edexcel

GCSE (9-1) Chemistry

Specification

Pearson Edexcel Level 1/Level 2 GCSE (9-1) in Chemistry (1CH0)

First teaching from September 2016

First certification from June 2018

Issue 2

Pearson

Summary of Pearson Level 1/Level 2 GCSE (9–1) in Chemistry (1CH0) specification Issue 2 changes

Summary of changes made between previous issue and this current issue	Page number
Inclusion of calculation information in the assessment overview section	4
Specification statement 1.31 has been moved to the end of the Covalent bonding section	13
Specification statements 1.41 and 1.42 have been moved to the end of the Types of substance section	14
Specification statement 1.44 has been reworded to include 'percentage composition'	15
Specification statement 2.7 has been reworded for clarity	17
Specification statement 4.11 has been amended to 'life-cycle assessment' rather than 'life time assessment'	22
Specification statement 6.12 has been amended to include 'the substances that are oxidised and which are reduced'	28
Specification statement 8.26 has been amended to include a new part a about the composition of today's atmosphere	34
Specification statement 9.27C has been amended to include 'and that alcohols can be dehydrated to form alkenes' to the end of the statement	39
Specification statement 9.30C has been amended to include 'and that solutions of carboxylic acids have typical acidic properties' to the end of the statement	39
In *Appendix 5: Practical Science Statement* the statement has been amended	62
Addition of *Appendix 9: Calculators* which contains the rules around calculator use in the examinations	67

If you need further information on these changes or what they mean, contact us via our website at: qualifications.pearson.com/en/support/contact-us.html

Contents

1 Introduction

Why choose Edexcel GCSE in Chemistry?

Supporting success in science

Science matters. That's why we've built the most inclusive GCSE (9–1) courses, so every student can enjoy science and succeed in their studies.

Every student is different. With the same science and equal number of exams across our tiered qualifications, you can structure the courses in the ways that mean you can best support and stretch your students together.

Our specifications are straightforward, and our selection of core practicals are designed to help bring science learning to life. And when it comes to our assessments, they're shaped to encourage all students to best show what they know and can do.

Supporting you in planning and implementing this qualification

Planning

- Our **Getting Started** guide gives you an overview of the new GCSE qualifications to help you to get to grips with the changes to content and assessment and to help you understand what these changes mean for you and your students.
- We will give you editable **schemes of work** that you can adapt to suit your department.
- **Our mapping documents** highlight key differences between the new and 2011 qualifications.

Teaching and learning

There will be lots of free teaching and learning support to help you deliver the new qualifications, including:

- a free series of teacher, student and technician worksheets will help cover each element of planning and delivering every core practical
- a free practical guide to help you prepare for the changes to practical assessment
- a free maths guide for scientists to help you embed mathematics in your science teaching.

Preparing for exams

We will also provide a range of resources to help you prepare your students for the assessments, including:

- additional assessment materials to support formative assessments and mock exams
- marked exemplars of student work with examiner commentaries.

ResultsPlus

ResutsPlus provides the most detailed analysis available of your students' exam performance. It can help you identify the topics and skills where further learning would benefit your students.

Get help and support

Our subject advisor service, led by Stephen Nugus and Julius Edwards will ensure you receive help and guidance from us and that you can share ideas and information with other teachers.

Learn more at qualifications.pearson.com

examWizard

examWizard is a free exam preparation tool containing a bank of Edexcel GCSE Science exam questions, mark schemes and examiners' reports. Existing questions will be reviewed and tagged to our new specifications so they can still be used, and question descriptions will be updated.

Qualification at a glance

Content and assessment overview

The Pearson Edexcel Level 1/Level 2 GCSE (9–1) in Chemistry consists of two externally-examined papers. These are available at foundation tier and higher tier.

Students must complete all assessments in the same tier.

Students must complete all assessment in May/June in any single year.

Paper 1 (*Paper code: 1CH0/1F and 1CH0/1H)
Written examination: 1 hour and 45 minutes ***50% of the qualification*** ***100 marks***
Content overview • Topic 1 – Key concepts in chemistry • Topic 2 – States of matter and mixtures • Topic 3 – Chemical changes • Topic 4 – Extracting metals and equilibria • Topic 5 – Separate chemistry 1
Assessment overview A mixture of different question styles, including multiple-choice questions, short answer questions, calculations and extended open-response questions. Calculators may be used in the examination. Information on the use of calculators during the examinations for this qualification can be found in *Appendix 9: Calculators*.

Paper 2 (Paper code: 1CH0/2F and 1CH0/2H)
Written examination: 1 hour and 45 minutes ***50% of the qualification*** ***100 marks***
Content overview • Topic 1 – Key concepts in chemistry • Topic 6 – Groups in the periodic table • Topic 7 – Rates of reaction and energy changes • Topic 8 – Fuels and Earth science • Topic 9 – Separate chemistry 2
Assessment overview A mixture of different question styles, including multiple-choice questions, short answer questions, calculations and extended open-response questions. Calculators may be used in the examination. Information on the use of calculators during the examinations for this qualification can be found in *Appendix 9: Calculators*.

*See *Appendix 8: Codes* for a description of this code and all other codes relevant to this qualification.

2 Subject content

Qualification aims and objectives

GCSE study in the sciences provides the foundation for understanding the material world. Scientific understanding is changing our lives and is vital to the world's future prosperity. All students should learn essential aspects of the knowledge, methods, processes and uses of science. They should gain appreciation of how the complex and diverse phenomena of the natural world can be described in terms of a small number of key ideas that relate to the sciences and that are both inter-linked and of universal application. These key ideas include:

- the use of conceptual models and theories to make sense of the observed diversity of natural phenomena
- the assumption that every effect has one or more cause
- that change is driven by differences between different objects and systems when they interact
- that many such interactions occur over a distance without direct contact
- that science progresses through a cycle of hypothesis, practical experimentation, observation, theory development and review
- that quantitative analysis is a central element both of many theories and of scientific methods of inquiry.

These key ideas are relevant in different ways and with different emphases in the three subjects. Examples of their relevance are given for each subject in the separate sections below for Biology, Chemistry and Physics.

The three GCSE Science qualifications enable students to:

- develop scientific knowledge and conceptual understanding through the specific disciplines of Biology, Chemistry and Physics
- develop understanding of the nature, processes and methods of science, through different types of scientific enquiries that help them to answer scientific questions about the world around them
- develop and learn to apply observational, practical, modelling, enquiry and problem-solving skills in the laboratory, in the field and in other learning environments
- develop their ability to evaluate claims based on science through critical analysis of the methodology, evidence and conclusions, both qualitatively and quantitatively.

Students should study the sciences in ways that help them to develop curiosity about the natural world, that give them an insight into how science works and that enable them to appreciate its relevance to their everyday lives. The scope and nature of the study should be broad, coherent, practical and satisfying. It should encourage students to be inspired, motivated and challenged by the subject and its achievements.

The key ideas specific to the Chemistry content include:

- matter is composed of tiny particles called atoms and there are about 100 different naturally occurring types of atoms called elements
- elements show periodic relationships in their chemical and physical properties
- these periodic properties can be explained in terms of the atomic structure of the elements
- atoms bond by either transferring electrons from one atom to another or by sharing electrons

- the shapes of molecules (groups of atoms bonded together) and the way giant structures are arranged is of great importance in terms of the way they behave
- there are barriers to reaction so reactions occur at different rates
- chemical reactions take place in only three different ways:
  - proton transfer
  - electron transfer
  - electron sharing
- energy is conserved in chemical reactions so can therefore be neither created nor destroyed.

All of these key ideas will be assessed as part of this qualification, through the subject content.

Working scientifically

The GCSE in Chemistry requires students to develop the skills, knowledge and understanding of working scientifically. Working scientifically will be assessed through examination and the completion of the eight core practicals.

1 Development of scientific thinking

a Understand how scientific methods and theories develop over time.

b Use a variety of models, such as representational, spatial, descriptive, computational and mathematical, to solve problems, make predictions and to develop scientific explanations and an understanding of familiar and unfamiliar facts.

c Appreciate the power and limitations of science, and consider any ethical issues that may arise.

d Explain everyday and technological applications of science; evaluate associated personal, social, economic and environmental implications; and make decisions based on the evaluation of evidence and arguments.

e Evaluate risks both in practical science and the wider societal context, including perception of risk in relation to data and consequences.

f Recognise the importance of peer review of results and of communicating results to a range of audiences.

2 Experimental skills and strategies

a Use scientific theories and explanations to develop hypotheses.

b Plan experiments or devise procedures to make observations, produce or characterise a substance, test hypotheses, check data or explore phenomena.

c Apply a knowledge of a range of techniques, instruments, apparatus and materials to select those appropriate to the experiment.

d Carry out experiments appropriately, having due regard to the correct manipulation of apparatus, the accuracy of measurements and health and safety considerations.

e Recognise when to apply a knowledge of sampling techniques to ensure any samples collected are representative.

f Make and record observations and measurements using a range of apparatus and methods.

g Evaluate methods and suggest possible improvements and further investigations.

3 Analysis and evaluation

Apply the cycle of collecting, presenting and analysing data, including:

a presenting observations and other data using appropriate methods.

b translating data from one form to another.

c carrying out and representing mathematical and statistical analysis.

d representing distributions of results and making estimations of uncertainty.

e interpreting observations and other data (presented in verbal, diagrammatic, graphical, symbolic or numerical form), including identifying patterns and trends, making inferences and drawing conclusions.

f presenting reasoned explanations, including relating data to hypotheses.

g being objective, evaluating data in terms of accuracy, precision, repeatability and reproducibility and identifying potential sources of random and systematic error.

h communicating the scientific rationale for investigations, methods used, findings and reasoned conclusions through paper-based and electronic reports and presentations using verbal, diagrammatic, graphical, numerical and symbolic forms.

4 Scientific vocabulary, quantities, units, symbols and nomenclature

a Use scientific vocabulary, terminology and definitions.

b Recognise the importance of scientific quantities and understand how they are determined.

c Use SI units (e.g. kg, g, mg; km, m, mm; kJ, J) and IUPAC chemical nomenclature unless inappropriate.

d Use prefixes and powers of ten for orders of magnitude (e.g. tera, giga, mega, kilo, centi, milli, micro and nano).

e Interconvert units.

f Use an appropriate number of significant figures in calculation.

Practical work

The content includes eight mandatory core practicals, indicated as an entire specification point in italics.

Students must carry out all eight of the mandatory core practicals listed below.

Core practical:

2.11 *Investigate the composition of inks using simple distillation and paper chromatography*

3.6 *Investigate the change in pH on adding powdered calcium hydroxide or calcium oxide to a fixed volume of dilute hydrochloric acid*

3.17 *Investigate the preparation of pure, dry hydrated copper sulfate crystals starting from copper oxide including the use of a water bath*

3.31 *Investigate the electrolysis of copper sulfate solution with inert electrodes and copper electrodes*

5.9C *Carry out an accurate acid-alkali titration, using burette, pipette and a suitable indicator*

7.1 *Investigate the effects of changing the conditions of a reaction on the rates of chemical reactions by:*

- *a measuring the production of a gas (in the reaction between hydrochloric acid and marble chips)*
- *b observing a colour change (in the reaction between sodium thiosulfate and hydrochloric acid)*

9.6C *Identify the ions in unknown salts, using the tests for the specified cations and anions in 9.2C, 9.3C, 9.4C, 9.5C*

9.28C *Investigate the temperature rise produced in a known mass of water by the combustion of the alcohols ethanol, propanol, butanol and pentanol*

Students will need to use their knowledge and understanding of these practical techniques and procedures in the written assessments.

