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.

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.