1 if they satisfy the examiners in both coursework and controlled assessments, irrespective of the total marks obtained.

Part 1: Coursework

- The **coursework** will be linked to Learning Outcomes 1, 2, 3, 4, 5, 7, 8, 11, and 15.
- An overview of the coursework assignments is shown in the table below:

Part 1: Coursework (Levels 1 – 2 - 3) (30%)				
Assignment 1 (6%)	Assignment 2 (6%)	Assignment 3 (6%)	Assignment 4 (6%)	Assignment 5 (6%)
1 Investigation (4%) + 1 Experiment (2%)	3 Experiments (2% each)	1 Fieldwork (4%) + 1 Experiment (2%)	1 Site Visit (4%) + 1 Experiment (2%)	Project (6%)

Figure 1: Coursework Assignments for School Candidates

- Candidates will be assessed through 5 assignments carried out during a three-year programme - 2 assignments in Year 9, 2 assignments in Year 10 and 1 assignment in Year 11.
- Coursework Assignments 1 and 2 are mandatory and one can choose or repeat any of the 5 assignments in completing their coursework part.

- All assignment tasks shall be marked out of 100 according to guidelines and rubrics available with this syllabus.
- Levels 1-2-3 will be determined from the mark obtained in the task set, by a continuous method, during the course of instruction according to the following table.

MQF Level	1	2	3
Global % obtained	0 - 30	31 - 60	61 - 100

Figure 2: MQF Level cut off points

- School candidates' assignments, forming part of coursework, are to be available at the candidates' school for moderation purposes as indicated by the MATSEC Board.

Part 2: Controlled Assessment II

Part 2: Controlled Assessment II (2 hours) (70 %)
Paper consisting of about 10 - 15 items of graded difficulty at Level 1 – 2. **OR** Paper consisting of about 10 - 15 items of graded difficulty at Level 2 - 3.

Figure 3: Part 2 Controlled assessment for School Candidates

Controlled Assessment II will:

- cover most learning outcomes including all learning outcomes which are not indicated to be covered through coursework;
- have no sections and consist of 10 – 15 items of graded difficulty which are compulsory;
- be marked out of 100.

Private Candidates

Private candidates shall be assessed by means of two controlled assessments.

The first controlled assessment (I) will focus on the learning outcomes identified for school candidates' coursework. Learning outcomes with assessment criteria in the psychomotor domain can be assessed by asking questions in pen-and-paper format seeking understanding of the activity.

Part 1: Controlled Assessment I (2 hours) (30 %)
Paper consisting of about 10 - 15 items of graded difficulty at Level 1-2 **OR** Paper consisting of about 10-15 items of graded difficulty at Level 2-3.

Figure 4: Part 1 Controlled assessment for Private Candidates

Controlled Assessment I will:

- assess all learning outcomes which were indicated as part of school candidates' coursework and some other outcomes;
- have no sections and consist of 10 – 15 items of graded difficulty which are compulsory;
- include items which will focus on the practical aspect of the assessed learning outcomes;
- be marked out of 100.

The second controlled assessment (II) is common with school candidates.

Part 2: Controlled Assessment II (2 hours) (70 %)
Paper consisting of about 10 - 15 items of graded difficulty at Level 1-2 **OR** Paper consisting of about 10-15 items of graded difficulty at Level 2-3.

Figure 5: Part 2 Controlled assessment for Private Candidates

Appendices

Appendix A * - Periodic Table. (*All Controlled papers*)

PERIODIC TABLE OF THE ELEMENTS

1	2											3	4	5	6	7	0
							1 **H** Hydrogen 1										4 **He** Helium 2
7 **Li** Lithium 3	9 **Be** Beryllium 4											11 **B** Boron 5	12 **C** Carbon 6	14 **N** Nitrogen 7	16 **O** Oxygen 8	19 **F** Fluorine 9	20 **Ne** Neon 10
23 **Na** Sodium 11	24 **Mg** Magnesium 12											27 **Al** Aluminium 13	28 **Si** Silicon 14	31 **P** Phosphorus 15	32 **S** Sulfur 16	35.5 **Cl** Chlorine 17	40 **Ar** Argon 18
39 **K** Potassium 19	40 **Ca** Calcium 20	45 **Sc** Scandium 21	48 **Ti** Titanium 22	51 **V** Vanadium 23	52 **Cr** Chromium 24	55 **Mn** Manganese 25	56 **Fe** Iron 26	59 **Co** Cobalt 27	59 **Ni** Nickel 28	63.5 **Cu** Copper 29	65 **Zn** Zinc 30	70 **Ga** Gallium 31	73 **Ge** Germanium 32	75 **As** Arsenic 33	79 **Se** Selenium 34	80 **Br** Bromine 35	84 **Kr** Krypton 36
85 **Rb** Rubidium 37	88 **Sr** Strontium 38	89 **Y** Yttrium 39	91 **Zr** Zirconium 40	93 **Nb** Niobium 41	96 **Mo** Molybdenum 42	99 **Tc** Technetium 43	101 **Ru** Ruthenium 44	103 **Rh** Rhodium 45	106 **Pd** Palladium 46	108 **Ag** Silver 47	112 **Cd** Cadmium 48	115 **In** Indium 49	119 **Sn** Tin 50	122 **Sb** Antimony 51	128 **Te** Tellurium 52	127 **I** Iodine 53	131 **Xe** Xenon 54
133 **Cs** Caesium 55	137 **Ba** Barium 56	139 **La** Lanthanum 57	178 **Hf** Hafnium 72	181 **Ta** Tantalum 73	184 **W** Tungsten 74	186 **Re** Rhenium 75	190 **Os** Osmium 76	192 **Ir** Iridium 77	195 **Pt** Platinum 78	197 **Au** Gold 79	201 **Hg** Mercury 80	204 **Tl** Thallium 81	207 **Pb** Lead 82	209 **Bi** Bismuth 83	210 **Po** Polonium 84	210 **At** Astatine 85	222 **Rn** Radon 86

Key:

a	*relative atomic mass*
X	***SYMBOL***
Y	***Name***
b	*atomic number*

Appendix B * - Reactivity series. (*All Controlled papers*)

Reactivity series	
Decreasing Reactivity	Potassium
	Sodium
	Calcium
	Magnesium
	Aluminium
	Carbon
	Zinc
	Iron
	Lead
	Hydrogen
	Copper
	Silver
	Gold
	Platinum

Appendix C * - Order of discharge at electrodes. (*Controlled papers for Levels 1-2 only*)

Order of discharge at cathode	
Increasing Ease of Discharge	Na^+
	Mg^{2+}
	Al^{3+}
	Zn^{2+}
	Fe^{2+}
	Pb^{2+}
	H^+
	Cu^{2+}
	Ag^+

Order of discharge at anode
1. For aqueous very dilute solutions OH^- is discharged.
2. For aqueous concentrated solutions containing halide ions (Cl^-, Br^- and I^-), these are discharged in preference to OH^-.
3. SO_4^{2-}, NO_3^- and CO_3^{2-} are never discharged from aqueous solutions.

Appendix D * - List of polyatomic ions and their charges. (*Controlled papers for Levels 1-2 only*)

List of polyatomic ions and their charges.	
Name	**Formula**
Ammonium	NH_4^+
Nitrate	NO_3^-
Sulfate	SO_4^{2-}
Carbonate	CO_3^{2-}
Hydrogencarbonate	HCO_3^-
Hydroxide	OH^-

Appendix E * - Solubility rules. (Controlled papers for Levels 1-2 only)

Solubility rules	
Soluble	**Insoluble**
• All nitrates. • All hydrogencarbonates. • All group 1 metal salts. • All ammonium salts. • Halides except silver and lead halides. • Sulfates except barium, calcium, and lead sulfates.	• Carbonates except group 1 metal and ammonium carbonate. • Metal oxides except group 1 and 2 metal oxides that react with water. • Hydroxides except group 1 metal and ammonium hydroxides.

Appendix F - Qualitative test colours.

Metal ion	Flame test colour
lithium	red
sodium	golden yellow
potassium	lilac
calcium	orange-red

Qualitative test	Precipitate colour
Test for halide ions with acidified silver nitrate solution.	Chloride → White Bromide → Cream Iodide → Pale yellow
Test for metal cations with dilute sodium hydroxide solution.	Mg^{2+} → White Ca^{2+} → White Cu^{2+} → Blue Fe^{2+} → Green Fe^{3+} → Brown Al^{3+} → White (soluble in excess) Pb^{2+} → White (soluble in excess)
Confirmatory test for lead(II) ions with potassium iodide solution.	Canary yellow

Appendix G - Fractions of crude oil and their uses.

Fraction	Use
Refinery Gases	Bottled gas
Gasoline (Petrol)	Fuel for cars
Naphtha	Making chemicals
Kerosene	Aircraft fuel
Diesel Oil	Fuel for cars, lorries and buses
Fuel Oil	Fuel for ships and power stations
Residue	Bitumen for roads and roofs

Appendix H - Suggested non-exhaustive lists of activities suitable for LOs earmarked for coursework.

Subject Focus 1	**Substances from the Earth: The Atmosphere**
Learning Outcome 2	I can describe and explain the properties of gases that may be found in air and how to prepare them in the lab.

	Prepare and perform chemical tests on gases safely by selecting and assembling appropriate apparatus. *(This experiment can be done for H_2, CO_2 and O_2 individually.)*
	Project: Analysis of the amount of certain gases and particulates in the environment and how they may increase due to combustion reactions and natural causes based on local or foreign data.
	Fieldwork: Determine the amount of certain gases and particulates in the environment which may increase due to combustion reactions and natural causes.
	Visit sites that are concerned with air quality and monitoring.
	Project: Interpret data regarding environmental effects of some pollutants and discuss methods for reducing emission of pollutants into the atmosphere.

Subject Focus 2	**Substances from the Earth: Aquatic environments**
Learning Outcome 3	I can describe the solvent action of water including the impact of water hardness.

	Project: Water as a very precious resource in the world and a potential source of conflict.
	Produce crystals of salt from rock salt.
	Investigate the differences between hard and soft water.
	Project: Evaluation of desalination techniques that can be used to create demineralised water from sea water.
	Visit a reverse osmosis plant.
	Visit labs that ensure water quality.
	Fieldwork: Collect water from different fresh-water bodies (including natural lake-like reservoirs and potable water in constructed water reservoirs) and test for hardness.

Subject Focus 2	**Substances from the Earth: Aquatic environments**
Learning Outcome 4	I can describe the chemical properties of acids, bases and salts.

	Prepare a soluble salt by one of the following methods: metal + acid; insoluble base + acid; insoluble carbonate + acid.
	Prepare any three insoluble salts by precipitation.
	Prepare a sodium or a potassium salt using the titration method.
	Visit sites that use acids/bases in their operations.
	Investigations related to the application of acid-base concepts in everyday life.
	Fieldwork: Collect soil samples from different strata of rock and investigate their pH.

Subject Focus 2	**Substances from the Earth: Aquatic environments**
Learning Outcome 5	I can describe the conduction of electricity through solutions and molten salts.

	Electrolysis of aqueous solutions. *(Dilute sulfuric acid, copper(II) sulfate solution using inert and active electrodes and concentrated sodium chloride solution.)*
	Visit sites where electrolysis and its applications are used.
	Fieldwork: Test samples collected from the sea vs freshwater for electrical conductivity. *(Distilled water can be used as a control.)*

Subject Focus 2	**Substances from the Earth: Aquatic environments**
Learning Outcome 7	I can describe how substances dissolved in water can be identified and how their concentration can be measured.

	Perform paper chromatography. *(Solvents limited to water and ethanol.)*
	Visit sites where qualitative analysis is used.
	An investigation involving the analysis of both the cation and anion in three unknown substances. *(The unknowns may be either supplied as solids or in solution.)*
	Fieldwork: Identify the presence of cations and anions in soil and/or aquatic environments.
	Prepare a standard solution. *(Limited to sodium carbonate.)*
	Conduct an acid/base titration to calculate the concentration of a given solution. *(Example hydrochloric acid, sulfuric acid, nitric acid, ethanoic acid with sodium hydroxide, potassium hydroxide and sodium carbonate.)*

Subject Focus 3	**Substances from the Earth: The Land**
Learning Outcome 8	I can describe how different rocks contain important substances, their extraction, chemical nature, responsible use and environmental impact.

	Visit quarries and/or museums related to limestone.
	Project: Limestone and its use in Malta including the economic and environmental impact of open quarrying of stone.
	Investigate the simple physical and chemical properties of substances used in buildings and relate them to their use. *(E.g. Physical properties: density, heat and electrical conductivity and chemical properties: action of acids and water on limestone, concrete, wood, steel and aluminium.)*
	Investigate the conditions needed for iron to rust and the effectiveness of the various rust prevention techniques in different situations.
	Determine the position of an unknown metal (e.g. tin) with respect to other metals in the reactivity series from their reactions with water/steam and hydrochloric acid. *(Other metals limited to potassium, sodium, calcium, magnesium, aluminium, zinc, iron, lead, and copper.)*
	Determine metals' position in the reactivity series from displacement reactions. *(Metals limited to magnesium, aluminium, zinc, iron, lead, and copper.)*

	Visit a waste treatment plant to learn about the best course of action when considering the finite nature of many metals. *(Reduce, reuse, recycle.)*
	Project: The best course of action when considering the finite nature of many metals. *(Reduce, reuse, recycle.)*
	Fieldwork regarding the best course of action when considering the finite nature of many metals. *(Reduce, reuse, recycle.)*
	Fieldwork: Collect rock or sediment samples from a point or area which has different strata (ex: Għajn Tuffieħa) and analyse them (ex: pH, solubility in acid, etc.).
	Site visit along a bay (ex: marina) and an inland place to observe and compare implications and extent of rust.

Subject Focus 4	**Making New Substances: How fast? How far? How much?**
Learning Outcome 11	I can investigate why and how chemical reactions proceed at different rates.

	Investigate how the rate of reaction may be affected by a chosen factor. *(E.g. Surface area of reactants, concentration of reactants, temperature, light and the use of a catalyst.)*
	Visit sites that deal with control of reaction rates.

Subject Focus 5	**Carbon compounds from the Earth. Meeting our energy needs.**
Learning Outcome 15	I can describe the energy changes accompanying chemical changes.

	Determine the heat of combustion of ethanol.
	Determine the heat of combustion of different food samples.
	Measure the heat of neutralisation of the reaction between an acid and an alkali.
	Visit laboratories that are concerned with standards that determine the energy content of food and other substances.

Coursework Modes

Coursework Mode 1: Experiment

<table>
<tr><th colspan="2">Experiment</th></tr>
<tr><td>100 marks

internally-assessed

externally-moderated</td><td>
Practical work is a common element among the science subjects. Through experiments students develop experimental skills and techniques such as handling apparatus, performing tests or procedures, identifying variables to alter or control, conducting observations and measurements, and tabulating data. Furthermore, during data processing students can plot graphs, work out calculations, look for patterns and trends, analyse and interpret data observed, draw conclusions and link to scientific knowledge, principles and theory. Conducting experiments helps students to get a feel of the phenomena such as they can make the connections between observing concrete evidence and the more abstract ideas or theories.

Each experiment should take around a double lesson to complete. Experiments may be carried out in groups of ideally not more than four. Each group should gather and interpret their own data but each student must present his/her own individual report.

The following information shows the sections and respective notes that should be included in an experiment report. Third person past tense should be used when writing experimental reports.

A rubric for marking experiments is presented at the end of this document.

<table>
<tr><th>Section</th><th>Details</th></tr>
<tr><td>Date</td><td>Write the date when the experiment was carried out in the lab.</td></tr>
<tr><td>Title</td><td>The title indicates the links to particular assessment criteria as outlined in the curriculum.</td></tr>
<tr><td>Aim</td><td>The purpose of the experiment is clearly stated.</td></tr>
<tr><td>Apparatus</td><td>A list of apparatus and materials/chemicals used during the experiment.</td></tr>
<tr><td>Diagram</td><td>Clear diagram/s of the experimental setup are to be drawn and labelled in pencil. Diagrams should not be too small nor too large.</td></tr>
<tr><td>Procedure</td><td>This section will be given to the students.</td></tr>
<tr><td>Variables (if applicable)</td><td>A variables grid should be included specifying the independent variable (the one which is changed during the experiment) and the dependent variable (the one which is measured for a change in the independent variable).
Other variables which are kept constant, to ensure fair testing, should be included.</td></tr>
<tr><td>Precautions</td><td>A list of precautions taken to improve the accuracy of the experiment. Each precaution needs to be supported with reason/s explaining why such precautions are taken.</td></tr>
</table>
</td></tr>
</table>

Safety Considerations (if applicable)	A short paragraph/list that identifies safety considerations associated with the preparation and implementation of the experiments to prevent any accidents.

Results and Observations	Depending on the nature and type of the experiment:
	• Observations can be written in paragraphs or in tables. Observations are to be written in a sequential order as noted during the different stages of the experiment.
	• Numerical results should be tabulated.
	  ○ Write the name of the measurement and its units in the column headers of the table of results.
	  ○ Repeated readings should be taken when possible and recorded in the table.
	  ○ Numerical values should be given to the same number of significant figures appropriate to the measuring device.

Processing data	• Graphs are a pictorial way of looking at a table of results. Patterns can be observed and anomalous results can be identified. • Line graphs should include at least 5 data points. • Suitable scales should be chosen which makes it easy to plot data. At least 2/3 of the graph paper should be used. • Each axis should be labelled with the name and unit of the quantity being plotted. • The data points should be clearly marked and the points are joined to have a line of best fit or a smooth curve. • The line must go through the origin for quantities which are directly proportional. • Data can also be presented in the form of bar graphs. • Gradient of line graphs are calculated and answers are given with the appropriate units. • Show all steps in the calculations. • In working calculations, the answer should have the same number of significant figures as the measurements used in the calculation. • Avoid excessive rounding especially in calculations involving moles.
Discussion and Conclusion	Include the following points as applicable to the nature of the experiment. • A summary of the findings of the experiments and relate them clearly to the aim of the experiment. • A discussion of any patterns or trends in the data.

	• State any relationships discovered or confirmed between variables being tested in the experiment • Compare numerical results with known values from data books and suggest any reasons for any differences. • A complete analysis or interpretation of observations noted in the experiment (including balanced chemical equations and ionic equations where appropriate) • Draw a conclusion based on experimental evidence and relate it to scientific knowledge, laws, and theory.
Evaluation	• Identify and comment on any sources of error in the experiment. • Discuss any difficulties encountered in carrying out the experiment and any precautions taken to achieve accuracy. • Suggest way/s of improving the experimental set-up and or results. Suggest any other experiments which can be done to support the conclusions.

Marking Criteria: Experiment

MARKING CRITERIA – Experiment Maximum 100 marks		
Date & Title & Aim & Apparatus and Materials (0 – 10 marks)		
0 – 3 marks	**4 – 6 marks**	**7 – 10 marks**
Date when experiment was carried out is missing.	The date when experiment was conducted in the lab.	The date when experiment was conducted in the lab.
Title of the experiment is missing.	The title of the experiment.	A clear title of the experiment.
Only part of the aim of the experiment is written	Only part of the aim of the experiment is written	A clear and concise aim of the experiment.
Lists few or none of the chemicals or equipment used during the experiment.	Lists some of the chemicals and equipment used during the experiment.	Lists all chemicals and apparatus used during the experiment.
Diagram & Procedure & Variables (0 – 10 marks)		
0 – 3 marks	**4 – 6 marks**	**7 – 10 marks**
Poor diagrams are drawn which are not neat or completely labelled. Not all diagrams are presented.	Draws neat, labelled diagrams. Not all diagrams may be included with some missing labels.	Draws neat and labelled diagrams of all steps in the procedure.
No marks shall be given for procedure.		
Identifies variables without stating whether they are the dependent and independent variables. Few or none of the other variables that are kept constant during experiment to ensure fair testing are mentioned.	Identifies the dependent and independent variables and some of the other variables that are kept constant during experiment to ensure fair testing.	Identifies the dependent and independent variables and other variables that are kept constant during the experiment to ensure fair testing.
Precautions & Safety considerations (0 – 10 marks)		
0 – 3 marks	**4 – 6 marks**	**7 – 10 marks**
Lists few of the precautions taken during the experiment.	Lists most of the precautions without explaining why such precautions are taken.	Lists all precautions and explain why such precautions are taken during the experiment.
Identify few hazards in the experiment without suggesting methods of reducing the risk of harm.	Identifies some of the main hazards in the experiment and suggest methods of reducing the risk of harm.	Identifies the main hazards in the experiment and suggest methods of reducing the risk of harm.
Results and Observations & Processing data (0 – 20 marks)		
0 – 6 marks	**7 – 12 marks**	**13 – 20 marks**
Records only some of the observations noted during the experiment.	Records most of the observations noted during the experiment but observations are not be clearly organised.	Records all observations noted in the experiment in detail and organises them in a clear manner e.g. in a paragraph or in a table format.
An inadequate number of numerical data is poorly presented in a table with appropriate heading. Units may be missing and numerical values are not all given to the same number of significant figures appropriate to the measuring device.	A sufficient number of numerical data is presented in a table with appropriate headings. Some units may be missing and numerical values are not all given to the same number of significant figures appropriate to the measuring device.	An appropriate number of numerical data is presented in a table with appropriate headings and units. Numerical values are given the same number of significant figures appropriate to the measuring device.
No evidence of repeated readings.	Repeated readings are taken when instructed.	Repeated readings are taken when appropriate.