Centres must confirm that each student has completed the eight mandatory core practicals.

Students need to record the work that they have undertaken for the eight mandatory core practicals. The practical record must include the knowledge, skills and understanding they have derived from the practical activities. Centres must complete and submit a Practical Science Statement (see *Appendix 5*) to confirm that all students have completed the eight mandatory core practicals. This must be submitted to Pearson by 15th April in the year that the students will sit their examinations. Any failure by centres to provide this Practical Science Statement will be treated as malpractice and/or maladministration.

Scientific diagrams should be included, where appropriate, to show the set-up and to record the apparatus and procedures used in practical work.

It is important to realise that these core practicals are the minimum number of practicals that should be taken during the course. Suggested additional practicals are given beneath the content at the end of each topic. The eight mandatory core practicals cover all aspects of the apparatus and techniques listed in *Appendix 4: Apparatus and techniques*. This appendix also includes more detailed instructions for each core practical, which must be followed.

Safety is an overriding requirement for all practical work. Centres are responsible for ensuring appropriate safety procedures are followed whenever their students complete practical work.

These core practicals may be reviewed and amended if changes are required to the apparatus and techniques listed by the Department for Education. Pearson may also review and amend the core practicals if necessary. Centres will be told as soon as possible about any changes to core practicals.

Qualification content

The following notation is used in the tables that show the content for this qualification:

- text in **bold** indicates content that is for higher tier only
- entire specification points in italics indicates a core practical.

Specification statement numbers with a C in them refer to content which is only in the GCSE in Chemistry and is not found in the GCSE in Combined Science (e.g. 5.1C).

Mathematics

Maths skills that can be assessed in relation to a specification point are referenced in the maths column, next to this specification point. Please see *Appendix 1: Mathematical skills* for full details of each maths skill.

After each topic of content in this specification, there are details relating to the 'Use of mathematics' which contains the Chemistry specific mathematic skills that are found in each topic of content in the document *Biology, Chemistry and Physics GCSE subject content*, published by the Department for Education (DfE) in June 2014. The reference in brackets after each statement refers to the mathematical skills from *Appendix 1*.

Topics common to Paper 1 and Paper 2

Formulae, equations and hazards

Students should:		Maths skills
0.1	Recall the formulae of elements, simple compounds and ions	
0.2	Write word equations	
0.3	Write balanced chemical equations, including the use of the state symbols (s), (l), (g) and (aq)	1c
0.4	**Write balanced ionic equations**	1c
0.5	Describe the use of hazard symbols on containers a to indicate the dangers associated with the contents b to inform people about safe-working precautions with these substances in the laboratory	
0.6	Evaluate the risks in a practical procedure and suggest suitable precautions for a range of practicals including those mentioned in the specification	

Use of mathematics

- Arithmetic computation and ratio when balancing equations (1a and 1c).

Topic 1 – Key concepts in chemistry

Atomic structure

Students should:		Maths skills
1.1	Describe how the Dalton model of an atom has changed over time because of the discovery of subatomic particles	
1.2	Describe the structure of an atom as a nucleus containing protons and neutrons, surrounded by electrons in shells	
1.3	Recall the relative charge and relative mass of: a a proton b a neutron c an electron	
1.4	Explain why atoms contain equal numbers of protons and electrons	
1.5	Describe the nucleus of an atom as very small compared to the overall size of the atom	1d
1.6	Recall that most of the mass of an atom is concentrated in the nucleus	
1.7	Recall the meaning of the term mass number of an atom	
1.8	Describe atoms of a given element as having the same number of protons in the nucleus and that this number is unique to that element	
1.9	Describe isotopes as different atoms of the same element containing the same number of protons but different numbers of neutrons in their nuclei	
1.10	Calculate the numbers of protons, neutrons and electrons in atoms given the atomic number and mass number	3b
1.11	Explain how the existence of isotopes results in relative atomic masses of some elements not being whole numbers	1a, 1c
1.12	**Calculate the relative atomic mass of an element from the relative masses and abundances of its isotopes**	1a, 1c, 1d 3a, 3c

Use of mathematics

- Relate size and scale of atoms to objects in the physical world (1d).
- Estimate size and scale of atoms (1d).

The periodic table

Students should:		Maths skills
1.13	Describe how Mendeleev arranged the elements, known at that time, in a periodic table by using properties of these elements and their compounds	
1.14	Describe how Mendeleev used his table to predict the existence and properties of some elements not then discovered	
1.15	Explain that Mendeleev thought he had arranged elements in order of increasing relative atomic mass but this was not always true because of the relative abundance of isotopes of some pairs of elements in the periodic table	
1.16	Explain the meaning of atomic number of an element in terms of position in the periodic table and number of protons in the nucleus	
1.17	Describe that in the periodic table a elements are arranged in order of increasing atomic number, in rows called periods b elements with similar properties are placed in the same vertical columns called groups	
1.18	Identify elements as metals or non-metals according to their position in the periodic table, explaining this division in terms of the atomic structures of the elements	
1.19	Predict the electronic configurations of the first 20 elements in the periodic table as diagrams and in the form, for example 2.8.1	4a 5b
1.20	Explain how the electronic configuration of an element is related to its position in the periodic table	4a

Ionic bonding

Students should:		Maths skills
1.21	Explain how ionic bonds are formed by the transfer of electrons between atoms to produce cations and anions, including the use of dot and cross diagrams	5b
1.22	Recall that an ion is an atom or group of atoms with a positive or negative charge	
1.23	Calculate the numbers of protons, neutrons and electrons in simple ions given the atomic number and mass number	3b
1.24	Explain the formation of ions in ionic compounds from their atoms, limited to compounds of elements in groups 1, 2, 6 and 7	1c 5b
1.25	Explain the use of the endings –ide and –ate in the names of compounds	

Students should:		Maths skills
1.26	Deduce the formulae of ionic compounds (including oxides, hydroxides, halides, nitrates, carbonates and sulfates) given the formulae of the constituent ions	1c
1.27	Explain the structure of an ionic compound as a lattice structure a consisting of a regular arrangement of ions b held together by strong electrostatic forces (ionic bonds) between oppositely-charged ions	5b

Use of mathematics

- Represent three dimensional shapes in two dimensions and vice versa when looking at chemical structures (5b).

Covalent bonding

Students should:		Maths skills
1.28	Explain how a covalent bond is formed when a pair of electrons is shared between two atoms	
1.29	Recall that covalent bonding results in the formation of molecules	
1.30	Recall the typical size (order of magnitude) of atoms and small molecules	1d
1.31	Explain the formation of simple molecular, covalent substances, using dot and cross diagrams, including: a hydrogen b hydrogen chloride c water d methane e oxygen f carbon dioxide	5b

Use of mathematics

- Relate size and scale of atoms to objects in the physical world (1d).
- Estimate size and scale of atoms (1d).

Types of substance

Students should:	Maths skills
1.32 Explain why elements and compounds can be classified as: a ionic b simple molecular (covalent) c giant covalent d metallic and how the structure and bonding of these types of substances results in different physical properties, including relative melting point and boiling point, relative solubility in water and ability to conduct electricity (as solids and in solution)	
1.33 Explain the properties of ionic compounds limited to: a high melting points and boiling points, in terms of forces between ions b whether or not they conduct electricity as solids, when molten and in aqueous solution	4a
1.34 Explain the properties of typical covalent, simple molecular compounds limited to: a low melting points and boiling points, in terms of forces between molecules (intermolecular forces) b poor conduction of electricity	4a
1.35 Recall that graphite and diamond are different forms of carbon and that they are examples of giant covalent substances	
1.36 Describe the structures of graphite and diamond	5b
1.37 Explain, in terms of structure and bonding, why graphite is used to make electrodes and as a lubricant, whereas diamond is used in cutting tools	5b
1.38 Explain the properties of fullerenes including C_{60} and graphene in terms of their structures and bonding	5b
1.39 Describe, using poly(ethene) as the example, that simple polymers consist of large molecules containing chains of carbon atoms	5b
1.40 Explain the properties of metals, including malleability and the ability to conduct electricity	5b
1.41 Describe the limitations of particular representations and models, to include dot and cross, ball and stick models and two- and three-dimensional representations	5b
1.42 Describe most metals as shiny solids which have high melting points, high density and are good conductors of electricity whereas most non-metals have low boiling points and are poor conductors of electricity	

Use of mathematics

- Represent three dimensional shapes in two dimensions and vice versa when looking at chemical structures, e.g. allotropes of carbon (5b).
- Translate information between diagrammatic and numerical forms (4a).

Calculations involving masses

Students should:		Maths skills
1.43	Calculate relative formula mass given relative atomic masses	1a, 1c
1.44	Calculate the formulae of simple compounds from reacting masses or percentage composition and understand that these are empirical formulae	1a, 1c 2a
1.45	Deduce: a the empirical formula of a compound from the formula of its molecule b the molecular formula of a compound from its empirical formula and its relative molecular mass	1c
1.46	Describe an experiment to determine the empirical formula of a simple compound such as magnesium oxide	1a, 1c 2a
1.47	Explain the law of conservation of mass applied to: a a closed system including a precipitation reaction in a closed flask b a non-enclosed system including a reaction in an open flask that takes in or gives out a gas	1a
1.48	Calculate masses of reactants and products from balanced equations, given the mass of one substance	1a, 1c 2a
1.49	Calculate the concentration of solutions in g dm^{-3}	1a, 1c 2a 3b, 3c
1.50	**Recall that one mole of particles of a substance is defined as:** **a the Avogadro constant number of particles (6.02×10^{23} atoms, molecules, formulae or ions) of that substance** **b a mass of 'relative particle mass' g**	1b

Students should:	Maths skills
1.51 **Calculate the number of:** **a moles of particles of a substance in a given mass of that substance and vice versa** **b particles of a substance in a given number of moles of that substance and vice versa** **c particles of a substance in a given mass of that substance and vice versa**	1a, 1b, 1c 2a 3a, 3b, 3c
1.52 **Explain why, in a reaction, the mass of product formed is controlled by the mass of the reactant which is not in excess**	1c
1.53 **Deduce the stoichiometry of a reaction from the masses of the reactants and products**	1a, 1c

Use of mathematics

- Arithmetic computation and ratio when determining empirical formulae, balancing equations (1a and 1c).
- Arithmetic computation, ratio, percentage and multistep calculations permeates quantitative chemistry (1a, 1c and 1d).
- **Calculations with numbers written in standard form when using the Avogadro constant (1b)**.
- Change the subject of a mathematical equation (3b and 3c).
- Provide answers to an appropriate number of significant figures (2a).
- **Convert units where appropriate particularly from mass to moles (1c)**.

