For exams January, May and November onwards
For teaching from September 2021 onwards

SPECIFICATION

Learning Resource Network

LRN INTERNATIONAL GCSE
CHEMISTRY (6211)

Contents

BACKGROUND TO LRN

Learning Resource Network (LRN) is a recognised Awarding Organisation that offers a range of qualifications to candidates, educational institutes, training providers, schools and employers.

LRN is recognised for its high quality qualifications that enable candidates to progress to other areas of study and employment in their designated fields.

In producing its qualifications, LRN uses the experience and expertise of academics, professionals working in the pertinent industries and assessment practitioners with a wealth of best practice and knowledge of validation, verification, delivery and assessment.

ACCOLADES

Queen's Award

In April 2020, LRN received the Queen's Award for Enterprise for International Trade. LRN is one of 220 organisations in the UK to be recognised with this prestigious accolade. This was in recognition of the expansion LRN brought to the overseas qualification market.

MANAGEMENT SYSTEMS

LRN has been awarded international accreditation as part of its quality controls, policies, systems and overall approach to its management systems. These awards are externally validated by the British Assessment Bureau. LRN has achieved accreditation in the form of ISO 9001: Quality Management Systems, ISO 14001: Environment Management Systems and ISO 27001: Information Security Management Systems.

CUSTOMER SERVICE EXCELLENCE

LRN has achieved the prestigious award of Customer Service Excellence. This is in recognition of its customer service practices, approach to managing and dealing with UK and Overseas customer needs, including the diverse needs of its centres.

LRN was the first UK Awarding Organisation to achieve Customer Service Excellence.
Following reaccreditation in 2019, LRN received an award for Customer Service Excellence: Compliance Plus, demonstrating that LRN went above and beyond the delivery of its customer service principles.

INTRODUCTION

This specification provides an overview to the LRN International GCSE Chemistry[1]. This document is suitable for various users, including candidates, centres, administrators, employers, parents/guardians, teachers (and other related staff) and examiners. The specification outlines the key features and administrative procedures required for this international qualification.

OBJECTIVE

The LRN International GCSE Chemistry is designed to enable international candidates to demonstrate their ability, to work scientifically in both practical and theoretical terms across chemical elements, chemical properties, changes which occur in properties when chemicals are added, reactions, bonding and the periodic table.

MODE OF DELIVERY

This qualification has been constructed to be delivered within centres. Centres will need to demonstrate to LRN, through the centre recognition processes, that they have the resources, facilities and competence to deliver. However, centres must be able to demonstrate, in line with LRN's criteria, that they have the means, capability, capacity and resources (including suitably qualified centre staff) to deliver by the method chosen by the centre.

PROGRESSION

The LRN International GCSE Chemistry has been designed to reflect the wide variation in candidates' origins, levels of education and career aims. Progression opportunities may, therefore, take a variety of paths. Depending on the level of qualification achieved, it may be appropriate for the candidate to progress to:

1. Similar level 2 qualification in chemistry;
2. LRN Level 2 Certificate or Diploma in Pre A Foundation Studies;
3. LRN Level 3 Diploma in Pre A Foundation Studies;
4. A higher level of any qualification – e.g. A-Level, Diploma
5. Vocationally Related Qualifications

[1] LRN International GCSEs are globally recognised qualifications designed specifically for international candidates and are available outside the United Kingdom. Candidates based in England refer to the Ofqual register.

QUALIFICATION OVERVIEW

Number	Subject Content	AO	Exam
1	States of matter and methods of separation	1, 2 and 3	Combination of written exam papers (externally set and marked) and a practical demonstration of skills. **Paper 1:** Multiple Choice, Extended Theory and practical based skills. Duration: 2 hours **Paper 2:** Multiple Choice, Extended Theory and practical based skills. Duration: 2 hours
2	Atoms and the periodic table	1, 2 and 3	
3	Chemical bonding	1, 2 and 3	
4	Quantitative chemistry	1, 2 and 3	
5	Chemical changes	1, 2 and 3	
6	Reversible reactions and rate of reactions	1, 2 and 3	
7	Organic chemistry	1, 2 and 3	
8	Air and water chemistry	1, 2 and 3	

BREAKDOWN OF ASSESSMENT OBJECTIVES

AO1 - demonstrate knowledge and understanding of:

- scientific ideas
- scientific techniques and procedures

AO2 – apply knowledge and understanding of:

- scientific ideas
- scientific enquiry, techniques and procedures l

AO3 – analyse information and ideas to:

- interpret and evaluate
- make judgements and draw conclusions
- develop and improve experimental procedures

ASSESSMENT

The assessment for this qualification consists of (i) written exam papers, and (ii) practical demonstration of skills, set and marked by the LRN.

Assessment objectives (AOs)	Weighting	
	Paper 1	Paper 2
AO1	30%	30%
AO2	40%	40%
AO3	30%	30%

GUIDED LEARNING HOURS

The guided learning hours (GLH) for this qualification are 130. Please note the hours stated are indicative.

ENTRIES CODES

One entry per qualification is sufficient and will cover all the question papers including certification.

PRIVATE CANDIDATES

Centres are advised that private candidates are only to be enrolled with prior agreement and confirmation from LRN.

GRADING

Results are reported, as 9 to 1.

RESULTS

Exam series are in:

- January (results released in March)
- June (results released in August)
- November (results released in January)

RE-TAKES

Whereas candidates can re-take the whole qualification as often as they wish, individual components cannot be re-taken as it is a traditional linear specification.

