

# A Level Chemistry



## Specification

---

Pearson Edexcel Level 3 Advanced GCE in Chemistry (9CH0)

*First teaching from September 2015*

---

*First certification from 2017*

| Issue 2

## Rationale

---

The Pearson Edexcel Level 3 Advanced GCE in Chemistry meets the following purposes, which fulfil those defined by the Office of Qualifications and Examinations Regulation (Ofqual) for GCE qualifications in their *GCE Qualification Level Conditions and Requirements* document, published in April 2014.

The purposes of this qualification are to:

- define and assess achievement of the knowledge, skills and understanding that will be needed by students planning to progress to undergraduate study at UK higher education institutions, particularly (although not only) in the same subject area
- set out a robust and internationally comparable post-16 academic course of study to develop that knowledge, skills and understanding
- enable higher education institutions to identify accurately the level of attainment of students
- provide a basis for school and college accountability measures at age 18
- provide a benchmark of academic ability for employers.

### Qualification aims and objectives

The aims and objectives of the Pearson Edexcel Level 3 Advanced GCE in Chemistry are to enable students to develop:

- essential knowledge and understanding of different areas of the subject and how they relate to each other
- a deep appreciation of the skills, knowledge and understanding of scientific methods
- competence and confidence in a variety of practical, mathematical and problem-solving skills
- their interest in and enthusiasm for the subject, including developing an interest in further study and careers associated with the subject
- an understanding of how society makes decisions about scientific issues and how the sciences contribute to the success of the economy and society.

<b>Paper 1: Advanced Inorganic and Physical Chemistry</b> *Paper code: 9CH0/01	
<ul style="list-style-type: none"> <li>Externally assessed</li> <li>Availability: May/June</li> <li>First assessment: 2017</li> </ul>	<b>30% of the total qualification</b>
<p><b>Overview of content</b></p> <p>This paper will examine the following topics.</p> <ul style="list-style-type: none"> <li>Topic 1: Atomic Structure and the Periodic Table</li> <li>Topic 2: Bonding and Structure</li> <li>Topic 3: Redox I</li> <li>Topic 4: Inorganic Chemistry and the Periodic Table</li> <li>Topic 5: Formulae, Equations and Amounts of Substance</li> <li>Topic 8: Energetics I</li> <li>Topic 10: Equilibrium I</li> <li>Topic 11: Equilibrium II</li> <li>Topic 12: Acid-base Equilibria</li> <li>Topic 13: Energetics II</li> <li>Topic 14: Redox II</li> <li>Topic 15: Transition Metals</li> </ul>	
<p><b>Overview of assessment</b></p> <ul style="list-style-type: none"> <li>Assessment is 1 hour 45 minutes.</li> <li>The paper consists of 90 marks.</li> <li>The paper may include multiple-choice, short open, open-response, calculations and extended writing questions.</li> <li>The paper will include questions that target mathematics at Level 2 or above (see <i>Appendix 6: Mathematical skills and exemplifications</i>). Overall, a minimum of 20% of the marks across the three papers will be awarded for mathematics at Level 2 or above.</li> </ul>	

<b>Paper 2: Advanced Organic and Physical Chemistry</b> *Paper code: 9CH0/02	
<ul style="list-style-type: none"> <li>Externally assessed</li> <li>Availability: May/June</li> <li>First assessment: 2017</li> </ul>	<b>30% of the total qualification</b>
<p><b>Overview of content</b></p> <p>This paper will examine the following topics.</p> <ul style="list-style-type: none"> <li>Topic 2: Bonding and Structure</li> <li>Topic 3: Redox I</li> <li>Topic 5: Formulae, Equations and Amounts of Substance</li> <li>Topic 6: Organic Chemistry I</li> <li>Topic 7: Modern Analytical Techniques I</li> <li>Topic 9: Kinetics I</li> <li>Topic 16: Kinetics II</li> <li>Topic 17: Organic Chemistry II</li> <li>Topic 18: Organic Chemistry III</li> <li>Topic 19: Modern Analytical Techniques II</li> </ul>	
<p><b>Overview of assessment</b></p> <ul style="list-style-type: none"> <li>Assessment is 1 hour 45 minutes.</li> <li>The paper consists of 90 marks.</li> <li>The paper may include multiple-choice, short open, open-response, calculations and extended writing questions.</li> <li>The paper will include questions that target mathematics at Level 2 or above (see <i>Appendix 6: Mathematical skills and exemplifications</i>). Overall, a minimum of 20% of the marks across the three papers will be awarded for mathematics at Level 2 or above.</li> </ul>	

100% Exam

### Paper 3: General and Practical Principles in Chemistry

\*Paper code: 9CH0/03

- Externally assessed
- Availability: May/June
- First assessment: 2017

**40% of the  
total  
qualification**

#### Overview of content

- Questions in this paper may draw on any of the topics in this specification.
- The paper will include synoptic questions that may draw on two or more different topics listed.
- The paper will include questions that assess conceptual and theoretical understanding of experimental methods (indirect practical skills) that will draw on students' experiences of the core practicals.