Suggested practicals

- Investigate the size of an oil molecule.
- Investigate the properties of a metal, such as electrical conductivity.
- Investigate the different types of bonding: metallic, covalent and ionic.
- Investigate the typical properties of simple and giant covalent compounds and ionic compounds.
- Classify different types of elements and compounds by investigating their melting points and boiling points, solubility in water and electrical conductivity (as solids and in solution), including sodium chloride, magnesium sulfate, hexane, liquid paraffin, silicon(IV) oxide, copper sulfate, and sucrose (sugar).
- Determine the empirical formula of a simple compound.
- Investigate mass changes before and after reactions.
- Determine the formula of a hydrated salt such as copper sulfate by heating to drive off water of crystallisation.

Topics for Paper 1

Topic 2 – States of matter and mixtures

States of matter

Students should:		Maths skills
2.1	Describe the arrangement, movement and the relative energy of particles in each of the three states of matter: solid, liquid and gas	5b
2.2	Recall the names used for the interconversions between the three states of matter, recognising that these are physical changes: contrasted with chemical reactions that result in chemical changes	
2.3	Explain the changes in arrangement, movement and energy of particles during these interconversions	5b
2.4	Predict the physical state of a substance under specified conditions, given suitable data	1d 4a

Use of mathematics

- Translate information between diagrammatic and numerical forms (4a).

Methods of separating and purifying substances

Students should:		Maths skills
2.5	Explain the difference between the use of 'pure' in chemistry compared with its everyday use and the differences in chemistry between a pure substance and a mixture	
2.6	Interpret melting point data to distinguish between pure substances which have a sharp melting point and mixtures which melt over a range of temperatures	1a
2.7	Explain the types of mixtures that can be separated by using the following experimental techniques: a simple distillation b fractional distillation c filtration d crystallisation e paper chromatography	
2.8	Describe an appropriate experimental technique to separate a mixture, knowing the properties of the components of the mixture	

Students should:		Maths skills
2.9	Describe paper chromatography as the separation of mixtures of soluble substances by running a solvent (mobile phase) through the mixture on the paper (the paper contains the stationary phase), which causes the substances to move at different rates over the paper	
2.10	Interpret a paper chromatogram: a to distinguish between pure and impure substances b to identify substances by comparison with known substances c to identify substances by calculation and use of R_f values	3a, 3c 4a
2.11	*Core Practical: Investigate the composition of inks using simple distillation and paper chromatography*	
2.12	Describe how: a waste and ground water can be made potable, including the need for sedimentation, filtration and chlorination b sea water can be made potable by using distillation c water used in analysis must not contain any dissolved salts	

Use of mathematics

- Interpret charts (4a).

Topic 3 – Chemical changes

Acids

Students should:		Maths skills
3.1	Recall that acids in solution are sources of hydrogen ions and alkalis in solution are sources of hydroxide ions	
3.2	Recall that a neutral solution has a pH of 7 and that acidic solutions have lower pH values and alkaline solutions higher pH values	
3.3	Recall the effect of acids and alkalis on indicators, including litmus, methyl orange and phenolphthalein	
3.4	**Recall that the higher the concentration of hydrogen ions in an acidic solution, the lower the pH; and the higher the concentration of hydroxide ions in an alkaline solution, the higher the pH**	1c
3.5	**Recall that as hydrogen ion concentration in a solution increases by a factor of 10, the pH of the solution decreases by 1**	1c
3.6	*Core Practical: Investigate the change in pH on adding powdered calcium hydroxide* or *calcium oxide to a fixed volume of dilute hydrochloric acid*	4a, 4c
3.7	**Explain the terms dilute and concentrated, with respect to amount of substances in solution**	
3.8	**Explain the terms weak and strong acids, with respect to the degree of dissociation into ions**	
3.9	Recall that a base is any substance that reacts with an acid to form a salt and water only	
3.10	Recall that alkalis are soluble bases	
3.11	Explain the general reactions of aqueous solutions of acids with: a metals b metal oxides c metal hydroxides d metal carbonates to produce salts	
3.12	Describe the chemical test for: a hydrogen b carbon dioxide (using limewater)	
3.13	Describe a neutralisation reaction as a reaction between an acid and a base	
3.14	Explain an acid-alkali neutralisation as a reaction in which hydrogen ions (H^+) from the acid react with hydroxide ions (OH^-) from the alkali to form water	

Students should:		Maths skills
3.15	Explain why, if soluble salts are prepared from an acid and an insoluble reactant: a excess of the reactant is added b the excess reactant is removed c the solution remaining is only salt and water	
3.16	Explain why, if soluble salts are prepared from an acid and a soluble reactant: a titration must be used b the acid and the soluble reactant are then mixed in the correct proportions c the solution remaining, after reaction, is only salt and water	
3.17	*Core Practical: Investigate the preparation of pure, dry hydrated copper sulfate crystals starting from copper oxide including the use of a water bath*	
3.18	Describe how to carry out an acid-alkali titration, using burette, pipette and a suitable indicator, to prepare a pure, dry salt	
3.19	Recall the general rules which describe the solubility of common types of substances in water: a all common sodium, potassium and ammonium salts are soluble b all nitrates are soluble c common chlorides are soluble except those of silver and lead d common sulfates are soluble except those of lead, barium and calcium e common carbonates and hydroxides are insoluble except those of sodium, potassium and ammonium	
3.20	Predict, using solubility rules, whether or not a precipitate will be formed when named solutions are mixed together, naming the precipitate if any	
3.21	Describe the method used to prepare a pure, dry sample of an insoluble salt	

Suggested practicals

- Carry out simple neutralisation reactions of acids, using metal oxides, hydroxides and carbonates.
- Carry out tests for hydrogen and carbon dioxide.
- Prepare an insoluble salt by precipitation.

Electrolytic processes

Students should:	Maths skills
3.22 Recall that electrolytes are ionic compounds in the molten state or dissolved in water	
3.23 Describe electrolysis as a process in which electrical energy, from a direct current supply, decomposes electrolytes	
3.24 Explain the movement of ions during electrolysis, in which: a positively charged cations migrate to the negatively charged cathode b negatively charged anions migrate to the positively charged anode	
3.25 Explain the formation of the products in the electrolysis, using inert electrodes, of some electrolytes, including: a copper chloride solution b sodium chloride solution c sodium sulfate solution d water acidified with sulfuric acid e molten lead bromide (demonstration)	
3.26 Predict the products of electrolysis of other binary, ionic compounds in the molten state	
3.27 **Write half equations for reactions occurring at the anode and cathode in electrolysis**	1c
3.28 **Explain oxidation and reduction in terms of loss or gain of electrons**	
3.29 **Recall that reduction occurs at the cathode and that oxidation occurs at the anode in electrolysis reactions**	
3.30 Explain the formation of the products in the electrolysis of copper sulfate solution, using copper electrodes, and how this electrolysis can be used to purify copper	
3.31 *Core Practical: Investigate the electrolysis of copper sulfate solution with inert electrodes and copper electrodes*	1a 4a, 4b, 4c, 4d

Suggested practicals

- Investigate the electrolysis of:
  - a copper chloride solution
  - b sodium chloride solution
  - c sodium sulfate solution
  - d water acidified with sulfuric acid
  - e molten lead bromide (demonstration).

Topic 4 – Extracting metals and equilibria

Obtaining and using metals

Students should:		Maths skills
4.1	Deduce the relative reactivity of some metals, by their reactions with water, acids and salt solutions	
4.2	**Explain displacement reactions as redox reactions, in terms of gain or loss of electrons**	
4.3	Explain the reactivity series of metals (potassium, sodium, calcium, magnesium, aluminium, (carbon), zinc, iron, (hydrogen), copper, silver, gold) in terms of the reactivity of the metals with water and dilute acids and that these reactions show the relative tendency of metal atoms to form cations	
4.4	Recall that: a most metals are extracted from ores found in the Earth's crust b unreactive metals are found in the Earth's crust as the uncombined elements	
4.5	Explain oxidation as the gain of oxygen and reduction as the loss of oxygen	
4.6	Recall that the extraction of metals involves reduction of ores	
4.7	Explain why the method used to extract a metal from its ore is related to its position in the reactivity series and the cost of the extraction process, illustrated by a heating with carbon (including iron) b electrolysis (including aluminium) (knowledge of the blast furnace is not required)	
4.8	**Evaluate alternative biological methods of metal extraction (bacterial and phytoextraction)**	
4.9	Explain how a metal's relative resistance to oxidation is related to its position in the reactivity series	
4.10	Evaluate the advantages of recycling metals, including economic implications and how recycling can preserve both the environment and the supply of valuable raw materials	
4.11	Describe that a life-cycle assessment for a product involves consideration of the effect on the environment of obtaining the raw materials, manufacturing the product, using the product and disposing of the product when it is no longer useful	
4.12	Evaluate data from a life cycle assessment of a product	

Suggested practicals

- Investigate methods for extracting metals from their ores.
- Investigate simple oxidation and reduction reactions, such as burning elements in oxygen or competition reactions between metals and metal oxides.

Reversible reactions and equilibria

Students should:		Maths skills
4.13	Recall that chemical reactions are reversible, the use of the symbol ⇌ in equations and that the direction of some reversible reactions can be altered by changing the reaction conditions	
4.14	Explain what is meant by dynamic equilibrium	
4.15	Describe the formation of ammonia as a reversible reaction between nitrogen (extracted from the air) and hydrogen (obtained from natural gas) and that it can reach a dynamic equilibrium	
4.16	Recall the conditions for the Haber process as: a temperature 450 °C b pressure 200 atmospheres c iron catalyst	
4.17	**Predict how the position of a dynamic equilibrium is affected by changes in:** **a temperature** **b pressure** **c concentration**	

Suggested practicals

- Investigate simple reversible reactions, such as the decomposition of ammonium chloride.

Topic 5 – Separate chemistry 1

Transition metals, alloys and corrosion

Students should:		Maths skills
5.1C	Recall that most metals are transition metals and that their typical properties include: a high melting point b high density c the formation of coloured compounds d catalytic activity of the metals and their compounds as exemplified by iron	
5.2C	Recall that the oxidation of metals results in corrosion	
5.3C	Explain how rusting of iron can be prevented by: a exclusion of oxygen b exclusion of water c sacrificial protection	
5.4C	Explain how electroplating can be used to improve the appearance and/or the resistance to corrosion of metal objects	
5.5C	Explain, using models, why converting pure metals into alloys often increases the strength of the product	5b
5.6C	Explain why iron is alloyed with other metals to produce alloy steels	
5.7C	Explain how the uses of metals are related to their properties (and vice versa), including aluminium, copper and gold and their alloys including magnalium and brass	

Suggested practicals

- Carry out an activity to show that transition metal salts have a variety of colours.
- Investigate the rusting of iron.
- Electroplate a metal object.
- Make an alloy or investigate the properties of alloys.

