Syllabus

Cambridge IGCSE™
Physical Science 0652

Use this syllabus for exams in 2025 and 2026. Exams are available in the November series.

Please check the syllabus page at www.cambridgeinternational.org/0652 to see if this syllabus is available in your administrative zone.

For the purposes of screen readers, any mention in this document of Cambridge IGCSE refers to Cambridge International General Certificate of Secondary Education.
Why choose Cambridge International?

Cambridge International prepares school students for life, helping them develop an informed curiosity and a lasting passion for learning. We are part of Cambridge University Press & Assessment, which is a department of the University of Cambridge.

Our Cambridge Pathway gives students a clear path for educational success from age 5 to 19. Schools can shape the curriculum around how they want students to learn – with a wide range of subjects and flexible ways to offer them. It helps students discover new abilities and a wider world, and gives them the skills they need for life, so they can achieve at school, university and work.

Our programmes and qualifications set the global standard for international education. They are created by subject experts, rooted in academic rigour and reflect the latest educational research. They provide a strong platform for learners to progress from one stage to the next, and are well supported by teaching and learning resources.

Our mission is to provide educational benefit through provision of international programmes and qualifications for school education and to be the world leader in this field. Together with schools, we develop Cambridge learners who are confident, responsible, reflective, innovative and engaged – equipped for success in the modern world.

Every year, nearly a million Cambridge students from 10,000 schools in 160 countries prepare for their future with the Cambridge Pathway.

**School feedback:** ‘We think the Cambridge curriculum is superb preparation for university.’

**Feedback from:** Christoph Guttentag, Dean of Undergraduate Admissions, Duke University, USA

**Quality management**

Cambridge International is committed to providing exceptional quality. In line with this commitment, our quality management system for the provision of international qualifications and education programmes for students aged 5 to 19 is independently certified as meeting the internationally recognised standard, ISO 9001:2015. Learn more at [www.cambridgeinternational.org/ISO9001](http://www.cambridgeinternational.org/ISO9001)
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**Important: Changes to this syllabus**

The latest syllabus is version 1, published September 2022. There are no significant changes which affect teaching.

Any textbooks endorsed to support the syllabus for examination from 2019 are still suitable for use with this syllabus.
1 Why choose this syllabus?

Key benefits

Cambridge IGCSE is the world’s most popular international qualification for 14 to 16 year olds, although it can be taken by students of other ages. It is tried, tested and trusted.

Students can choose from 70 subjects in any combination – it is taught by over 4500 schools in over 140 countries.

Our programmes balance a thorough knowledge and understanding of a subject and help to develop the skills learners need for their next steps in education or employment.

**Cambridge IGCSE Physical Science** enables learners to:

- increase their understanding of the technological world
- take an informed interest in scientific matters
- recognise the usefulness (and limitations) of scientific method, and how to apply this to other disciplines and in everyday life
- develop relevant attitudes, such as a concern for accuracy and precision, objectivity, integrity, enquiry, initiative and inventiveness
- develop an interest in, and care for, the environment
- better understand the influence and limitations placed on scientific study by society, economy, technology, ethics, the community and the environment
- develop an understanding of the scientific skills essential for both further study and everyday life.

**School feedback:** ‘The strength of Cambridge IGCSE qualifications is internationally recognised and has provided an international pathway for our students to continue their studies around the world.’

**Feedback from:** Gary Tan, Head of Schools and CEO, Raffles International Group of Schools, Indonesia
International recognition and acceptance

Our expertise in curriculum, teaching and learning, and assessment is the basis for the recognition of our programmes and qualifications around the world. The combination of knowledge and skills in Cambridge IGCSE Physical Science gives learners a solid foundation for further study. Candidates who achieve grades A* to C are well prepared to follow a wide range of courses including Cambridge International AS & A Level Science subjects.

Cambridge IGCSEs are accepted and valued by leading universities and employers around the world as evidence of academic achievement. Many universities require a combination of Cambridge International AS & A Levels and Cambridge IGCSEs or equivalent to meet their entry requirements.

UK NARIC*, the national agency in the UK for the recognition and comparison of international qualifications and skills, has carried out an independent benchmarking study of Cambridge IGCSE and found it to be comparable to the standard of the GCSE in the UK. This means students can be confident that their Cambridge IGCSE qualifications are accepted as equivalent to UK GCSEs by leading universities worldwide.

* Due to the United Kingdom leaving the European Union, the UK NARIC national recognition agency function was re-titled as UK ENIC on 1 March 2021, operated and managed by Ecctis Limited. From 1 March 2021, international benchmarking findings are published under the Ecctis name.

Learn more at www.cambridgeinternational.org/ recognition

School feedback: ‘Cambridge IGCSE is one of the most sought-after and recognised qualifications in the world. It is very popular in Egypt because it provides the perfect preparation for success at advanced level programmes.’

Feedback from: Managing Director of British School of Egypt BSE
Supporting teachers

We provide a wide range of resources, detailed guidance, innovative training and professional development so that you can give your students the best possible preparation for Cambridge IGCSE. To find out which resources are available for each syllabus go to our School Support Hub.

The School Support Hub is our secure online site for Cambridge teachers where you can find the resources you need to deliver our programmes. You can also keep up to date with your subject and the global Cambridge community through our online discussion forums.

Find out more at www.cambridgeinternational.org/support

Support for Cambridge IGCSE

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<td>• Schemes of work</td>
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Sign up for email notifications about changes to syllabuses, including new and revised products and services at www.cambridgeinternational.org/syllabusupdates

Professional development

We support teachers through:

- Introductory Training – face-to-face or online
- Extension Training – face-to-face or online
- Enrichment Professional Development – face-to-face or online

Find out more at www.cambridgeinternational.org/events

- Cambridge Professional Development Qualifications

Find out more at www.cambridgeinternational.org/profdev

Supporting exams officers

We provide comprehensive support and guidance for all Cambridge exams officers.