Constructs a poor line graph with an inadequate scale. Incorrect plotting with missing headings and units on the axis.	Constructs an accurate line graph or bar chart but it is not of the appropriate scale. Headings and units may not be labelled on each axis.	Constructs an accurate line graph or bar chart of the data obtained using the appropriate scale. Headings and units are labelled on each axis.
Works out some of the calculations with missing steps. Answers may be incorrect and without the proper units.	Works out most of the calculations with a few missing steps. Answers are correct but not all units are included.	Works out the necessary calculations showing all the steps and giving correct answers and units.
Discussion and Conclusion & Evaluation (0 – 20 marks)		
0 – 6 marks	**7 – 12 marks**	**13 – 20 marks**
Presents an incomplete analysis/interpretation of observations or measurements/graphs with many errors.	Identifies trends or patterns in observations or measurements/graphs and supports them with a satisfactory analysis/interpretation of data with some errors.	Identifies trends or patterns in observations or measurements/graphs and supports them with a complete and correct analysis/ interpretation of data.
Draws a poor conclusion that is based on the evidence obtained in the experiment and poorly relates it to scientific knowledge, laws and theory.	Draws a satisfactory conclusion that is based on the evidence obtained in the experiment and relates it to scientific knowledge, laws and theory.	Draws a detailed conclusion that is based on the evidence obtained in the experiment and relates it to scientific knowledge, laws and theory.
Identifies few of the experimental errors but does not give an explanation of why such errors occurred.	Identifies some of the experimental errors or anomalous observations and gives a partial explanation why such errors are observed.	Identifies experimental errors or anomalous observations and gives an adequate explanation why such errors are observed.
Identifies few limitations of the experiment but does not discuss ways of improving experiment.	Discusses limitations of the experiment and suggests some ways of improving the experiment setup and/or results.	Discusses the limitations and weaknesses of the experiment and suggests ways of improving experimental setup and/or results.
Conducting the experiment (0 – 30 marks)		
0 - 9 marks	**10 – 18 marks**	**19 –30 marks**
Handles some of the apparatus and chemicals correctly and safely with guidance.	Handles most of the apparatus and chemicals correctly and safely.	Handles apparatus and chemicals carefully, correctly, safely and skilfully.
Uses inappropriate equipment for the task, making few observations and measurements and recorded data is not well organised.	Uses equipment appropriate for the task, makes most of the observations, takes measurements and records limited data.	Uses equipment appropriate for the task, makes systematic observations, takes accurate measurements and records data in an orderly manner. Works in an organised and diligent manner.
Works with others but is not always co-operative.	Works with others in a cooperative manner most of the time.	Works in a team and is respectful of others.
Fails to make use of the appropriate lab attire to ensure personal safety.	Makes use of the appropriate lab attire to ensure personal safety most of the time.	Makes use of the appropriate lab attire to ensure personal safety.
Does not clean the apparatus and leaves the working station in a disorganised manner.	Cleans the apparatus after being reminded but the working area is not so tidy.	Cleans the apparatus and bench after the experiment.

Coursework Mode 2: Investigation

<table>
<tr><th colspan="2">Investigation</th></tr>
<tr><td>100 marks

internally-assessed

externally-moderated</td><td>
Gott & Duggan (1995) define investigations as "… a specific type of problem solving which allow pupils a varying degree of autonomy and which are problems to which the solution is not obvious." Investigations should allow freedom, allowing students to be creative and choose their own methods to investigate the given problem.
Students must be allowed time (at least one lesson) to solve the problem and design an experiment to check their solution. The students' plan must be checked by the teacher for health and safety concerns only. Otherwise, the plan must be unchanged, and students must be allowed to carry out the investigation that they designed which should take approximately a double lesson.
The notes below contain information, definitions, and requirements that are important when carrying out an investigation. The following guidelines are designed to ensure that teachers can carry out valid and consistent assessment.
It is suggested that informal feedback is given to students after the investigation has been planned to ensure safety of the experiment.
Investigations may be carried out in groups of ideally not more than four. Each group should gather and interpret their own data but each student must present his/her own individual report.
The following information shows the sections and respective notes that should be included in an investigation report.
<table>
<tr><th>Section</th><th>Details</th></tr>
<tr><td>Investigation Outline</td><td>
This section should contain an outline of the procedure that will be devised in the investigation together with scientific theory required to understand the investigation.
The plan should be concise and written in the future tense.
This section should include:

The title.
A short statement of the problem to be investigated.
The aim of the investigation.
A brief description of the scientific procedure.
A list of materials and apparatus.
Any pre-experiment work.
A variables grid may be presented to highlight all the variables in the investigation (where applicable). Variables should be identified as independent and dependent variables. Other significant/relevant variables should be noted including the way they are controlled for results to be more reliable.
Any background theory/research where applicable is given.
The hypothesis section (where applicable) should give an outline of what may happen and why.

(Note: Students are to be made aware that no marks will be lost if the hypothesis is disproved.)
</td></tr>
</table>
</td></tr>
</table>

	Precautions and safety considerations	This section should include: • Any precautions taken to achieve a more accurate result and improve the outcome of the investigation. • Safety considerations associated with the preparation and implementation of the investigation to prevent any accidents.
	Procedure Followed	This section should include: A detailed account of the procedure followed. All the steps involved to perform the experiment including any modifications made to the plan and any additional materials and apparatus used should be stated. The method should include measurements used, diagrams, and photos, where applicable. Note: • Results should not be included in this section. • Third person past tense should be used. • Any concentrations, measurements, amounts, times, and temperatures should be quantified. • The procedure should be written in such a way that an independent person could repeat the experiment without referring to the person writing the report.
	Results and observations	This section should include: • All observations and/or measurements should be presented in an organised form. • Any calculated data should be presented showing all steps. • Graphical representations should be used to display data when possible. Note: • Tables may be the best way of presenting data. • Tables should have headings and units. • An adequate number of readings should be taken especially if a graph has to be plotted. • Results should not be interpreted in this section. • Third person past tense should be used to describe any observations.
	Discussion and Conclusion	This section should include: • A brief summary of the aim of the investigation. • A summary of the most important findings including trends and patterns emerging from analysis of the results. • An explanation why calculations were used if any, and their link to the investigation. • A very brief description stating whether the investigation has supported/falsified the hypothesis.

	• A description and an explanation of how the results relate to the expectations based on laws, theories, relationships, patterns and models studied. • This section should be concluded by a closure of all findings.
Evaluation and references	This section should include: • A list of procedural/sources of errors that may have affected the result. • A list of improvements and any other experiments which can be done to support the conclusions. All sources cited in the text should be listed in full. A basic format should be used when listing the sources.

Marking Criteria: Investigation

MARKING CRITERIA – Investigation Maximum 100 marks		
Investigation outline (0 – 20 marks)		
0 – 6 marks	**7 – 12 marks**	**13 – 20 marks**
A poor outline of the investigation is given, providing the following requirements (where applicable)	A less detailed outline of the investigation is given, providing the following requirements (where applicable)	A detailed outline of the investigation is given, providing the following requirements (where applicable)
The title and statement of the problem is not stated.	The title or statement of the problem is stated.	The title and statement of the problem is stated in detail.
The aim is stated poorly.	The aim is stated adequately.	The aim is stated in detail.
Some of the stages of the scientific procedure are included.	Most stages of the scientific procedure are included.	A detailed description of the scientific procedure is included as well as any pre experiment work if applicable.
Lists some of the materials and equipment required.	Lists most of the materials and equipment required.	Lists all the materials and equipment required.
Mentions variables but the dependent and independent variables are not specified. Few or none of the variables that are controlled are mentioned.	Includes a variable grid which specifies the dependent and independent variables, including some of the variables that are controlled.	Includes a variable grid which specifies the dependent and independent variables, including variables that are controlled.
Mentions aspects of the scientific background knowledge related to the investigation.	Gives a brief summary of the scientific background knowledge related to the investigation.	Gives a comprehensive summary of the scientific background knowledge related to the investigation.
States the hypothesis but the relationship is not clear and no explanation is given.	States the hypothesis showing the relationship between variables but no explanation is given.	States the hypothesis clearly and its justification.
Precautions and Safety considerations (0 – 10 marks)		
0 – 3 marks	**4 – 6 marks**	**7 – 10 marks**
A list of few of the precautions and no explanations are given.	A list of some of the precautions, including an explanation.	A comprehensive list of precautions, including an explanation.
A list of few safety considerations without giving reasons.	A list of some of the safety considerations giving reasons.	A list of all safety considerations giving reasons.
Procedure Followed (0 – 10 marks)		
0 – 3 marks	**4 – 6 marks**	**7 – 10 marks**
List some of the steps of the procedure but not in sequential order. Some steps may be missing or incomplete. Names a few of any additional equipment needed.	Lists most of the steps of the procedure which are easy to follow. Discusses some of refinements and names some of the additional equipment (if needed) to the outline of the investigation.	Lists all steps of the procedure in a detailed, sequential order that are easy to follow. Discusses refinements and names all the additional equipment (if needed) to the outline of the investigation.
Draws poorly labelled diagrams. Not all diagrams are included.	Draws suitably labelled diagrams but not all diagrams are included.	Draws neat and labelled diagrams showing of all steps in the method.

Results and observations (0 – 10 marks)		
0 – 3 marks	**4 – 6 marks**	**7 – 10 marks**
Records only some of the observations noted.	Records most of the observations noted but observations are not clearly organised.	Records all observations in detail and organises them in a clear manner e.g. in a paragraph or in a table format.
An inadequate number of numerical data is poorly presented in a table with appropriate heading. Units may be missing and numerical values are not all given to the same number of significant figures appropriate to the measuring device. No evidence of repeated readings.	A sufficient number of numerical data is presented in a table with appropriate headings. Some units may be missing and numerical values are not all given to the same number of significant figures appropriate to the measuring device. Repeated readings taken when appropriate.	An appropriate number of numerical data is presented in a table with appropriate headings and units. Numerical values are given to the same number of significant figures appropriate to the measuring device. Repeated readings taken when appropriate.
Works out some of the calculations with missing steps. Answers may be incorrect and without the proper units.	Works out most of the calculations with a few missing steps. Answers are correct but not all units are included.	Works out the necessary calculations showing all the steps and giving correct answers and units.
Constructs a poor line graph with an inadequate scale. Incorrect plotting with missing headings and units on the axis.	Constructs an accurate line graph or bar chart but it is not of the appropriate scale. Headings and units may not be labelled on each axis.	Constructs an accurate line graph or bar chart of the data obtained using the appropriate scale. Headings and units are labelled on each axis.
Discussion & Conclusion (0 – 10 marks)		
0 – 3 marks	**4 – 6 marks**	**7 – 10 marks**
Presents an incomplete analysis/ interpretation of observations or measurements with many errors.	Identifies trends or patterns in observations or measurements/ graphs and supports them with a satisfactory analysis/ interpretation of data. Some errors are present.	Identifies trends or patterns in observations or measurements /graphs and supports them with a complete and correct analysis/interpretation of the data.
Makes a poor conclusion that is partially based on the observations/ data obtained. Gives a poor explanation it in terms of scientific knowledge.	Makes a satisfactory conclusion which is consistent with the observations/ data and explains it in terms of scientific knowledge.	Makes a detailed conclusion which is consistent with the observations/ data and explains it in terms of scientific knowledge.
Poorly relates the outcome of the investigation to the hypotheses stated without explaining whether it is supported or falsified.	Satisfactorily relates the outcome of the investigation to the hypotheses stated without explaining whether it is supported or falsified.	Relates the outcome of the investigation to the hypotheses stated explaining whether it is supported or falsified.
Evaluation and References (0 – 10 marks)		
0 - 3 marks	**4 – 6 marks**	**7 – 10 marks**
Identifies few of the experimental errors but does not give an explanation why such errors are observed.	Identifies some of the experimental errors or anomalous observations and gives a partial explanation why such errors are observed.	Identifies any experimental errors or anomalous observations and gives an adequate explanation why such errors are observed. Indicates whether the range and quality of data collected was sufficient to draw a conclusion.

Identifies few limitations of the experiment but does not discuss ways of improving experiment.	Discusses limitations of the experiment and suggest some ways of improving the experiment set up and/ or results	Discusses the limitations and weaknesses of the investigation and suggests ways of improving the experimental set up and/or results. Suggests follow up experiments to investigate further ideas related to the investigation.
Few or no references are listed.	Most references are listed correctly.	All references are listed correctly.
Conducting the Investigation (0 – 30 marks)		
0 - 9 marks	**10 – 18 marks**	**19 – 30 marks**
Can handle some of the apparatus and chemicals correctly and safely, when instructed by the teacher during the fieldwork.	Handles most of the apparatus and chemicals correctly and safely.	Handles apparatus and chemicals safely, correctly and skilfully.
Not always using equipment appropriate for the task, making few observations and measurements and recorded data is not organised appropriately.	Using equipment appropriate for the task, making most of the observations, taking measurements and records limited data.	Using equipment appropriate for the task, making systematic observations, taking accurate measurements and records data in an orderly manner. Works in an organised and diligent manner.
Working with others but not always being cooperative.	Works with others in a cooperative manner most of the time.	Works in a team and is respectful of others.
Failing to make use of the appropriate attire ensuring personal safety.	Makes use of the appropriate attire ensuring personal safety most of the time.	Makes use of the appropriate attire ensuring personal safety.
Does not clean the apparatus and leaves the working station in a disorganised manner.	Cleans the apparatus and workstation after being reminded.	Cleans the apparatus and workstation.

Coursework Mode 3: Fieldwork

<table>
<tr><th colspan="2">Fieldwork</th></tr>
<tr><td>100 marks

internally-assessed

externally-moderated</td><td>
Fieldwork in science is an important complementary approach to learning outside the classroom. It permits first-hand experience of the practical uses and applications of Chemistry in industry and in everyday life. Fieldwork is understood as an investigation which happens outside of the usual laboratory setting. It can be an experiment or an investigation which contains a significant portion of work done outside school, followed by a session in the laboratory (e.g. sample analysis). Fieldwork helps students understand scientific theories, integrate knowledge and develop important scientific, intra and interpersonal skills.
Fieldwork should be well planned before the actual activity. The teacher should pay a site visit, a few days prior to the activity to recognise and set clear learning objectives. Students should be prepared in advance in detailing the theoretical knowledge and informed of site conditions that may affect the outcome of the fieldwork.
Students should be well informed of site-specific information so as not to disrupt the site whether it is an urban or natural setting. They should also be informed of all relevant hazard/s which might be present on the site and to follow the instructions of their guide at all times.
Visits to sites should be coordinated (including applying for permits) with the relevant authority or company responsible for the management of the site. This includes the Environment and Resources Authority or various Non-Governmental Organisations in the case of certain open-air sites. Consent forms from the students' parents/guardians should also be obtained prior to the fieldwork visit. The following shows the relevant sections to be included in the fieldwork report. There is no minimum word limit, however the notes accompanying the sections give a clear indication of the work that is expected.
A rubric for marking fieldwork is presented at the end of this document.
<table>
<tr><th>Section</th><th>Details</th></tr>
<tr><td>Title</td><td>The title should contain the keywords describing the work presented. It should be short and unambiguous but with an adequate description of the work. Keywords can include type of fieldwork, location and date.</td></tr>
<tr><td>Overview</td><td>Describe the location of where the fieldwork took place (include a map of the area where necessary)
Explain whether fieldwork was performed as a single outdoor session or whether it was followed up by a laboratory session.
Discuss which aspects of chemistry are relevant to the fieldwork carried out.
Describe the main features being observed or investigated
Discuss the rationale behind sampling techniques and other fieldwork methods being used.
Identify any human impact on the location (if applicable).</td></tr>
</table>
</td></tr>
</table>

Precautions and Safety considerations	This section should contain all relevant hazard/s which might be present on the site and precautionary measures taken to reduce these hazards/risks (including physical hazards, man-made hazards and health issues). The majority of these can be identified and discussed prior to the fieldwork
Field Activities	This section should include reports regarding a number of hands-on fieldwork activities performed by students that were carried out on site and/or in the laboratory. Each activity should be reported using the following format: **(A) Title and aim of activity** – This should be short and to the point and outline the scope of the exercise (e.g.: To identify, compare and contrast …, analyse the presence of). **(B) Equipment required** – This should include a list of materials and equipment, kits and chemicals needed for this specific activity (e.g.: chemical test kits, test tubes etc.). **(C) Procedure** – A sequence of instructions and/or protocols (including any pre-experiment work) stating the steps involved to perform the particular activity. This component can include specific measurement, diagrams and photos if applicable. Third person past tense should be used in writing the procedure. **(D) Precautions –** A list of experimental precautions taken e.g. when collecting samples from site and other precautions to ensure accuracy.
Results and Observations	This section should convey the results in a clear and accurate visual manner. Data should be represented in this section under an appropriate heading for each activity by including: ● Quantitative data can be presented using tables. ● Observations can be presented in paragraph or in tables. ● Presentation of results should be without interpretation.
Processing results	Results can be processed by using calculations, pie and bar charts, histograms, and line graphs. The type of process used should reflect the data taken. Pie and bar charts are used for categorical variables while histograms and line graphs indicate continuous variables.
Discussion and Evaluation	This section should include an analysis and an evaluation of the results by including: ● Discussion and interpretation of the results obtained. Discussion of the relationships, patterns or trends of the results obtained. ● Description and explanation of how the results relate to the expectations and literature. Laws, theories and model studies should be referred to. ● Reference to possible sources of errors arising from the use of measuring instruments and/or chemical kits.
Conclusion	Briefly evaluate data collected from the activity and draw scientific conclusions.
References	All sources cited in the report should be listed in full. A basic format should be used when listing the sources.

Marking Criteria: Fieldwork

MARKING CRITERIA – Fieldwork Maximum 100 marks		
Title & Overview & Precautions and Safety considerations (0 – 10 marks)		
0 – 3 marks	**4 – 6 marks**	**7 – 10 marks**
Title of the fieldwork with missing keywords or completely missing.	Parts of title such as type of fieldwork, location and date are missing.	Title includes type of fieldwork, location and date.
An overview with some of the criteria listed discussed to limited extent.	An overview with several of the criteria listed discussed in detail.	An overview including all criteria discussed in detail.
Identifies few of the hazards and health issues without discussing the precautionary measures taken to reduce these hazards.	Identifies some of the hazards and health issues and the precautionary measures taken to reduce them.	Identifies most of the hazards and health issues and the precautionary measures taken to reduce them.
Fieldwork activities and Lab Activities (if any) (0 – 10 marks)		
0 – 3 marks	**4 – 6 marks**	**7 – 10 marks**
A limited description of each fieldwork activity undertaken, with some of the criteria of this segment missing or lacking the correct detail.	A description of each fieldwork activity undertaken, including the title and aim of each specific activity, the equipment required, the procedure/protocol used with most steps in order and the precautions taken to ensure the accuracy of the activity.	A detailed description of each fieldwork activity undertaken, including the title and aim of each specific activity, the equipment required, a detailed procedure/protocol used with all the steps in order and the precautions taken to ensure the accuracy of the activity.
Results and Observations & Processing results (0 – 20 marks)		
0 – 6 marks	**7 – 12 marks**	**13 – 20 marks**
Records some observations of the activities undertaken. Observations are not organised under the appropriate heading of each activity.	Records most observations of all activities undertaken but not clearly organised under the heading of each activity.	Records all observations of all activities undertaken organised under the heading of each activity.
Some observations are noted. Variables and/or units are not listed.	Most observations are noted. Variables and units are listed.	All observations are noted in detail. All variables and units are listed.
Numerical data is not expressed to the same number of significant figures, as would be appropriate to the activity undertaken.	Some numerical data is expressed to the same number of significant figures appropriate to the activity undertaken.	All numerical data is expressed to the same number of significant figures appropriate to the activity undertaken.
Constructs a poor graph/chart with an inadequate scale. Incorrect plotting with missing headings and units on the axis.	Constructs an accurate graph/chart but it is not of the appropriate scale. Headings and units may not be labelled on each axis.	Constructs an accurate graph/chart of the data obtained using the appropriate scale. Headings and units are labelled on each axis.
Works out some of the calculations with missing steps. Answers may be incorrect and without the proper units.	Works out most of the calculations with a few missing steps. Answers are correct but not all units are included.	Works out the necessary calculations showing all the steps and giving correct answers and units.

Discussion and Evaluation & Conclusion & References (0 – 30 marks)		
0 – 9 marks	**10 – 18 marks**	**19 – 30 marks**
An incomplete analysis (relationships, patterns or trends) and assessment of the results and/or observations.	A satisfactory analysis (relationships, patterns or trends) and assessment of the results and/or observations.	A detailed analysis (relationships, patterns or trends) and assessment of the results and/or observations.
An incomplete discussion of the environmental factor that affect the local environment.	A satisfactory discussion of the environmental factors that affect the local environment.	A detailed discussion of the environmental factors that affect the local environment.
An incomplete discussion and explanation of how the results relate to expectations and literature. Limited or no referencing.	A satisfactory discussion and explanation of how the results relate to expectations and literature. Some literature used is referenced.	A detailed discussion and explanation of how the results relate to expectations and literature. All literature used is referenced.
Few or no sources of errors given.	Reference to several sources of error.	A comprehensive reference to all possible sources of error.
A poor conclusion referring to a few activities of the fieldwork.	An adequate conclusion with reference to most activities of the fieldwork.	A detailed conclusion referring to all activities of the fieldwork.
Conducting the fieldwork (0 – 30 marks)		
0 – 9 marks	**10 – 18 marks**	**19 – 30 marks**
Can handle some of the apparatus and chemicals correctly and safely, when instructed by the teacher during the fieldwork.	Handles most of the apparatus and chemicals correctly and safely.	Handles apparatus and chemicals safely, correctly and skilfully.
Not always using equipment appropriate for the task, making few observations and measurements and recorded data is not organised appropriately.	Using equipment appropriate for the task, making most of the observations, taking measurements and records limited data.	Using equipment appropriate for the task, making systematic observations, taking accurate measurements and records data in an orderly manner. Works in an organised and diligent manner.
Working with others but not always being co-operative.	Works with others in a cooperative manner most of the time.	Works in a team and is respectful of others.
Failing to make use of the appropriate attire ensuring personal safety.	Makes use of the appropriate attire ensuring personal safety most of the time.	Makes use of the appropriate attire ensuring personal safety.
Does not clean the apparatus and leaves the working station and / or the site visited in a disorganised manner.	Cleans the apparatus and / or the site visited after being reminded.	Cleans the apparatus and / or site visited.