Quantitative analysis

Students should:		Maths skills
5.8C	**Calculate the concentration of solutions in mol dm^{-3} and convert concentration in g dm^{-3} into mol dm^{-3} and vice versa**	1a, 1b, 1c, 1d 2a 3b, 3c
5.9C	*Core Practical: Carry out an accurate acid-alkali titration, using burette, pipette and a suitable indicator*	
5.10C	**Carry out simple calculations using the results of titrations to calculate an unknown concentration of a solution or an unknown volume of solution required**	1a, 1c, 1d 2a, 2b 3a, 3b, 3c
5.11C	Calculate the percentage yield of a reaction from the actual yield and the theoretical yield	1a, 1c, 1d 2a 3b, 3c
5.12C	Describe that the actual yield of a reaction is usually less than the theoretical yield and that the causes of this include: a incomplete reactions b practical losses during the experiment c competing, unwanted reactions (side reactions)	
5.13C	Recall the atom economy of a reaction forming a desired product	
5.14C	Calculate the atom economy of a reaction forming a desired product	1a, 1c, 1d 2a 3c
5.15C	**Explain why a particular reaction pathway is chosen to produce a specified product, given appropriate data such as atom economy, yield, rate, equilibrium position and usefulness of by-products**	
5.16C	**Describe the molar volume, of any gas at room temperature and pressure, as the volume occupied by one mole of molecules of any gas at room temperature and pressure** **(The molar volume will be provided as 24 dm^3 or 24000 cm^3 in calculations where it is required)**	
5.17C	**Use the molar volume and balanced equations in calculations involving the masses of solids and volumes of gases**	1a, 1c, 2a 3b, 3c
5.18C	**Use Avogadro's law to calculate volumes of gases involved in a gaseous reaction, given the relevant equation**	1a, 1c, 1d

Use of mathematics

- Arithmetic computation when calculating yields and atom economy (1a and 1c).
- Arithmetic computation, ratio, percentage and multistep calculations permeates quantitative chemistry (1a, 1c and 1d).
- Change the subject of a mathematical equation (3b and 3c).
- Provide answers to an appropriate number of significant figures (2a).
- **Convert units where appropriate particularly from mass to moles (1c)**.

Suggested practicals

- Prepare a substance and calculate the percentage yield, given the theoretical yield.
- Determine the volume of one mole of hydrogen gas by using the reaction of magnesium with hydrochloric acid.

Dynamic equilibria

Students should:		Maths skills
5.19C	Describe the Haber process as a reversible reaction between nitrogen and hydrogen to form ammonia	
5.20C	**Predict how the rate of attainment of equilibrium is affected by:** **a changes in temperature** **b changes in pressure** **c changes in concentration** **d use of a catalyst**	
5.21C	**Explain how, in industrial reactions, including the Haber process, conditions used are related to:** **a the availability and cost of raw materials and energy supplies** **b the control of temperature, pressure and catalyst used produce an acceptable yield in an acceptable time**	
5.22C	Recall that fertilisers may contain nitrogen, phosphorus and potassium compounds to promote plant growth	
5.23C	Describe how ammonia reacts with nitric acid to produce a salt that is used as a fertiliser	
5.24C	Describe and compare: a the laboratory preparation of ammonium sulfate from ammonia solution and dilute sulfuric acid on a small scale b the industrial production of ammonium sulfate, used as a fertiliser, in which several stages are required to produce ammonia and sulfuric acid from their raw materials and the production is carried out on a much larger scale (details of the industrial production of sulfuric acid are not required)	

Suggested practicals

- Prepare a sample of ammonium sulfate from ammonia solution and dilute sulfuric acid.

Chemical cells and fuel cells

Students should:		Maths skills
5.25C	Recall that a chemical cell produces a voltage until one of the reactants is used up	
5.26C	Recall that in a hydrogen–oxygen fuel cell hydrogen and oxygen are used to produce a voltage and water is the only product	
5.27C	Evaluate the strengths and weaknesses of fuel cells for given uses	

Topics for Paper 2

Topic 6 – Groups in the periodic table

Group 1

Students should:		Maths skills
6.1	Explain why some elements can be classified as alkali metals (group 1), halogens (group 7) or noble gases (group 0), based on their position in the periodic table	
6.2	Recall that alkali metals: a are soft b have relatively low melting points	
6.3	Describe the reactions of lithium, sodium and potassium with water	
6.4	Describe the pattern in reactivity of the alkali metals, lithium, sodium and potassium, with water; and use this pattern to predict the reactivity of other alkali metals	
6.5	Explain this pattern in reactivity in terms of electronic configurations	

Group 7

Students should:		Maths skills
6.6	Recall the colours and physical states of chlorine, bromine and iodine at room temperature	
6.7	Describe the pattern in the physical properties of the halogens, chlorine, bromine and iodine, and use this pattern to predict the physical properties of other halogens	1d 2c
6.8	Describe the chemical test for chlorine	
6.9	Describe the reactions of the halogens, chlorine, bromine and iodine, with metals to form metal halides, and use this pattern to predict the reactions of other halogens	
6.10	Recall that the halogens, chlorine, bromine and iodine, form hydrogen halides which dissolve in water to form acidic solutions, and use this pattern to predict the reactions of other halogens	
6.11	Describe the relative reactivity of the halogens chlorine, bromine and iodine, as shown by their displacement reactions with halide ions in aqueous solution, and use this pattern to predict the reactions of astatine	
6.12	**Explain why these displacement reactions are redox reactions in terms of gain and loss of electrons, identifying which of the substances are oxidised and which are reduced**	

Students should:		Maths skills
6.13	Explain the relative reactivity of the halogens in terms of electronic configurations	

Group 0

Students should:		Maths skills
6.14	Explain why the noble gases are chemically inert, compared with the other elements, in terms of their electronic configurations	
6.15	Explain how the uses of noble gases depend on their inertness, low density and/or non-flammability	
6.16	Describe the pattern in the physical properties of some noble gases and use this pattern to predict the physical properties of other noble gases	1d 2c

Suggested practicals

- Investigate displacement reactions of halogens reacting with halide ions in solution.

Topic 7 – Rates of reaction and energy changes

Rates of reaction

Students should:		Maths skills
7.1	*Core Practical: Investigate the effects of changing the conditions of a reaction on the rates of chemical reactions by:* *a measuring the production of a gas (in the reaction between hydrochloric acid and marble chips)* *b observing a colour change (in the reaction between sodium thiosulfate and hydrochloric acid)*	1a, 1c 4a, 4b, 4c, 4d, 4e
7.2	Suggest practical methods for determining the rate of a given reaction	4b, 4c, 4d, 4e
7.3	Explain how reactions occur when particles collide and that rates of reaction are increased when the frequency and/or energy of collisions is increased	1c
7.4	Explain the effects on rates of reaction of changes in temperature, concentration, surface area to volume ratio of a solid and pressure (on reactions involving gases) in terms of frequency and/or energy of collisions between particles	1c, 1d 5c
7.5	Interpret graphs of mass, volume or concentration of reactant or product against time	1c 4a, 4d, 4e
7.6	Describe a catalyst as a substance that speeds up the rate of a reaction without altering the products of the reaction, being itself unchanged chemically and in mass at the end of the reaction	
7.7	Explain how the addition of a catalyst increases the rate of a reaction in terms of activation energy	
7.8	Recall that enzymes are biological catalysts and that enzymes are used in the production of alcoholic drinks	

Use of mathematics

- Arithmetic computation, ratio when measuring rates of reaction (1a and 1c).
- Drawing and interpreting appropriate graphs from data to determine rate of reaction (4b and 4c).
- Determining gradients of graphs as a measure of rate of change to determine rate (4d and **4e**).
- Proportionality when comparing factors affecting rate of reaction (1c).

Suggested practicals

- Investigate the effect of potential catalysts on the rate of decomposition of hydrogen peroxide.

Heat energy changes in chemical reactions

Students should:		Maths skills
7.9	Recall that changes in heat energy accompany the following changes: a salts dissolving in water b neutralisation reactions c displacement reactions d precipitation reactions and that, when these reactions take place in solution, temperature changes can be measured to reflect the heat changes	
7.10	Describe an exothermic change or reaction as one in which heat energy is given out	
7.11	Describe an endothermic change or reaction as one in which heat energy is taken in	
7.12	Recall that the breaking of bonds is endothermic and the making of bonds is exothermic	
7.13	Recall that the overall heat energy change for a reaction is: a exothermic if more heat energy is released in forming bonds in the products than is required in breaking bonds in the reactants b endothermic if less heat energy is released in forming bonds in the products than is required in breaking bonds in the reactants	
7.14	**Calculate the energy change in a reaction given the energies of bonds (in kJ mol^{-1})**	1a, 1c
7.15	Explain the term activation energy	
7.16	Draw and label reaction profiles for endothermic and exothermic reactions, identifying activation energy	4a

Use of mathematics

- Arithmetic computation when calculating energy changes (1a).
- Interpretation of charts and graphs when dealing with reaction profiles (4a).

Suggested practicals

- Measure temperature changes accompanying some of the following types of change:
  - a salts dissolving in water
  - b neutralisation reactions
  - c displacement reactions
  - d precipitation reactions.

Topic 8 – Fuels and Earth science

Fuels

Students should:		Maths skills
8.1	Recall that hydrocarbons are compounds that contain carbon and hydrogen only	
8.2	Describe crude oil as: a a complex mixture of hydrocarbons b containing molecules in which carbon atoms are in chains or rings (names, formulae and structures of specific ring molecules not required) c an important source of useful substances (fuels and feedstock for the petrochemical industry) d a finite resource	
8.3	Describe and explain the separation of crude oil into simpler, more useful mixtures by the process of fractional distillation	
8.4	Recall the names and uses of the following fractions: a gases, used in domestic heating and cooking b petrol, used as fuel for cars c kerosene, used as fuel for aircraft d diesel oil, used as fuel for some cars and trains e fuel oil, used as fuel for large ships and in some power stations f bitumen, used to surface roads and roofs	
8.5	Explain how hydrocarbons in different fractions differ from each other in: a the number of carbon and hydrogen atoms their molecules contain b boiling points c ease of ignition d viscosity and are mostly members of the alkane homologous series	4a, 4c
8.6	Explain an homologous series as a series of compounds which: a have the same general formula b differ by CH_2 in molecular formulae from neighbouring compounds c show a gradual variation in physical properties, as exemplified by their boiling points d have similar chemical properties	1c, 1d 4a

Students should:		Maths skills
8.7	Describe the complete combustion of hydrocarbon fuels as a reaction in which: a carbon dioxide and water are produced b energy is given out	
8.8	Explain why the incomplete combustion of hydrocarbons can produce carbon and carbon monoxide	
8.9	Explain how carbon monoxide behaves as a toxic gas	
8.10	Describe the problems caused by incomplete combustion producing carbon monoxide and soot in appliances that use carbon compounds as fuels	
8.11	Explain how impurities in some hydrocarbon fuels result in the production of sulfur dioxide	
8.12	Explain some problems associated with acid rain caused when sulfur dioxide dissolves in rain water	
8.13	Explain why, when fuels are burned in engines, oxygen and nitrogen can react together at high temperatures to produce oxides of nitrogen, which are pollutants	
8.14	Evaluate the advantages and disadvantages of using hydrogen, rather than petrol, as a fuel in cars	
8.15	Recall that petrol, kerosene and diesel oil are non-renewable fossil fuels obtained from crude oil and methane is a non-renewable fossil fuel found in natural gas	
8.16	Explain how cracking involves the breaking down of larger, saturated hydrocarbon molecules (alkanes) into smaller, more useful ones, some of which are unsaturated (alkenes)	1c
8.17	Explain why cracking is necessary	2c

Suggested practicals

- Investigate the fractional distillation of synthetic crude oil and the ease of ignition and viscosity of the fractions.
- Investigate the products produced from the complete combustion of a hydrocarbon.
- Investigate the cracking of paraffin oil.