Please remember, one entry per qualification is sufficient and will cover all the question papers including certification.

CUSTOMER SERVICE STATEMENT

Learning Resource Network (LRN) is committed to ensuring all customers are dealt with promptly and in a professional and helpful manner. In order to guarantee this, we commit to ensuring the following in our day to day interactions with candidates, assessment centres and our stakeholder network:

- All customers will be treated equally and with respect;
- All customer information will only be used in a way which has been agreed in advance, unless we are informed of something that places them or others at risk of harm;
- All customers will be treated by staff in a professional manner.

LRN has arrangements in place to provide a telephone and e-mail helpdesk which will be staffed from 09:00 to 17:00 from Monday to Friday. Furthermore, it will respond to each e-mail, letter or telephone message it receives regarding feedback on its qualifications, centre approvals process or other matters relating to its products and/or services. The timetable for responding is as follows:

- E-mail: 5 working days
- Letter: 5 working days
- Telephone message: 5 working days

DIVERSITY AND EQUALITY

Learning Resource Network (LRN) is committed to ensuring fair and equal access to its qualifications, examinations and support materials. Our Diversity and Equality policy seeks to eliminate unjustifiable discrimination, harassment and/or victimisation and to advance equality of opportunity, thereby ensuring all candidates are treated fairly, in accordance with the protected characteristics of the Equality Act 2010. Specifically, we comply fully with the requirements laid out in the Equality Act 2010. In addition, and within the constraints of this policy, LRN will have due regard for the General data Protection Regulations (GDPR) in the retention of information which is unnecessary.

1	**States of matter and methods of separation**

Aim

The aim of this subject content is to improve understanding of states of matter and methods of separation.

Learning Outcomes - The learner will:		**Assessment Criteria - The learner can:**	
1	Understand states of matter.	1.1	**Describe** solids, liquids, and gases in terms of particle arrangement proximity and motion.
		1.2	**Explain** differences of solids, liquids, and gases in terms of (i) volume, (ii) ability to flow, (iii) ability to be compressed, and (iv) relative kinetic energy of particles.
		1.3	**Describe** the physical changes of state of substances as a result in temperature change.
		1.4	**Explain** the kinetic particle model.
		1.5	**Describe** the principle of Brownian motion.
		1.6	**List** examples of Brownian motion.
		1.7	**Define** diffusion.
		1.8	**Explain** factors that influence diffusion.
		1.9	**Outline** why diffusion is unable to occur within solids.
		1.10	**Describe** the pressure and temperature of gases in terms of motion of particles
		1.11	**Carry out** practicals involving investigation of rates of diffusion. 1.Temperature and diffusion e.g., soluble solid added to hot and cold water and record observations and explain results. 2.Molecular mass and rate of diffusion e.g., hydrogen chloride gas and ammonia

			and observed result of principates location and explain results. 3. Demonstrations of Brownian motion.
2	Understand methods of purification.	2.1	**List** apparatus for the measurement of time, temperature, mass, and volume.
		2.2	**Explain** the processes carried out during paper chromatography.
		2.3	**Outline** how chromatography techniques can be applied to colourless substances using locating agents.
		2.4	**Carry out** chromatography on the following: 1. A mixture of water-soluble pigments and calculate Rf value and determine the number of pure substances in a mixture based on results. 2. A mixture of non-water-soluble pigments and the use of an organic solvent to separate the mixture. Explain the importance of using a pencil to draw the origin line and solvent front. Explain the chemical nature of substances and reasons for using the difference solvents. E.g., polar substances only dissolve in polar, and non-polar only dissolve in non-polar solvents.
		2.5	**Identify** substances and assess purity of substances based on melting and boiling points.
		2.6	**Carry out** a practical of stearic acid (or alternative substance that has a low melting point) and construct a table of results and plot a heating curve and cooling curve.
		2.7	**Describe** the effect of impurities on melting and boiling points of substances.
		2.8	**Explain** the need for pure substances in medicines and food additives.
		2.9	**Explain** the term conservation of mass**.**

		2.10	**Evaluate** methods of purification including in terms of solubility, density, boiling points in the suitability of each method (i)-(v).: i) Process of filtration. ii) Process of crystallisation. iii) Process of solvent extraction. iv) Process of simple distillation and fractional distillation. v) Process of centrifugation. • Identify all equipment used from diagrams for methods of purification listed above. • Describe a suitable method of purification from information provided.
		2.11	**Carry out** each method of separation. Examples include: 1.Sand, salt water to separate to achieve pure sand, pure salt, and pure water. 2. Achieved solid copper sulphate from copper sulphate solution. 3. Ethanol from water. 4. Blood separation into components.
3	Be able to demonstrate a practical awareness of states of matter and methods of separation.	3.1	**Investigate** methods of heating and cooling of pure substances and report findings.
		3.2	**Interpret** simple chromatograms.
		3.3	**Interpret** simple chromatograms using Rf values.
		3.4	**Investigate** the effect of impurities on melting and boiling points of substances and report findings.