Coursework Mode 4: Site Visit

<table>
<tr><th colspan="2">Site Visit</th></tr>
<tr><td>100 marks

internally-assessed

externally-moderated</td><td>
Site visits offer opportunities to observe the actual world and relate the theory learned in class to a contextualised setting giving an authentic picture of science, its relevance to everyday life and its social purposes. During a site visit, students are exposed to multiple stimuli, thus attracting students of different learning styles, learning abilities and backgrounds. Such contextualised settings drive students to explore and discover new environments and become involved in the activity. In fact, it is a symbiosis of intrinsic motivation to learn and an engaging environment that promotes significant learning gains for the students. Research shows that sites of scientific interest help the students consolidate the work carried out in class, allow them to apply theory to the actual world, introduce the students to the world of work, help them take actions in their real life as they increase awareness about issues discussed and contribute to less compartmentalisation among subjects.
For a site-visit experience to be valuable, prior work is required. This involves preparation such as planning ahead of time to compliment work carried out in class, carrying out risk assessment of the site and showing pictures to familiarise the students with the premises thus reducing the novelty effect that can hinder the commencement of cognitive tasks. Prior to the students' visit, communication with the guide on the premises is essential to determine the learning objectives. However, one should be aware that the learning that occurs during a site visit is not exclusive to knowledge and facts. Learning outcomes set must be achieved during the site visit.
The following shows the relevant sections in the site visit report. There is no established word limit, however the guidelines accompanying each section give a clear indication of the amount of work expected. Each student should present an individual report. This may include various forms such as text, photographs with captions, labelled diagrams/drawings and tables with information.
A rubric for marking a site visit report is presented at the end of this document.
<table>
<tr><th>Section</th><th>Details</th></tr>
<tr><td>Date</td><td>Date of site visit</td></tr>
<tr><td>Title</td><td>The title should include the name of the site where the visit is being carried out.</td></tr>
<tr><td>Aim</td><td>The aim should consist of a brief note stating the aim/s and objectives of the visit.</td></tr>
<tr><td>Preparatory activities</td><td>This section should include:
background information about the scientific aspects relevant to the site visit;
questions the students would be asking the relevant practitioner/s;
an outline of any activities to be carried out.</td></tr>
</table>
</td></tr>
</table>

Site details	This section should include: • a brief history of the site (where applicable). • a description of the location where the site visit took place.
Precautions and Safety Considerations	This section should contain potential hazard/s and the precautionary measures taken to reduce them. Potential hazards are to include physical, chemical and biological hazards as applicable.
Site Activities	This section should include a description of the activities carried out on site. Each activity should be reported in the third person past tense.
Communication of outcomes	This section should include the answers to the questions prepared by the students prior to the visit and any other information collected during the visit.
Discussion, Evaluation, Reflection and References	This section should include a discussion, evaluation and/or interpretation of the outcomes achieved or information collected with respect to the aim/s set out for the site visit. This section should also include the students' self-reflection/s on their experience of the site visit, related to good practices, possible improvements and alternative activities that could have been carried out during the visit. All sources cited in the report should be listed in full. A consistent format should be used when listing the sources.

Marking Criteria: Site Visit

MARKING CRITERIA – Site Visit Maximum 100 marks		
Date, Title & Aim (0 – 10 marks)		
0 - 3 marks	**4 – 6 marks**	**7 – 10 marks**
Title is missing.	Title is incomplete.	Title includes the full name of the site and the location where the visit took place.
Date is missing.	Date is missing.	Date of site visit.
A limited description of the aim/s and objective/s of the site visit is given.	A partial description of the aim/s and objective/s of the site visit.	Aim/s and objective/s of the visit clearly stated.
Preparatory Activities (0 – 20 marks)		
0 – 6 marks	**7 – 12 marks**	**13 – 20 marks**
No/minimal background information about the scientific aspects relevant to the site visit.	Limited background information about the scientific aspects relevant to the site visit.	Background information about the scientific aspects relevant to the site visit.
No/minimal number of questions to ask the relevant practitioner/s.	Few or not so relevant questions the students would be asking the practitioner/s on site.	Relevant questions the students would be asking the practitioner/s on site.
No/minimal outline of activities to be carried out.	An incomplete and/or incoherent outline of activities to be carried out.	A thorough outline of the activities to be carried out.
Site Details (0 – 10 marks)		
0 – 3 marks	**4 – 6 marks**	**7 – 10 marks**
No/minimal description of the location.	An incomplete and/or incoherent description of the location.	A complete description of the location.
No/incorrect map/plan of the site.	An incomplete map/plan of the site.	A detailed map/plan of the site.
No/incorrect history of the site.	An incomplete history of the site.	A brief history of the site.
The main purpose of the site is not stated.	The main purpose of the site is not clearly stated.	The main purpose of the site is clearly stated.
Precautions and Safety Considerations (0 – 10 marks)		
0 - 3 marks	**4 – 6 marks**	**7 – 10 marks**
No/minimal list of potential hazard/s and the precautionary measures taken to reduce them is presented.	An incomplete list of potential hazard/s and the precautionary measures taken to reduce them is presented.	A comprehensive list of potential hazard/s and the precautionary measures taken to reduce them is presented.
Site Activities (0 – 20 marks)		
0 – 6 marks	**7 – 12 marks**	**13 – 20 marks**
No/minimal description of the activities carried out on site.	Incomplete description of the activities carried out on site.	Detailed description of the activities carried out on site.

Communication of Outcomes (0 – 10 marks)		
0 – 3 marks	**4 – 6 marks**	**7 – 10 marks**
No/poor communication of outcomes to the questions prepared by the students.	Good communication of outcomes to the questions prepared by the students.	Comprehensive communication of outcomes to the questions prepared by the students.
Discussion, Evaluation, Reflection & References (0 – 20 marks)		
0 - 6 marks	**7 – 12 marks**	**13 – 20 marks**
No/poor discussion, evaluation and/or interpretation of the outcomes achieved or information collected with respect to the aim/s and objective/s set.	A good discussion, evaluation and/or interpretation of the outcomes achieved or information collected with respect to the aim/s and objective/s set.	A comprehensive discussion, evaluation and/or interpretation of the outcomes achieved or information collected with respect to the aim/s and objective/s set.
No/minimal self-reflection/s on the experience of the site visit including good practices, possible improvements and alternative activities.	Superficial self-reflection/s on the experience of the site visit including good practices, possible improvements and alternative activities.	Thorough self-reflection/s on the experience of the site visit including good practices, possible improvements and alternative activities.
No sources cited listed.	Incomplete list of sources cited and/or presented inconsistently.	All sources cited in the report are listed in full in a basic format.

Coursework Mode 5: Project

Project	
100 marks internally-assessed externally-moderated	A project is an interdisciplinary approach that involves tasks based on challenging questions and / or problems, culminating in realistic tangible products. The project should help enhance the student creativity and interest in the subject whilst improving knowledge and attitude towards science. A project gives the students the opportunity to apply and enhance a range of skills (e.g. cognitive, technical, physical, creative). Projects are of particular importance in science classes because they give students the opportunity to work like scientists. Furthermore, '*A growing body of evidence suggests that inquiry-based instruction resulting from project work results in significantly higher student achievement with respect to content knowledge, reasoning, and argumentation skills.'* (Abdi 2014; Riga et al. 2017). The project in the Chemistry laboratory/classroom assesses how students apply their knowledge to work on a solution to a single task, situation and/or scenario which the students propose, based upon the theme/s indicated by the teacher. A project should consist of ONE of components A, B, or C in addition to component D as outlined below. A. Written: students use written language to communicate ideas and information supported, where applicable, by data, tables, flow charts, diagrams, referenced research, etc.; (e.g. a report, an article for a journal/magazine, leaflet, chart, script for a role play, infographic, etc. (about 500 words)) **OR** B. Product: using a range of skills students create a product (e.g. a model or digital presentation) **OR** C. Demonstration: students will make an actual demonstration in class/laboratory of an innovative/creative way how to represent a scientific situation or concept **AND** D. Spoken: students use spoken language to explain the written, product, or demonstration component, to confirm their understanding of scientific concepts involved in the project as well as the authenticity of the project (e.g. oral presentation, interview by the teacher (2 - 3 minutes)). It is being suggested that the students work individually on the project. The whole project should take around 6 lessons, which might not be consecutive, and include all the steps indicated in the guidelines below. Students should be given some continuous class time to develop their project. They can continue their work on the project at home. The following steps related to the implementation of the project in a classroom setting, are being suggested: 1. The teacher indicates the theme/s for the project based on one or more Learning Outcomes/ Assessment Criteria. The student is to be made aware of the types of projects which can be submitted, keeping in mind the scientific merit of the project as explained in the attached rubric. It is important that students are allowed to choose their own project format, based on their interests, and the most suitable way to present it. The student should be encouraged to research the area under study to help determine the project that is to be carried out. 2. The student selects an appropriate project and presents a plan of action that would lead to the final product. 3. It is suggested that the teacher gives feedback to the student about the plan. The student can revise the plan based on the feedback received. 4. The project is carried out over a period of time established by the teacher. 5. The project is submitted together with the journal and is presented to the class. This might take the form of a 2 - 3-minute oral presentation followed by questions from the teacher or an interview by the teacher. Additional resources (e.g. visual aids etc.) may be used to assist the student in the presentation. The student may also answer questions from the rest of the class.

The Project Guidelines

Section	Details
Title and Plan	This section should include: • An appropriate title. • The aim/s of the project. • A brief description (short paragraph) of what the project will consist of including the related scientific concepts
Written or Product or Demonstration Component	The student will present the chosen Project component to the teacher: A: Written OR B: Product OR C: Demonstration
The Learning Journal	The journal should include: • The plan of the project. • A step by step log of the procedure involved in creating the project. • The relevant research, diagrams, photographic evidence of the process, etc. required for the project development. Reflections related to the process by which the project was realised including any suggested improvements.
Spoken Component	In this section the student needs to explain: • The aim of the project. • The steps involved in developing the project. • What was learnt/concluded from the project.
	The student answers questions to show: • mastery of the scientific concepts covered by the project; • involvement in the actual build-up of the project itself.

Marking Criteria: Project

MARKING CRITERIA – Project Maximum 100 marks		
Title and Plan (0 – 10 marks)		
0 – 3 marks	**4 – 6 marks**	**7 – 10 marks**
Title is missing or not relevant to the project presented.	Title is vague and not indicative of what the project is about.	A relevant and indicative title.
Aim is missing/vague.	Aim is clear however does not make use of accurate scientific terminology.	The aim is clear, concise and fully stated with accurate terms.
Description of the project plan lacks basic details or not well explained and no/wrong scientific concepts are identified.	Description of the project plan is not always clear and cannot be understood completely and some scientific concepts are identified and listed.	The project plan description includes a clear outline of what is being proposed and the scientific concepts covered in the project are all listed.
The Project (0 – 50 marks)		
0 – 15 marks	**16 – 30 marks**	**31 – 50 marks**
Project is very basic, lacks organisation and does not show effort.	Project shows basic levels of organisation and thought. It shows minimal effort.	Project is organized, and easy to understand. Project is complete with strong evidence of effort.
Scientific Merit of the Project		
The chosen project: • Demonstrates no original ideas or thoughts. • Relays information that required no research. • The student's knowledge of science has not been extended beyond what was covered in class	The chosen project: • Is an experiment or an idea that has already been done/discussed in class. • Relays information that required a slight amount of research. • The student's knowledge of science has been increased marginally.	The chosen project: • Is an innovative application of a science concept; • Is an innovative comparative study / observation / investigation. • Is an interesting and insightful piece of work that furthers the student's knowledge of science
The Learning Journal (0 – 30 marks)		
0 – 9 marks	**10 – 18 marks**	**19 – 30 marks**
Does not include the project plan.	Includes the project plan without any revisions suggested by the teacher.	Includes the project plan with revisions as suggested by the teacher's feedback.
Steps are missing, not well explained and not in a chronological order.	List of the steps required to construct the project but they are not in order and have missing steps.	Chronologically documents all the steps taken during the process to construct the project.
No evidence of research, preparatory work relevant to the development of the project.	Inadequate/incomplete evidence of the research/preparatory work required for the development of the project.	Detailed evidence of research/preparatory work involved in developing the project.
The student does not reflect on the process leading to the end product of the project.	The student reflects poorly on the process leading to the end product or reflection lacks detail.	The student's reflection on the process leading to the end product is detailed and meaningful.

Spoken Component (0 – 10 marks)		
0 – 3 marks	**4 – 6 marks**	**7 – 10 marks**
Demonstrated little or no knowledge of the subject. Unable to comment further on any part of the presentation. Communicated scientific concepts poorly. Student was not well prepared for the presentation.	Demonstrated basic knowledge of the subject matter - did not provide any additional information. Communicated scientific concepts adequately. Student was somewhat prepared but had to use prompts to finish presentation.	Demonstrated thorough knowledge of the subject matter. Communicated scientific concepts in a clear manner. Student was well prepared for the presentation.
Student is unable to address questions posed by teacher. The students' knowledge about the Chemistry content covered by the project is very basic. Student finds it hard to elaborate further even when prompted. Student is not knowledgeable about the process required to construct the project.	Student is able to address a few questions posed by the teacher. Students' knowledge about the scientific content covered by the project is adequate however cannot elaborate further even when prompted. Student can briefly explain the most important aspects of building this project.	Student is able to address almost/all questions posed by the teacher about the project. The student shows mastery of the scientific content covered by the project and makes use of scientific terms and concepts while explaining. Student gives a well-organised, comprehensive account of the most important aspects in building this project.

Specimen Assessments

This section presents sample assessments with respective marking schemes. It should be reminded that a marking scheme is not a list of model answers. Teachers may use these guiding documents to develop an assignment based on one of the modes presented in this syllabus as specimen. Otherwise, teachers may develop their own assignment and select an appropriate mode for assessment as long as this assignment is sent to MATSEC for approval before being given to students.

Specimen Assessments: Controlled Paper MQF 1-2

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE
EXAMINATIONS BOARD

L-Università ta' Malta

SECONDARY EDUCATION CERTIFICATE LEVEL
SAMPLE PAPER

SUBJECT:	**Chemistry**
PAPER NUMBER:	**Level 1 – 2**
DATE:	
TIME:	2 Hours

Useful data:

Avogadro constant = 6.02×10^{23}

Specific heat capacity of water = 4.2 J g^{-1} $^{o}C^{-1}$

The molar volume for gases = 22.4 dm^3 at STP

STP conditions = 0 ^{o}C and 10^5 Pa/1 atm.

Directions to Candidates

- Write your index number in the space at the top left-hand corner of this page.
- Answer **ALL** questions in the spaces provided in this booklet.
- The mark allocation is indicated at the end of each question. Marks allocated to parts of questions are also indicated in brackets.
- You are reminded of the necessity for orderly presentation in your answers.
- In calculations, you are advised to show all the steps in your working, giving your answer at each stage.
- The use of electronic calculators is permitted.
- The following information is printed on the back of this booklet:
    - Periodic Table
    - Reactivity Series
    - Order of discharge at electrodes
    - List of polyatomic ions and their charges
    - Solubility rules

Answer ALL questions.

1) The atmosphere consists of different gases. When the atmosphere is polluted, other gases are also present.

a) The following gases are found in air.

Nitrogen	Carbon monoxide
Water vapour	Helium

Place them in the appropriate box of the following table. Each box may be used once, more than once or not at all.

	Natural	Man-Made
Element		
Compound		

(4)

b) Find the best match between the following substances and their properties.

Nitrogen	•	• Supports combustion
Water vapour	•	• Toxic gas
Oxygen	•	• Inert
Carbon monoxide	•	• Condenses at 100 ^{o}C

(4)

c) Name **ONE** use for the following gases:

i) Helium: _____ (1)

ii) Carbon dioxide: _____ (1)

(Total: 10 marks)

2) Common salt is a compound that is made of the elements sodium and chlorine that are chemically joined together.

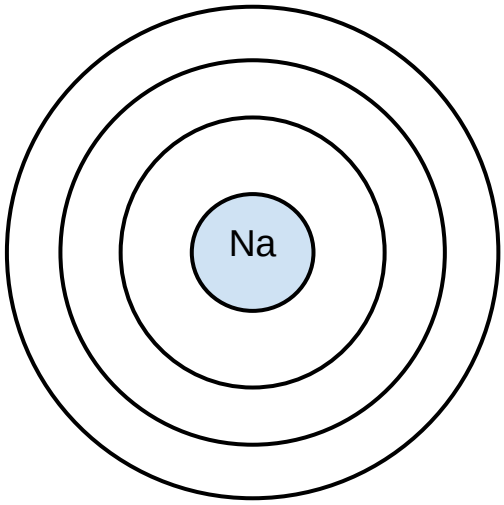
a) Use the periodic table provided to give the following information about a sodium atom.

i) Atomic number: _____ (1)

ii) Mass number: _____ (1)

iii) Number of electrons: _____ (1)

b) Draw the electron configuration on the structure of the sodium atom below. (2)



c) Chlorine is an element whose relative atomic mass is 35.5. It consists of two types of chlorine atoms, Cl-35 and Cl-37.

i) What is the name of these kinds of atoms?

_____ (1)

ii) Which of these variations of chlorine is more common?

_____ (1)

(Total: 7 marks)

3)

a) Group 7 of the periodic table consists of elements such as chlorine, bromine and iodine.

i) Give the name of this group of elements.

_____ (1)

ii) Name **ONE** use of chlorine compounds that are added to swimming pool water.

_____ (1)

iii) State the colour and physical state of iodine at room temperature.

Colour: _____ (1)

Physical state: _____ (1)

b) Group 1 of the periodic table consists of elements such as sodium and potassium.

i) Give the name of this group of elements.

_____ (1)

ii) Name **ONE** physical property typical of these elements.

_____ (1)

iii) Give the chemical formula of potassium bromide.

_____ (2)

iv) Give the name of the compound that forms when potassium reacts with oxygen.

_____ (1)

(Total: 9 marks)

4) Malta's bedrock consists of several layers of sedimentary rock.

a) Limestone is cut from open air sites called quarries. Mention **TWO** environmental impacts of this process.

_____

_____

_____ (2)

b) Limestone contains a high percentage of calcium carbonate.

i) A piece of limestone is added to some hydrochloric acid. Give **ONE** observation for this reaction.

_____ (1)

ii) Describe a chemical test that shows the presence of calcium ions in the solution produced in part (b) (i).

_____

_____ (2)

c) Name **ONE** use of limestone.

_____ (1)

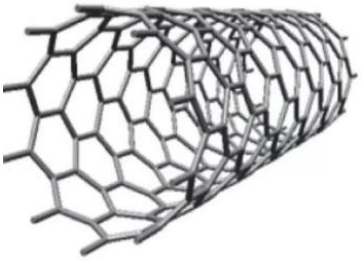
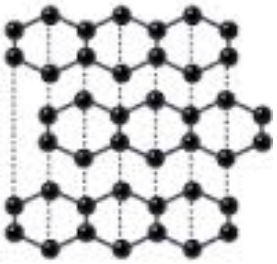
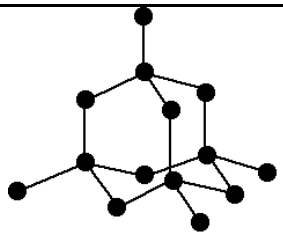
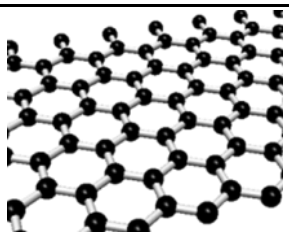
d) Limestone can be used as a starting material to produce quicklime and then slaked lime. State what is required to change:

i) limestone to quicklime; _____ (1)

ii) quicklime to slaked lime. _____ (1)

(Total: 8 marks)

5) Name the following carbon structures:

(Total: 4 marks)

6) Aluminium is an important metal. It is extracted from bauxite.

a) Name **TWO** advantages of using aluminium.

_____

_____ (2)

b) Bauxite needs to be chemically processed so that alumina (purified aluminium oxide) can be obtained. Alumina is then electrolysed to obtain aluminium. Discuss why it makes sense to recycle aluminium.

_____

_____

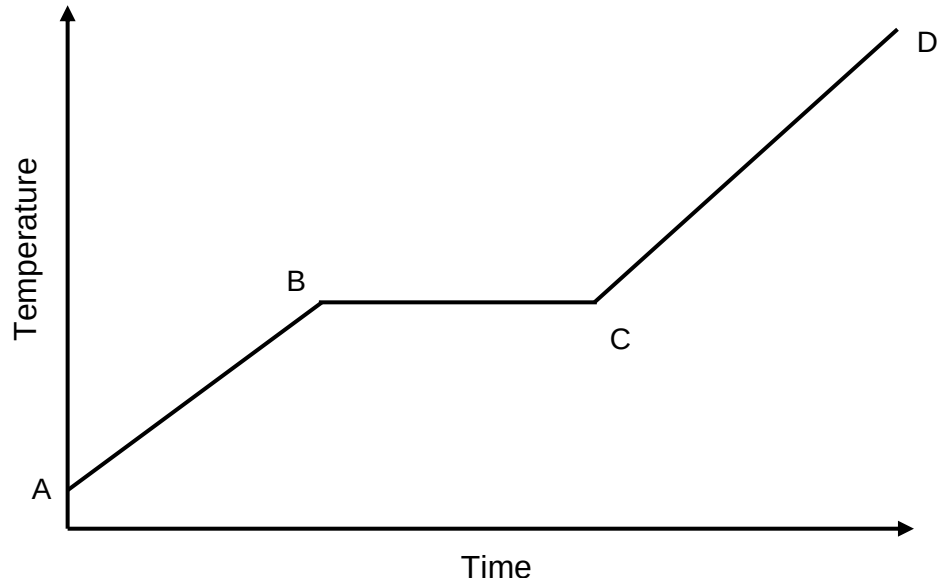
_____ (2)

c) Bauxite is an ore that is usually excavated from open quarries. Mention **ONE** environmental issue related to the mining of aluminium.