Earth and atmospheric science

Students should:		Maths skills
8.18	Recall that the gases produced by volcanic activity formed the Earth's early atmosphere	
8.19	Describe that the Earth's early atmosphere was thought to contain: a little or no oxygen b a large amount of carbon dioxide c water vapour d small amounts of other gases and interpret evidence relating to this	2c 3a 4a
8.20	Explain how condensation of water vapour formed oceans	
8.21	Explain how the amount of carbon dioxide in the atmosphere was decreased when carbon dioxide dissolved as the oceans formed	
8.22	Explain how the growth of primitive plants used carbon dioxide and released oxygen by photosynthesis and consequently the amount of oxygen in the atmosphere gradually increased	
8.23	Describe the chemical test for oxygen	
8.24	Describe how various gases in the atmosphere, including carbon dioxide, methane and water vapour, absorb heat radiated from the Earth, subsequently releasing energy which keeps the Earth warm: this is known as the greenhouse effect	
8.25	Evaluate the evidence for human activity causing climate change, considering: a the correlation between the change in atmospheric carbon dioxide concentration, the consumption of fossil fuels and temperature change b the uncertainties caused by the location where these measurements are taken and historical accuracy	2c, 2h 4a
8.26	Describe: a the composition of today's atmosphere b the potential effects on the climate of increased levels of carbon dioxide and methane generated by human activity, including burning fossil fuels and livestock farming c that these effects may be mitigated: consider scale, risk and environmental implications	

Use of mathematics

- Extract and interpret information from charts, graphs and tables (2c and 4a).
- Use orders of magnitude to evaluate the significance of data (2h).

Suggested practicals

- Investigate the proportion of oxygen in the atmosphere.
- Investigate the presence of water vapour and carbon dioxide in the atmosphere.
- Investigate the volume of air used up and products formed when candles are burned.
- Carry out the test for oxygen.

Topic 9 – Separate chemistry 2

Qualitative analysis: tests for ions

Students should:		Maths skills
9.1C	Explain why the test for any ion must be unique	
9.2C	Describe flame tests to identify the following ions in solids: a lithium ion, Li^+ (red) b sodium ion, Na^+ (yellow) c potassium ion, K^+ (lilac) d calcium ion, Ca^{2+} (orange-red) e copper ion, Cu^{2+} (blue-green)	
9.3C	Describe tests to identify the following ions in solids or solutions as appropriate: a aluminium ion, Al^{3+} b calcium ion, Ca^{2+} c copper ion, Cu^{2+} d iron(II) ion, Fe^{2+} e iron(III) ion, Fe^{3+} f ammonium ion, NH_4^+ using sodium hydroxide solution	
9.4C	Describe the chemical test for ammonia	
9.5C	Describe tests to identify the following ions in solids or solutions as appropriate: a carbonate ion, CO_3^{2-}, using dilute acid and identifying the carbon dioxide evolved b sulfate ion, SO_4^{2-}, using dilute hydrochloric acid and barium chloride solution c chloride ion, Cl^-, bromide ion, Br^-, iodide ion, I^-, using dilute nitric acid and silver nitrate solution	
9.6C	*Core Practical: Identify the ions in unknown salts, using the tests for the specified cations and anions in 9.2C, 9.3C, 9.4C, 9.5C*	
9.7C	Identify the ions in unknown salts, using results of the tests above	
9.8C	Describe that instrumental methods of analysis are available and that these may improve sensitivity, accuracy and speed of tests	

Students should:	Maths skills
9.9C Evaluate data from a flame photometer: a to determine the concentration of ions in dilute solution using a calibration curve b to identify metal ions by comparing the data with reference data (no knowledge of the instrument or how it works is required)	4a

Use of mathematics

- Interpret charts, particularly in spectroscopy (4a).

Hydrocarbons

Students should:	Maths skills
9.10C Recall the formulae of molecules of the alkanes, methane, ethane, propane and butane, and draw the structures of these molecules, showing all covalent bonds	5b
9.11C Explain why the alkanes are saturated hydrocarbons	
9.12C Recall the formulae of molecules of the alkenes, ethene, propene, butene, and draw the structures of these molecules, showing all covalent bonds (but-1-ene and but-2-ene only)	5b
9.13C Explain why the alkenes are unsaturated hydrocarbons, describing that their molecules contain the functional group C=C	
9.14C Recall the addition reaction of ethene with bromine, showing the structures of reactants and products, and extend this to other alkenes	5b
9.15C Explain how bromine water is used to distinguish between alkanes and alkenes	
9.16C Describe how the complete combustion of alkanes and alkenes involves the oxidation of the hydrocarbons to produce carbon dioxide and water	

Suggested practicals

- Test for unsaturation using bromine water.

Polymers

Students should:	Maths skills
9.17C Recall that a polymer is a substance of high average relative molecular mass made up of small repeating units	
9.18C Describe: a how ethene molecules can combine together in a polymerisation reaction b that the addition polymer formed is called poly(ethene) (conditions and mechanisms not required)	5b
9.19C Describe how other addition polymers can be made by combining together other monomer molecules containing C=C, to include poly(propene), poly(chloroethene) (PVC) and poly(tetrafluoroethene) (PTFE) (conditions and mechanisms not required)	5b
9.20C Deduce the structure of a monomer from the structure of an addition polymer and vice versa	5b
9.21C Explain how the uses of polymers are related to their properties and vice versa: including poly(ethene), poly(propene), poly(chloroethene) (PVC) and poly(tetrafluoroethene) (PTFE)	
9.22C **Explain:** **a why polyesters are condensation polymers** **b how a polyester is formed when a monomer molecule containing two carboxylic acid groups is reacted with a monomer molecule containing two alcohol groups** **c how a molecule of water is formed each time an ester link is formed**	5b
9.23C Describe some problems associated with polymers including the: a availability of starting materials b persistence in landfill sites, due to non-biodegradability c gases produced during disposal by combustion d requirement to sort polymers so that they can be melted and reformed into a new product	
9.24C Evaluate the advantages and disadvantages of recycling polymers, including economic implications, availability of starting materials and environmental impact	
9.25C Recall that: a DNA is a polymer made from four different monomers called nucleotides (names of nucleotides not required) b starch is a polymer based on sugars c proteins are polymers based on amino acids	5b

Alcohols and carboxylic acids

Students should:		Maths skills
9.26C	Recall the formulae of molecules of the alcohols, methanol, ethanol, propanol (propan-1-ol only) and butanol (butan-1-ol only), and draw the structures of these molecules, showing all covalent bonds	5b
9.27C	Recall that the functional group in alcohols is –OH and that alcohols can be dehydrated to form alkenes	
9.28C	*Core Practical: Investigate the temperature rise produced in a known mass of water by the combustion of the alcohols ethanol, propanol, butanol and pentanol*	1a, 1c 2c
9.29C	Recall the formulae of molecules of the carboxylic acids, methanoic, ethanoic, propanoic and butanoic acids, and draw the structures of these molecules, showing all covalent bonds	5b
9.30C	Recall that the functional group in carboxylic acids is –COOH and that solutions of carboxylic acids have typical acidic properties	
9.31C	Recall that ethanol can be oxidised to produce ethanoic acid and extend this to other alcohols (reagents not required)	
9.32C	Recall members of a given homologous series have similar reactions because their molecules contain the same functional group and use this to predict the products of other members of these series	
9.33C	Describe the production of ethanol by fermentation of carbohydrates in aqueous solution, using yeast to provide enzymes	
9.34C	Explain how to obtain a concentrated solution of ethanol by fractional distillation of the fermentation mixture	

Suggested practicals

- Prepare a solution of ethanol by fermentation.

Bulk and surface properties of matter including nanoparticles

Students should:		Maths skills
9.35C	Compare the size of nanoparticles with the sizes of atoms and molecules	1b, 1d 2h
9.36C	Describe how the properties of nanoparticulate materials are related to their uses including surface area to volume ratio of the particles they contain, including sunscreens	1c 5c
9.37C	Explain the possible risks associated with some nanoparticulate materials	
9.38C	Compare, using data, the physical properties of glass and clay ceramics, polymers, composites and metals	2c

Students should:		Maths skills
9.39C	Explain why the properties of a material make it suitable for a given use and use data to select materials appropriate for specific uses	2c

Use of mathematics

- Estimate size and scale of atoms and nanoparticles (1d).
- Interpret, order and calculate with numbers written in standard form when dealing with nanoparticles (1b).
- Use ratios when considering relative sizes and surface area to volume comparisons (1c).
- Calculate surface areas and volumes of cubes (5c).

3 Assessment information

Paper 1 (Paper code: 1CH0/1F and 1CH0/1H)

- First assessment: May/June 2018.
- The assessment is 1 hour and 45 minutes.
- The assessment is out of 100 marks.
- The assessment consists of ten questions.
- Students must answer all questions.
- The paper will include multiple-choice, short answer questions, calculations and extended open-response questions.
- Calculators may be used in the examination.
- Available at foundation tier and higher tier.
- Students must complete all assessments for this qualification in the same tier.
- The Foundation tier paper will target grades 1–5.
- The Higher tier paper will target grades 4–9.
- 27 marks of the paper will be overlap questions that appear in both the foundation and higher tier papers.

Content assessed

- Topic 1 – Key concepts in chemistry
- Topic 2 – States of matter and mixtures
- Topic 3 – Chemical changes
- Topic 4 – Extracting metals and equilibria
- Topic 5 – Separate chemistry 1

Paper 2 (Paper code: 1CH0/2F and 1CH0/2H)

- First assessment: May/June 2018.
- The assessment is 1 hour and 45 minutes.
- The assessment is out of 100 marks.
- The assessment consists of ten questions.
- Students must answer all questions.
- The paper will include multiple-choice, short answer questions, calculations and extended open-response questions.
- Calculators may be used in the examination.
- Available at foundation tier and higher tier.
- Students must complete all assessments for this qualification in the same tier.
- The foundation tier paper will target grades 1–5.
- The higher tier paper will target grades 4–9.
- 27 marks of the paper will be overlap questions that appear in both the foundation and higher tier papers.