2	Atoms and the periodic table		
Aim The key aim of this subject content is to develop an understanding of the structure of the atom and how atoms are arranged in the periodic table.			
Learning Outcomes - The learner will:		**Assessment Criteria - The learner can:**	
1	Understand the structure of atoms.	1.1	**State** the relative mass and charge of a proton, neutron, and electron.
		1.2	**Outline** the term proton number and nucleon number.
		1.3	**Describe** the importance of proton number to explain the periodic table.
		1.4	**Define** the term relative atomic mass and relative formula mass.
		1.5	**Define** the term isotope.
		1.6	**State** two types of isotope as being radioactive and non-radioactive.
		1.7	**State** a range of medical and industrial uses of isotopes.
		1.8	**Evaluate** how isotopes have the same chemical properties due to have the same number of electrons in the outer shell.
		1.9	**Explain** the significance of the noble gas electronic structure and outer shell electrons in terms of chemical reactivity.
		1.10	**Describe** the differences between elements, compounds, and mixtures.
		1.11	**Outline** the build-up of electron shells/energy levels
2	Understand the periodic table.	2.1	**Explain** the arrangement of the periodic table in terms of: 1. Changes through time 2. Mendeleev and his work 3. Universal use of element symbols in Latin.

		2.2	**Describe** the changes from metallic to non-metallic character across a period.
		2.3	**Define** appearance of various elements in the periodic table
		2.4	**Summarise** the relationship between group number and number of electrons in outer shell.
		2.5	**Evaluate** the relationship between period and number of electron shells.
		2.6	**Describe** the differences between metals and non-metals.
		2.7	**Identify** trends in the periodic table including: 1. Orders of magnitude of atoms across the period and down the group. 2. Metallic and non-metallic across the period. 3. States of matter across the period and down the group. Specific group trends requirements highlighted in other learning outcomes.
		2.8	**Describe** the trends in physical and chemical properties of group 1 metals in terms of: (i) melting and boiling points, (ii) density, (iii) reactivity, (iv) colour of oxides formed, (v) formation of hydroxides after reacting with water, and (vi) other properties of metals.
		2.9	**Describe** and explain the importance of appropriate storage of group 1 metals
		2.10	**Explain** changes of reactivity of group 1 in terms of ease of loss of outer electron due to weaker force of attraction between the nuclei and outer electron.
		2.11	**Outline** how halogens are considered as diatomic molecules.
		2.12	**Describe** the trends in physical properties of the group VII elements (Halogens) in terms of: (i) colour of appearance, (ii) melting and boiling points, (iii) states of matter, and (iv) reactivity.
		2.13	**State** the uses of group VII elements.

		2.14	**Predict** properties of other elements in group VII.
		2.15	**Explain** changes of reactivity of group VII in terms of ease of gaining of additional electrons due to stronger force of attraction between the nuclei and outer electrons
		2.16	**Describe** the noble gases as being unreactive, monatomic gases and explain this in terms of electronic structure.
		2.17	**Outline** uses of noble gases and explain appropriateness due to creating an inert atmosphere
		2.18	**Describe** properties of transition elements in terms of: (i) high melting and boiling points, (ii) high densities, (iii) forming coloured compounds, (iv) acting as catalysts, (v) variable oxidation states, and (vi) other metal properties.
		2.19	**Describe** uses of transition metals.
		2.20	**Carry out** various tests to demonstrate metallic versus non metallic properties including: 1.Adding range of metals to acids and observe results. 2. Testing relative conductivity of metals / non-metals in a simple series circuit. 3. Magnetic properties of iron versus other metals and non-metals. 4. Demonstrate Vanadium oxide and hydrogen peroxide to demonstrate catalyst properties. 5. Making various metal-coloured compounds such as hydrated copper sulphate (blue), potassium permanganate (purple), iron oxide (brown) and other suitable examples.
3	Be able to demonstrate a practical awareness as to the structure of atoms.	3.1	**Calculate** the number of protons, neutrons and electrons of an element using the periodic table.
		3.2	**Investigate** how lithium, sodium and potassium reacts with water.

		3.3	**Investigate** and predict properties of other group 1 metals.
		3.4	**Investigate** trends in other groups from specified provided.

3	Chemical bonding		
Aim The aim of this subject content is to enhance understanding of bonding between atoms.			
Learning Outcomes - The learner will:		**Assessment Criteria - The learner can:**	
1	Understand structure and bonding.	1.1	**Explain** that bulk properties of substances are related to the type of bonding present. In terms of: 1. Bond strength of intermolecular forces 2. Bonding arrangement Recall that individual atoms do not have these properties.
		1.2	**Explain** the formation of ions by electrons loss or gain.
		1.3	**Describe** ionic bonding in terms of forces of attraction between positive and negative ions, referred to as an electrostatic force.
		1.4	**Outline** the formation of ionic bonds between metallic and non-metallic elements.
		1.5	**Outline** the formation of ionic bonds between elements groups I and VII.
		1.6	**Outline** the formation of ionic bonds between elements groups II and VI.
		1.7	**Describe** the lattice structure of ionic compounds.
		1.8	**Evaluate** the importance of balancing the ions when determining chemical formula of ionic compounds.
		1.9	**Describe** covalent bonding in terms of sharing of electrons.
		1.10	**Describe** the formation of simple covalent bonds, specifically: (i) hydrogen, (ii) chlorine, (iii) water, (iv) ammonia, (v) hydrogen chloride, and (vi) methane
		1.11	**Define** the term ‘lone pair of electrons’
		1.12	**Outline** the idea of bonding leading to a noble gas electron configuration due to bonding.