_____ (1)

(Total: 5 marks)

7) The sketch below shows a heating curve for a substance that sublimes.



a) What is the state of matter during the parts on the graph indicated by:

i) AB; _____ (1)

ii) CD. _____ (1)

b) Heat is continuously supplied from A to D. State what happens with respect to the:

i) physical state of the substance during phase BC;

_____ (1)

ii) temperature of the substance during phase CD.

_____ (1)

c) Name the reverse process of sublimation.

_____ (1)

d) Underline the correct word in the following statement:

Sublimation is a (chemical/physical) change. (1)

(Total: 6 marks)

8) Pure lead(II) sulfate can be produced in the lab by adding lead(II) nitrate solution to dilute sulfuric acid. Lead(II) sulfate forms a precipitate which is filtered, washed with distilled water and dried.

a) Name **ONE** safety precaution related to sulfuric acid and state the reason for this precaution.

Safety precaution: _____(1)

Reason:_____ (1)

b) State what was done to ensure that pure lead(II) sulfate is produced.

_____ (1)

c) Calculate the relative molecular mass of H_2SO_4.

_____

_____ (2)

d) Calculate the percentage by mass of sulfur in H_2SO_4.

_____

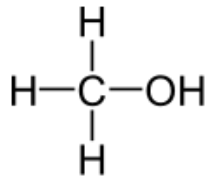
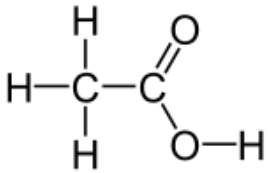
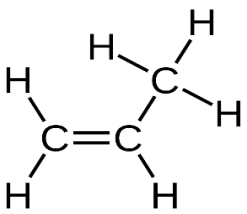
_____ (2)

e) Write a balanced chemical equation for the reaction between lead(II) nitrate solution and sulfuric acid. Include state symbols.

_____ (3)

(Total: 10 marks)

9) Name the homologous series of the following organic molecules.

Structural formula	Homologous Series
	(1)
	(1)
	(1)

(Total: 3 marks)

10) Crude oil is a very important resource that contains a variety of substances.

a) State the collective name of the substances found in crude oil.

_____ (1)

b) Place the following fractions obtained from crude oil in order.

naphtha, residue, gasoline/petrol, kerosene, diesel oil, refinery gases, fuel oil

_____ (1)

c) Identify the fraction from which the following fuels are obtained:

i) Liquefied petroleum gas (LPG): _____ (1)

ii) Aeroplane fuel: _____ (1)

iii) Fuels used for trucks and lorries: _____ (1)

d) The global demand for light fuels exceeds that for heavier fuels. For this reason, the molecules in heavier fuels need to be transformed into smaller molecules.

i) Name this process.

_____ (1)

ii) Describe how this process works.

_____ (1)

e) Describe a chemical test that distinguishes between alkanes and alkenes.

_____

_____

_____ (2)

f) Name the homologous series of propane.

_____ (1)

g) Write a balanced chemical equation for the complete combustion of propane (C_3H_8). Include state symbols.

_____ (3)

h) Name **TWO** substances that are produced during incomplete combustion but **not** during complete combustion of hydrocarbons.

_____

_____ (2)

(Total: 15 marks)

11) Alkenes are unsaturated hydrocarbons that are capable of producing polymers. Polythene is a common polymer that has many uses.

a) Give the meaning of the following terms:

i) unsaturated;

_____ (1)

ii) hydrocarbon;

_____ (1)

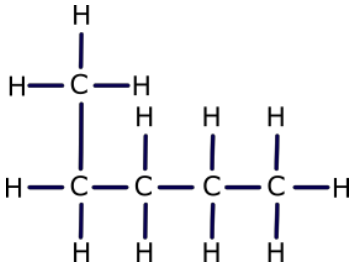
iii) alkene.

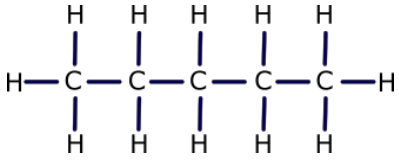
_____ (1)

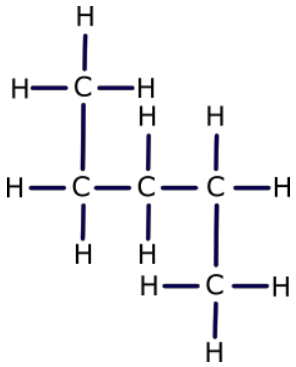
b) Name **ONE** use of polyethene.

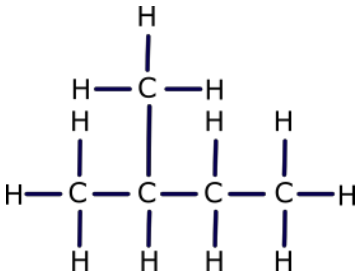
_____ (1)

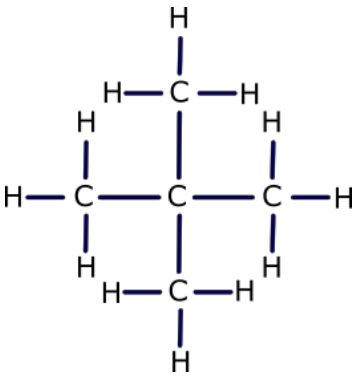
c) Draw a circle around the displayed formulae below that are isomers of pentane which are branched hydrocarbons. (2)











(Total: 6 marks)

12) A student prepared and collected a sample of carbon dioxide gas by reacting hydrochloric acid with magnesium carbonate. The student noted that the reaction is exothermic.

a) Write a balanced chemical equation to represent the reaction between hydrochloric acid and magnesium carbonate. Include state symbols.

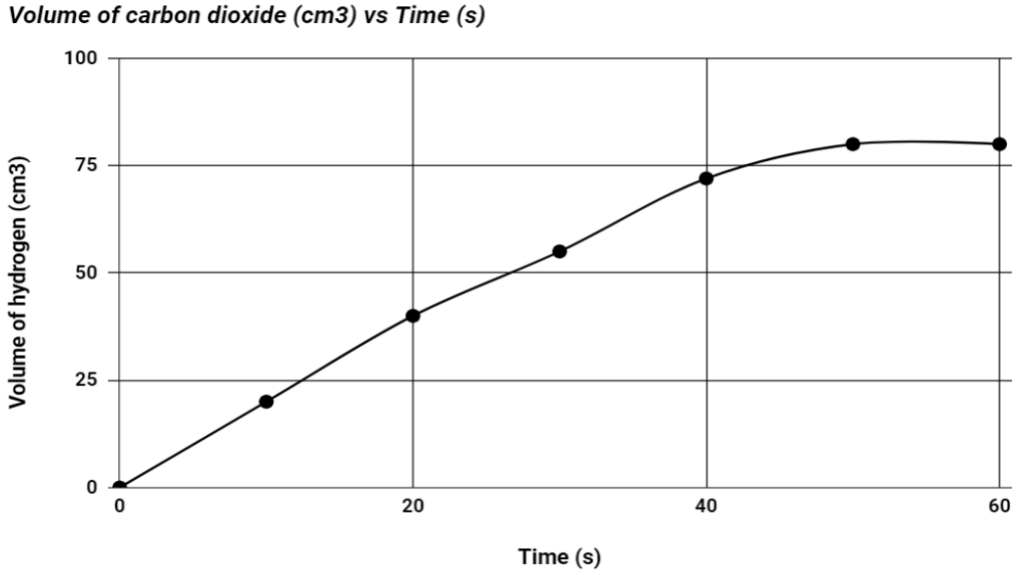
_____ (3)

b) State how the student notes that the reaction is exothermic.

_____ (1)

c) Draw a labelled energy level diagram for an exothermic reaction. (4)

d) The following graph shows the amount of carbon dioxide collected against time.



i) At which point in time does the reaction finish?

_____ (1)

ii) Explain why, another point is plotted on the graph beyond the finishing point.

_____ (1)

iii) From the graph, give the maximum amount of carbon dioxide that is produced.

_____ (1)

e) The student repeats the experiment. State what the student should do to produce:

i) the same amount of carbon dioxide;

_____ (1)

ii) the same amount of carbon dioxide in a shorter period of time;

_____ (1)

f) Carbon dioxide is a gas that is present in the atmosphere; some of it due to natural causes but a substantial amount is due to the combustion of fossil fuels.

i) Explain why carbon dioxide among other gases, is responsible for global warming.

_____ (1)

ii) Mention **TWO** gases that share this property with carbon dioxide.

_____ (2)

iii) State whether a solution of carbon dioxide in water would be alkaline, acidic or neutral.

_____ (1)

(Total: 17 marks)

END OF PAPER

PERIODIC TABLE OF THE ELEMENTS

1	2											3	4	5	6	7	0
							1 **H** Hydrogen 1										4 **He** Helium 2
7 **Li** Lithium 3	9 **Be** Beryllium 4											11 **B** Boron 5	12 **C** Carbon 6	14 **N** Nitrogen 7	16 **O** Oxygen 8	19 **F** Fluorine 9	20 **Ne** Neon 10
23 **Na** Sodium 11	24 **Mg** Magnesium 12											27 **Al** Aluminium 13	28 **Si** Silicon 14	31 **P** Phosphorus 15	32 **S** Sulfur 16	35.5 **Cl** Chlorine 17	40 **Ar** Argon 18
39 **K** Potassium 19	40 **Ca** Calcium 20	45 **Sc** Scandium 21	48 **Ti** Titanium 22	51 **V** Vanadium 23	52 **Cr** Chromium 24	55 **Mn** Manganese 25	56 **Fe** Iron 26	59 **Co** Cobalt 27	59 **Ni** Nickel 28	63.5 **Cu** Copper 29	65 **Zn** Zinc 30	70 **Ga** Gallium 31	73 **Ge** Germanium 32	75 **As** Arsenic 33	79 **Se** Selenium 34	80 **Br** Bromine 35	84 **Kr** Krypton 36
85 **Rb** Rubidium 37	88 **Sr** Strontium 38	89 **Y** Yttrium 39	91 **Zr** Zirconium 40	93 **Nb** Niobium 41	96 **Mo** Molybdenum 42	99 **Tc** Technetium 43	101 **Ru** Ruthenium 44	103 **Rh** Rhodium 45	106 **Pd** Palladium 46	108 **Ag** Silver 47	112 **Cd** Cadmium 48	115 **In** Indium 49	119 **Sn** Tin 50	122 **Sb** Antimony 51	128 **Te** Tellurium 52	127 **I** Iodine 53	131 **Xe** Xenon 54
133 **Cs** Caesium 55	137 **Ba** Barium 56	139 **La** Lanthanum 57	178 **Hf** Hafnium 72	181 **Ta** Tantalum 73	184 **W** Tungsten 74	186 **Re** Rhenium 75	190 **Os** Osmium 76	192 **Ir** Iridium 77	195 **Pt** Platinum 78	197 **Au** Gold 79	201 **Hg** Mercury 80	204 **Tl** Thallium 81	207 **Pb** Lead 82	209 **Bi** Bismuth 83	210 **Po** Polonium 84	210 **At** Astatine 85	222 **Rn** Radon 86

Key:

a **X** Y b

relative atomic mass
SYMBOL
Name
atomic number

Reactivity series	
Decreasing Reactivity ↓	Potassium
	Sodium
	Calcium
	Magnesium
	Aluminium
	Carbon
	Zinc
	Iron
	Lead
	Copper
	Silver
	Gold
	Platinum

Order of discharge at cathode	
Increasing Ease of Discharge ↓	Na^+
	Mg^{2+}
	Al^{3+}
	Zn^{2+}
	Fe^{2+}
	Pb^{2+}
	H^+
	Cu^{2+}
	Ag^+
	Au^{3+}

Order of discharge at anode
1. For aqueous very dilute solutions OH^- is discharged. 2. For aqueous concentrated solutions containing halide ions (Cl^-, Br^- and I^-), these are discharged in preference to OH^-. 3. SO_4^{2-}, NO_3^- and CO_3^{2-} are never discharged from aqueous solutions

List of polyatomic ions and their charges	
Name	**Formula**
Ammonium	NH_4^+
Nitrate	NO_3^-
Sulfate	SO_4^{2-}
Carbonate	CO_3^{2-}
Hydrogencarbonate	HCO_3^-
Hydroxide	OH^-

Solubility Rules	
Soluble	**Insoluble**
• All nitrates • All hydrogencarbonates • All group 1 metal salts • All ammonium salts • Halides except silver and lead halides • Sulfates except barium, calcium, and lead sulfates	• Carbonates except group 1 metal and ammonium carbonate • Metal oxides except group 1 and 2 metal oxides that react with water. • Hydroxides except group 1 metal and ammonium hydroxides

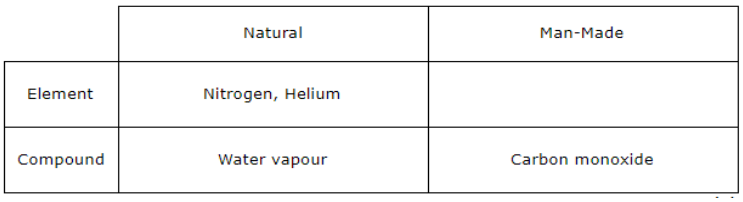
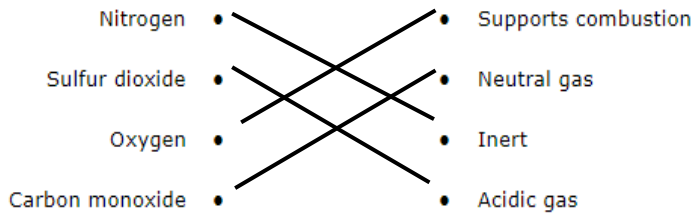
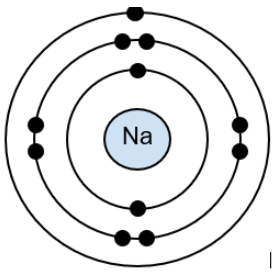
Specimen Assessments: Controlled Paper MQF 1-2 Marking Scheme

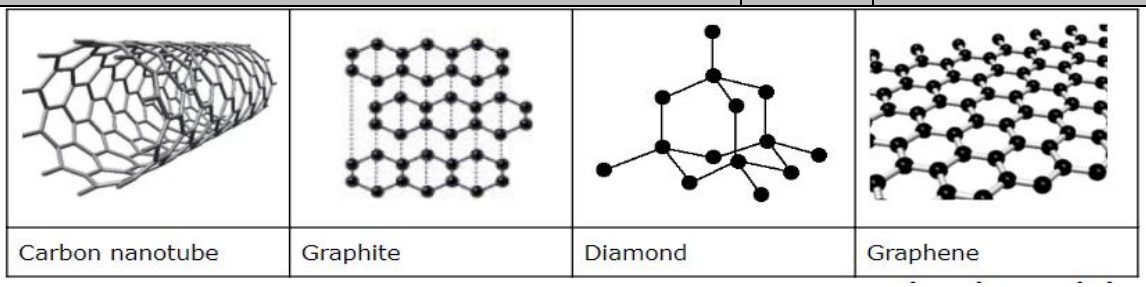
L-Università ta' Malta

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

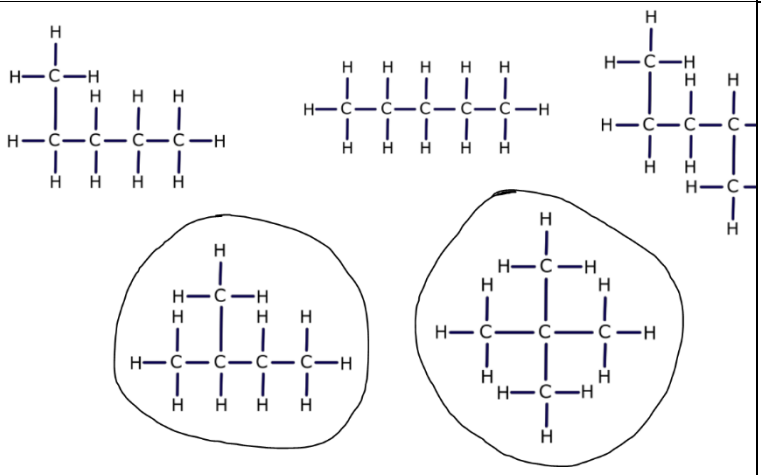
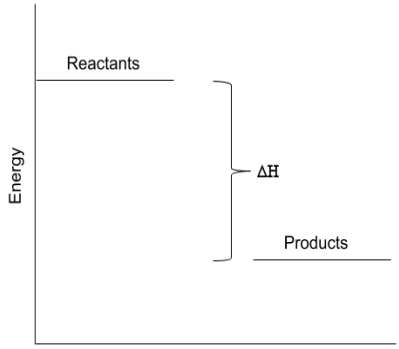
SECONDARY EDUCATION CERTIFICATE LEVEL
SAMPLE PAPER MARKING SCHEME

SUBJECT:	**Chemistry**
PAPER NUMBER:	**Level 1 – 2**
DATE:	
TIME:	2 Hours

Question			Suggested answers	Marks	Additional notes
1	a			4	1 mark for each placing
	b			4	1 mark for each correct match
	c	i	Helium is used to fill high altitude balloons.	1	Accept other correct answers
	c	ii	Carbon dioxide is used to extinguish fires.	1	Accept other correct answers
			Total	**10**	
2	a	i	11	1	
	a	ii	23	1	
	a	iii	11	1	
	b			2	- 1 mark for correct electron configuration - 1 mark for correct order (that is 2 on innermost (first) shell, 8 on the second and 1 on the third).
	c	i	Isotopes	1	
	c	ii	Cl-35	1	
			Total	**7**	

Question			Suggested answers	Marks	Additional notes
3	a	i	Halogens.	1	
	a	ii	To sanitise the water	1	
	a	iii	Dark purple. Solid.	1 1	
	b	i	Alkali metals.	1	
	b	ii	They are relatively light metals.	1	Accept they float on water.
	b	iii	KBr	2	1 mark symbols 1 mark for formula
	b	iv	Potassium oxide.	1	Do not accept the formula
			Total	**9**	
4	a		- Is a very dusty process - Increases the amount of particulates in air - Quarries are an eyesore	2	Any two
	b	i	Effervescence is observed	1	
	b	ii	Add NaOH(aq) until in excess to a solution containing calcium ions. A white precipitate insoluble in excess NaOH shows the presence of calcium ions.	1 1	
	c		As a building material. OR To make statues.	1	
	d	i	Apply strong heat	1	
	d	ii	Add water	1	
			Total	**8**	
5			 Carbon nanotube | Graphite | Diamond | Graphene		
			Total	**4**	
6	a		• It does not corrode easily. • It is relatively lightweight.	2	
	b		• Chemical processing of bauxite uses a lot of resources that lead to a higher cost of the metal. • Electrolysis is a high energy process which also increases the cost of the metal. • Recycling aluminium is cheaper than producing it from scratch.	2	Any two
	c		Open quarries lead to increased amounts of dust pollution	1	
			Total	**5**	
7	a	i	Solid	1	
	a	ii	Gas	1	
	b	i	The substance is undergoing a change of state	1	
	b	ii	The temperature of the substance is increasing	1	
	c		Deposition	1	
	d		Physical	1	
			Total	**6**	

Question			Suggested answers	Marks	Additional notes
8	a		Latex gloves must be worn due to the corrosiveness of the acid. **OR** Safety specs must be worn to protect the eyes from acid splashes as it is corrosive.	2	1 mark for safety precaution. 1 mark for related reason.
	b		Lead(II) sulfate was filtered then washed with distilled water.	1	
	c		RMM (H_2SO_4): (1x2) + 32 + (16 x 4) = 98	2	1 mark for working. 1 mark for answer.
	d		% by mass = $\frac{mass\ of\ sulfur}{mass\ of\ sulfuric\ acid}$ x 100 = (32/98) x 100 = 32.65 %	2	1 mark for working. 1 mark for answer. Apply follow through.
	e		$Pb(NO_3)_2(aq) + H_2SO_4(aq) \rightarrow PbSO_4(s) + 2HNO_3(aq)$	3	1 mark for chemical formulae. 1 mark for balancing. 1 mark for reversible reaction sign.
			Total	**10**	
9			alcohol, carboxylic acid OR alkanoic acid, alkene	1 1 1	Do not accept names of substances.
			Total	**3**	
10	a		hydrocarbons	1	
	b		refinery gases, gasoline/petrol, naphtha, kerosene, diesel oil, fuel oil and residue.	1	Accept reverse order
	c	i	Refinery gas	1	
	c	ii	Kerosene	1	
	c	iii	Diesel oil	1	
	d	i	Cracking	1	
	d	ii	Large hydrocarbons are heated until they crack into smaller hydrocarbons.	1	
	e		Alkenes decolourise bromine water while alkanes don't.	2	
	f		Alkane	1	
	g		$C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(l)$	3	1 mark for formulae. 1 mark for balancing. 1 mark for state symbols.
	h		Soot, Carbon monoxide	1,1	
			Total	**15**	
11	a	i	An organic substance that has a double or triple bond between two of its carbons.	1	
	a	ii	An organic substance that contains carbon and hydrogen only.	1	

Question			Suggested answers	Marks	Additional notes
	a	iii	A hydrocarbon that has a double bond between two of its carbon atoms.	1	
	b	i	Packaging in the food industry.	1	Accept other correct answers
	c			2	
			Total	**6**	
12	a		1. $2HCl(aq) + MgCO_3(s) \rightarrow MgCl_2(aq) + H_2O(l) + CO_2(g)$	3	1 mark for chemical formulae. 1 mark for balancing. 1 mark for state symbols.
	b		The reaction vessel increases in temperature during the reaction.	1	
	c			4	1 mark for each label and corresponding correct placement.
	d	i	At the 50^{th} second	1	
	d	ii	To ensure that reaction has come to an end	1	
	d	iii	$80cm^3$	1	
	e	i	By using the same amount of substances	1	
	e	ii	By increasing temperature OR increasing concentration of acid OR by crushing the carbonate into smaller pieces.	1	
	f	i	It is a greenhouse gas	1	
	f	ii	Water vapour and methane	2	
	f	iii	Acidic	1	
			Total	**17**	

Specimen Assessments: Controlled Paper MQF 2-3

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE
EXAMINATIONS BOARD

L-Università ta' Malta

SECONDARY EDUCATION CERTIFICATE LEVEL
SAMPLE PAPER

SUBJECT:	**Chemistry**
PAPER NUMBER:	**Level 2 – 3**
DATE:	
TIME:	2 Hours

Useful data:

Avogadro constant = 6.02×10^{23}

Specific heat capacity of water = 4.2 J g^{-1} $^{o}C^{-1}$

The molar volume for gases = 22.4 dm^3 at STP

STP conditions = 0 ^{o}C and 10^5 Pa/1 atm.