Content assessed

- Topic 1 – Key concepts in chemistry
- Topic 6 – Groups in the periodic table
- Topic 7 – Rates of reaction and energy changes
- Topic 8 – Fuels and Earth science
- Topic 9 – Separate chemistry 2

Assessment Objectives

Students must:		% in GCSE
AO1	Demonstrate knowledge and understanding of: • scientific ideas • scientific techniques and procedures.	40
AO2	Apply knowledge and understanding of: • scientific ideas • scientific enquiry, techniques and procedures.	40
AO3	Analyse information and ideas to: • interpret and evaluate • make judgements and draw conclusions • develop and improve experimental procedures.	20
	Total	**100%**

Breakdown of Assessment Objectives

Paper	Assessment Objectives			Total for all Assessment Objectives
	AO1 %	AO2 %	AO3 %	
Paper 1 (F/H)	20	20	10	50%
Paper 2 (F/H)	20	20	10	50%
Total for GCSE	**40% ±3**	**40% ±3**	**20% ±3**	**100%**

Synoptic assessment

Synoptic assessment requires students to work across different parts of a qualification and to show their accumulated knowledge and understanding of a topic or subject area.

Synoptic assessment enables students to show their ability to combine their skills, knowledge and understanding with breadth and depth of the subject.

Questions that naturally draw together different aspects of chemistry will assess synopticity.

Sample assessment materials

Sample papers and mark schemes can be found in the *Pearson Edexcel Level 1/Level 2 GCSE (9–1) in Chemistry Sample Assessment Materials* (SAMs) document.

4 Administration and general information

Entries

Details of how to enter students for the examinations for this qualification can be found in our *UK Information Manual*. A copy is made available to all examinations officers and is available on our website: qualifications.pearson.com

Discount code and performance tables

Centres should be aware that students who enter for more than one GCSE, or other Level 2 qualifications with the same discount code, will have only the grade for their 'first entry' counted for the purpose of the school and college performance tables (please see *Appendix 8: Codes*). For further information about what constitutes 'first entry' and full details of how this policy is applied, please refer to the DfE website: www.gov.uk/government/organisations/department-for-education

Students should be advised that if they take two GCSEs with the same discount code, schools and colleges they wish to progress to are likely to take the view that this achievement is equivalent to only one GCSE. The same view may be taken if students take two GCSEs or other Level 2 qualifications that have different discount codes but have significant overlap of content. Students or their advisers who have any doubts about their subject combinations should check with the institution they wish to progress to before embarking on their programmes.

Access arrangements, reasonable adjustments, special consideration and malpractice

Equality and fairness are central to our work. Our equality policy requires all students to have equal opportunity to access our qualifications and assessments, and our qualifications to be awarded in a way that is fair to every student.

We are committed to making sure that:

- students with a protected characteristic (as defined by the Equality Act 2010) are not, when they are undertaking one of our qualifications, disadvantaged in comparison to students who do not share that characteristic
- all students achieve the recognition they deserve for undertaking a qualification and that this achievement can be compared fairly to the achievement of their peers.

Language of assessment

Assessment of this qualification will be available in English. All student work must be in English.

Access arrangements

Access arrangements are agreed before an assessment. They allow students with special educational needs, disabilities or temporary injuries to:

- access the assessment
- show what they know and can do without changing the demands of the assessment.

The intention behind an access arrangement is to meet the particular needs of an individual student with a disability, without affecting the integrity of the assessment. Access arrangements are the principal way in which awarding bodies comply with the duty under the Equality Act 2010 to make 'reasonable adjustments'.

Access arrangements should always be processed at the start of the course. Students will then know what is available and have the access arrangement(s) in place for assessment.

Reasonable adjustments

The Equality Act 2010 requires an awarding organisation to make reasonable adjustments where a person with a disability would be at a substantial disadvantage in undertaking an assessment. The awarding organisation is required to take reasonable steps to overcome that disadvantage.

A reasonable adjustment for a particular person may be unique to that individual and therefore might not be in the list of available access arrangements.

Whether an adjustment will be considered reasonable will depend on a number of factors, which will include:

- the needs of the student with the disability
- the effectiveness of the adjustment
- the cost of the adjustment; and
- the likely impact of the adjustment on the student with the disability and other students.

An adjustment will not be approved if it involves unreasonable costs to the awarding organisation, timeframes or affects the security or integrity of the assessment. This is because the adjustment is not 'reasonable'.

Special consideration

Special consideration is a post-examination adjustment to a student's mark or grade to reflect temporary injury, illness or other indisposition at the time of the examination/ assessment, which has had, or is reasonably likely to have had, a material effect on a candidate's ability to take an assessment or demonstrate their level of attainment in an assessment.

Private candidates

Private candidates can complete this qualification only if they carry-out the mandatory core practicals with the centre in which they are sitting the exams, as long as the centre is willing to accept the candidate. These candidates need to fulfil the same requirements as all other candidates.

Further information

Please see our website for further information about how to apply for access arrangements and special consideration.

For further information about access arrangements, reasonable adjustments and special consideration, please refer to the JCQ website: www.jcq.org.uk.

Malpractice

Candidate malpractice

Candidate malpractice refers to any act by a candidate that compromises or seeks to compromise the process of assessment or which undermines the integrity of the qualifications or the validity of results/certificates.

Candidate malpractice in examinations **must** be reported to Pearson using a *JCQ M1 Form* (available at www.jcq.org.uk/exams-office/malpractice). The form can be emailed to pqsmalpractice@pearson.com or posted to Investigations Team, Pearson, 190 High Holborn, London, WC1V 7BH. Please provide as much information and supporting documentation as possible. Note that the final decision regarding appropriate sanctions lies with Pearson.

Failure to report malpractice constitutes staff or centre malpractice.

Staff/centre malpractice

Staff and centre malpractice includes both deliberate malpractice and maladministration of our qualifications. As with candidate malpractice, staff and centre malpractice is any act that compromises or seeks to compromise the process of assessment or which undermines the integrity of the qualifications or the validity of results/certificates.

All cases of suspected staff malpractice and maladministration **must** be reported immediately, before any investigation is undertaken by the centre, to Pearson on a *JCQ M2(a) Form* (available at www.jcq.org.uk/exams-office/malpractice). The form, supporting documentation and as much information as possible can be emailed to pqsmalpractice@pearson.com or posted to Investigations Team, Pearson, 190 High Holborn, London, WC1V 7BH. Note that the final decision regarding appropriate sanctions lies with Pearson.

Failure to report malpractice itself constitutes malpractice.

More-detailed guidance on malpractice can be found in the latest version of the document *JCQ General and Vocational Qualifications Suspected Malpractice in Examinations and Assessments,* available at www.jcq.org.uk/exams-office/malpractice.

Awarding and reporting

This qualification will be graded, awarded and certificated to comply with the requirements of Ofqual's General Conditions of Recognition.

This GCSE qualification will be graded and certificated on a nine-grade scale from 9 to 1 using the total subject mark where 9 is the highest grade. Individual papers are not graded. For foundation tier, grades 1–5 are available and for higher tier, grades 4–9 are available, however if the mark achieved is a smaller number of marks below the 4/3 grade boundary, then a grade 3 may be awarded.

Students whose level of achievement is below the minimum judged by Pearson to be of sufficient standard to be recorded on a certificate will receive an unclassified U result.

The first certification opportunity for this qualification will be 2018.

Student recruitment and progression

Pearson follows the JCQ policy concerning recruitment to our qualifications in that:

- they must be available to anyone who is capable of reaching the required standard
- they must be free from barriers that restrict access and progression
- equal opportunities exist for all students.

Prior learning and other requirements

This qualification is based on the subject content, published by the DfE. The DfE designed the subject content to reflect or build on Key Stage 3. Consequently, students taking this qualification will benefit from previously studying Chemistry at Key Stage 3.

Progression

Students can progress from this qualification to:

- GCEs, for example in Chemistry
- Level 3 vocational qualifications in science, for example BTEC Level 3 in Applied Science
- employment, for example in a science-based industry where an Apprenticeship may be available.

The content and skills for these qualifications are set by the DfE to be suitable to allow these progression routes.

Appendices

Appendix 1: Mathematical skills

This appendix is taken from the document *Biology, Chemistry and Physics GCSE subject content* published by the Department for Education (DfE) in June 2014.

The mathematical skills and use of mathematics statements listed will be assessed through the content of this qualification in the examinations. The minimum level of mathematics in the foundation tier examination papers will be equivalent to Key Stage 3 mathematics. The minimum level of mathematics in the higher tier examination papers will be equivalent to foundation tier GCSE in Mathematics.

Mathematical skills

Details of the mathematical skills in other science subjects are given for reference.

		Biology	Chemistry	Physics
1	**Arithmetic and numerical computation**			
a	Recognise and use expressions in decimal form	✓	✓	✓
b	Recognise and use expressions in standard form	✓	✓	✓
c	Use ratios, fractions and percentages	✓	✓	✓
d	Make estimates of the results of simple calculations	✓	✓	✓
2	**Handling data**			
a	Use an appropriate number of significant figures	✓	✓	✓
b	Find arithmetic means	✓	✓	✓
c	Construct and interpret frequency tables and diagrams, bar charts and histograms	✓	✓	✓
d	Understand the principles of sampling as applied to scientific data	✓		
e	Understand simple probability	✓		
f	Understand the terms mean, mode and median	✓		✓
g	Use a scatter diagram to identify a correlation between two variables	✓		✓
h	Make order of magnitude calculations	✓	✓	✓
3	**Algebra**			
a	Understand and use the symbols: =, <, <<, >>, >, ∝, ~	✓	✓	✓
b	Change the subject of an equation		✓	✓
c	Substitute numerical values into algebraic equations using appropriate units for physical quantities		✓	✓
d	Solve simple algebraic equations	✓		✓

		Biology	Chemistry	Physics
4	**Graphs**			
a	Translate information between graphical and numeric form	✓	✓	✓
b	Understand that $y = mx + c$ represents a linear relationship	✓	✓	✓
c	Plot two variables from experimental or other data	✓	✓	✓
d	Determine the slope and intercept of a linear graph	✓	✓	✓
e	Draw and use the slope of a tangent to a curve as a measure of rate of change		✓	✓
f	Understand the physical significance of area between a curve and the x-axis and measure it by counting squares as appropriate			✓
5	**Geometry and trigonometry**			
a	Use angular measures in degrees			✓
b	Visualise and represent 2D and 3D forms, including two dimensional representations of 3D objects		✓	✓
c	Calculate areas of triangles and rectangles, surface areas and volumes of cubes	✓	✓	✓

Appendix 2: Taxonomy

The following table lists the command words used in the external assessments.