		1.13	**Describe** the arrangement of electrons for complex covalent molecules including examples.
		1.14	**List** examples of electrons for complex covalent molecules.
		1.15	**Describe** the term single, double and triple covalent bonds with examples.
		1.16	**List** examples of single, double, and triple covalent bonds with examples.
		1.17	**Explain** the term valency.
		1.18	**Describe** giant covalent structures with examples such as diamond, graphite, fullerenes, and graphene.
		1.19	**Define** the term 'macromolecular structure'.
		1.20	**Describe** differences in physical properties of ionic and covalent substances in terms of: (i) volatility, (ii) electrical conductivity, (iii) solubility, and (iv) melting and boiling points.
		1.21	**Define** the term 'metallic bonding' in terms of a lattice of positive ions floating in a sea of delocalised electrons.
		1.22	**Explain** properties of metals.
2	Be able to demonstrate a practical awareness as to the purpose of chemical bonding.	2.1	**Draw** cross and dot diagrams representing electron transfer for ionically bonded substances.
		2.2	**Draw** chemical diagrams representing a covalent bond with a single line e.g. H – H
		2.3	**Deduce** uses of diamond, graphite, fullerenes, and graphene relating to their structure.
		2.4	**Compare** diamond and silicon (IV) dioxide in terms of structure and properties.
		2.5	**Deduce** unknown substances as metal, non-metal, ionic, simple covalent or giant covalent based on information provided about properties.

4	Quantitative Chemistry		
Aim The aim of this subject content is to enhance understanding of quantitative chemistry.			
Learning Outcomes - The learner will:		**Assessment Criteria - The learner can:**	
1	Understand chemical formula	1.1	**Differentiate** between metals and non-metals, metal and non-metal compounds, and covalent compounds.
		1.2	**Define** the terms ‘products’ and ‘reactions.
		1.3	**Outline** the following states of matter symbols: (i) s, (ii) l, (iii) g, (iv) aq.
		1.4	**Define** the term ‘spectator ions’.
2	Be able to demonstrate a practical awareness as to chemical formula.	2.1	**Write** chemical formula for elements and simple compounds.
		2.2	**Deduce** formula of ionic compounds using valency of elements present.
		2.3	**Deduce** the formula of compounds from diagrams.
		2.4	**Construct** word, chemical and balanced chemical equations form information provided.
		2.5	**Construct** balanced ionic chemical equations.
3	Understand chemical calculations.	3.1	**Describe** the term mole and the Avogadro constant.
		3.2	**Describe** titrations as methods to identify an unknown concentration of a solution.
		3.3	**Describe** the terms ‘percentage yield’ and ‘percentage purity’.

4	Be able to demonstrate a practical awareness as to chemical calculations.	4.1	**Deduce** relative atomic mass and relative formula mass of various chemical compounds.
		4.2	**Use** moles in calculating stoichiometric reacting masses including the following calculations: 1. Moles (mol) = mass (g) / relative formula molar mass (Ar or Mr) 2. Moles (mol) = concentration (mol/dm^3) * volume (dm^3) 3. Moles (mol) = volume (dm^3) / 24 (dm^3) volume of gas at room temp. 4. Concentration (mol/dm^3) = Mass (g) / volume (dm^3)
		4.3	**Calculate** theoretical yield of product from a given amount of reactant.
		4.4	**Deduce** which reactant is limiting or in excess by comparing number of moles of each reactant considering the stoichiometry of the equation.
		4.5	**Calculate** the percentage by mass of an element in a compound
		4.6	**Calculate** (i) percentage yield, (ii) percentage purity', (iii) empirical formulae, and (iv) molecular formulae.
		4.7	**Calculate** the concentration of a given solution.

5	Chemical Changes		
Aim The aim of this subject content is to enhance understanding of chemical changes.			
Learning Outcomes - The learner will:		**Assessment Criteria - The learner can:**	
1	Understand chemical changes.	1.1	**List** examples of physical and chemical changes.
		1.2	**Explain** what is meant by physical and chemical changes with examples.
		1.3	**Describe** the terms exothermic and endothermic in terms of: 1. Net energy gain and loss from a reaction. 2. Change in surrounding temperature.
		1.4	**State** various finite fuels including coal, oil, gas, hydrogen, and uranium
		1.5	**Describe** the processes involved in release energy from fuels.
		1.6	**Evaluate** differences in energy output by fuels per kg of fuel.
		1.7	**Describe** various polluting products produced from energy production.
		1.8	**Describe** the production of electrical energy from simple cells.
		1.9	**Explain** differences between electrochemical cells and electrolysis.
		1.10	**Explain** differences in voltage of electrochemical cells linking differences to reactivity series.
		1.11	**Describe** how hydrogen is used in fuel cells and used in the production of electricity.
		1.12	**Evaluate** the use of hydrogen as a fuel compared to other fuels.

2	Be able to demonstrate a practical awareness as to chemical changes.	2.1	**Draw**, label and interpret energy level diagrams.
		2.2	**Calculate** the energy absorbed / released from reactions using bond energy values.
		2.3	**Deduce** a reaction as exothermic or endothermic from given.
		2.4	**Investigate** fuels using calorimetry to measure energy released.
		2.5	**Draw** and label simple electrochemical cells.
		2.6	**Investigate** metal combinations and voltage output.
		2.7	**Create** a model of a fuel cell.
		2.8	**Write** balanced chemical half reactions for acidic and alkaline electrolytes in fuel cells.
3	Understand acid and bases.	3.1	**Describe** the terms neutral, acid, base, and alkali.
		3.2	**Define** acids and bases in terms of proton transfer.
		3.3	**Evaluate** the differences between strong and weak acids in terms of: **1.** Hydrogen ion concentration and term pH. **2.** Ability of acid substance to dissociate to form hydrogen ions. **3.** Examples of laboratory acids and chemical formula - Hydrochloric acid HCl - Sulphuric acid H_2SO_4 - Nitric acid HNO_3 **Evaluate** the differences between strong and weak alkali in terms of: - 1. Hydroxide ion concentration.