Find out more at: www.cambridgeinternational.org/eoguide
2 Syllabus overview

Aims

The aims describe the purposes of a course based on this syllabus.

You can deliver some of the aims using suitable local, international or historical examples and applications, or through collaborative experimental work.

The aims are to:

- provide an enjoyable and worthwhile educational experience for all learners, whether or not they go on to study science beyond this level
- enable learners to acquire sufficient knowledge and understanding to:
  - become confident citizens in a technological world and develop an informed interest in scientific matters
  - be suitably prepared for studies beyond Cambridge IGCSE
- allow learners to recognise that science is evidence-based and understand the usefulness, and the limitations, of scientific method
- develop skills that:
  - are relevant to the study and practice of science
  - are useful in everyday life
  - encourage a systematic approach to problem-solving
  - encourage efficient and safe practice
  - encourage effective communication through the language of science
- develop attitudes relevant to science such as:
  - concern for accuracy and precision
  - objectivity
  - integrity
  - enquiry
  - initiative
  - inventiveness
- enable learners to appreciate that:
  - science is subject to social, economic, technological, ethical and cultural influences and limitations
  - the applications of science may be both beneficial and detrimental to the individual, the community and the environment.

Cambridge Assessment International Education is an education organisation and politically neutral. The contents of this syllabus, examination papers and associated materials do not endorse any political view. We endeavour to treat all aspects of the exam process neutrally.
Content overview

The subject content is divided into two sections: Chemistry (C1–C12) and Physics (P1–P5). **Candidates must study both sections.**

Chemistry

C1 The particulate nature of matter  
C2 Experimental techniques  
C3 Atoms, elements and compounds  
C4 Stoichiometry  
C5 Electricity and chemistry  
C6 Energy changes in chemical reactions  
C7 Acids, bases and salts  
C8 The Periodic Table  
C9 Metals  
C10 Air and water  
C11 Carbonates  
C12 Organic chemistry

Physics

P1 General physics  
P2 Thermal physics  
P3 Properties of waves, including light and sound  
P4 Electricity and magnetism  
P5 Atomic physics
### Assessment overview

All candidates take three components. Candidates will be eligible for grades A* to G.

Candidates who have studied the Core subject content, or who are expected to achieve a grade D or below, should be entered for Paper 1, Paper 3 and either Paper 5 or Paper 6. These candidates will be eligible for grades C to G.

Candidates who have studied the Extended subject content (Core and Supplement), and who are expected to achieve a grade C or above, should be entered for Paper 2, Paper 4 and either Paper 5 or Paper 6. These candidates will be eligible for grades A* to G.

<table>
<thead>
<tr>
<th>Core candidates take:</th>
<th>Extended candidates take:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Paper 1</strong> 45 minutes Multiple Choice (Core) 30% 40 marks 40 four-option multiple-choice questions Questions will be based on the Core subject content. Externally assessed</td>
<td><strong>Paper 2</strong> 45 minutes Multiple Choice (Extended) 30% 40 marks 40 four-option multiple-choice questions Questions will be based on the Extended subject content (Core and Supplement). Externally assessed</td>
</tr>
<tr>
<td>and Core candidates take:</td>
<td>and Extended candidates take:</td>
</tr>
<tr>
<td><strong>Paper 3</strong> 1 hour 15 minutes Theory (Core) 50% 80 marks Short-answer and structured questions Questions will be based on the Core subject content. Externally assessed</td>
<td><strong>Paper 4</strong> 1 hour 15 minutes Theory (Extended) 50% 80 marks Short-answer and structured questions Questions will be based on the Extended subject content (Core and Supplement). Externally assessed</td>
</tr>
<tr>
<td>All candidates take either:</td>
<td>or</td>
</tr>
<tr>
<td><strong>Paper 5</strong> 1 hour 15 minutes Practical Test 20% 40 marks Questions will be based on the experimental skills in section 4. Externally assessed</td>
<td><strong>Paper 6</strong> 1 hour Alternative to Practical 20% 40 marks Questions will be based on the experimental skills in section 4. Externally assessed</td>
</tr>
</tbody>
</table>

Information on availability is in the Before you start section.
Assessment objectives

The assessment objectives (AOs) are:

AO1 Knowledge with understanding
Candidates should be able to demonstrate knowledge and understanding of:

- scientific phenomena, facts, laws, definitions, concepts and theories
- scientific vocabulary, terminology and conventions (including symbols, quantities and units)
- scientific instruments and apparatus, including techniques of operation and aspects of safety
- scientific and technological applications with their social, economic and environmental implications.

Subject content defines the factual material that candidates may be required to recall and explain. Candidates will also be asked questions which require them to apply this material to unfamiliar contexts and to apply knowledge from one area of the syllabus to another.

Questions testing this assessment objective will often begin with one of the following words: define, state, describe, explain (using your knowledge and understanding) or outline (see the Glossary of terms used in science papers).

AO2 Handling information and problem-solving
Candidates should be able, in words or using other written forms of presentation (i.e. symbolic, graphical and numerical), to:

- locate, select, organise and present information from a variety of sources
- translate information from one form to another
- manipulate numerical and other data
- use information to identify patterns, report trends and draw inferences
- present reasoned explanations for phenomena, patterns and relationships
- make predictions and hypotheses
- solve problems, including some of a quantitative nature.

Questions testing these skills may be based on information that is unfamiliar to candidates, requiring them to apply the principles and concepts from the syllabus to a new situation, in a logical, deductive way.