Directions to Candidates

- Write your index number in the space at the top left-hand corner of this page.
- Answer **ALL** questions in the spaces provided in this booklet.
- The mark allocation is indicated at the end of each question. Marks allocated to parts of questions are also indicated in brackets.
- You are reminded of the necessity for orderly presentation in your answers.
- In calculations, you are advised to show all the steps in your working, giving your answer at each stage.
- The use of electronic calculators is permitted.
- The following information is printed on the back of this booklet:
    - Periodic Table
    - Reactivity Series

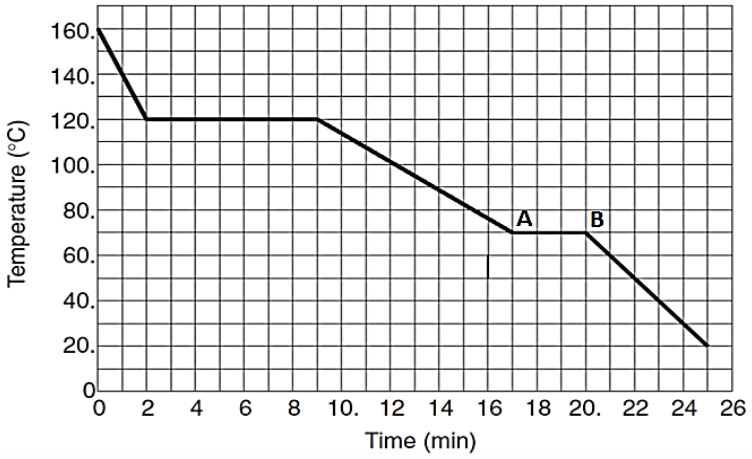
Answer ALL questions.

1)

a) Read the following statements and indicate whether they are True or False. (4)

	True/False
i. The rusting of iron is an example of a physical change.	
ii. Potassium oxide is a mixture of potassium and oxygen.	
iii. Sublimation is the process during which a solid, changes into a gas without going through the liquid phase when heated.	
iv. The conversion of anhydrous copper(II) sulfate to hydrated copper(II) sulfate is an example of a reversible reaction.	

b) The following graph shows a cooling curve of a pure substance. The graph starts as a gas above its boiling point.



adapted from: http://www.aplusphysics.com/courses/honors/thermo/phase_changes.html

i. Use the graph to write down the temperature at which the gas condenses.

_____ (1)

ii. Use the kinetic theory to explain what happens to the arrangement of particles in the pure substance between 10 to 16 minutes.

_____

_____ (1)

iii. In a different experiment, another cooling curve was plotted. However, this time the line **AB** obtained was at a different distance from the x-axis. Suggest a reason for this observation.

_____ (1)

(Total: 7 marks)

2) The following table shows the electron configuration of five unknown elements labelled **V**, **W**, **X**, **Y** and **Z**. These letters are not the actual chemical symbols of the unknown elements.

Element	Electron Configuration
V	2,1
W	2,4
X	2,6
Y	2,8
Z	2,8,5

a) Use letters **V-Z** to indicate the element which:

i. is a noble gas; _____ (1)

ii. has an atomic number of 6; _____ (1)

iii. is in period 3 of the periodic table. _____ (1)

b) Elements **V** and **X** react to form an ionic compound. Write the electronic configuration of an ion of:

i. **V**;_____ (1)

ii. **X**. _____ (1)

c) Give **ONE** physical property of ionic compounds.

_____ (1)

d) State whether the oxide of element **V** is acidic or basic.

_____ (1)

e) Draw a dot-cross diagram (*showing outer electron shells only*) to show bonding in a compound formed when atoms **W** and **X** react together. (2)

(Total: 9 marks)

3) A student wants to investigate how the reactivity of group 1 metals changes along the group. She fills a trough with water and gently drops a small sample of lithium in the trough. Any observations are noted. She then repeats the same procedure for sodium and potassium metals. All alkali metals are stored in separate containers filled with oil.

a) Give **ONE** reason why alkali metals are stored under oil.

_____ (1)

b) Write a balanced chemical equation, to show what happens when a small sample of sodium metal reacts with water.

_____ (2)

c) Explain what happens to the reactivity of group 1 metals on going down the group, in terms of atomic structure.

_____

_____

_____

_____ (3)

d) The student then carefully heated a sample of sodium in air. The compound was analysed and the following results were obtained.

- Mass of sodium = 14.10 g
- Mass of oxygen = 4.90 g

i. Calculate the empirical formula of the compound formed.

_____

_____

_____

_____

_____ (3)

ii. Work out its molecular formula if the relative formula mass of the compound is 62.

_____

_____ (2)

(Total: 11 marks)

4) Local car owners are converting their vehicle's fuel system to liquid petroleum gas (LPG). LPG is a mixture of the following alkanes propane and butane each having the respective molecular formula: C_3H_8 and C_4H_{10}.

a) There are two isomers with the molecular formula C_4H_{10}. Draw the displayed formulae of these **TWO** isomers. (2)

b) Predict whether propane or butane would have the highest boiling point. Give **ONE** reason for your answer.

_____

_____

_____ (2)

c) When burnt in air, both propane and butane undergo complete combustion. Write a balanced chemical equation to show the complete combustion of butane.

_____ (2)

d) Name **ONE** gaseous product which is formed when LPG burns in a limited supply of air rather than when burnt in a plentiful supply of air.

_____ (1)

e) Propene and butene are examples of alkenes. Describe a simple chemical test (other than combustion) to distinguish between samples of propene and propane. Your answer should include any colour changes noted.

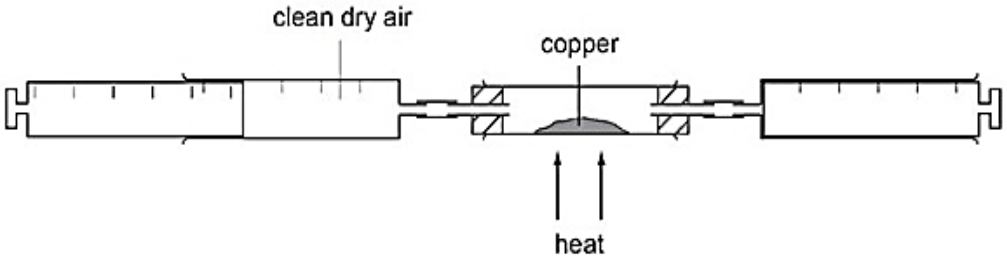
_____

_____

_____ (3)

(Total: 10 marks)

5) Air is a mixture of gases. Two students were asked to measure the percentage of oxygen present in air by setting up the apparatus shown below. They heated a known mass of copper turnings in a combustion tube fixed to two gas syringes. A fixed volume of air was passed over the copper turnings from one gas syringe to the other.



a) During the heating process, the copper turnings changed colour. State the final colour obtained.

_____ (1)

b) Once the reaction was over, the apparatus was allowed to cool before measuring the final volume of the remaining gas in the syringe. Give **ONE** reason for this precaution.

_____

_____ (1)

c) Use the following information to calculate the percentage of oxygen in the sample of air.

- Volume of air in the gas syringe before heating = 75.00 cm^3
- Volume of air in the gas syringe after heating = 59.25 cm^3

_____

_____

_____ (2)

d) Name the main gas component which is left behind in the combustion tube once all of the oxygen is used during the reaction.

_____ (1)

e) A small percentage of air is composed of noble gases. One common noble gas found in air is argon. State **ONE** use of argon.

_____ (1)

(Total: 6 marks)

6) Chlorine gas can be produced in the lab by gently heating a sample of manganese(IV) oxide with concentrated hydrochloric acid. Chlorine gas is then collected in a gas syringe. The reaction can be summarised as shown in the following equation:

$$\underline{Mn}O_2(s) + 4H\underline{Cl}(aq) \rightarrow MnCl_2(aq) + Cl_2(g) + 2H_2O(l)$$

a) The above reaction is an example of a redox reaction. State whether the underlined ions are being oxidised or reduced. Give a reason for your answer in terms of oxidation numbers.

$\underline{Mn}O_2$: _____ (1)

Reason: _____ (1)

H$\underline{Cl}$: _____ (1)

Reason: _____ (1)

b) During the reaction, 5.09 g of solid manganese(IV) oxide were added to excess concentrated hydrochloric acid. All of the manganese(IV) oxide reacted with the acid. Calculate:

i. The number of moles of manganese(IV) oxide used during the reaction.

_____

_____(2)

ii. The number of moles of hydrochloric acid which reacted with solid manganese(IV) oxide.

_____

_____(2)

iii. The volume of chlorine gas collected at standard temperature and pressure (STP).

_____

_____

_____

_____ (3)

iv. Give a suitable test which can be used to prove that the gas produced during the reaction is chlorine gas.

_____(1)

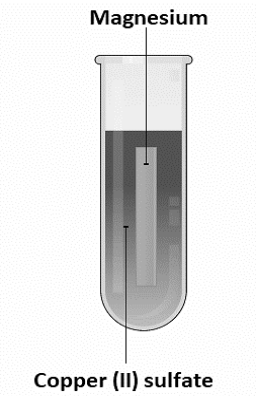
(Total: 12 marks)

7) Consider the following metals: aluminium, copper and calcium.

a) Complete the table below by writing the name of the corresponding element next to each of following statements. Each metal can be used more than once. (5)

	Description	**Elements**
i.	Gives an orange red colour when burnt in a Bunsen burner flame.	
ii.	A metal which does not react with cold water or steam.	
iii.	Deposits zinc when added to a solution of zinc nitrate.	
iv.	Salts of this metal are responsible in the formation of scale around the heating element of electric kettles.	
v.	A solution of an ionic salt of this metal reacts with sodium hydroxide solution to form a white precipitate which is soluble in excess sodium hydroxide.	

b) A strip of magnesium metal was dipped in a blue solution of copper(II) sulfate.



i. Write a net ionic equation to show the reaction which occurs when a strip of magnesium metal is dipped in a solution of copper(II) sulfate.

_____

_____

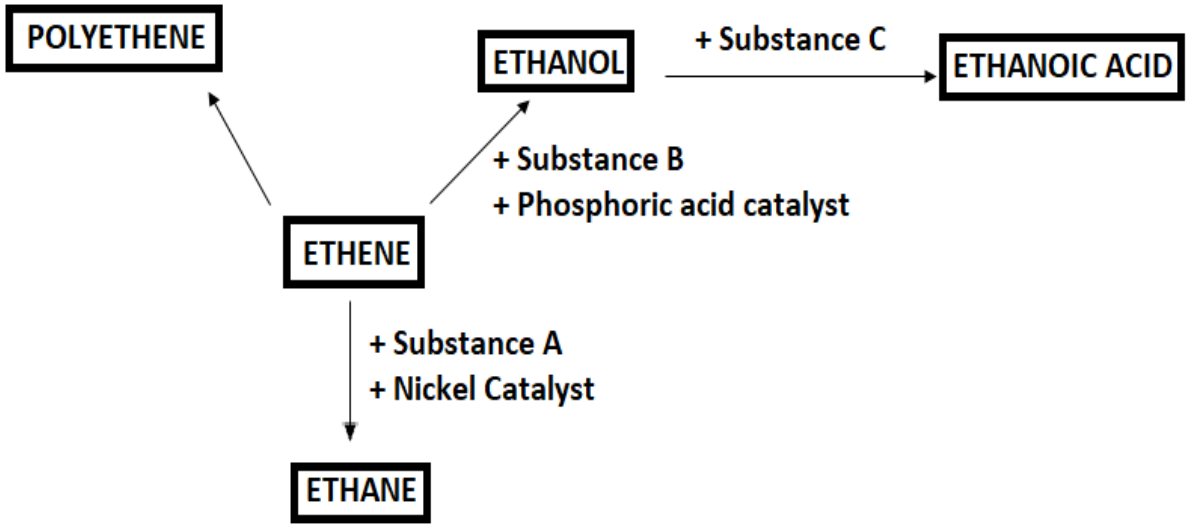
_____ (2)

ii. Give **ONE** observation related to the reaction between magnesium metal and copper(II) sulfate solution.

_____ (1)

(Total: 8 marks)

8) The following scheme shows reaction conversions involving ethene. Letters **A**, **B** and **C** are not actual chemical symbols of the reagents required for successful conversions.



a) Give the chemical name of:

i. Substance **A:** _____

ii. Substance **B:** _____

iii. Substance **C:** _____ (3)

b) Ethanol reacts with ethanoic acid to form an organic compound called ethyl ethanoate.

i. Name the homologous series of the compound ethyl ethanoate.

_____ (1)

ii. Write a balanced chemical equation to show the reaction of ethanol with ethanoic acid.

_____ (2)

c) Ethanol can also be produced by a fermentation reaction. Give **ONE** advantage and **ONE** disadvantage of producing ethanol by fermentation.

_____

_____

_____ (2)

d) Polyethene is an addition polymer. Draw the displayed formula of polyethene showing 3 monomer units joined together. (2)

(Total: 10 marks)

9) Ammonia is an important compound, prepared during the Haber Process. The industrial preparation of ammonia involves the reaction of nitrogen with hydrogen gas under special conditions. The reaction which takes place is as follows:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \quad \Delta H = -92 \text{ kJ mol}^{-1}$$

a) What does the negative sign of ΔH indicate about the reaction?

_____ (1)

b) Explain, giving reasons, how the position of equilibrium is affected with an increase in pressure.

_____

_____

_____

_____ (3)

c) Usually when the temperature of a reaction increases, the rate of reaction would increase too. Explain this statement in terms of the collision theory.

_____

_____

_____ (2)

d) An iron catalyst is also used in the Haber Process. Discuss the importance of this catalyst in the industrial production of ammonia.

_____

_____

_____ (2)

e) Ammonia can be prepared in the laboratory by reacting an alkali with an ammonium salt. Give a balanced net ionic equation, for the reaction of ammonium sulfate with sodium hydroxide solution.

_____

_____

_____ (2)

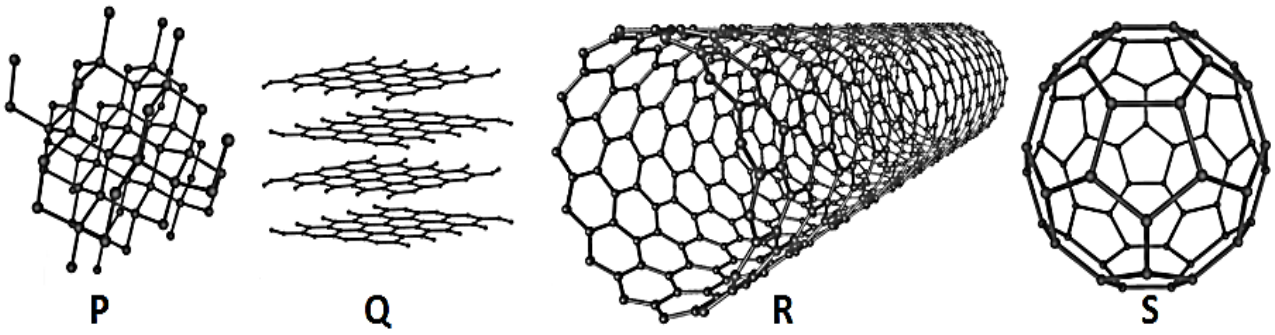
(Total: 10 marks)

10) Aluminium is a metal of economic importance. It can be extracted from its ore by electrolysis.

a) Give the name of the ore which is used in the electrolytic extraction of aluminium metal.

_____ (1)

b) Carbon electrodes are used during the electrolytic process of aluminium. The following diagrams show four carbon allotropes labelled **P, Q, R** and **S**.



adapted from https://commons.wikimedia.org/w/index.php?curid=584786

i. Give the letter of **ONE** of the diagrams which represents the structure of graphite.

_____ (1)

ii. Give **ONE** reason why the carbon allotrope named in part (b) (i) is used as an electrode during the electrolytic process of aluminium.

_____ (1)

iii. The anode used during the electrolysis of aluminium needs to be replaced from time to time. Explain why.

_____

_____ (2)

c) "Aluminium is extensively recycled because less energy is needed to produce recycled aluminium than to extract aluminium from its ore."

http://www.bbc.co.uk/schools/gcsebitesize/science/aqa_pre_2011/rocks/metalsrev7.shtml

Use this statement to explain how recycling aluminium can have a positive influence on the economy and natural environment.

_____

_____

_____

_____ (2)

(Total: 7 marks)

11. Read the following passage and then answer the questions that follow.

An oil-eating bacterium that can help clean up pollution and spills

Research associate Dr. Tarek Rouissi studied "technical data sheets" for many bacterial strains with the aim of finding the perfect candidate for a dirty job: cleaning up oil spills. *Alcanivorax borkumensis,* a harmless marine bacterium, caught his attention. The microorganism is classified as "hydrocarbonoclastic" -- i.e., as a bacterium that uses hydrocarbons as a source of energy. This bacterium is present in all oceans and drifts with the current, multiplying rapidly in areas where the concentration of oil compounds is high, which partly explains the natural degradation observed after some spills.

Alcanivorax borkumensis boasts an impressive set of tools: during its evolution, it has accumulated a range of specific enzymes that degrade almost everything found in oil. To test the microscopic cleaner, the research team purified a few of the enzymes and used them to treat samples of contaminated soil. Professor Satinder Kaur Brar, a researcher working on this project, stated that "the degradation of hydrocarbons using the enzyme extract is really encouraging and reached over 80% for various compounds. It has been tested under a number of different conditions to show that it is a powerful way to clean up polluted land and marine environments."

Text adapted from: Science Daily https://www.sciencedaily.com/releases/2018/04/180409144725.htm

a) Explain why the bacterium *Alcanivorax borkumensis* "multiplies rapidly in areas where the concentration of oil compounds is high".

_____

_____ (2)

b) The mixture of hydrocarbons present in crude oil can be separated from each other by fractional distillation.

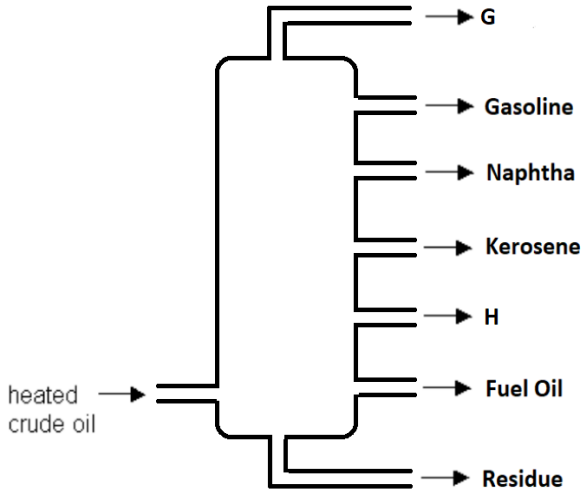
i. Define the term hydrocarbon.

_____ (1)

ii. Suggest **ONE** property of hydrocarbons which allows them to be separated from crude oil by fractional distillation.

_____ (1)

iii. The following is a representation showing the different fractions collected during fractional distillation of crude oil. Name the fractions labelled **G** and **H**.



G: _____

H: _____ (2)

c) Ethene can be manufactured by cracking the heavier fractions, which are separated during fractional distillation of crude oil.

i. Explain how cracking is different from fractional distillation.

_____

_____

_____ (2)

ii. Write a balanced chemical equation to show the cracking of $C_{10}H_{22}$ to produce two products: ethene and another hydrocarbon.