		3.4	**Describe** indicators used to identify acids and alkalis, specifically: (i) litmus, (ii) methyl orange, (iii) Phenolphthalein, and (iv) universal indicator.
		3.5	**Carry out** a range of chemical tests on variety of substances using the full range of indictors stated in 3.4(i)-(iv). Including the ability to deduce the chemical nature of unknown chemicals based on observations.
		3.6	**Describe** properties of acidic substances
		3.7	**Evaluate** the importance of using bases to assist in regulating pH of soils.
		3.8	**List** examples of oxides as: (i) acidic, (ii) basic, (iii) neutral, and (iv) amphoteric.
		3.9	**Classify** oxides as acidic, basic, neutral, and amphoteric with examples.
4	Be able to demonstrate a practical awareness as to acids and bases.	4.1	**Deduce** the acidity / alkalinity of a substance based on given information.
		4.2	**Apply** the following general equations in given examples: (i) Metal + acid -> salt + hydrogen, (ii) metal oxide + acid -> salt + water, (iii) metal carbonate + acid -> salt + water + carbon dioxide, (iv) metal hydroxides + acid -> salt + water, and (v) aqueous ammonia + acid -> salt.
		4.3	**Write** word, chemical and balanced chemical equations of reactions including states of matter symbols for acid-base reactions.
		4.4	**Write** ionic equations for acid-base reactions.
		4.5	**Carry out** a range of metal, metal oxide, metal carbonate and metal hydroxide reactions using range of laboratory acids.
5	Understand the process for making salts	5.1	**Describe** methods of preparation, separation, and purification of (i) salts from metal, (ii) a soluble base, and (iii) an insoluble base.
		5.2	**Carry out** experiment to make metal salts from metals, metal oxides, metal carbonates and metal hydroxides reacted with laboratory acids e.g., copper oxide + sulphuric acid to make solid copper sulphate.

		5.3	**Describe** the preparation of insoluble salts by precipitation reactions.
		5.4	**Describe** methods and observation for the following chemical tests: (i) test for oxygen, and (ii) test for carbon dioxide, (iii) test for water, and (iv) test for sulphur dioxide, (v) test for ammonia, and (vi) test for chlorine.
		5.5	**Describe** the tests for cations using the following: (i) precipitation reactions, and (ii) flame tests.
		5.6	**Describe** the test for anions, specifically: (i) testing for halides using precipitation, (ii) reactions, (iii) testing for carbonates by analysis gas product carbon dioxide, (iii) testing for nitrates by identifying ammonia using litmus, (iv) testing for sulphate by identifying sulphur dioxide using potassium manganate (VII).
		5.7	**Carry out** each method described in 5.6(i)-(iv) using appendix for tests and positive results required.
6	Be able to demonstrate a practical awareness as the process for making salts.	6.1	**Deduce** a suitable method of making a salt from information provided.
		6.2	**Carry** out a titration to make potassium sulphate.
		6.3	**Deduce** unknown substances by qualitative analysis based on given information.
		6.4	**Carry** out observations for the following chemical tests: (i) test for oxygen, and (ii) test for carbon dioxide, (iii) test for water, and (iv) test for sulphur dioxide, (v) test for ammonia, and (vi) test for chlorine.
7	Understand metals and reactivity.	7.1	**Define** the term ‘alloy’.
		7.2	**State** metals that determine the following alloys: (i) brass, (ii) bronze, (iii) solder, and (iv) stainless steel.
		7.3	**Describe** the properties and uses of the following alloys (i) brass, (ii) bronze, (iii) solder, and (iv) stainless steel.
		7.4	**Identify** alloys from given information (diagrams).

		7.5	**Describe** metals that are above hydrogen in the reactivity series.
		7.6	**State** metals that react with (i) water, (ii) steam, and (iii) acids.
		7.7	**Describe** metal reactivity in terms of displacement reactions.
		7.8	**Carry out** a range of metal + acid reactions and construct a reactivity series based on observations on vigorousness of reaction.
		7.9	**Describe** reactivity of metals in terms of valency and ability to lose electrons.
		7.10	**Explain** the use of carbon as a reducing agent for some metal oxides.
		7.11	**Evaluate** the difference between freshly made aluminium and old aluminium.
		7.12	**Define** the term 'thermal decomposition'.
		7.13	**Describe** the action of heat on hydroxides and nitrates.
		7.14	**Outline** the relationship of thermal decomposition with reactivity series of metals.
		7.15	**State** the correct word, chemical **and** balanced chemical formula for the thermal decomposition of (i) hydroxides, and (ii) nitrates
8	Be able to demonstrate a practical awareness as to metals and reactivity.	8.1	**Investigate** metals placed in a reactivity series in terms of reactions with water, steam, and acids.
		8.2	**Deduce** reactivity of metals based on given information.
9	Understand electricity and chemistry.	9.1	**Define** the term electrolysis
		9.2	**Define** the term cation and anion.
		9.3	**State** the word, chemical **and** balanced chemical equation for electrolysis reactions.
		9.4	**Explain** products at electrodes in terms of reactivity referring to 'discharge series'.