Questions testing these skills will often begin with one of the following words: predict, suggest, calculate or determine (see the Glossary of terms used in science papers).

AO3 Experimental skills and investigation
Candidates should be able to:

- demonstrate knowledge of how to safely use techniques, apparatus and materials (including following a sequence of instructions where appropriate)
- plan experiments and investigations
- make and record observations, measurements and estimates
- interpret and evaluate experimental observations and data
- evaluate methods and suggest possible improvements.
Weighting for assessment objectives

The approximate weightings allocated to each of the assessment objectives (AOs) are summarised below.

### Assessment objectives as a percentage of the qualification

<table>
<thead>
<tr>
<th>Assessment objective</th>
<th>Weighting in IGCSE %</th>
</tr>
</thead>
<tbody>
<tr>
<td>AO1 Knowledge with understanding</td>
<td>50</td>
</tr>
<tr>
<td>AO2 Handling information and problem-solving</td>
<td>30</td>
</tr>
<tr>
<td>AO3 Experimental skills and investigations</td>
<td>20</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

### Assessment objectives as a percentage of each component

<table>
<thead>
<tr>
<th>Assessment objective</th>
<th>Weighting in components %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Papers 1 and 2</td>
</tr>
<tr>
<td>AO1 Knowledge with understanding</td>
<td>63</td>
</tr>
<tr>
<td>AO2 Handling information and problem-solving</td>
<td>37</td>
</tr>
<tr>
<td>AO3 Experimental skills and investigations</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>
3 Subject content

This syllabus gives you the flexibility to design a course that will interest, challenge and engage your learners. Where appropriate, you are responsible for selecting resources and examples to support your learners’ study. These should be appropriate for the learners’ age, cultural background and learning context as well as complying with your school policies and local legal requirements.

The subject content that follows is divided into two sections: Chemistry (C1–C12) and Physics (P1–P5). Candidates must study both sections.

All candidates should be taught the Core subject content. Candidates who are only taught the Core subject content can achieve a maximum of grade C. Candidates aiming for grades A* to C should be taught the Extended subject content. The Extended subject content includes both the Core and the Supplement.

Scientific subjects are, by their nature, experimental. Learners should pursue a fully integrated course which allows them to develop their practical skills by carrying out practical work and investigations within all of the topics listed.

Chemistry

C1 The particulate nature of matter

C1.1 The particulate nature of matter

<table>
<thead>
<tr>
<th>Core</th>
<th>Supplement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 State the distinguishing properties of solids, liquids and gases</td>
<td>3 Explain changes of state in terms of the kinetic particle theory and the energy changes involved</td>
</tr>
<tr>
<td>2 Describe the structure of solids, liquids and gases in terms of particle separation, arrangement and types of motion</td>
<td>5 Describe and explain dependence of rate of diffusion on molecular mass</td>
</tr>
<tr>
<td>4 Describe and explain diffusion in terms of the movement of particles (atoms, molecules or ions)</td>
<td></td>
</tr>
</tbody>
</table>

C2 Experimental techniques

C2.1 Measurement

<table>
<thead>
<tr>
<th>Core</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Name and suggest appropriate apparatus for the measurement of time, temperature, mass and volume, including burettes, pipettes and measuring cylinders</td>
</tr>
</tbody>
</table>
0652 Chemistry

C2.2 Criteria of purity

<table>
<thead>
<tr>
<th>Core</th>
<th>Supplement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Interpret simple chromatograms</td>
<td>2 Interpret simple chromatograms, including the use of $R_f$ values</td>
</tr>
<tr>
<td>3 Recognise that mixtures melt and boil over a range of temperatures</td>
<td>4 Outline how chromatography techniques can be applied to colourless substances by exposing chromatograms to substances called locating agents (Knowledge of specific locating agents is not required.)</td>
</tr>
<tr>
<td></td>
<td>5 Identify substances and assess their purity from melting point and boiling point information</td>
</tr>
</tbody>
</table>

C2.3 Methods of purification

<table>
<thead>
<tr>
<th>Core</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Describe and explain methods of separation and purification by the use of a suitable solvent, filtration, crystallisation, distillation, fractional distillation and paper chromatography</td>
</tr>
<tr>
<td>2 Suggest suitable separation and purification techniques, given information about the substances involved</td>
</tr>
</tbody>
</table>

C3 Atoms, elements and compounds

C3.1 Physical and chemical changes

<table>
<thead>
<tr>
<th>Core</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Identify physical and chemical changes, and understand the differences between them</td>
<td></td>
</tr>
</tbody>
</table>

C3.2 Elements, compounds and mixtures

<table>
<thead>
<tr>
<th>Core</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Describe the differences between elements, mixtures and compounds, and between metals and non-metals</td>
</tr>
<tr>
<td>2 Define the terms solvent, solute, solution and concentration</td>
</tr>
</tbody>
</table>
## 0652 Chemistry

### C3.3 Atomic structure and the Periodic Table

<table>
<thead>
<tr>
<th>Core</th>
<th>Supplement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Describe the structure of an atom in terms of a central nucleus, containing protons and neutrons, and ‘shells’ of electrons</td>
<td></td>
</tr>
<tr>
<td>2 Describe the build-up of electrons in ‘shells’ and understand the significance of the noble gas electronic structures and of the outer-shell electrons</td>
<td></td>
</tr>
<tr>
<td>(The ideas of the distribution of electrons in s and p orbitals and in d-block elements are not required.)</td>
<td></td>
</tr>
<tr>
<td>3 State the relative charge and approximate relative mass of a proton, a neutron and an electron</td>
<td></td>
</tr>
<tr>
<td>4 Define and use proton number (atomic number) as the number of protons in the nucleus of an atom</td>
<td></td>
</tr>
<tr>
<td>5 Define and use nucleon number (mass number) as the total number of protons and neutrons in the nucleus of an atom</td>
<td></td>
</tr>
<tr>
<td>6 Use proton number and the simple structure of atoms to explain the basis of the Periodic Table, with special reference to the elements of proton numbers 1 to 20</td>
<td></td>
</tr>
<tr>
<td>7 Define isotopes as atoms of the same element which have the same proton number but a different nucleon number</td>
<td></td>
</tr>
</tbody>
</table>

Note: a copy of the Periodic Table as shown in the Appendix will be provided in Papers 1, 2, 3 and 4.