_____ (2)

(Total: 10 marks)

END OF PAPER

PERIODIC TABLE OF THE ELEMENTS

1	2											3	4	5	6	7	0
							1 **H** Hydrogen 1										4 **He** Helium 2
7 **Li** Lithium 3	9 **Be** Beryllium 4											11 **B** Boron 5	12 **C** Carbon 6	14 **N** Nitrogen 7	16 **O** Oxygen 8	19 **F** Fluorine 9	20 **Ne** Neon 10
23 **Na** Sodium 11	24 **Mg** Magnesium 12											27 **Al** Aluminium 13	28 **Si** Silicon 14	31 **P** Phosphorus 15	32 **S** Sulfur 16	35.5 **Cl** Chlorine 17	40 **Ar** Argon 18
39 **K** Potassium 19	40 **Ca** Calcium 20	45 **Sc** Scandium 21	48 **Ti** Titanium 22	51 **V** Vanadium 23	52 **Cr** Chromium 24	55 **Mn** Manganese 25	56 **Fe** Iron 26	59 **Co** Cobalt 27	59 **Ni** Nickel 28	63.5 **Cu** Copper 29	65 **Zn** Zinc 30	70 **Ga** Gallium 31	73 **Ge** Germanium 32	75 **As** Arsenic 33	79 **Se** Selenium 34	80 **Br** Bromine 35	84 **Kr** Krypton 36
85 **Rb** Rubidium 37	88 **Sr** Strontium 38	89 **Y** Yttrium 39	91 **Zr** Zirconium 40	93 **Nb** Niobium 41	96 **Mo** Molybdenum 42	99 **Tc** Technetium 43	101 **Ru** Ruthenium 44	103 **Rh** Rhodium 45	106 **Pd** Palladium 46	108 **Ag** Silver 47	112 **Cd** Cadmium 48	115 **In** Indium 49	119 **Sn** Tin 50	122 **Sb** Antimony 51	128 **Te** Tellurium 52	127 **I** Iodine 53	131 **Xe** Xenon 54
133 **Cs** Caesium 55	137 **Ba** Barium 56	139 **La** Lanthanum 57	178 **Hf** Hafnium 72	181 **Ta** Tantalum 73	184 **W** Tungsten 74	186 **Re** Rhenium 75	190 **Os** Osmium 76	192 **Ir** Iridium 77	195 **Pt** Platinum 78	197 **Au** Gold 79	201 **Hg** Mercury 80	204 **Tl** Thallium 81	207 **Pb** Lead 82	209 **Bi** Bismuth 83	210 **Po** Polonium 84	210 **At** Astatine 85	222 **Rn** Radon 86

Key:

a
X
Y
b

relative atomic mass
SYMBOL
Name
atomic number

Reactivity series	
	Potassium
	Sodium
	Calcium
	Magnesium
	Aluminium
	Carbon
	Zinc
	Iron
	Lead
	Copper
	Silver
	Gold
	Platinum

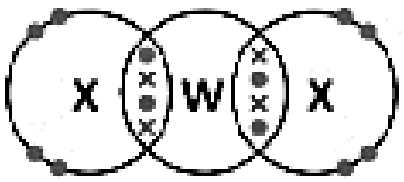
Specimen Assessments: Controlled Paper MQF 2-3 Marking Scheme

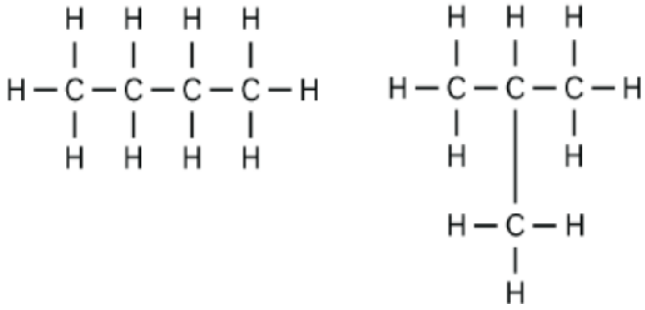
MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

L-Università ta' Malta

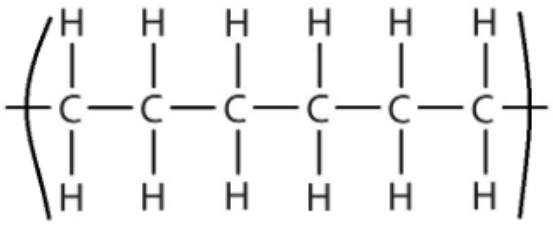
SECONDARY EDUCATION CERTIFICATE LEVEL
SAMPLE PAPER MARKING SCHEME

SUBJECT:	**Chemistry**
PAPER NUMBER:	**Level 2 – 3**
DATE:	
TIME:	2 Hours

Question			Suggested answers	Marks	Remarks
1	a	i	False	1	
	a	ii	False	1	
	a	iii	True	1	
	a	vi	True	1	
	b	i	120 °C	1	deduct ½ mark if units are missing
	b	ii	As temperature decreases, the kinetic energy of particles decreases, hence particles move closer to each other	1	
	b	iii	A different substance was used which had it its own varied freezing point.	1	Award ½ mark if it is stated that the substance has a different freezing point, but no reason is given.
			Total:	**7**	
2	a	i	Y	1	
	a	ii	W	1	
	a	iii	Z	1	
	b	i	2	1	
	b	ii	2,8	1	
	c		Conduct electricity when molten or in an aqueous solution **OR** Have high melting and boiling points	1	
	d		Basic oxide	1	
	e			1 mark for sharing of electrons 1 mark for the lone pairs on X	No marks if bonding is not correct
			Total:	**9**	

Question			Suggested answers	Marks	Remarks
3	a		Prevents them from reacting with oxygen in air due to being highly reactive	1	
	b		$2Na + 2H_2O \rightarrow 2NaOH + H_2$	2	1 mark correct equation 1 mark correct balancing
	c		• Reactivity increases down the group • Due to increasing atomic radius and shielding effect • The attraction between the nucleus and the outer electron gets weaker so less energy is needed to remove the outer electron	1 1 1	
	d	i	Moles sodium = 14.10/23 = 0.61 Moles oxygen = 4.90/16 = 0.306 Ratio=2:1 → E.F = Na_2O	1 1 1	
	d	ii	E.F = (RAM Na)x2 + (RAM O) = 62 M.F = 62/62 = 1 M.F = Na_2O	1 1	
			Total:	**11**	
4	a			2	1 mark for each correct isomer.
	b		Butane • The longer the hydrocarbon chain the more intermolecular forces between molecules so more energy is needed to break the weak bonds.	1 1	Accept Van der Waals forces
	c		$2C_4H_{10} + 13O_2 \rightarrow 8CO_2 + 10H_20$	2	1 mark correct equation 1 mark correct balancing
	d		Carbon monoxide **OR** Water vapour	1	Do not accept carbon (soot)
	e		Adding bromine (water) • When added to propene a colour change from reddish brown to colourless is observed. • When added to propane no colour change is observed.	1 1 1	
			Total:	**10**	

Question			Suggested answers	Marks	Remarks
5	a		It changes to black	1	
	b		The remaining air in the apparatus would have a larger volume as air would have expanded on heating	1	
	c		Volume O_2 =Volume before heating-volume after heating = 75.00 - 59.25 = **15.75 cm^3** (15.75/75.00) x 100 = **21%**	1 1	
	d		Nitrogen	1	
	e		Any **ONE** of the following: • Used in arc welding • Used in filament light bulbs	1	
			Total:	**6**	
6	a	i	$\underline{Mn}O_2$ • reduced • decrease in oxidation number (+4 → +2) $H\underline{Cl}$ • oxidised • increase in oxidation number (-1 → 0)	 1 1 1 1	
	b	i	1 mole of MnO_2 = 87g ? = 5.09g 5.09/87 = 0.058moles	1 1	
	b	ii	Ratio=MnO_2:HCl = 1:4 Moles of hydrochloric acid = 0.058 x 4 = 0.234 moles	1 1	
	b	iii	Ratio=MnO_2:Cl_2 = 1:1 Moles of chlorine = 0.058 moles 1 mole of Cl_2 = 22.4dm^3 0.058 moles = ? 0.058 x 22.4 = 1.32dm^3	1 1 1	
	b	iv	Chlorine changes moist blue litmus paper red and then bleaches it white	1	
			Total:	**12**	
7	a	i	Calcium	1	
	a	ii	Copper	1	
	a	iii	Aluminium **OR** Calcium	1	
	a	iv	Calcium	1	
	a	v	Aluminium	1	
	b	i	$Mg\ (s) + CuSO_4\ (aq) \rightarrow MgSO_4\ (aq) + Cu\ (s)$ $Mg(s) + Cu^{2+}(aq)\ SO_4^{2-}\ (aq) \rightarrow Mg^{2+}(aq)\ SO_4^{2-}\ (aq) + Cu(s)$ Removing spectator ions $Mg\ (s) + Cu^{2+}(aq) \rightarrow Mg^{2+}\ (aq) + Cu\ (s)$	1 mark correct ionic equation 1 mark correct state symbols	
	b	ii	Blue coloured solution of copper(II) sulfate starts fading **OR** Reddish-brown deposit of copper observed	1	Do not accept bubbles.
			Total:	**8**	

Question			Suggested answers	Marks	Remarks
8	a	i	Hydrogen	1	
	a	ii	Steam	1	
	a	iii	Acidified potassium dichromate / aerial oxidation	1	
	b	i	Ester	1	
	b	ii	$CH_3COOH + C_2H_5OH \rightleftharpoons CH_3COOC_2H_5 + H_2O$	1 mark correct equation 1 mark correct balancing	
	c		Advantages: • Uses renewable resources (available crops) • Re-uses organic waste matter • Low amounts of energy needed to drive the reaction Disadvantages • Yeast cells may become inactive, stopping the production of alcohol • Large volumes of raw material needed to yield a relatively small volume of ethanol • A slow process	1 1	Any **ONE** advantage Any **ONE** disadvantage
	d			1 mark for correct structure showing single bonds 1 mark for vacant bonds at the end of both sides of the chain	Incorrect displayed formula of polyethene award 0 marks If no vacant bonds at the end of both sides of the chain deduct 1 mark
			Total:	**10**	
9	a		Heat is given out **OR** The reaction is exothermic	1	
	b		• The position of equilibrium is shifted to the right • The system will try to decrease the pressure by shifting the equilibrium to the side where there is less pressure to minimise the change. • On the right = Less pressure - 2 volumes of gas • On the left = High pressure - 4 volumes of gas (1+3)	1 1 1	
	c		With an increase in temperature: • The reactant particles move quicker due to increased energy. • The particles collide more often and collisions are more successful, resulting in an increase in the rate of reaction.	1 1	
	d		• It increases the rate at which dynamic equilibrium is reached • and so, speeds up the reaction	1 1	
	e		$NH_4^+ (aq) + OH^- (aq) \rightarrow NH_3 (g) + H_2O (l)$	2	1 mark for formulae 1 mark balancing Ignore state symbols
			Total:	**10**	

Question			Suggested answers	Marks	Remarks
10	a		Bauxite	1	
	b	i	Q	1	
	b	ii	It conducts electrical charges due to free moving electrons	1	
	b	iii	Due to high temperatures, the carbon atoms in the graphite electrode react with oxygen released at the anode. These forms oxides of carbon which erode the graphite electrode.	1 1	
	c		• Less fossil fuels are burnt, releasing less carbon dioxide gas in the atmosphere. Carbon dioxide is a greenhouse gas which leads to global warming. • Preserves limited natural resources. No need for mining and extraction, thus conserving raw substances. • Aluminium can be recycled indefinitely for an unlimited number of times. • Recycling aluminium reduces the amount of waste products in landfill sites. This minimizes land pollution and environmental degradation. • Reduces energy consumption • Aluminium extraction plants produce fine cryolite dust which can have a negative impact on the environment. Recycling plants do not produce such pollutants.	2	1 mark for each of any two mentioned points.
			Total:	**7**	
11	a	i	• The bacteria feed on hydrocarbons as source of energy • Bacteria multiply faster in areas rich in oil which consists of a mixture of hydrocarbons	1 1	
	b	i	An organic compound which is made of carbon and hydrogen atoms only.	1	
	b	ii	They separate due to having different boiling points.	1	
	b	iii	G: Refinery Gases H: Diesel Oil	1 1	
	c	i	• Cracking is the process during which long chained hydrocarbons are broken down into smaller and more useful hydrocarbons in the presence of high temperatures. • Fractional distillation is the process during which the mixture of hydrocarbons making up crude oil are boiled and separate into different fractions, depending on their diverse boiling points.	1 1	
	c	ii	$C_{10}H_{22} \rightarrow C_2H_4 + C_8H_{18}$	2	1 mark correct equation 1 mark correct balancing
			Total:	**10**	

Specimen Assessments: Private Candidates Paper MQF 1-2

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE
EXAMINATIONS BOARD

L-Università ta' Malta

SECONDARY EDUCATION CERTIFICATE LEVEL
PRIVATE CANDIDATES SAMPLE PAPER

SUBJECT:	**Chemistry**
PAPER NUMBER:	**Level 1 – 2**
DATE:	
TIME:	2 Hours

Useful data:

Avogadro constant = 6.02×10^{23}

Specific heat capacity of water = 4.2 J g^{-1} $^{o}C^{-1}$

The molar volume for gases = 22.4 dm^3 at STP

STP conditions = 0 ^{o}C and 10^5 Pa/1 atm.

Directions to Candidates

- Write your index number in the space at the top left-hand corner of this page.
- Answer **ALL** questions in the spaces provided in this booklet.
- The mark allocation is indicated at the end of each question. Marks allocated to parts of questions are also indicated in brackets.
- You are reminded of the necessity for orderly presentation in your answers.
- In calculations you are advised to show all the steps in your working, giving your answer at each stage.
- The use of electronic calculators is permitted.
- The following information is printed on the back of this booklet:
    - Periodic Table
    - Reactivity Series
    - Order of discharge at electrodes
    - List of polyatomic ions and their charges
    - Solubility rules

Answer ALL questions.

1) A student tested three solutions (**X**, **Y**, and **Z**) with litmus paper to find out whether they are acidic, alkaline or neutral. The observations are listed in the following table.

Solution	Observation with red litmus paper	Observation with blue litmus paper
X	Remains red	Remains blue
Y	Remains red	Turns red
Z	Turns blue	Remains blue

b) State whether **each** solution is acidic, alkaline or neutral.

i) **X** _____ (1)

ii) **Y** _____ (1)

iii) **Z** _____ (1)

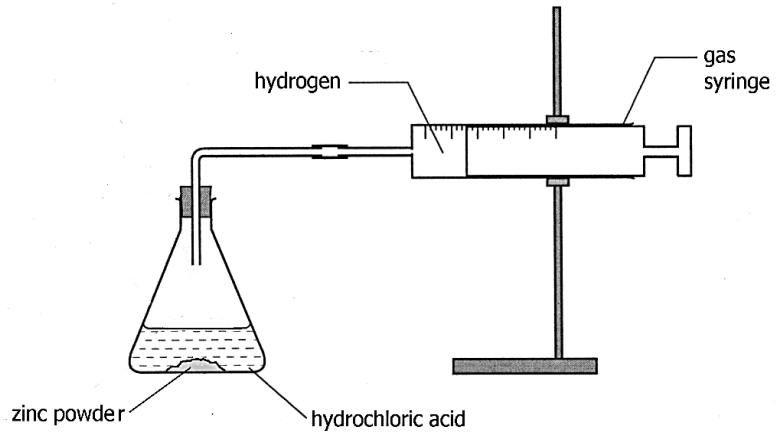
c) The student then tested the solutions using universal indicator. Complete the following table by matching the solution **(X**, **Y** or **Z**) with the appropriate pH.

Solution	pH
	2
	7
	13

(3)

(Total: 6 marks)

2) The following diagram shows the apparatus used to investigate the reaction between zinc and hydrochloric acid.



The reaction occurs as follows:

zinc + hydrochloric acid → zinc chloride + hydrogen

a) Describe a simple test to confirm that the gas produced is in fact hydrogen.

_____

_____ (2)

b) State **TWO** ways by which the reaction can be made to go faster.

i) _____ (1)

ii) _____ (1)

c) Hydrogen may also be collected over water. Draw a labelled diagram of the apparatus set up to prepare and collect hydrogen over water. (7)

d) State **ONE** property of hydrogen. Explain why it is not safe to prepare and collect large volumes of hydrogen because of this property.

Property: _____ (1)

Explanation: _____ (1)

(Total: 13 marks)

3) Two students were investigating endothermic and exothermic reactions. The results are shown in the table below.

	Experiment 1 vinegar + baking soda	**Experiment 2 Hydrochloric acid + magnesium**
Final temperature	13.40 °C	25.05 °C
Initial temperature	18.55 °C	21.12 °C
Temperature change		
Endothermic/exothermic		

a) Find the temperature change in each experiment and write your answer in the table. (2)

b) Use the results to determine whether each reaction is endothermic or exothermic. Write your answer in the table. (2)

(Total: 4 marks)

4) Two students are setting up an experiment using lead(II) bromide and the following apparatus:

crucible, electrodes, connecting wires, wire gauze, tripod,

Bunsen burner, DC power supply and light bulb.

a) Draw a simple labelled diagram of the apparatus that may be set up to show that molten lead(II) bromide is an electrolyte. (6)

b) Give the observations expected if molten lead(II) bromide is an electrolyte.

_____

_____

_____ (3)

c) State what would be observed if a non-electrolyte is tested.

_____

_____ (2)

(Total: 11 marks)

5) Tap water in Malta is hard water. This is due to salts of calcium and magnesium which are dissolved in it.

a) Describe how a soap solution can be used to show the difference between a sample of hard water and a sample of distilled water. Include any observations recorded.

_____

_____ (2)

b) Describe a simple experiment that can be used to show the presence of temporary hardness in tap water. Include any observations recorded.

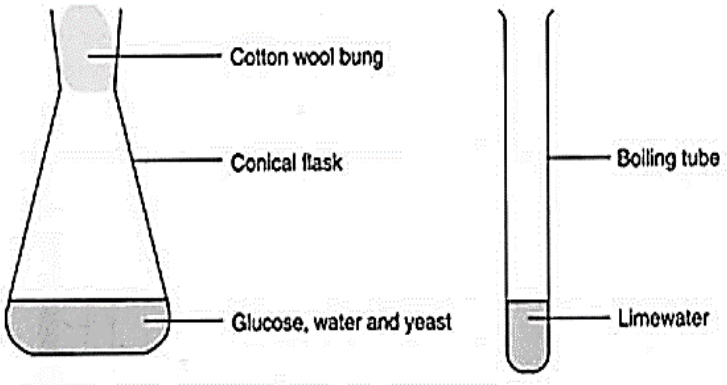
_____

_____ (2)

(Total: 4 marks)

6) A group of students wanted to investigate fermentation. They found the following instructions:

- Put 5 g of glucose in a conical flask and add 50 cm^3 of warm water. Swirl the flask to dissolve the glucose.
- Add 1 g of yeast to the solution and loosely plug the top of the flask with cotton wool.
- Wait while fermentation takes place.
- Remove the cotton wool and pour the invisible gas into the boiling tube containing limewater. Take care not to pour in any liquid as well.



(Royal Society of Chemistry http://www.rsc.org)

a) Explain how the students will know that fermentation is taking place.

_____ (1)

b) Give the name or formula of the gas produced during fermentation.

_____ (1)

c) Describe what will happen to the limewater when the gas is poured into the boiling tube.

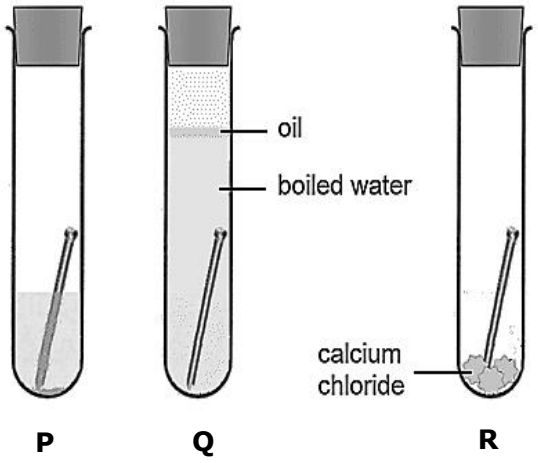
_____ (1)

d) Apart from the gas, fermentation gives another product. Name the product.

_____ (1)

(Total: 4 marks)

7) In an experiment to investigate rusting of iron, two students set up the following experiment using identical iron nails placed in different conditions as shown in the diagram below.



a) The test tubes were left in the laboratory for several days. Only the iron nail in test tube P rusted.

i) Explain why rusting happens in test tube P.

_____

_____ (2)

ii) Explain why the iron nail in test tube Q does not rust.

_____

_____ (3)

iii) Explain why the iron nail in test tube R does not rust.

_____

_____ (3)

b) Use the results of this experiment to explain why an iron door started to rust when the paint was scratched.

_____

_____ (2)

(Total: 10 marks)

8) A group of students are planning an investigation to find the best catalyst to produce oxygen by the decomposition of hydrogen peroxide. The reaction is quite slow at room temperature. The equation for the reaction is:

$$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$$

The following oxides were considered as catalysts:

manganese(IV) oxide (MnO_2)	lead(II) oxide (PbO)
magnesium oxide (MgO)	lead(IV) oxide (PbO_2)

While planning the investigation, the students wrote down notes on pieces of paper. Read what the students wrote and then answer the following questions about this investigation.

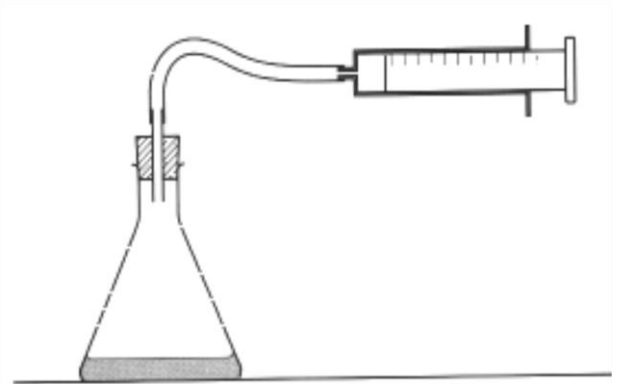
We would like to find out which oxide is the best catalyst.

We think that PbO and PbO_2 are equally good catalysts because they are both oxides of lead.

Method (sentences not in order)

1. Repeat the experiment for each oxide.
2. Place 50 cm^3 of water in the conical flask.
3. Measure the volume of oxygen produced every 15 seconds for 5 minutes.
4. Place 0.1g of manganese(IV) oxide in the water.
5. Add 10cm^3 of hydrogen peroxide and seal the flask quickly.
6. Set up the apparatus.

We will use this apparatus



We will record our results using a table:

Time (s)	Volume of oxygen collected when using:			
	MnO_2	MgO	PbO	PbO_2
0				
15				

a) Choose and write the sentence (from the students' notes) which shows the aim of the investigation.