Command word	Definition
Add/Label	Requires the addition or labelling to a stimulus material given in the question, for example labelling a diagram or adding units to a table.
Assess	Give careful consideration to all the factors or events that apply and identify which are the most important or relevant. Make a judgement on the importance of something, and come to a conclusion where needed.
Calculate	Obtain a numerical answer, showing relevant working. If the answer has a unit, this must be included. This can include using an equation to calculate a numerical answer.
Comment on	Requires the synthesis of a number of variables from data/information to form a judgement.
Compare	Looking for the similarities **or** differences of two (or more) things. Should not require the drawing of a conclusion. Answer must relate to both (or all) things mentioned in the question.
Compare and contrast	Looking for the similarities **and** differences of two (or more) things. Should not require the drawing of a conclusion. Answer must relate to both (or all) things mentioned in the question. The answer must include at least one similarity and one difference.
Complete	Requires the completion of a table/diagram.
Deduce	Draw/reach conclusion(s) from the information provided.
Describe	To give an account of something. Statements in the response need to be developed as they are often linked but do not need to include a justification or reason.
Determine	The answer must have an element which is quantitative from the stimulus provided, or must show how the answer can be reached quantitatively. To gain maximum marks there must be a quantitative element to the answer.
Devise	Plan or invent a procedure from existing principles/ideas.
Discuss	Identify the issue/situation/problem/argument that is being assessed within the question. Explore all aspects of an issue/situation/problem/argument. Investigate the issue/situation etc. by reasoning or argument.
Draw	Produce a diagram either using a ruler or using freehand.
Estimate	Find an approximate value, number, or quantity from a diagram/given data or through a calculation.

Command word	Definition
Evaluate	Review information (e.g. data, methods) then bring it together to form a conclusion, drawing on evidence including strengths, weaknesses, alternative actions, relevant data or information. Come to a supported judgement of a subject's qualities and relation to its context.
Explain	An explanation requires a justification/exemplification of a point. The answer must contain some element of reasoning/ justification, this can include mathematical explanations.
Give/State/Name	All of these command words are really synonyms. They generally all require recall of one or more pieces of information.
Give a reason/reasons	When a statement has been made and the requirement is only to give the reasons why.
Identify	Usually requires some key information to be selected from a given stimulus/resource.
Justify	Give evidence to support (either the statement given in the question or an earlier answer).
Measure	To determine the dimensions or angle from a diagram using an instrument such as a ruler or protractor.
Plot	Produce a graph by marking points accurately on a grid from data that is provided and then drawing a line of best fit through these points. A suitable scale and appropriately labelled axes must be included if these are not provided in the question.
Predict	Give an expected result.
Show that	Verify the statement given in the question.
Sketch	Produce a freehand drawing. For a graph this would need a line and labelled axis with important features indicated, the axis are not scaled.
State and explain	Make a point and link ideas to justify that point. An explanation requires a justification/exemplification of a point. The answer must contain some element of reasoning/justification, this can include mathematical explanations.
State what is meant by	When the meaning of a term is expected but there are different ways of how these can be described.
Write	When the questions ask for an equation.

Verbs preceding a command word	
Suggest a …	Suggest an explanation or suggest a description.

The 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	[98] **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	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac*** actinium 89	[261] **Rf** rutherfordium 104	[262] **Db** dubnium 105	[266] **Sg** seaborgium 106	[264] **Bh** bohrium 107	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated						

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

**** The lanthanoids (atomic numbers 58-71) and the actinoids (atomic numbers 90-103) have been omitted.***

The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.

Appendix 4: Apparatus and techniques

The apparatus and techniques listed in the table below are taken from the document *Biology, Chemistry and Physics GCSE Subject content* published by the Department for Education (DfE) in June 2014.

Use and coverage of the apparatus and techniques listed are mandatory. The eight mandatory core practicals cover all aspects of the listed apparatus and techniques and are referenced in the table.

Safety is an overriding requirement for all practical work. Centres are responsible for ensuring that whenever their students complete practical work appropriate safety procedures are followed.

Scientific diagrams should be included, where appropriate, to show the set-up and to record the apparatus and procedures used in practical work.

Apparatus and techniques		Core practical (specification reference)	
1	Use of appropriate apparatus to make and record a range of measurements accurately, including mass, time, temperature, and volume of liquids and gases	2.11	*Investigate the composition of inks using simple distillation and paper chromatography*
		3.6	*Investigate the change in pH on adding powdered calcium hydroxide or calcium oxide to a fixed volume of dilute hydrochloric acid*
		3.17	*Investigate the preparation of pure, dry hydrated copper sulfate crystals starting from copper oxide including the use of a water bath*
		3.31	*Investigate the electrolysis of copper sulfate solution with inert electrodes and copper electrodes*
		5.9C	*Carry out an accurate acid-alkali titration, using burette, pipette and a suitable indicator*
		7.1	*Investigate the effects of changing the conditions of a reaction on the rates of chemical reactions by:* *a measuring the production of a gas (in the reaction between hydrochloric acid and marble chips)* *b observing a colour change (in the reaction between sodium thiosulfate and hydrochloric acid)*
		9.28C	*Investigate the temperature rise produced in a known mass of water by the combustion of the alcohols ethanol, propanol, butanol and pentanol*

Apparatus and techniques		Core practical (specification reference)	
2	Safe use of appropriate heating devices and techniques including use of a Bunsen burner and a water bath or electric heater	2.11	*Investigate the composition of inks using simple distillation and paper chromatography*
		3.17	*Investigate the preparation of pure, dry hydrated copper sulfate crystals starting from copper oxide including the use of a water bath*
		7.1	*Investigate the effects of changing the conditions of a reaction on the rates of chemical reactions by:* *a measuring the production of a gas (in the reaction between hydrochloric acid and marble chips)* *b observing a colour change (in the reaction between sodium thiosulfate and hydrochloric acid)*
3	Use of appropriate apparatus and techniques for conducting and monitoring chemical reactions, including appropriate reagents and/or techniques for the measurement of pH in different situations	3.6	*Investigate the change in pH on adding powdered calcium hydroxide or calcium oxide to a fixed volume of dilute hydrochloric acid*
		3.31	*Investigate the electrolysis of copper sulfate solution with inert electrodes and copper electrodes*
		5.9C	*Carry out an accurate acid-alkali titration, using burette, pipette and a suitable indicator*
		7.1	*Investigate the effects of changing the conditions of a reaction on the rates of chemical reactions by:* *a measuring the production of a gas (in the reaction between hydrochloric acid and marble chips)* *b observing a colour change (in the reaction between sodium thiosulfate and hydrochloric acid)*
		9.6C	*Identify the ions in unknown salts, using the tests for the specified cations and anions in 9.2C, 9.3C, 9.4C, 9.5C*
		9.28C	*Investigate the temperature rise produced in a known mass of water by the combustion of the alcohols ethanol, propanol, butanol and pentanol*
4	Safe use of a range of equipment to purify and/or separate chemical mixtures including evaporation, filtration, crystallisation, chromatography and distillation	2.11	*Investigate the composition of inks using simple distillation and paper chromatography*
		3.17	*Investigate the preparation of pure, dry hydrated copper sulfate crystals starting from copper oxide including the use of a water bath*

Apparatus and techniques		Core practical (specification reference)	
5	Making and recording of appropriate observations during chemical reactions including changes in temperature and the measurement of rates of reaction by a variety of methods such as production of gas and colour change	3.6	*Investigate the change in pH on adding powdered calcium hydroxide or calcium oxide to a fixed volume of dilute hydrochloric acid*
		5.9C	*Carry out an accurate acid-alkali titration, using burette, pipette and a suitable indicator*
		7.1	*Investigate the effects of changing the conditions of a reaction on the rates of chemical reactions by:* *a measuring the production of a gas (in the reaction between hydrochloric acid and marble chips)* *b observing a colour change (in the reaction between sodium thiosulfate and hydrochloric acid)*
		9.28C	*Investigate the temperature rise produced in a known mass of water by the combustion of the alcohols ethanol, propanol, butanol and pentanol*
6	Safe use and careful handling of gases, liquids and solids, including careful mixing of reagents under controlled conditions, using appropriate apparatus to explore chemical changes and/or products	2.11	*Investigate the composition of inks using simple distillation and paper chromatography*
		3.6	*Investigate the change in pH on adding powdered calcium hydroxide or calcium oxide to a fixed volume of dilute hydrochloric acid*
		3.17	*Investigate the preparation of pure, dry hydrated copper sulfate crystals starting from copper oxide including the use of a water bath*
		3.31	*Investigate the electrolysis of copper sulfate solution with inert electrodes and copper electrodes*
		5.9C	*Carry out an accurate acid-alkali titration, using burette, pipette and a suitable indicator*
		7.1	*Investigate the effects of changing the conditions of a reaction on the rates of chemical reactions by:* *a measuring the production of a gas (in the reaction between hydrochloric acid and marble chips)* *b observing a colour change (in the reaction between sodium thiosulfate and hydrochloric acid)*
		9.6C	*Identify the ions in unknown salts, using the tests for the specified cations and anions in 9.2C, 9.3C, 9.4C, 9.5C*
		9.28C	*Investigate the temperature rise produced in a known mass of water by the combustion of the alcohols ethanol, propanol, butanol and pentanol*

Apparatus and techniques		Core practical (specification reference)	
7	Use of appropriate apparatus and techniques to draw, set up and use electrochemical cells for separation and production of elements and compounds	3.31	*Investigate the electrolysis of copper sulfate solution with inert electrodes and copper electrodes*
8	Use of appropriate qualitative reagents and techniques to analyse and identify unknown samples or products including gas tests, flame tests, precipitation reactions, and the determination of concentrations of strong acids and strong alkalis	5.9C 9.6C	*Carry out an accurate acid-alkali titration, using burette, pipette and a suitable indicator* *Identify the ions in unknown salts, using the tests for the specified cations and anions in 9.2C, 9.3C, 9.4C, 9.5C*

These core practicals may be reviewed and amended if changes are required to the apparatus and techniques listed by the Department for Education. Pearson may also review and amend the core practicals if necessary. Centres will be told about any changes as soon as possible.

This appendix also includes more detailed instructions for each core practical, which must be followed.

Core practical		Description
2.11	*Investigate the composition of inks using simple distillation and paper chromatography*	This core practical is in two parts; a simple chromatography practical to obtain a chromatogram of dyes in ink and using simple distillation apparatus to separate pure water from ink. It needs to cover usage of a Bunsen burner, methods used in chromatography and distillation and safety of handling liquids.
3.6	*Investigate the change in pH on adding powdered calcium hydroxide or calcium oxide to a fixed volume of dilute hydrochloric acid*	This practical focuses on recording the pH at intervals when calcium hydroxide or calcium oxide reacts with dilute hydrochloric acid. An initial mass of the solid must be added to a fixed volume of the acid, and the pH recorded each time more of the solid is added to the acid. The pH can be recorded using a pH meter, or universal indicator paper with a glass rod used to take a pH measurement at each interval.