### C3.4 Ions and ionic bonds

<table>
<thead>
<tr>
<th>Core</th>
<th>Supplement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Describe the formation of ions by electron loss or gain</td>
<td></td>
</tr>
<tr>
<td>2 Use dot-and-cross diagrams to describe the formation of ionic bonds between Group I and Group VII</td>
<td></td>
</tr>
<tr>
<td>3 Describe the formation of ionic bonds between metallic and non-metallic elements to include the strong attraction between ions because of their opposite electrical charges</td>
<td></td>
</tr>
<tr>
<td>4 Describe the lattice structure of ionic compounds as a regular arrangement of alternating positive and negative ions, exemplified by the sodium chloride structure</td>
<td></td>
</tr>
</tbody>
</table>
### C3.5 Molecules and covalent bonds

**Core**

1. State that non-metallic elements form simple molecules with covalent bonds between atoms.
2. Describe the formation of single covalent bonds in $\text{H}_2$, $\text{Cl}_2$, $\text{H}_2\text{O}$, $\text{CH}_4$, $\text{NH}_3$ and $\text{HCl}$ as the sharing of pairs of electrons leading to the noble gas configuration including the use of dot-and-cross diagrams.
3. Describe the differences in volatility, solubility and electrical conductivity between ionic and covalent compounds.

**Supplement**

3. Use and draw dot-and-cross diagrams to represent the bonding in the more complex covalent molecules such as $\text{N}_2$, $\text{C}_2\text{H}_4$, $\text{CH}_3\text{OH}$ and $\text{CO}_2$.
4. Explain the differences in melting point and boiling point of ionic and covalent compounds in terms of attractive forces.

### C3.6 Macromolecules

**Core**

1. State that there are several different forms of carbon, including diamond and graphite.
2. Describe the giant covalent structures of diamond and graphite.

**Supplement**

3. Relate the structures of diamond and graphite to their uses, e.g. graphite as a lubricant and a conductor and diamond in cutting tools.
0652 Chemistry

C4 Stoichiometry

C4.1 Stoichiometry

Core

1. Use the symbols of the elements and write the formulae of simple compounds.
2. Deduce the formula of a simple compound from the relative numbers of atoms present.
3. Deduce the formula of a simple compound from a model or a diagrammatic representation.
4. Construct and use word equations.
5. Interpret and balance simple symbol equations.

Supplement

2. Determine the formula of an ionic compound from the charges on the ions present.
7. Construct and use symbol equations with state symbols, including ionic equations.
8. Deduce the balanced equation of a chemical reaction, given relevant information.
9. Define relative atomic mass \( A_r \) as the average mass of naturally occurring atoms of an element on a scale where the \(^{12}\text{C} \) atom has a mass of exactly 12 units.
10. Define relative molecular mass \( M_r \) and calculate it as the sum of the relative atomic masses (the term relative formula mass or \( M_r \) will be used for ionic compounds).
11. Calculate stoichiometric reacting masses, volumes of gases and solutions and solution concentrations expressed in g/dm\(^3\) and mol/dm\(^3\) (Calculations based on limiting reactants may be set. Questions on the gas laws and the conversion of gaseous volumes to different temperatures and pressures will not be set.)

C5 Electricity and chemistry

C5.1 Electricity and chemistry

Core

1. Define electrolysis as the breakdown of an ionic compound when molten or in aqueous solution by the passage of electricity.
2. Use the terms inert electrode, electrolyte, anode and cathode.
3. Describe the electrode products and the observations made, using inert electrodes (platinum or carbon), in the electrolysis of:
   - molten lead(II) bromide
   - concentrated aqueous sodium chloride
   - dilute sulfuric acid

Supplement

3. Describe electrolysis in terms of the ions present and the reactions at the electrodes, in terms of gain of electrons by cations and loss of electrons by anions to form atoms.
5. Predict the products of the electrolysis of a specified molten binary compound.
0652 Chemistry

C6 Energy changes in chemical reactions

### C6.1 Energetics of a reaction

<table>
<thead>
<tr>
<th>Core</th>
<th>Supplement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Describe the meaning of <strong>exothermic</strong> and <strong>endothermic</strong> reactions</td>
<td>2. Describe bond breaking as an endothermic process and bond forming as an exothermic process</td>
</tr>
<tr>
<td>3. Draw and label energy level diagrams for exothermic and endothermic reactions using data provided</td>
<td>4. Interpret energy level diagrams showing exothermic and endothermic reactions and the activation energy of a reaction</td>
</tr>
</tbody>
</table>

### C6.2 Energy transfer

<table>
<thead>
<tr>
<th>Core</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Describe the release of thermal energy by burning fuels</td>
</tr>
<tr>
<td>2. State the use of hydrogen as a fuel</td>
</tr>
</tbody>
</table>