#### Overview of assessment

- Assessment is 2 hours 30 minutes.
- The paper consists of 120 marks.
- The paper may include short open, open-response, calculations and extended writing questions.
- The paper will include questions that target mathematics at Level 2 or above (see Appendix 6: *Mathematical skills and exemplifications*). Overall, a minimum of 20% of the marks across the three papers will be awarded for mathematics at Level 2 or above.
- Some questions will assess conceptual and theoretical understanding of experimental methods (see Appendix 5: *Working scientifically*).

100% Exam

**Important Scientists:**

J.J. Thomson – Electron 1897  
Ernest Rutherford Proton 1911  
James Chadwick Neutron 1932

Subatomic Particle	Mass (relative to 1/12 of a carbon-12 atom)	Relative Charge	Location
Electron	1/1836	-1	Outside
Proton	1	+1	Inside
Neutron	1	0	Inside

The relative isotopic mass of an isotope or nuclide is the mass of the isotope relative to 1/12 of the mass of a carbon-12 atom.

The relative atomic mass is the weighted average of all isotopes of an element relative to 1/12 of the mass of a carbon-12 atom.

**Unit 1: Atomic Structure**

**Mass Spectrometry**

Isotopes can be seen on mass spectra. Chlorine has 2 isotopes (35 and 37) and Chlorine molecules (Cl<sub>2</sub>) have 3 isotopes (70, 72 and 74).

For a molecule the peak furthest to the right on the molecular ion M<sup>+</sup> is a small peak to the right of the base peak. This is the molecular ion M<sup>+</sup>.

Big jumps in IE means moving from one shell to another. Within a shell successive ionisation energy always increases due to less and less electron-electron repulsion.

**Across a period**

IE increases due to extra protons and additional electrostatic attraction. This is further increased by reduced atomic radius.

**Down a group**

IE decreases due to outer electrons having more electron energy (higher energy level), despite having more protons.

**First Ionisation Energies**

More protons means more electrostatic attraction between the nucleus and outer electron. More energy is therefore needed to remove an electron.

2p subshell is higher in energy than 2s meaning less energy than expected needed to remove an electron.

Paired electrons in the 2p subshell need more energy than expected to remove the electron.

**Ionisation Energy**

Ionisation energy is the energy required to remove one mole of electrons from one mole of atoms when they are a gas.

First IE:  $X(g) \rightarrow X^+(g) + e^-$   
Second IE:  $X^+(g) \rightarrow X^{2+}(g) + e^-$

**Electronic Configuration**

1. Hund's rule: electrons will occupy orbitals singly before pairing up (p, d, f).  
2. Pauli Exclusion principle: 2 electrons cannot occupy the same orbital with the same spin (opposite spins).

Example:

Element	Li	Be	B	C	N	O	F	Ne
Configuration	1s <sup>2</sup> 2s <sup>1</sup>	1s <sup>2</sup> 2s <sup>2</sup>	1s <sup>2</sup> 2s <sup>2</sup> 2p <sup>1</sup>	1s <sup>2</sup> 2s <sup>2</sup> 2p <sup>2</sup>	1s <sup>2</sup> 2s <sup>2</sup> 2p <sup>3</sup>	1s <sup>2</sup> 2s <sup>2</sup> 2p <sup>4</sup>	1s <sup>2</sup> 2s <sup>2</sup> 2p <sup>5</sup>	1s <sup>2</sup> 2s <sup>2</sup> 2p <sup>6</sup>

**Periodicity**

Periodicity is the pattern of physical and chemical properties across the periodic table.

**s, p, and d Atomic Orbitals**

Orbitals are regions of space where there is a high probability of finding an electron.

s orbitals are spherical. p orbitals are dumbbell-shaped. d orbitals are complex shapes.

**Relative Atomic Mass**

Relative atomic mass is the weighted average of all isotopes of an element relative to 1/12 of the mass of a carbon-12 atom.

Example: Chlorine has two isotopes, <sup>35</sup>Cl and <sup>37</sup>Cl. The relative atomic mass is 35.5.

**Electronegativity**

Electronegativity is the ability of an atom to attract electrons towards itself in a covalent bond.

It increases across a period and decreases down a group.

**Electronegativity**

Electronegativity is the ability of an atom to attract electrons towards itself in a covalent bond.

It increases across a period and decreases down a group.

**Atomic Structure**

Atoms consist of a central nucleus containing protons and neutrons, surrounded by a cloud of electrons.

Isotopes are atoms of the same element with different numbers of neutrons.