Core practical		Description
3.17	*Investigate the preparation of pure, dry hydrated copper sulfate crystals starting from copper oxide including the use of a water bath*	Excess copper oxide must be added to warm dilute sulfuric acid (warmed using a water bath), which will react to produce a blue solution of the salt copper(II) sulfate. The solution then needs to be filtered using filter paper and evaporated using an evaporating basin and Bunsen burner, followed by final drying using a watch glass to allow all the water to evaporate.
3.31	*Investigate the electrolysis of copper sulfate solution with inert electrodes and copper electrodes*	This involves setting up an electrolysis to investigate the effect of changing the current on the mass of the copper electrodes used in the electrolysis of copper sulfate solution. The second part of this investigation covers the products formed during the electrolysis of copper sulfate solution using inert (graphite) electrodes. Quantitative analysis when using copper electrodes will be expected.
5.9C	*Carry out an accurate acid-alkali titration, using burette, pipette and a suitable indicator*	A titration is carried out to determine the volume of hydrochloric acid required to neutralise a solution of unknown concentration of sodium hydroxide. An indicator must be used to determine the end point. Standard procedure for a titration must be carried out, such as the use of a white tile and swirling the conical flask to obtain an accurate end point. The data must then be used to determine the concentration of the unknown solution.
7.1	*Investigate the effects of changing the conditions of a reaction on the rates of chemical reactions by:* *a measuring the production of a gas (in the reaction between hydrochloric acid and marble chips)* *b observing a colour change (in the reaction between sodium thiosulfate and hydrochloric acid)*	This investigation is in two parts. Both parts require the reaction to be observed with respect to time to obtain the rate. In the first part, marble chips must be added to hydrochloric acid, and the volume of gas collected and measured over time. This will lead to graphical analysis to calculate rate, as well as an appreciation for how the rate may change with varying concentration of acid/temperature/surface area of marble chips. The second part involves sodium thiosulfate reacting with dilute hydrochloric acid to produce a precipitate using the idea of a 'disappearing cross' to observe the change in the appearance of the reaction mixture as a precipitate of sulfur is formed. This must be carried out at different temperatures by warming the thiosulfate solution. A graph must be drawn to show the time taken for the reaction to take place at different temperatures.

Core practical		Description
9.6C	*Identify the ions in unknown salts, using the tests for the specified cations and anions in 9.2C, 9.3C, 9.4C, 9.5C*	Tests must be carried out to determine the ions present as described in specification points 9.2C, 9.3C, 9.4C and 9.5C. This will include gas tests, flame tests and precipitation reactions.
9.28C	*Investigate the temperature rise produced in a known mass of water by the combustion of the alcohols ethanol, propanol, butanol and pentanol*	Apparatus set up to measure the increase in temperature when the different fuels given are burnt. This must lead to a comparison of the results for the four alcohols.

Appendix 5: Practical Science Statement

Pearson Edexcel Level 1/Level 2 GCSE (9–1) in Biology/Chemistry/Physics/Combined Science

Head Teacher Declaration Form

Pearson Edexcel Level 1/Level 2 GCSE (9–1) in Biology/Chemistry/Physics/Combined Science	
Centre number:	Centre name:
Subject(s): *Please tick as appropriate* ☐ Biology (1BI0) ☐ Chemistry (1CH0) ☐ Physics (1PH0) ☐ Combined Science (1SC0)	
Biology (1BI0) – students must carry out all eight of the mandatory core practicals listed on page 8 of the specification. Chemistry (1CH0) – students must carry out all eight of the mandatory core practicals listed on page 8 of the specification. Physics (1PH0) – students must carry out all eight of the mandatory core practicals listed on page 9 of the specification.	

Head teacher declaration

I declare that reasonable steps have been taken to ensure each candidate has completed the practical activities set out above in accordance with Pearson Edexcel Level 1/Level 2 GCSE (9–1) in Biology/Chemistry/Physics/Combined Science practical science work requirements.

Each candidate has made a contemporaneous record of:

i the work that they have undertaken during these practical activities, and

ii the knowledge, skills and understanding which that learner has derived from those practical activities.

Head teacher name:			
Head teacher signature:		**Date:**	

Please send this completed form by email to **science2011@pearson.com** by 15th May. Failure to complete the form may lead to a malpractice investigation.

Appendix 6: The context for the development of this qualification

All our qualifications are designed to meet our World Class Qualification Principles[1] and our ambition to put the student at the heart of everything we do.

We have developed and designed this qualification by:

- reviewing other curricula and qualifications to ensure that it is comparable with those taken in high-performing jurisdictions overseas
- consulting with key stakeholders on content and assessment, including learned bodies, subject associations, higher education academics and teachers to ensure this qualification is suitable for a UK context
- reviewing the legacy qualification and building on its positive attributes.

This qualification has also been developed to meet criteria stipulated by Ofqual in their documents *GCSE (9 to 1) Qualification Level Conditions and Requirements* and *GCSE Subject Level Conditions and Requirements for Single Science (Biology, Chemistry and Physics)* published in April 2014.

[1] Pearson's World Class Qualification Principles ensure that our qualifications are:

- **demanding**, through internationally benchmarked standards, encouraging deep learning and measuring higher-order skills
- **rigorous**, through setting and maintaining standards over time, developing reliable and valid assessment tasks and processes, and generating confidence in end users of the knowledge, skills and competencies of certified students
- **inclusive**, through conceptualising learning as continuous, recognising that students develop at different rates and have different learning needs, and focusing on progression
- **empowering**, through promoting the development of transferable skills, see *Appendix 7*.

From Pearson's Expert Panel for World Class Qualifications

May 2014

"The reform of the qualifications system in England is a profoundly important change to the education system. Teachers need to know that the new qualifications will assist them in helping their learners make progress in their lives.

When these changes were first proposed we were approached by Pearson to join an 'Expert Panel' that would advise them on the development of the new qualifications.

We were chosen, either because of our expertise in the UK education system, or because of our experience in reforming qualifications in other systems around the world as diverse as Singapore, Hong Kong, Australia and a number of countries across Europe.

We have guided Pearson through what we judge to be a rigorous qualification development process that has included:

- extensive international comparability of subject content against the highest-performing jurisdictions in the world
- benchmarking assessments against UK and overseas providers to ensure that they are at the right level of demand
- establishing External Subject Advisory Groups, drawing on independent subject-specific expertise to challenge and validate our qualifications
- subjecting the final qualifications to scrutiny against the DfE content and Ofqual accreditation criteria in advance of submission.

Importantly, we have worked to ensure that the content and learning is future oriented. The design has been guided by what is called an 'Efficacy Framework', meaning learner outcomes have been at the heart of this development throughout.

We understand that ultimately it is excellent teaching that is the key factor to a learner's success in education. As a result of our work as a panel we are confident that we have supported the development of qualifications that are outstanding for their coherence, thoroughness and attention to detail and can be regarded as representing world-class best practice."

Sir Michael Barber (Chair)

Chief Education Advisor, Pearson plc

Professor Lee Sing Kong

Director, National Institute of Education, Singapore

Bahram Bekhradnia

President, Higher Education Policy Institute

Professor Jonathan Osborne

Stanford University

Dame Sally Coates

Principal, Burlington Danes Academy

Professor Dr Ursula Renold

Federal Institute of Technology, Switzerland

Professor Robin Coningham

Pro-Vice Chancellor, University of Durham

Professor Bob Schwartz

Harvard Graduate School of Education

Dr Peter Hill

Former Chief Executive ACARA

All titles correct as at May 2014

Appendix 7: Transferable skills

The need for transferable skills

In recent years, higher education institutions and employers have consistently flagged the need for students to develop a range of transferable skills to enable them to respond with confidence to the demands of undergraduate study and the world of work.

The Organisation for Economic Co-operation and Development (OECD) defines skills, or competencies, as 'the bundle of knowledge, attributes and capacities that can be learned and that enable individuals to successfully and consistently perform an activity or task and can be built upon and extended through learning.' [1]

To support the design of our qualifications, the Pearson Research Team selected and evaluated seven global 21st-century skills frameworks. Following on from this process, we identified the National Research Council's (NRC) framework as the most evidence-based and robust skills framework. We adapted the framework slightly to include the Program for International Student Assessment (PISA) ICT Literacy and Collaborative Problem Solving (CPS) Skills.

The adapted National Research Council's framework of skills involves: [2]

Cognitive skills

- **Non-routine problem solving** – expert thinking, metacognition, creativity.
- **Systems thinking** – decision making and reasoning.
- **Critical thinking** – definitions of critical thinking are broad and usually involve general cognitive skills such as analysing, synthesising and reasoning skills.
- **ICT literacy** – access, manage, integrate, evaluate, construct and communicate. [3]

Interpersonal skills

- **Communication** – active listening, oral communication, written communication, assertive communication and non-verbal communication.
- **Relationship-building skills** – teamwork, trust, intercultural sensitivity, service orientation, self-presentation, social influence, conflict resolution and negotiation.
- **Collaborative problem solving** – establishing and maintaining shared understanding, taking appropriate action, establishing and maintaining team organisation.

Intrapersonal skills

- **Adaptability** – ability and willingness to cope with the uncertain, handling work stress, adapting to different personalities, communication styles and cultures, and physical adaptability to various indoor and outdoor work environments.
- **Self-management and self-development** – ability to work remotely in virtual teams, work autonomously, be self-motivating and self-monitoring, willing and able to acquire new information and skills related to work.

Transferable skills enable young people to face the demands of further and higher education, as well as the demands of the workplace, and are important in the teaching and learning of this qualification. We will provide teaching and learning materials, developed with stakeholders, to support our qualifications.

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[1] OECD – *Better Skills, Better Jobs, Better Lives* (OECD Publishing, 2012)

[2] Koenig J A, National Research Council – *Assessing 21st Century Skills: Summary of a Workshop* (National Academies Press, 2011)

[3] PISA – *The PISA Framework for Assessment of ICT Literacy* (2011)

Appendix 8: Codes

Type of code	Use of code	Code
Discount codes	Every qualification eligible for performance tables is assigned a discount code that indicates the subject area to which it belongs. Discount codes are published by the DfE.	Please see the GOV.UK website*
Regulated Qualifications Framework (RQF) codes	Each qualification title is allocated an Ofqual Regulated Qualifications Framework (RQF) code. The RQF code is known as a Qualification Number (QN). This is the code that features in the DfE Section 96 and on the LARA as being eligible for 16–18 and 19+ funding, and is to be used for all qualification funding purposes. The QN will appear on students' final certification documentation.	The QN for this qualification is: 601/8611/2
Subject codes	The subject code is used by centres to enter students for a qualification. Centres will need to use the entry codes only when claiming students' qualifications.	GCSE – 1CH0
Paper codes	These codes are provided for reference purposes. Students need to be entered for individual papers at the same tier.	Paper 1: 1CH0/1F or 1CH0/1H Paper 2: 1CH0/2F or 1CH0/2H

*www.gov.uk/government/publications/2018-performance-tables-discount-code

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Appendix 9: Calculators

Candidates may use a calculator in assessments for this qualification. Centres are responsible for making sure that calculators used by their students meet the requirements highlighted in the table below.

Candidates must be familiar with the requirements before their assessments for this qualification.

<table>
<tr>
<td>Calculators must be:
of a size suitable for use on a desk
either battery or solar powered
free of lids, cases and covers that have printed instructions or formulae.</td>
<td rowspan="2">Calculators must not:
be designed or adapted to offer any of these facilities:
language translators
symbolic algebraic manipulation
symbolic differentiation or integration
communication with other machines or the internet
be borrowed from another candidate during an examination for any reason*
have retrievable information stored in them, and this includes:
databanks
dictionaries
mathematical formulae
text.</td>
</tr>
<tr>
<td>The candidate is responsible for the following:
the calculator’s power supply
the calculator’s working condition
clearing anything stored in the calculator.</td>
</tr>
</table>

*An invigilator may give a candidate a replacement calculator

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