### C6.3 Rate (speed) of reaction

<table>
<thead>
<tr>
<th>Core</th>
<th>Supplement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Describe practical methods for investigating the rate of a reaction which produces a gas</td>
<td>4. Describe and explain the effect of concentration in terms of frequency of collisions between reacting particles</td>
</tr>
<tr>
<td>2. Interpret data obtained from experiments concerned with rate of reaction</td>
<td>5. Describe and explain the effect of changing temperature in terms of the frequency of collisions between reacting particles and more colliding particles possessing the minimum energy (activation energy) to react</td>
</tr>
<tr>
<td>3. Describe the effect of concentration, particle size, catalysts (including enzymes) and temperature on the rate of reactions</td>
<td></td>
</tr>
<tr>
<td>6. Describe how concentration, temperature and surface area create a danger of explosive combustion with fine powders (e.g. flour mills) and gases (e.g. methane in mines)</td>
<td></td>
</tr>
</tbody>
</table>

Note: Candidates should be encouraged to use the term *rate* rather than *speed.*
0652 Chemistry

C6.4 Redox

Core
1 Describe oxidation and reduction in chemical reactions in terms of oxygen loss/gain (Oxidation state limited to its use to name ions, e.g. iron(II), iron(III), copper(II)).

Supplement
2 Define and identify an oxidising agent as a substance which oxidises another substance during a redox reaction and a reducing agent as a substance which reduces another substance during a redox reaction.

C7 Acids, bases and salts

C7.1 The characteristic properties of acids and bases

Core
1 Describe the characteristic properties of acids (exemplified by dilute hydrochloric acid and dilute sulfuric acid) including their effect on litmus paper and their reactions with metals, bases and carbonates.
2 Describe the characteristic properties of bases including their effect on litmus paper and their reactions with acids and ammonium salts.
3 Describe neutrality and relative acidity and alkalinity in terms of pH (whole numbers only) measured using universal indicator.
4 Describe and explain the importance of controlling acidity in soil.

Supplement
3 Define acids and bases in terms of proton transfer, limited to aqueous solutions.

C7.2 Types of oxides

Core
1 Classify oxides as either acidic or basic, related to the metallic and non-metallic character.

Supplement
2 Further classify other oxides as neutral or amphoteric.

C7.3 Preparation of salts

Core
1 Describe the preparation, separation and purification of salts using techniques specified in Section C2 and the reactions specified in Section C7.1.

Supplement
2 Suggest a method of making a given salt from suitable starting material given appropriate information, including precipitation.
0652 Chemistry

C7.4 Identification of ions and gases

Core

1. Describe and use the following tests to identify:
   - **aqueous cations:**
     - ammonium, calcium, copper(II), iron(II), iron(III)
     - and zinc, using aqueous sodium hydroxide and aqueous ammonia as appropriate (formulae of complex ions are not required)
   - **cations:**
     - flame tests to identify lithium, sodium, potassium and copper(II)
   - **anions:**
     - carbonate (by reaction with dilute acid and then limewater), chloride and bromide (by reaction under acidic conditions with aqueous silver nitrate), nitrate (by reduction with aluminium) and sulfate (by reaction under acidic conditions with aqueous barium ions)
   - **gases:**
     - ammonia (using damp red litmus paper), carbon dioxide (using limewater), chlorine (using damp litmus paper), hydrogen (using a lighted splint), oxygen (using a glowing splint)

C8 The Periodic Table

C8.1 The Periodic Table

Core

1. Describe the Periodic Table as a method of classifying elements and its use to predict properties of elements

C8.2 Periodic Trends

Core

1. Describe the change from metallic to non-metallic character across a period

Supplement

2. Describe and explain the relationship between group number, number of outer-shell electrons and metallic/non-metallic character
### C8.3 Group properties

**Core**

1. Describe lithium, sodium and potassium in Group I (the alkali metals) as a collection of relatively soft metals showing a trend in melting point, density and reaction with water.

3. Describe the halogens, chlorine, bromine and iodine in Group VII, as a collection of diatomic non-metals showing a trend in colour and physical state.

**Supplement**

2. Predict the properties of other elements in Group I given data, where appropriate.

4. State the reaction of chlorine, bromine and iodine with other halide ions.

5. Predict the properties of other elements in Group VII, given data where appropriate.

6. Identify trends in other groups, given data about the elements concerned.

### C8.4 Transition elements

**Core**

1. Describe the transition elements as a collection of metals having high densities, high melting points and forming coloured compounds, and which, as elements and compounds, often act as catalysts.

### C8.5 Noble gases

**Core**

1. Describe the noble gases, in Group VIII or 0, as being unreactive, monoatomic gases and explain this in terms of electronic structure.

2. State the uses of the noble gases in providing an inert atmosphere, i.e. argon in lamps, helium for filling balloons.

### C9 Metals

#### C9.1 Properties of metals

**Core**

1. Describe the general physical properties of metals as solids with high melting and boiling points, malleable and good conductors of heat and electricity.

3. Describe alloys, such as brass, as mixtures of a metal with other elements.

4. Explain in terms of their properties why alloys are used instead of pure metals.

**Supplement**

2. Describe metallic bonding as a lattice of positive ions in a ‘sea of electrons’ and use this to explain the electrical conductivity and malleability of metals.