**Atomic Structure**

Atoms consist of a central nucleus containing protons and neutrons, surrounded by a cloud of electrons.

Isotopes are atoms of the same element with different numbers of neutrons.

**Atomic Structure**

Atoms consist of a central nucleus containing protons and neutrons, surrounded by a cloud of electrons.

Isotopes are atoms of the same element with different numbers of neutrons.

**Atomic Structure**

Atoms consist of a central nucleus containing protons and neutrons, surrounded by a cloud of electrons.

Isotopes are atoms of the same element with different numbers of neutrons.

# Knowledge Organisers

## Text book

## Seneca

## Lab book

**Edexcel Topic 2 Structure and bonding – Knowledge organiser**

When a metal and a non-metal react together, the metal atom loses electrons and becomes a positive ion. The non-metal atom gains electrons and becomes a negative ion.

When non-metals bond together, they share electrons forming **covalent bonds**.

A **covalent bond** is the electrostatic attraction between the positively charged nuclei of the bonded atoms and the electrons shared between them.

Atoms only share electrons in their outermost shells. Atoms share electrons to gain a full outermost shell, by doing so they have the configuration of a noble gas which gives them stability.

Simple covalent molecules are made up of a few atoms covalently bonded together. For e.g. H<sub>2</sub>, F<sub>2</sub>, H<sub>2</sub>O, CH<sub>4</sub>, CO<sub>2</sub>, NH<sub>3</sub>, etc.

Covalent dot and cross diagrams show which atoms the electrons have come from but don't show relative size of atoms or their arrangement in space.

A single covalent bond contains one shared pair of electrons. A double covalent bond contains four electrons (2 shared pairs of electrons).

Simple covalent molecules have **low melting points and boiling points** and are gases or liquids at room temperature. This is because there are only **weak intermolecular forces of attraction** (London, permanent dipole-dipole or hydrogen bonds) between molecules, which don't need much energy to overcome.

Graphite contains layers with each carbon having 3 bonds. The extra electrons become delocalised between the layers.

Graphite can conduct electricity because the **delocalised electrons can move** and carry an electric current.

Graphite's layers of hexagons are held in place by **weak forces of attraction**.

Graphite has a **high melting and boiling point** because the covalent bonds within the layers require a lot of energy to break.

Graphite is soft and slippery because the layers can slide.

Graphene is one layer of graphite that is one atom thick.

Graphene is strong, light and can conduct electricity because it contains delocalised electrons.

Fullerenes are cage like structures and tubes which also contain hexagonal rings.

Fullerenes form incredibly thin cylinders with a high tensile strength. Can be used for drug delivery in the body, lubricants, catalysts (large surface to volume ratio) and in electronics.

Metals consist of a giant metallic structure.

Metals consist of a lattice of **positive ions** surrounded by a **sea of delocalised electrons**.

The metallic bond is the attraction between the positive ions and sea of delocalised electrons.

Metals **conduct** electricity because the delocalised electrons are free to move and carry a charge.

Metals have **high melting and boiling points** because it takes a lot of energy to break the strong metallic bonds.

Metals are **malleable and ductile** because the layers of ions can slide over each other.

Alloys are a mixture of two or more metals or a non-metal and a metal. Steel is an alloy of iron and carbon.

Alloys are **harder** than pure metals because the different sized atoms distort the layers making it harder for them to slide.

## Science Practical Endorsement\*\*

\*Paper code: 9CH0/04

- Internally assessed and externally monitored by Pearson.
- Availability: May/June
- First assessment: 2017

### Overview of content

The assessment of practical skills is a compulsory requirement of the course of study for A level chemistry. It will appear on all students' certificates as a separately reported result, alongside the overall grade for the qualification.

Students must carry out a minimum of 12 practical activities which, together, meet the requirements of *Appendices 5b (Practical skills identified for direct assessment and developed through teaching and learning)* and *5c (Use of apparatus and techniques)* from the prescribed subject content.

The practical activities prescribed in this specification (the "core practicals") provide opportunities for demonstrating competence in all the skills identified, together with the use of apparatus and techniques for each subject. However, students can also demonstrate these competencies in any additional practical activity undertaken throughout the course of study which covers the requirements of *Appendix 5c*.

### Overview of assessment

Students' practical work will be assessed by teachers, using common practical assessment criteria (CPAC) that are consistent across exam boards. These criteria can be found on pages 48–49.

Students who demonstrate the required standard across all the requirements of the CPAC will receive a 'pass' grade.

Students may work in groups but teachers who award a pass to their students need to be confident of individual students' competence.

The correct application of CPAC to students' work will be monitored through a system of visits to centres. These visits will be coordinated across the exam boards by JCQ, to ensure that all centres are visited regularly, although not necessarily in each science subject.

Practical work and standard lab techniques are important.