		9.5	**Summarise** electrolysis in terms of electron transfer.
		9.6	**Explain** electrolysis in the context of purifying copper, including the type of electrolyte used and electrodes used.
		9.7	**Describe** the process of electrolysis in electroplating.
		9.8	**Outline** the uses of electroplating in terms of: (i) protection against corrosion, and (ii) improving of appearance of metals.
		9.9	**Carry out** an electroplating experiment on conductive material e.g., using copper sulphate solution and an iron nail.
		9.10	**Describe** the purpose of purifying aluminium from bauxite including the type of electrolyte and electrodes used.
		9.11	**Define** the term conductor and insulator in terms of energy transfer within a material.
		9.12	**Describe** the use of thick steel-cored aluminium wires for high voltage electrical cables in terms of electron transfer and resistance.
		9.13	**Outline** the role fulfilled using copper in electrical wiring.
		9.14	**Explain** why plastics and ceramics are used as insulators.
		9.15	**Describe** the tests for identifying substances, specifically: (i) halides in concentrated solutions, (ii) electrolysis of brine to manufacture chlorine, (iii) hydroxide, and (iv) sodium hydroxide.
10	Be able to demonstrate a practical awareness as to electricity and chemistry.	10.1	**Label** components of an electrolysis cell.
		10.2	**Deduce** the products at electrodes of a molten ionic compound and ionic compounds in solution.

		10.3	**Carry** out observations of products formed at electrodes and identify substances based on these observations, specifically: (i) halides in concentrated solutions, (ii) electrolysis of brine to manufacture chlorine, (iii) hydroxide, and (iv) sodium hydroxide.
		10.4	**Construct** half equations for reactions occurring at both electrodes
11	Understand the process of metal extraction.	11.1	**Describe** bauxite as an ore of aluminium.
		11.2	**Explain** metal extraction in terms of their position on the reactivity series.
		11.3	**Describe** the process of extraction of zinc from zinc blende.
		11.4	**Describe** hematite as an ore of iron.
		11.5	**Explain** the chemical reactions that occur in the blast furnace in the production of iron.
		11.6	**State** the raw materials used in the process of producing iron in a blast furnace
		11.7	**Describe** how iron is converted into steel
		11.8	**Outline** the role of basic oxides and oxygen in steel making.
		11.9	**Describe** the changing of properties of iron by addition of additives
		11.10	**Explain** the difference between a blast furnace and steel making processes.
		11.11	**State** the uses of (i) aluminium, (ii) mild steel, (iii) stainless steel, and (iv) copper.
		11.12	**Describe** uses of these metals related to their properties: (i) aluminium, (ii) mild steel, (iii) stainless steel, and (iv) copper.
		11.13	**Evaluate** advantages and disadvantages of recycling metals
		11.14	**Explain** the uses of zinc for galvanising and for making of brass.

6	**Reversible reactions and rate of reactions**		
Aim The aim of this subject content is to enhance understanding reversible reactions and rate of reactions.			
Learning Outcomes - The learner will:		**Assessment Criteria - The learner can:**	
1	Understand the rate of reactions.	1.1	**Describe** suitable methods to calculate rate of reactions based on: (i) calculating mass loss of reactants in a given time, (ii) calculating volume of product in a given time, and (iii) calculating the time taken in a precipitation reaction.
		1.2	**Outline** suitable methods named equipment to measure: (i) calculating mass loss of reactants in a given time, (ii) calculating volume of product in a given time, and (iii) calculating the time taken in a precipitation reaction.
		1.3	**Evaluate** suitable methods for calculating rate of reactions based on information provided.
		1.4	**Explain** changes from data and graphs regarding rates of reactions.
		1.5	**Describe** how the following factors affect rate of reaction: (i) surface area, (ii) temperature, (iii) catalyst, and (iv) concentration.
		1.6	**Carry out a range of practicals to observe rates of reactions:** Examples include: 1. Measuring volume of carbon dioxide produced over a period of time using metal carbonate + acid. 2. Measuring mass decrease over a period of time e.g., metal carbonate + acid. 3. Using difference sizes of reactants e.g., lumps versus powder.
		1.7	**Describe** the role of light in photochemical reactions.

		1.8	**State** the word, chemical **and** balanced chemical equation of photosynthesis.
		1.9	**Describe** the use of silver salts in photography.
		1.10	**State** the word, chemical **and** balanced chemical equation for the redox reactions in photography using silver salts.
2	Be able to demonstrate a practical awareness as to the rate of reactions.	2.1	**Investigate** the use of dependent, independent and control variables based on given information.
		2.2	**Interpret** data and graphs when describing rate of reactions, in terms of (i) chance of successful collisions between reacting particles, and (ii) kinetic energy and activation energy.
		2.3	**Calculate** rate of reaction from data and graphs based on given information.
3	Understand reversible reactions.	3.1	**Evaluate** the conditions which must be present when chemical reactions are reversible.
		3.2	**Identify** a reversible reaction using ⇌ symbol
		3.3	**Describe** reversible reactions in terms of changing conditions including: (i) hydrous and anhydrous copper sulphate due to presence of water, (ii) carbon dioxide as gas and carbon dioxide in solution due to change in pressure, and (iii) use of cobalt chloride to test presence of water vapour.
		3.4	**Define** the term ‘water crystallisation’.
		3.5	**Describe** appearance of hydrous and anhydrous copper sulphate.
		3.6	**Carry out** an experiment to observe the hydrated and anhydrous versions of copper sulphate.
		3.7	**Define** what is meant by the term ‘closed system’.