5. Describe how the properties of iron are changed by the controlled use of additives to form steel alloys, such as mild steel and stainless steel.
0652 Chemistry

C9.2 Reactivity series

Core
1 Place in order of reactivity: potassium, sodium, calcium, magnesium, aluminium, (carbon), zinc, iron, (hydrogen) and copper, by reference to the reactions, if any, of the elements with:
   - water or steam
   - dilute hydrochloric acid
   - reduction of their oxides with carbon
3 Deduce an order of reactivity from a given set of experimental results

Supplement
2 Describe the reactivity series in terms of the tendency of a metal to form its positive ion, illustrated by its reaction, if any, with the aqueous ions of other listed metals

C9.3 Extraction of metals

Core
1 Describe the use of carbon in the extraction of some metals from their ores
2 Know that aluminium is extracted from the ore bauxite by electrolysis

Supplement
3 Describe and explain the essential reactions in the extraction of iron from hematite in the blast furnace
   \[ C + O_2 \rightarrow CO_2 \]
   \[ C + CO_2 \rightarrow 2CO \]
   \[ Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2 \]

C9.4 Uses of metals

Core
1 Describe the uses of aluminium:
   - in aircraft parts because of its strength and low density
   - in food containers because of its resistance to corrosion
3 State the uses of mild steel (car bodies and machinery) and stainless steel (chemical plant and cutlery)

Supplement
2 Describe and explain the apparent unreactivity of aluminium in terms of the oxide layer which adheres to the metal
4 Explain the uses of zinc for galvanising steel and for making brass

C10 Air and water

C10.1 Water

Core
1 Describe a chemical test for water using copper(II) sulfate and cobalt(II) chloride
3 Describe, in outline, and explain the purification treatment of the water supply in terms of filtration and chlorination

Supplement
2 Describe how hydration can be reversed (e.g. by heating hydrated copper(II) sulfate or hydrated cobalt(II) chloride)
## 0652 Chemistry

### C10.2 Air

<table>
<thead>
<tr>
<th>Core</th>
<th>Supplement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. State the composition of clean air as being a mixture of 78% nitrogen, 21% oxygen and small quantities of noble gases, water vapour and carbon dioxide.</td>
<td>4. Describe some approaches to reducing emissions of sulfur dioxide, including the use of low sulfur petrol and flue gas desulfurisation by calcium oxide.</td>
</tr>
<tr>
<td>2. Name the common pollutants in air as being carbon monoxide, sulfur dioxide and oxides of nitrogen.</td>
<td>5. Describe, in outline, how a catalytic converter removes nitrogen monoxide and carbon monoxide from exhaust emissions by reaction over a hot catalyst.</td>
</tr>
<tr>
<td>3. State the source of each of these pollutants:</td>
<td>6. State the adverse effect of these common air pollutants on buildings and on health.</td>
</tr>
<tr>
<td>- carbon monoxide from the incomplete combustion of carbon-containing substances</td>
<td>7. State the conditions required for the rusting of iron (presence of oxygen and water).</td>
</tr>
<tr>
<td>- sulfur dioxide from the combustion of fossil fuels which contain sulfur compounds (leading to acid rain)</td>
<td>8. Describe and explain barrier methods of rust prevention, including paint and other coatings.</td>
</tr>
<tr>
<td>- oxides of nitrogen from car engines</td>
<td>9. Describe and explain sacrificial protection in terms of the reactivity series of metals and galvanising as a method of rust prevention.</td>
</tr>
</tbody>
</table>

### C10.3 Carbon dioxide and methane

<table>
<thead>
<tr>
<th>Core</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. State the formation of carbon dioxide:</td>
</tr>
<tr>
<td>- as a product of complete combustion of carbon-containing substances</td>
</tr>
<tr>
<td>- as a product of respiration</td>
</tr>
<tr>
<td>- as a product of the reaction between an acid and a carbonate</td>
</tr>
<tr>
<td>- as a product of thermal decomposition of calcium carbonate</td>
</tr>
<tr>
<td>2. State that carbon dioxide and methane are greenhouse gases</td>
</tr>
</tbody>
</table>
0652 Chemistry

C11 Carbonates

C11.1 Carbonates

Core

1. Describe the manufacture of lime (calcium oxide) from limestone (calcium carbonate) in terms of the chemical reactions involved, and the use of limestone in treating acidic soil and neutralising acidic industrial waste products.

2. Describe the thermal decomposition of calcium carbonate (limestone).

C12 Organic chemistry

C12.1 Names of compounds

Core

1. Name and draw the structures of methane, ethane, ethene and ethanol.

2. State the type of compound present, given a chemical name ending in -ane, -ene and -ol or a molecular structure.

C12.2 Fuels

Core

1. State that coal, natural gas and petroleum are fossil fuels that produce carbon dioxide on combustion.

2. Name methane as the main constituent of natural gas.

3. Describe petroleum as a mixture of hydrocarbons and its separation into useful fractions by fractional distillation.

5. Name the uses of the fractions as:
   - refinery gas for bottled gas for heating and cooking
   - gasoline fraction for fuel (petrol) in cars
   - naphtha fraction as a feedstock for making chemicals
   - diesel oil/gas oil for fuel in diesel engines
   - bitumen for road surfaces

Supplement

4. Describe the properties of molecules within a fraction.
### C12.3 Homologous series

**Supplement**

1. Describe the homologous series of alkanes and alkenes as families of compounds with the same general formula and similar chemical properties.

### C12.4 Alkanes

**Core**

1. Describe alkanes as saturated hydrocarbons whose molecules contain only single covalent bonds.
2. Describe the properties of alkanes (exemplified by methane) as being generally unreactive, except in terms of burning.
3. Describe the complete combustion of hydrocarbons to give carbon dioxide and water.

### C12.5 Alkenes

**Core**

1. Describe alkenes as unsaturated hydrocarbons whose molecules contain one double covalent bond.
2. State that cracking is a reaction that produces alkenes.
3. Recognise saturated and unsaturated hydrocarbons:
   - from molecular structures
   - by their reaction with aqueous bromine
4. Describe the formation of poly(ethene) as an example of addition polymerisation of monomer units.
5. Describe the properties of alkenes in terms of addition reactions, with bromine, hydrogen and steam, exemplified by ethene.