_____ (1)

b) Choose and write the sentence (from the students' notes) which shows the students' prediction (what they think will happen).

_____ (1)

c) Write the sentences which describe the method in the correct order to show how the students will do the experiment.

_____

_____

_____

_____

_____

_____ (6)

d) Identify the variable that is being investigated in this experiment.

_____ (1)

e) Name **ONE** other variable which should be controlled for the experiment to be fair.

_____ (1)

f) Explain how the results may be used to find the rate of reaction for each experiment.

_____

_____ (2)

g) Explain how the students may use the results to find out which of the four oxides is the best catalyst.

_____

_____ (2)

(Total: 14 marks)

9) Two unknown inorganic compounds labelled **A** and **F** were analysed and the results are given below. You may use the solubility rules to help you answer the questions that follow.

a) Tests on compound **A.**

Test	**Observation**
Appearance	White solid
Flame test	Lilac colour
Prepare a solution of compound **A** in water and add dilute nitric acid and silver nitrate.	A cream precipitate **B** is formed.

i) Give the name or formula of substances **A** and **B**.

- **A** _____ (1)
- **B** _____ (1)

ii) Describe how a flame test is performed.

_____

_____

_____ (3)

b) Tests on compound **F.**

Tests	Observations
Dissolve some solid **F** in water and add sodium hydroxide solution.	A brown precipitate **G** was formed.
Add dilute nitric acid and silver nitrate to the solution of **F**.	A white precipitate **H** is formed. This precipitate immediately darkened in the presence of light.

i) Give the name or formula of substances **F**, **G** and **H**.

- **F** _____ (1)
- **G** _____ (1)
- **H** _____ (1)

ii) Give balanced chemical equations for the reactions occurring:

- between **F** and sodium hydroxide solution;

_____ (3)

- between **F** and silver nitrate solution.

_____ (3)

(Total: 14 marks)

10) This question is about separation techniques used to obtain pure sodium chloride crystals from a sample of salt contaminated with sand.

Devise an experiment to obtain pure sodium chloride crystals from this mixture and present your work in the form of a laboratory report with the following headings:

a) Aim; (1)
b) Labelled diagrams of apparatus setups; (8)
c) Procedure; (7)
d) Conclusion. (3)

(Total: 19 marks)

END OF PAPER

PERIODIC TABLE OF THE ELEMENTS

1	2											3	4	5	6	7	0
							1 **H** Hydrogen 1										4 **He** Helium 2
7 **Li** Lithium 3	9 **Be** Beryllium 4											11 **B** Boron 5	12 **C** Carbon 6	14 **N** Nitrogen 7	16 **O** Oxygen 8	19 **F** Fluorine 9	20 **Ne** Neon 10
23 **Na** Sodium 11	24 **Mg** Magnesium 12											27 **Al** Aluminium 13	28 **Si** Silicon 14	31 **P** Phosphorus 15	32 **S** Sulfur 16	35.5 **Cl** Chlorine 17	40 **Ar** Argon 18
39 **K** Potassium 19	40 **Ca** Calcium 20	45 **Sc** Scandium 21	48 **Ti** Titanium 22	51 **V** Vanadium 23	52 **Cr** Chromium 24	55 **Mn** Manganese 25	56 **Fe** Iron 26	59 **Co** Cobalt 27	59 **Ni** Nickel 28	63.5 **Cu** Copper 29	65 **Zn** Zinc 30	70 **Ga** Gallium 31	73 **Ge** Germanium 32	75 **As** Arsenic 33	79 **Se** Selenium 34	80 **Br** Bromine 35	84 **Kr** Krypton 36
85 **Rb** Rubidium 37	88 **Sr** Strontium 38	89 **Y** Yttrium 39	91 **Zr** Zirconium 40	93 **Nb** Niobium 41	96 **Mo** Molybdenum 42	99 **Tc** Technetium 43	101 **Ru** Ruthenium 44	103 **Rh** Rhodium 45	106 **Pd** Palladium 46	108 **Ag** Silver 47	112 **Cd** Cadmium 48	115 **In** Indium 49	119 **Sn** Tin 50	122 **Sb** Antimony 51	128 **Te** Tellurium 52	127 **I** Iodine 53	131 **Xe** Xenon 54
133 **Cs** Caesium 55	137 **Ba** Barium 56	139 **La** Lanthanum 57	178 **Hf** Hafnium 72	181 **Ta** Tantalum 73	184 **W** Tungsten 74	186 **Re** Rhenium 75	190 **Os** Osmium 76	192 **Ir** Iridium 77	195 **Pt** Platinum 78	197 **Au** Gold 79	201 **Hg** Mercury 80	204 **Tl** Thallium 81	207 **Pb** Lead 82	209 **Bi** Bismuth 83	210 **Po** Polonium 84	210 **At** Astatine 85	222 **Rn** Radon 86

Key:

a
X
y
b

relative atomic mass
SYMBOL
Name
atomic number

Reactivity series	
Decreasing Reactivity ↓	Potassium
	Sodium
	Calcium
	Magnesium
	Aluminium
	Carbon
	Zinc
	Iron
	Lead
	Copper
	Silver
	Gold
	Platinum

Order of discharge at cathode	
Increasing Ease of Discharge ↓	Na^+
	Mg^{2+}
	Al^{3+}
	Zn^{2+}
	Fe^{2+}
	Pb^{2+}
	H^+
	Cu^{2+}
	Ag^+
	Au^{3+}

Order of discharge at anode
1. For aqueous very dilute solutions OH^- is discharged. 2. For aqueous concentrated solutions containing halide ions (Cl^-, Br^- and I^-), these are discharged in preference to OH^-. 3. SO_4^{2-}, NO_3^- and CO_3^{2-} are never discharged from aqueous solutions

List of polyatomic ions and their charges	
Name	**Formula**
Ammonium	NH_4^+
Nitrate	NO_3^-
Sulfate	SO_4^{2-}
Carbonate	CO_3^{2-}
Hydrogencarbonate	HCO_3^-
Hydroxide	OH^-

Solubility Rules	
Soluble	**Insoluble**
• All nitrates • All hydrogencarbonates • All group 1 metal salts • All ammonium salts • Halides except silver and lead halides • Sulfates except barium, calcium, and lead sulfates	• Carbonates except group 1 metal and ammonium carbonate • Metal oxides except group 1 and 2 metal oxides that react with water. • Hydroxides except group 1 metal and ammonium hydroxides

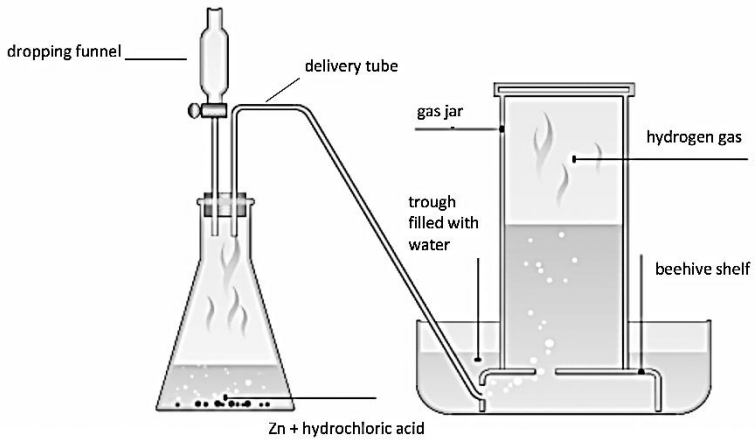
Specimen Assessments: Private Candidates Paper MQF 1-2 Marking Scheme

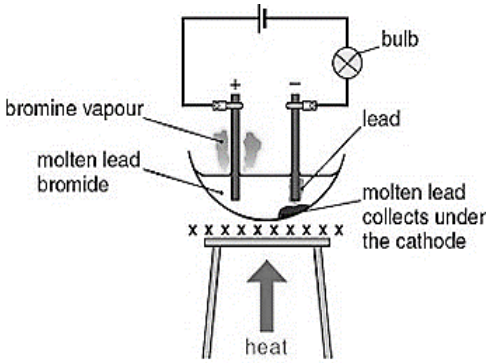
L-Università ta' Malta

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

SECONDARY EDUCATION CERTIFICATE LEVEL
PRIVATE CANDIDATES' SAMPLE PAPER MARKING SCHEME

SUBJECT:	**Chemistry**
PAPER NUMBER:	**Level 1 – 2**
DATE:	
TIME:	2 Hours

Question			Suggested answers	Marks	Additional notes
1	a	i	neutral	1	
	a	ii	acidic	1	
	a	iii	alkaline	1	
	b		Y = pH2 X = pH7 Z = pH13	1 1 1	
			Total:	**6**	
2	a		Place a lighted splint at the top of the test-tube containing a sample of the gas.	1	
			Hydrogen burns with a pop	1	
	b	i	Increase the temperature of the hydrochloric acid	1	
	b	ii	Increase the concentration of the hydrochloric acid	1	
	c			1 1 1 1 1 1 1	1 mark for the general assembly 1 mark for each labelled item (name and diagram)
	d		Hydrogen is light and diffuses fast. Storing hydrogen is unsafe as it escapes very quickly.	1 1	Accept other possible answers
			Total	**13**	

3			<table><tr><th></th><th>Experiment 1 vinegar + baking soda</th><th>Experiment 2 Hydrochloric acid + magnesium</th></tr><tr><td>Temperature change</td><td>-5.15</td><td>3.93</td></tr><tr><td>Endothermic/exothermic</td><td>Endothermic</td><td>Exothermic</td></tr></table>	1 1 1 1	1 mark for temperature change (exp 1) 1 mark for endothermic 1 mark for temperature change (exp 2) 1 mark for exothermic
			Total	**4**	
4	a			1 1 1 1 1 1	1 mark for set up 1 mark for circuit 1 mark for electrodes 1 mark for crucible 1 mark for lead(II) bromide 1 mark for heat source (Bunsen, gauze, tripod)
	b		Bulb lights Reddish vapour around positive electrode Metal deposited around/under the cathode	1 1 1	
	c		No changes around the electrodes. Bulb does not light.	1 1	
			Total	**11**	
5	a		Adding a few drops of soap to equal amounts of water samples and shaking. The distilled water will produce lather while the hard water will produce little or no lather.	1 1	
	b		Place some hard water in a beaker and heat allowing the water to boil. Scale will form on the beaker.	1 1	
			Total	**4**	
6	a		Students will observe bubbles of gas formed.	1	
	b		Carbon dioxide or CO_2.	1	
	c		Limewater turns cloudy.	1	
	d		Ethanol	1	Accept also alcohol
			Total	**4**	
7	a	i	Test-tube A contains air and water.	1 1	
	a	ii	Test-tube B: boiling the water expels the air The oil ensures that no air enters the water The nail does not rust in the absence of air.	1 1 1	
	a	iii	Test-tube C: calcium chloride dries the air inside test-tube C The nail is surrounded by dry air (no moisture) The nail does not dry in the absence of water	1 1 1	
	b		When paint is scratched, the iron comes into contact with air and water Hence it rusts.	1 1	
			Total	**11**	

8	a		*We would like to find out which oxide is the best catalyst.*	1	
	b		*We think that PbO and PbO_2 are equally good catalysts because they are both oxides of lead*	1	
	c		Place 50 cm^3 of water in the conical flask. Place 0.1g of manganese(IV) oxide in the water. Set up the apparatus Add 10cm^3 of hydrogen peroxide and seal the flask quickly. Measure the volume of oxygen produced every 15 seconds for 5 minutes Repeat the experiment for each oxide. Accept also: Set up the apparatus Place 50 cm^3 of water in the conical flask. Place 0.1g of manganese(IV) oxide in the water. Add 10cm^3 of hydrogen peroxide and seal the flask quickly. Measure the volume of oxygen produced every 15 seconds for 5 minutes Repeat the experiment for each oxide.	1 1 1 1 1 1	1 mark each
	d		*Rate of formation of oxygen or amount of oxygen produced in 5 minutes*	1	
	e		*Amount of hydrogen peroxide used.*	1	
	f		Plot a graph of volume of oxygen against time	1 1	
	g		Compare the graphs obtained The best catalyst is the one where the reaction was over in the shortest time/ produces a large volume of oxygen in the shortest time	1 1	
			Total	**14**	
9	a	i	A = Potassium bromide B = Silver bromide	1 1	
	a	ii	dip a clean wire loop into concentrated sulfuric acid and then into a solid sample of the compound being tested put the loop into the edge of the blue flame from a Bunsen burner observe and record the flame colour produced	1 1 1	
	b	i	F = iron(III) chloride G = iron (III) hydroxide H = silver chloride	1 1 1	Accept name and formula
	b	ii.	$FeCl_3(aq) + 3NaOH(aq) \rightarrow Fe(OH)_3(s) + 3NaCl(aq)$ $FeCl_3(aq) + 3AgNO_3(aq) \rightarrow Fe(NO_3)_3(aq) + 3AgCl(s)$	1 1 1 1 1 1	1 mark for chemical formulae. 1 mark for balancing. 1 mark for state symbols.
			Total	**14**	

10	a		To obtain pure sodium chloride from a mixture of salt and sand.	1	
	b		Solution – mixture, water, beaker and stirrer Filtration – funnel, filter paper, beaker with filtrate, beaker with mixture to be filtered Crystallisation – Bunsen burner, tripod, gauze, evaporating basin with solution Set-up of crystallisation apparatus	1 1 1 1 1 1 1 1	
	c		Procedure: **1.** Pour the sand-salt mixture into a beaker. **2.** Add water. **3.** Stir the mixture gently for a few minutes. **4.** Filter the mixture into a beaker/conical flask. **5.** Pour the filtrate into an evaporating basin. **6.** Heat the salt solution gently until it crystals start to form. **7.** Turn off the Bunsen burner and let the salt form by evaporation.	1 1 1 1 1 1 1	
	d		Salt is soluble in water while sand is not. They can be separated by first forming a solution, filtering to remove the insoluble sand and then evaporating the water to obtain salt crystals from solution.	1 1 1	
			Total	**19**	

Specimen Assessments: Private Candidates Paper MQF 2-3

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

L-Università ta' Malta

SECONDARY EDUCATION CERTIFICATE LEVEL
PRIVATE CANDIDATES SAMPLE PAPER

SUBJECT:	**Chemistry**
PAPER NUMBER:	Level 2-3
DATE:	
TIME:	2 hours

Useful data:

Avogadro constant = 6.02×10^{23}

Specific heat capacity of water = 4.2 J g^{-1} $^{o}C^{-1}$

The molar volume for gases = 22.4 dm^3 at STP

STP conditions = 0 ^{o}C and 10^5 Pa/1 atm.

Directions to Candidates

- Write your index number in the space at the top left-hand corner of this page.
- Answer **ALL** questions in the spaces provided in this booklet.
- The mark allocation is indicated at the end of each question. Marks allocated to parts of questions are also indicated in brackets.
- You are reminded of the necessity for orderly presentation in your answers.
- In calculations, you are advised to show all the steps in your working, giving your answer at each stage.
- The use of electronic calculators is permitted.
- The following information is printed on the back of this booklet:
    - Periodic Table
    - Reactivity Series

Answer ALL questions.

1) A chemical test to confirm the presence of iodide ions in solution is the addition of lead(II) nitrate solution to the test solution. If iodide ions are present, a canary yellow precipitate forms.

a) Write the formula of the anion present in lead(II) nitrate solution.

_____ (1)

b) Write a balanced net ionic equation for the reaction between lead(II) and iodide ions.

_____ (2)

c) Another test to distinguish between the halide ions is done through the addition of acidified silver nitrate solution. Describe what you would observe if acidified silver nitrate is added to a solution of:

i. chloride ions;

_____ (1)

ii. bromide ions;

_____ (1)

iii. iodide ions.

_____ (1)

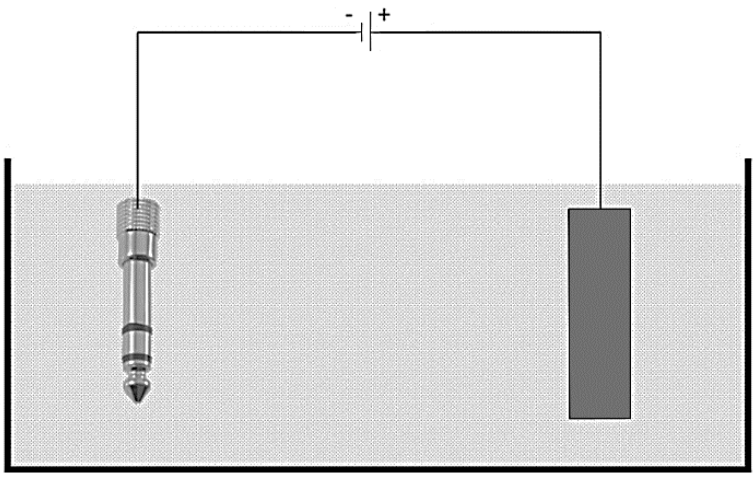
(Total: 6 marks)

2) Silver electroplating is a technique which was invented in the 19th century to apply a thin layer of silver to metal objects. This makes the metal look shinier and prevents corrosion. Nowadays, silver electroplating is most important in the electronics industry.

a) Silver electroplating is achieved using active electrodes. Explain what is meant by the term active in this context.

_____ (1)

b) The diagram below shows a simple setup for silver electroplating. Label the cathode and the anode. (2)



c) Write the ionic half equation happening at the anode.

_____ (1)

d) State what you would expect to observe at the anode.

_____ (1)

e) Write the ionic half equation for the reaction happening at the cathode.

_____ (1)

f) What would you expect to observe at the cathode?

_____ (1)

(Total: 7 marks)

3) Tin is a metal which has been known since antiquity. It is used in soldering, tin plating, and in the production of alloys such as bronze. Tin is found in nature as tin oxide (SnO_2). Its ore is called Cassiterite. The reactivity of tin is similar to that of iron.

a) Predict whether tin is extracted industrially by using reduction with carbon or electrolysis.

_____ (1)

b) Predict whether a displacement reaction will happen between tin metal and zinc ions in solution.

_____ (1)

c) Suggest whether tin corrodes more or less easily than lead.

_____ (1)

d) Cassiterite is obtained from open-pit mines. Name **TWO** environmental concerns involving the mining of this metal ore.

_____

_____ (2)

e) Name **ONE** possible method of reducing the negative environmental impact of the extraction of tin. Give a reason for your answer.

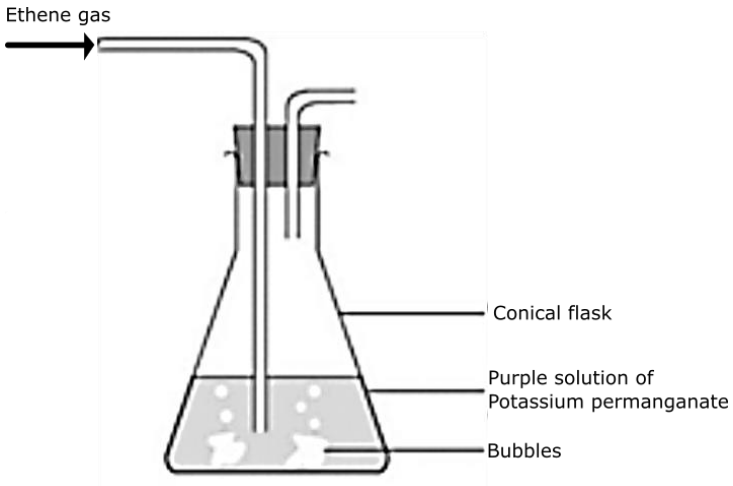
Method: _____ (1)

Reason: _____

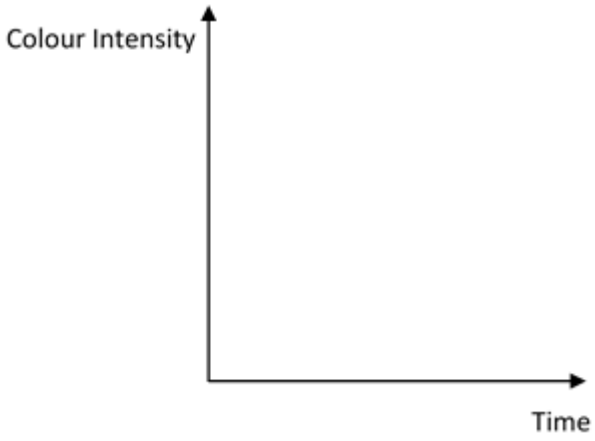
_____ (1)

(Total: 7 marks)

4) Potassium permanganate (a dark purple solution) reacts with ethene (a colourless gas) to form products which are all colourless. For the reaction to happen, a flow of ethene gas is bubbled through a solution of potassium permanganate, as shown below.



a) Sketch how the intensity of the purple colour of the potassium permanganate solution will change over time as ethene is bubbled through it. Use the axis below. (2)



b) Would you expect the reaction to happen faster or slower if the potassium permanganate solution is heated slightly? Explain why.

_____

_____ (2)

c) Would you expect the reaction to happen faster or slower when ethene is bubbled into the solution through a special nozzle which forces the ethene gas to form very small bubbles, rather than through a regular tube? Explain why.

_____

_____ (2)

d) Name the apparatus required to measure rate of this reaction.

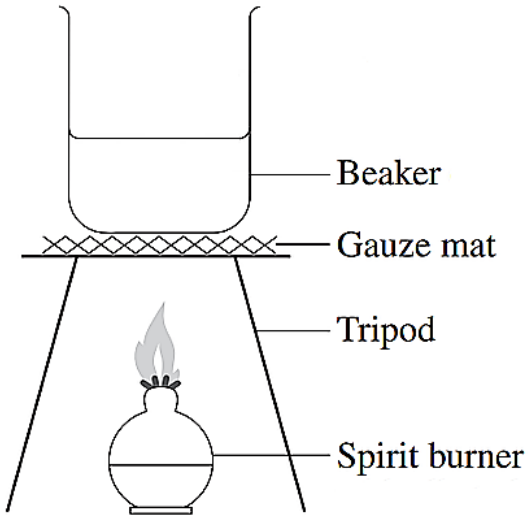
_____ (1)

e) Besides the temperature and the size of the bubbles of ethene, name **ONE** other variable which needs to be kept constant in order to measure the rate of the reaction in a fair manner.