		3.8	**State** what is meant by the term 'equilibrium', specifically: when it occurs in a closed system, (i) when concentrations of reactants and products are fixed, and (ii) during forward and reverse reaction taking place at the same rate.
		3.9	**Define** the term 'shifting equilibrium'.
		3.10	**Describe** changes of equilibrium under the following conditions: (i) changes in concentration of reactants / products, (ii) changes in temperature, and (iii) during the use of a catalyst, (iv) when there are changes in pressure
		3.11	**Describe** the following: (i) Haber process, and (ii) contact process
		3.12	**Determine** changes of equilibrium based on given information.
		3.13	**Define** the term oxidation and reduction in terms of: (i) gain or loss of electrons, (ii) gain or loss of oxygen, (iii) gain or loss of hydrogen.
		3.14	**Evaluate** the importance of oxidation states.
		3.15	**Define** the terms oxidising agents and reducing agents.
		3.16	**State** the chemical **and** balanced chemical half reactions for redox reactions.
		3.17	**Identify** redox reactions by changes in oxidation state and by colour changes using potassium manganate (VII) and potassium iodide.
4	Understand the chemical industry.	4.1	**Explain** the need for nitrogen, phosphorous and potassium containing fertilisers.
		4.2	**Describe** the displacement of ammonia from its salts.
		4.3	**Describe** the sources of hydrogen and nitrogen used to make ammonia.
		4.4	**Explain** the essential conditions and chemical used in the Haber process including: (i) temperature, (ii) pressure, and (iii) use of iron as a catalyst.
		4.5	**State** sources of sulphur.

		4.6	**Evaluate** changes in equilibriums of the Haber process and its impact of yield versus rate of reaction.
		4.7	**Describe** uses of sulphur and sulphur dioxide.
		4.8	**Outline** the properties and uses of dilute and concentrated sulfuric acid.
		4.9	**Explain** the manufacturing process involved in sulfuric acid by the contact process.
		4.10	**Describe** the essential conditions and reactions of the Contact process, in terms of (i) temperature, (ii) pressure, and (iii) use of Vanadium (V) oxide as a catalyst.
		4.11	**Describe the manufacture of lime in terms of thermal decomposition.**
		4.12	**State** uses of (i) lime, (ii) slaked lime, and (iii) calcium carbonate.

7	**Organic Chemistry**		
Aim The aim of this subject content is to enhance understanding of organic chemistry.			
Learning Outcomes - The learner will:		**Assessment Criteria - The learner can:**	
1	Understand organic chemistry and petrochemicals.	1.1	**Describe** the term 'homologous series in terms of a group of similar compounds with similar chemical properties due to the presence of the same functional group.
		1.2	**Describe** the general characteristics of a homologous series.
		1.3	**Explain** the compounds in homologous series have the same general formula.
		1.4	**State** the structures of methane, ethane, ethanol, and ethanoic acid
		1.5	**Define** the term 'hydrocarbon'.
		1.6	**State and draw the structural formulae** the structures of alkanes up to 6 carbon atoms.
		1.7	**Define** the term 'isomers.
		1.8	**Describe** structural isomers from given information.
		1.9	**Outline** the characteristics of the following fuels: (i) coal, (ii) natural gas, and (iii) petroleum (crude oil).
		1.10	**Describe** the fuels obtained from petroleum.
		1.11	**Describe** the properties of molecules within a fraction
		1.12	**Describe** the products of complete combustion of a hydrocarbon fuel as carbon dioxide and water.
		1.13	**Describe** the separation of petroleum into different fractions by fractional distillation.

		1.14	**State** uses of fractions from fractional distillation.
2	Understand alkanes and alkenes.	2.1	**Describe** the properties of alkanes.
		2.2	**Describe** the bonding of alkanes.
		2.3	**Summarise** the reaction of alkanes with chlorine.
		2.4	**Explain** the manufacturing process of: (i) alkenes, and (ii) hydrogen by cracking.
		2.5	**State and draw the structural formulae** of alkenes up to 6 carbon atoms.
		2.6	**Differentiate** between saturated and unsaturated hydrocarbons in terms of: (i) presence of double C bond, and (ii) reactions with aqueous bromine.
		2.7	**Describe** the addition reactions of alkenes with bromine, steam and hydrogen.
		2.8	**Evaluate** the formation of ethanol by fermentation and by the addition of steam to ethane
		2.9	**Describe** the uses of ethanol.
		2.10	**State and draw the structural formulae** of alcohols up to four carbon atoms.
		2.11	**Describe** how ethanoic acid is made.
		2.12	**Explain** the properties of ethanoic acid in terms of: (i) strength of acid, and (ii) its reaction with ethanol.
		2.13	**State and draw the structural formulae** of carboxylic acids up to four carbon atoms.
		2.14	**State and draw the structural formulae** of esters up to four carbon atoms
3	Understand polymers.	3.1	**Define** the following terms: (i) macromolecule, (ii) monomer', (iii) polymer, and (iv) polymerisation.
		3.2	**State** some uses of plastics and man-made fibres**.**

		3.3	**Define** the structure of a polymer from a given alkene.
		3.4	**Describe and evaluate** the problems of pollution caused by non-biodegradable plastics.
		3.5	**State** the structure of a monomer from a given addition polymer.
		3.6	**State** the structure of monomers and additional polymers.
		3.7	**Outline** the characteristics which represent amide-linkage and ester linkage.
		3.8	**Define** the following terms: (i) polyamide, and (ii) polyester.
		3.9	**Explain** condensation polymerisation.
		3.10	**Describe** the formation of nylon and terylene.
		3.11	**Differentiate** between addition polymers and condensation polymers.
4	Understand biological molecules.	4.1	**Describe** DNA as a polymer made of four different monomers called nucleotides. 1. Each adjacent nucleotide is chemically bonded by a phosphodiester bond in a single DNA strand. 2. Hydrogen bonding occurs between the two DNA strands.
		4.2	**Define** proteins and carbohydrates as constituents of food.
		4.3	**Define** the term ‘macromolecule’.
		4.4	**State** the chemical structure of a protein.
		4.5	**Describe** the process of hydrolysis reactions when breaking down proteins to amino acids.
		4.6	**Describe** the process of condensation reactions when building proteins from amino acids.