**Supplement**

3. Describe the formation of smaller alkanes, alkenes and hydrogen by the cracking of larger alkane molecules and state the conditions required for cracking.
5. Describe the properties of alkenes in terms of addition reactions, with bromine, hydrogen and steam, exemplified by ethene.

### C12.6 Alcohols

**Core**

1. State that ethanol may be formed by fermentation and by reaction between ethene and steam.
3. Describe the complete combustion of ethanol to give carbon dioxide and water.
4. State the uses of ethanol as a solvent and as a fuel.

**Supplement**

2. Describe the formation of ethanol by fermentation and the catalytic addition of steam to ethene.
Physics

P1 General physics

P1.1 Length and time

Core

1. Use and describe the use of rules and measuring cylinders to find a length or a volume
2. Use and describe the use of clocks and devices, both analogue and digital, for measuring an interval of time
3. Obtain an average value for a small distance and for a short interval of time by measuring multiples (including the period of a pendulum)

Supplement

2. Understand that a micrometer screw gauge is used to measure very small distances

P1.2 Motion

Core

1. Define speed and calculate average speed from
\[
\text{average speed} = \frac{\text{total distance}}{\text{total time}}
\]
2. Plot and interpret a speed–time graph and a distance–time graph
3. Recognise from the shape of a speed–time graph when a body is:
   - at rest
   - moving with constant speed
   - moving with changing speed
4. Calculate the area under a speed–time graph to work out the distance travelled for motion with constant acceleration
5. Demonstrate understanding that acceleration and deceleration are related to changing speed including qualitative analysis of the gradient of a speed–time graph
6. State that the acceleration of free fall \( g \) for a body near to the Earth is constant

Supplement

2. Distinguish between speed and velocity
3. Define and calculate acceleration using
\[
\text{acceleration} = \frac{\text{change in velocity}}{\text{time taken}}
\]
4. Calculate acceleration from the gradient of a speed–time graph
5. Recognise linear motion for which the acceleration is not constant
6. Describe qualitatively the motion of bodies falling in a uniform gravitational field with and without air resistance including reference to terminal velocity
### 0652 Physics

#### P1.3 Mass and weight

**Core**

1. Show familiarity with the idea of the mass of a body
2. State that weight is a gravitational force
3. Distinguish between mass and weight
4. Demonstrate understanding that weights (and hence masses) may be compared using a balance
5. Recognise that $g$ is the gravitational force on unit mass and is measured in N/kg
6. Recall and use the equation $W = mg$

**Supplement**

2. Demonstrate an understanding that mass is a property which ‘resists’ change in motion
6. Describe and use the concept of weight as the effect of a gravitational field on a mass

#### P1.4 Density

**Core**

1. Recall and use the equation $p = \frac{m}{V}$
2. Describe an experiment to determine the density of a liquid and of a regularly-shaped solid and make the necessary calculation

**Supplement**

3. Describe the determination of the density of an irregularly-shaped solid by the method of displacement and make the necessary calculation

#### P1.5 Forces

**P1.5.1 Effects of forces**

**Core**

1. Recognise that a force may produce a change in the size, shape and motion of a body
2. Understand friction as the force between two surfaces which impedes motion and results in heating
3. Recognise air resistance as a form of friction
4. Find the resultant of two or more forces acting along the same line
5. Recognise that if there is no resultant force on a body it either remains at rest or continues at constant speed in a straight line

**Supplement**

2. Plot and interpret extension–load graphs and describe the associated experimental procedure
3. State Hooke’s law and recall and use the equation $F = kx$ where $k$ is the spring constant
4. Recognise the significance of the term ‘limit of proportionality’ for an extension–load graph
5. Recall and use the relationship between resultant force, mass and acceleration, $F = ma$

*continued*
## P1.5 Forces continued

### P1.5.2 Turning effect

**Core**

1. Describe the moment of a force as a measure of its turning effect and give everyday examples.
2. Calculate moment using the product $\text{force} \times \text{perpendicular distance from the pivot}$.  
3. Recognise that when there is no resultant force and no resultant turning effect, a system is in equilibrium.

**Supplement**

3. Apply the principle of moments to the balancing of a weightless beam about a pivot.

### P1.5.3 Centre of mass

**Core**

1. Perform and describe an experiment to determine the position of the centre of mass of a plane lamina.
2. Describe qualitatively the effect of the position of the centre of mass on the stability of simple objects.

### P1.5.4 Pressure

**Core**

1. Relate qualitatively pressure to force and area, using appropriate examples.

**Supplement**

2. Recall and use the equation $p = \frac{F}{A}$.

### P1.6 Work, energy and power

#### P1.6.1 Work

**Core**

1. Relate (without calculation) work done to the magnitude of a force and distance moved in the direction of the force.

**Supplement**

2. Recall and use $W = Fd = \Delta E$.  

*continued*
0652  Physics

P1.6  Work, energy and power continued

P1.6.2  Energy

Core

1. Demonstrate an understanding that work done = energy transferred
2. Demonstrate understanding that an object may have energy due to its motion (kinetic energy, KE) or its position (potential energy, PE) and that energy may be transferred and stored
3. Give and identify examples of changes in kinetic, gravitational potential, chemical potential, elastic (strain), nuclear and thermal energy that have occurred as a result of an event or process
4. Recognise that energy is transferred during events and processes, including examples of transfer by forces (mechanical working), by electric currents (electrical working), by heating and by waves
5. Apply the principle of conservation of energy to simple examples

Supplement

4. Recall and use the expressions KE = \( \frac{1}{2}mv^2 \) and gravitational potential energy (GPE) = \( mg\Delta h \) or change in GPE = \( mg\Delta h \)