_____ (1)

(Total: 8 marks)

5) EPA is liquid biofuel made from algae which is being used nowadays as an alternative to traditional petrol and diesel. You have been asked to determine the heat of combustion ($\Delta H_{combustion}$) for this chemical using the apparatus shown below.



a) Label clearly on the diagram above where the EPA should be placed in order to conduct the experiment. (1)

b) Suggest **TWO** improvements to the setup shown above.

_____

_____ (2)

c) Draw an energy level diagram for the combustion reaction in the space below. (2)

d) How will the calculated value for $\Delta H_{combustion}$ of EPA change if a larger mass of water is used?

_____ (1)

(Total: 6 marks)

6) This question is about the gases Ar, Cl_2 and CO_2.

a) Name **ONE** gas from the list above which is monoatomic. Give a reason for your answer.

i. Name: _____ (1)

ii. Reason: _____ (1)

b) One mole of CO_2 molecules and one mole of Cl_2 molecules both occupy 22.4 dm^3 at STP conditions. However, the density of Cl_2 gas is higher than that of CO_2 gas. Give a reason for this observation.

_____ (1)

c) Name two chemicals which, when reacted together at room temperature, safely produce CO_2.

_____ (1)

d) In the space below, draw a labelled diagram of the setup required for collecting CO_2 over water. Make sure to indicate where the CO_2 being collected enters the apparatus. (2)

e) Describe a test to determine whether the gas collected is actually CO_2. Include the expected result.

_____

_____ (2)

(Total: 8 marks)

7) Two students in a lab have obtained a solution of hydrochloric acid, however they do not know its concentration. They start performing a titration in order to find the concentration of the hydrochloric acid solution using sodium carbonate, Na_2CO_3.

a) Make a list of the steps which are required to prepare 250 cm^3 of a 0.5 mol dm^{-3} solution of Na_2CO_3 in distilled water. The first step has been done for you.

i. Measure 13.25 g of Na_2CO_3 accurately using a weighing boat.

ii. _____

_____

iii. _____

_____

iv. _____

_____

v. _____

_____ (4)

b) The students then transfer 25 cm^3 of the prepared Na_2CO_3 solution into a conical flask. Name the apparatus which they should use to measure 25 cm^3 of the solution accurately.

_____ (1)

c) Calculate the number of moles of Na_2CO_3 in the conical flask.

_____ (1)

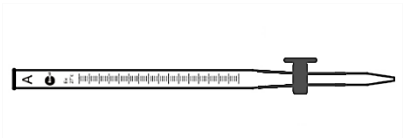
d) Write a balanced chemical equation for the reaction of hydrochloric acid and sodium carbonate solution.

_____ (2)

e) State what should be added to the conical flask in order to be able to see the end-point of the titration.

_____ (1)

f) Name the apparatus shown in the diagram.



_____ (1)

g) Before starting the titration, the students observe the liquid level of hydrochloric acid in the glassware above as follows:

Write the correct reading which the students should note in their lab book:

_____ cm^3 (1)

h) The end-point of the titration was 47.2 cm^3. Calculate the titre value for this titration.

_____ (1)

i) Calculate the concentration of the hydrochloric acid solution.

_____

_____

_____

_____

_____ (3)

j) State why the students should have done the experiment more than once.

_____ (1)

k) Name **ONE** other experimental precaution which the students should have taken.

_____ (1)

(Total: 17 marks)

8) This question is about water hardness, an issue common in the Maltese Islands due to the rocks which they are made of.

a) Plan an experiment to determine the presence of hardness in a sample of water. Make sure to include in your plan:

i. A list of the chemicals which you would need.

_____

_____ (2)

ii. A list of the apparatus which you would use.

_____

_____ (2)

iii. The method which you would use.

_____

_____

_____ (2)

b) What is the observable difference between permanent and temporary water hardness?

_____

_____ (2)

c) Name **ONE** way of removing permanent water hardness from water.

_____ (1)

(Total: 9 marks)

9) You are working in a lab and have been tasked with preparing a pure dry sample of calcium sulfate, starting from a pure dry sample of calcium nitrate.

a) Name any other chemical/s which you will need.

_____ (1)

b) Make a list of the steps which you would follow in order to prepare the requested salt.

_____

_____

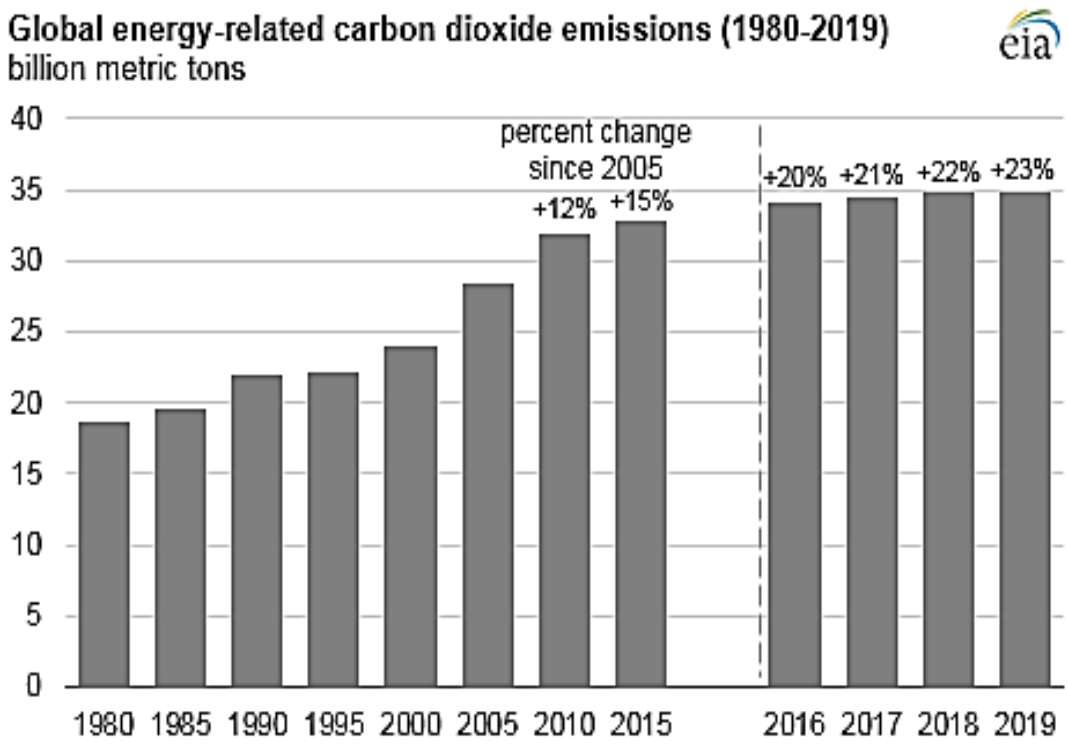
_____

_____

_____ (4)

(Total: 5 marks)

10) The graph below shows global energy-related carbon dioxide emissions between 1980 - 2015.



From: https://www.eia.gov/todayinenergy/detail.php?id=34872

a) What is the most important piece of information that this graph is expressing?

_____ (1)

b) Name the independent variable in the graph.

_____ (1)

c) The amount of CO_2 in the air can be measured using a sensor attached to a mobile phone or laptop. You have been asked to measure the amount of CO_2 in the air every month for one year. Name **TWO** variables which you should keep constant when making these measurements.

_____

_____ (2)

d) Human activity since the Industrial Revolution has been linked to global warming. Discuss this statement in detail. Make sure to include in your explanation:
   - what global warming is;
   - how CO_2 causes global warming;
   - how human activity is related to global warming.

_____

_____

_____

_____

_____ (5)

e) Discuss at least **TWO** methods of reducing the amount of CO_2 being emitted into the atmosphere each year. Make sure to explain how the methods which you propose will reduce emissions.

_____

_____

_____

_____

_____

_____

_____ (6)

(Total: 15 marks)

11) Sulfur burns easily in air, forming sulfur dioxide as the main product.

a) Describe a simple experiment which can be used to verify that sulfur dioxide (SO_2) is an acidic gas. Include any important observations expected.

_____

_____

_____ (2)

b) Name **ONE** important safety precaution to be followed when performing this experiment. Give a reason for your answer.

_____

_____ (2)

c) Name **ONE** important experimental precaution to ensure that the results are correct. Give a reason for your answer.

_____

_____ (2)

d) SO_2 is a pollutant responsible for acid rain. Which industrial human activity releases the most SO_2 into the air?

_____ (1)

e) Natural sources of large quantities of SO_2 also exist. Name **ONE** such natural source.

_____ (1)

f) Discuss the effects of acid rain. Mention at least **THREE** points.

_____

_____

_____ (3)

g) Describe **ONE** way of reducing human-generated SO_2 emissions.

_____ (1)

(Total: 12 marks)

END OF PAPER

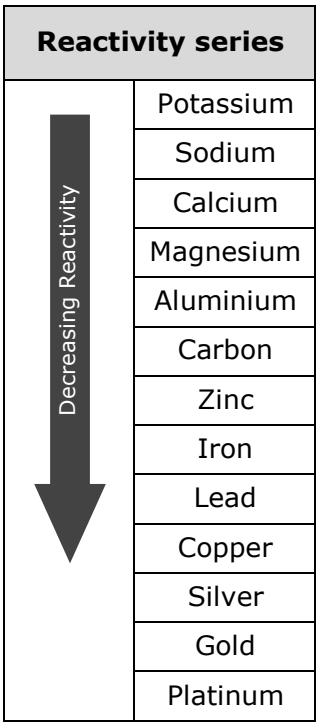
PERIODIC TABLE OF THE ELEMENTS

1	2											3	4	5	6	7	0
							1 **H** Hydrogen 1										4 **He** Helium 2
7 **Li** Lithium 3	9 **Be** Beryllium 4											11 **B** Boron 5	12 **C** Carbon 6	14 **N** Nitrogen 7	16 **O** Oxygen 8	19 **F** Fluorine 9	20 **Ne** Neon 10
23 **Na** Sodium 11	24 **Mg** Magnesium 12											27 **Al** Aluminium 13	28 **Si** Silicon 14	31 **P** Phosphorus 15	32 **S** Sulfur 16	35.5 **Cl** Chlorine 17	40 **Ar** Argon 18
39 **K** Potassium 19	40 **Ca** Calcium 20	45 **Sc** Scandium 21	48 **Ti** Titanium 22	51 **V** Vanadium 23	52 **Cr** Chromium 24	55 **Mn** Manganese 25	56 **Fe** Iron 26	59 **Co** Cobalt 27	59 **Ni** Nickel 28	63.5 **Cu** Copper 29	65 **Zn** Zinc 30	70 **Ga** Gallium 31	73 **Ge** Germanium 32	75 **As** Arsenic 33	79 **Se** Selenium 34	80 **Br** Bromine 35	84 **Kr** Krypton 36
85 **Rb** Rubidium 37	88 **Sr** Strontium 38	89 **Y** Yttrium 39	91 **Zr** Zirconium 40	93 **Nb** Niobium 41	96 **Mo** Molybdenum 42	99 **Tc** Technetium 43	101 **Ru** Ruthenium 44	103 **Rh** Rhodium 45	106 **Pd** Palladium 46	108 **Ag** Silver 47	112 **Cd** Cadmium 48	115 **In** Indium 49	119 **Sn** Tin 50	122 **Sb** Antimony 51	128 **Te** Tellurium 52	127 **I** Iodine 53	131 **Xe** Xenon 54
133 **Cs** Caesium 55	137 **Ba** Barium 56	139 **La** Lanthanum 57	178 **Hf** Hafnium 72	181 **Ta** Tantalum 73	184 **W** Tungsten 74	186 **Re** Rhenium 75	190 **Os** Osmium 76	192 **Ir** Iridium 77	195 **Pt** Platinum 78	197 **Au** Gold 79	201 **Hg** Mercury 80	204 **Tl** Thallium 81	207 **Pb** Lead 82	209 **Bi** Bismuth 83	210 **Po** Polonium 84	210 **At** Astatine 85	222 **Rn** Radon 86

Key:

a
X
y
b

relative atomic mass
SYMBOL
Name
atomic number


Reactivity series
Decreasing Reactivity
Potassium
Sodium
Calcium
Magnesium
Aluminium
Carbon
Zinc
Iron
Lead
Copper
Silver
Gold
Platinum

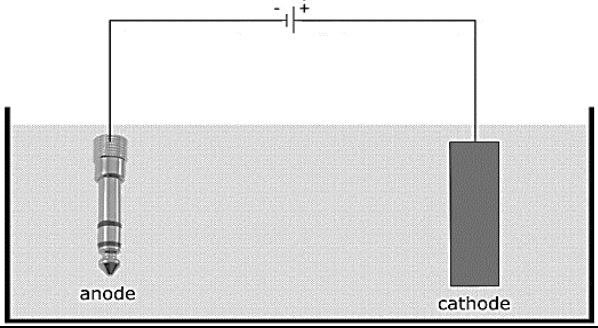
Specimen Assessments: Private Candidates Paper MQF 2-3 Marking Scheme

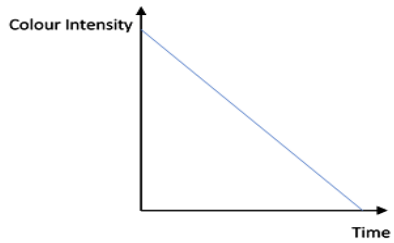
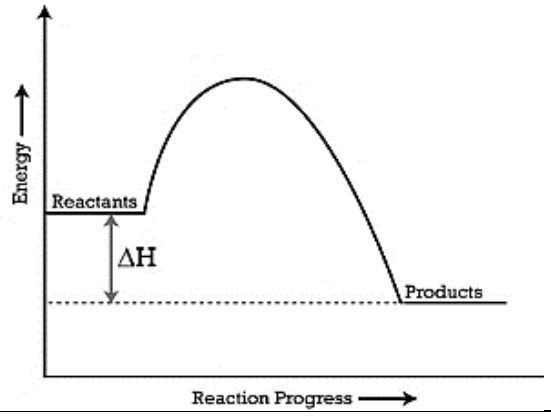
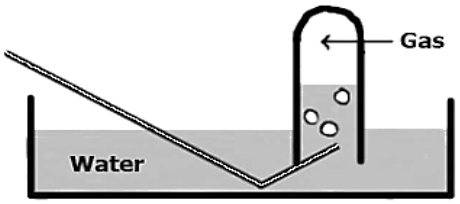
MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

L-Università ta' Malta

SECONDARY EDUCATION CERTIFICATE LEVEL
PRIVATE CANDIDATES SAMPLE PAPER

SUBJECT:	**Chemistry**
PAPER NUMBER:	Level 2-3
DATE:	
TIME:	2 hours

Question			Suggested answers	Marks	Additional notes
1	a		NO_3^-	1	
	b		$Pb^{2+} + 2I^- \rightarrow PbI_2$	2	1 mark for correct equation 1 mark for balancing
	c	i	white precipitate	1	
	c	ii	cream precipitate	1	
	c	iii	pale yellow precipitate	1	
			Total:	**6**	
2	a		Electrodes which take part in the reaction.	1	
	b			2	
	c		$Ag \rightarrow Ag^+ + e^-$	1	
	d		The anode slowly dissolves	1	
	e		$Ag^+ + e^- \rightarrow Ag$	1	
	f		The cathode becomes coated with a layer of silver.	1	
			Total:	**7**	
3	a		Reduction with Carbon	1	
	b		No	1	
	c		More easily	1	
	d		Damage to the physical habitat due to rock removal. Damage to aquatic habitats due to water run-off.	2	Other answers acceptable.
	e		Recycling of Tin. This reduces the quantity extracted from the Earth	2	1 1
			Total:	**7**	

4	a			2	Non-linear also acceptable (ex: exponential (first-order) decay) 1 mark for starting at a high colour intensity 1 mark for ending the line on the x-axis
	b		Faster. The particles would move more quickly and increase the chance of successful collisions.	1 1	
	c		Faster The gas would have a higher surface area. There would be an increased chance of collisions.	1 1	
	d		Stopwatch	1	Colorimeter also acceptable.
	e		Concentration of the permanganate solution. **OR** Pressure of the ethene in the pipe.	1	
			Total:	**8**	
5	a		EPA labelled in the spirit burner.	1	
	b		Using a Lid Using a calorimeter instead of a beaker Moving the flame of the spirit burner to touch the calorimeter Reflectors placed on the side Adding a thermometer	2	Any two. Other answers acceptable.
	c			2	1 mark for drawing reactant above products. 1 mark for correct labelling of axes, reactants and products in this order
	d		The value will not change.	1	
			Total:	**6**	
6	a	i	Argon	1	
	a	ii	Each atom is not bonded to another atom	1	
	b		The RMM of Cl_2 is higher than that of CO_2	1	
	c		Any two reactants. Eg: Na_2CO_3 and HCl	1	Only award mark if both reactants are correct.
	d			2 (1 mark for drawing and 1 mark for labelling)	One mark for correct drawing. One mark for indicating entry point. (end of pipe) Diagram of gas collected in a gas jar placed on a beehive shelf also acceptable.
	e		Bubble the gas through lime water Lime water turns milky if CO_2 is present	2	
			Total:	**8**	

7	a	ii	Transfer the solid completely into a volumetric flask. **OR** to a beaker and dissolve solid in water and transfer this solution to the volumetric flask.	1	
	a	iii	Rinse the weighing boat and add the washings to the contents of the flask. **OR** rinse the beaker and add the washing to the volumetric flask	1	
	a	iv	Fill the volumetric flask roughly to the ¾ mark with distilled water and make sure that all the solid has dissolved by closing the flask and shaking vigorously.	1	
	a	v	Allow the solution to settle, then bring the solution up to the mark with distilled water.	1	
	b		Volumetric Pipette	1	Do not accept pipette.
	c		0.0125 mol	1	
	d		$2HCl + Na_2CO_3 \rightarrow 2NaCl + H_2O + CO_2$	2	1 for balancing 1 for correct chemical formulae
	e		An acid-base indicator	1	Accept correct examples of indicators.
	f		Burette	1	
	g		0.7	1	Note that units are given.
	h		46.5 cm^3	1	
	i		moles of HCl reacted = 0.0125 mol x 2 = 0.0250 mol concentration of HCl = (0.0250/46.5) x 1000 = 0.538 mol/dm^3	3	1 mark for moles of HCl reacted (no marks awarded if this part is missing) 1 mark for final concentration 1 mark for correct use of units throughout
	j		To obtain multiple concordant results and improve validity.	1	
	k		Taking readings at eye level. **OR** Checking for and removing any air bubbles. **OR** Rinsing the volumetric pipette with the solution being measured. **OR** Rinsing the burette with the solution being measured.	1	Other answers acceptable Do not accept: • taking multiple readings • washing the beaker/weighing boat
			Total:	**17**	
8	a	i	Correct answers depend on the method which the student chose. (eg: titration with soap or salting out and measuring the mass of ppt. collected.)	2	2 marks for correct chemicals depending on the method used.
	a	ii		2	2 mark for correct (and comprehensive) list of apparatus.
	a	iii		2	2 marks for a description of the method to be used.
	b		A precipitate forms (formation of scale) when the water is heated if temporary hardness is present.	2	
	c		Any method named correctly (e.g.: ion exchange resin)	1	
			Total:	**9**	

9	a		H_2SO_4	1	
	b		1. The calcium nitrate is dissolved in water. 2. A small quantity of H_2SO_4 is added. * 3. The precipitate is filtered off. 4. The precipitate is washed with distilled water and allowed to dry dried to constant weight.	1 1 1 1	* (No marks given if "small quantity" is not written)
			Total:	**5**	
10	a		CO_2 emissions have been increasing since 1980.	1	Similar answers acceptable.
	b		Time	1	
	c		Any two variables which might influence. Ex: Time of day, Location.	2	1 mark each
	d		Discussion should include how: 1. CO_2 is generated when burning fuels to run engines and machines. 2. CO_2 accumulates in the air and has been increasing over the past years. 3. CO_2 is a greenhouse gas which traps heat from the sun by stopping low energy infra-red waves from escaping from the atmosphere.	1 2 2	
	e		Any two methods named and discussed. Examples: 1. The use of renewable sources of energy such as solar panels. These do not generate (generate much less) CO_2 since they trap energy from the sun, rather than release it from fuels. 2. Using more efficient vehicles/power stations/etc. If more useful energy is gained for every molecule of CO_2 released, then less emissions needs to be created to perform the same amount of work.	6	1 mark each for naming the methods. 2 marks each for correct explanations.
			Total:	**15**	
11	a		Passing the gas through water containing an indicator or over a moist indicator strip. Observation: Colour change in indicator (ex: damp blue litmus paper turns red)	2	Award only 1 mark if the word "damp" or "moist" (or equivalent) is not included.
	b		Performing the experiment in a fume hood. Sulfur dioxide is toxic.	2	Other answers acceptable.
	c		Using a control. (ex: passing air over/through the indicator before passing SO_2) To check that the colour change is really due to the presence of sulfur dioxide.	2	Other answers acceptable.
	d		Burning of sulfur-rich fossil fuels	1	
	e		Volcanic activity	1	
	f		Reduces the pH in freshwater bodies, harming the aquatic life within it. Reduces the pH of soil, affecting plants. Causes damage to limestone rocks and buildings.	3	Other answers acceptable. 1 mark per point.
	g		Desulfurization of flue gases	1	Other answers acceptable.
			Total:	**12**	