		4.7	**Evaluate** the purpose of amide linkage / peptide bond as the bond formed between the amine and carboxyl group of an amino acid.
		4.8	**Describe** the hydrolysis of starch and cellulose.
		4.9	**Describe** the formation of complex carbohydrates by polymerisation of simple sugars.
		4.10	**Describe** how chromatography can be used to identify the products of hydrolysis of carbohydrates and proteins.
		4.11	**Describe** enzymes as proteins that act as a biological catalyst.
		4.12	**Describe** the fermentation of simple sugars.
		4.13	**Compare** the two methods of producing ethanol.

8	Air and water Chemistry		
Aim The aim of this subject content is to enhance understanding of air and water chemistry.			
Learning Outcomes - The learner will:		**Assessment Criteria - The learner can:**	
1	Understand air and water	1.1	**Describe** the chemical tests for water.
		1.2	**Define** the term potable water.
		1.3	**Explain** the treatment of water in terms of filtration and chlorination.
		1.4	**Describe** domestic and industrial uses of water.
		1.5	**Explain** the problems of an inadequate supply of water.
		1.6	**Describe** the problems of an inadequate supply of water.
		1.7	**Explain** the changes in composition from early Earth's atmosphere to present day
		1.8	**State** the relative composition of gases in the atmosphere.
		1.9	**Explain** the process of separating nitrogen and oxygen from liquid air by fractional distillation.
		1.10	**Describe** uses of nitrogen and oxygen.
		1.11	**Summarise** the sources of various air pollutants including: (i) carbon monoxide, (ii) lead compounds, (iii) nitrogen oxides, (iv) carbon dioxide, (v) methane, and (vi) sulphur dioxides.
		1.12	**Explain** the negative effects of air pollutants including: (i) global warming, (ii) acid rain, (iii) respiratory conditions, (iv) formation of ground level ozone, (v) brain damage, (vi) reduced oxygen carrying capacity of blood, (vii) damage to environments.

		1.13	**Describe** strategies to prevent and reduce impacts of air pollutants: i) Use of pollutant scrubbers, (ii) use of catalytic converters, (iii) flue gas desulphurisation, (iv) governmental agreements, (v) changes in human behaviour, (vi) use of renewables / alternative sources of energy production.
		1.14	**Explain** the various stages of the carbon cycle.
		1.15	**State** the conditions needed for rusting to occur.
		1.16	**Describe** various methods of rust prevention including: (i) addition of coatings such as pain and grease, and (ii) galvanising.
		1.17	**Evaluate** the process of sacrificial protection in terms of reactivity.

APPENDIX

MATHEMATICAL REQUIREMENTS

Calculators may be used in all parts of the examination.

Candidates should be able to:

1. Complete equations involving addition, subtraction, multiplication, and division
2. Calculate percentages
3. Calculate percentage change
4. Manipulate a range of formula to identify the unknown variable.
5. Carry out unit conversions
6. Judge appropriate orders of magnitude and scale
7. Calculate surface area and volume of a range of shapes circle, square, rectangle and triangle
8. Estimate values based on trends / sequences
9. Apply standard form to data
10. Able to sufficiently round data correctly
11. Provide answers to significant figures
12. Present values in line with equipment measurements e.g., 1.1cm^3 for a burette
13. Calculate energy efficiency
14. Calculate mean, mode and median
15. Calculate probability
16. Understand ratios.

SAFETY IN THE LABORATORY

Candidates should be able to:

1. Identify relevant hazards and associated risks of equipment used
2. Identify relevant hazards and associated risks chemicals used
3. Carry out practical procedures carefully and thoroughly applying good practice
4. Individual core practical hazards and risks can be found at https://www.cleapss.org.uk/ (Members only)

The safety of candidates and staff are the responsibility of the centre involved, full guidance can be found on https://www.cleapss.org.uk/ (Members only).

APPENDIX TESTS:

Flame test colours for ions:

Metal ion	Flame test colour
Lithium (Li+)	Red
Sodium (Na+)	Yellow
Potassium (K+)	Lilac
Copper (Cu2+)	Blue - green
Calcium (Ca2+)	Orange - red
Barium (Ba2+)	Green

Testing for halides:

Halide ion	Precipitate colour
Chloride, Cl^-	White
Bromide, Br^-	Cream
Iodide, I^-	Yellow

Testing for cations:

Metal ion	Precipitate colour – (metal hydroxide added)
Aluminium, Al^{3+}	White
Calcium, Ca^{2+}	White
Copper, Cu^{2+}	Blue
Iron(II), Fe^{2+}	Green
Iron(III), Fe^{3+}	Brown
Zn 2+	White
Chromium 3+	Red

Testing for other anions:

Anion	Test	Result
Nitrate NO_3^-	Add sodium hydroxide solution, aluminium foil and heat	Ammonia gas produced, can test using red litmus turning blue.
Sulphate SO_2^{2-}	Add to aqueous barium nitrate	White precipitate formed
Sulphite SO_3^{2-}	Add dilute hydrochloric acid, warm gently.	Sulphur dioxide produced will turn acidified aqueous potassium manganate (VII) from purple to colourless.