P1.6.3  Power

Core

1. Relate (without calculation) power to work done and time taken, using appropriate examples

Supplement

2. Recall and use the equation \( P = \Delta E/ t \) in simple systems

continued
0652 Physics

P1.6 Work, energy and power continued

### P1.6.4 Energy resources

<table>
<thead>
<tr>
<th>Core</th>
<th>Supplement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Distinguish between renewable and non-renewable sources of energy</td>
<td>5. Understand that the Sun is the source of energy for all our energy resources except geothermal, nuclear and tidal</td>
</tr>
<tr>
<td>2. Describe how electricity or other useful forms of energy may be obtained from:</td>
<td>6. Understand that the source of tidal energy is mainly the moon</td>
</tr>
<tr>
<td>- chemical energy stored in fuel</td>
<td>7. Show an understanding that energy is released by nuclear fusion in the Sun</td>
</tr>
<tr>
<td>- energy from water, including the energy stored in waves, in tides, and in water behind hydroelectric dams</td>
<td>8. Recall and use the equations:</td>
</tr>
<tr>
<td>- geothermal resources</td>
<td>- efficiency = ( \frac{\text{useful energy output}}{\text{energy input}} \times 100% )</td>
</tr>
<tr>
<td>- nuclear fission</td>
<td>- efficiency = ( \frac{\text{useful power output}}{\text{power input}} \times 100% )</td>
</tr>
<tr>
<td>- heat and light from the Sun (solar cells and panels)</td>
<td>- wind energy</td>
</tr>
<tr>
<td>- wind energy</td>
<td>3. Give advantages and disadvantages of each method in terms of renewability, cost, reliability, scale and environmental impact</td>
</tr>
<tr>
<td>3. Give advantages and disadvantages of each method in terms of renewability, cost, reliability, scale and environmental impact</td>
<td></td>
</tr>
<tr>
<td>4. Show a qualitative understanding of efficiency</td>
<td></td>
</tr>
</tbody>
</table>
P2.1 Thermal properties and temperature

P2.1.1 Thermal expansion of solids, liquids and gases

Core
1. State the distinguishing properties of solids, liquids and gases
2. Describe qualitatively the molecular structure of solids, liquids and gases in terms of the arrangement, separation, and motion of the molecules
3. Describe qualitatively the pressure of a gas and the temperature of a gas, liquid or solid in terms of the motion of its particles
4. Describe qualitatively the thermal expansion of solids, liquids and gases at constant pressure
5. Identify and explain some of the everyday applications and consequences of thermal expansion
6. Know the relative order of the magnitude of the expansion of solids, liquids and gases

P2.1.2 Measurement of temperature

Core
1. Describe how a physical property which varies with temperature may be used for the measurement of temperature and state examples of such properties
2. Recognise the need for and identify fixed points
3. Describe and explain the structure and action of liquid-in-glass thermometers

Supplement
2. Demonstrate understanding of sensitivity, range and linearity
5. Use and describe the use of thermometers to measure temperature on the Celsius scale
6. Describe the structure of a thermocouple and show understanding of its use as a thermometer for measuring high temperatures and those which vary rapidly

continued
## 0652  Physics

### P2.1  Thermal properties and temperature continued

#### P2.1.3  Melting and boiling

<table>
<thead>
<tr>
<th>Core</th>
<th>Supplement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Describe melting and boiling in terms of energy input without a change in temperature</td>
</tr>
<tr>
<td>2</td>
<td>State the meaning of melting point and boiling point, and recall the melting and boiling points for water</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Core</th>
<th>Supplement</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Distinguish between boiling and evaporation</td>
</tr>
</tbody>
</table>

### P2.2  Thermal processes

#### P2.2.1  Conduction

<table>
<thead>
<tr>
<th>Core</th>
<th>Supplement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Recognise and name typical good and bad thermal conductors</td>
</tr>
<tr>
<td>2</td>
<td>Describe experiments to demonstrate the properties of good and bad thermal conductors</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Core</th>
<th>Supplement</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Explain conduction in solids in terms of molecular vibrations and transfer by electrons</td>
</tr>
</tbody>
</table>

#### P2.2.2  Convection

<table>
<thead>
<tr>
<th>Core</th>
<th>Supplement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Recognise convection as the main method of energy transfer in fluids</td>
</tr>
<tr>
<td>2</td>
<td>Relate convection in fluids to density changes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Core</th>
<th>Supplement</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Interpret and describe experiments designed to illustrate convection in liquids and gases (fluids)</td>
</tr>
</tbody>
</table>

#### P2.2.3  Radiation

<table>
<thead>
<tr>
<th>Core</th>
<th>Supplement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Recognise radiation as the method of energy transfer that does not require a medium to travel through</td>
</tr>
<tr>
<td>2</td>
<td>Identify infrared radiation as the part of the electromagnetic spectrum often involved in energy transfer by radiation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Core</th>
<th>Supplement</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Describe the effect of surface colour (black or white) and texture (dull or shiny) on the emission, absorption and reflection of radiation</td>
</tr>
<tr>
<td>4</td>
<td>Interpret and describe experiments to investigate the properties of good and bad emitters and good and bad absorbers of infrared radiation</td>
</tr>
</tbody>
</table>

**continued**
**0652  Physics**

**P2.2  Thermal processes continued**

P2.2.4 Consequences of energy transfer

Core

1. Identify and explain some of the everyday applications and consequences of conduction, convection and radiation

**P3  Properties of waves, including light and sound**

**P3.1  General wave properties**

<table>
<thead>
<tr>
<th>Core</th>
<th>Supplement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Demonstrate understanding that waves transfer energy without transferring matter</td>
<td>5. Distinguish between transverse and longitudinal waves and give suitable examples</td>
</tr>
<tr>
<td>2. Describe what is meant by wave motion as illustrated by vibration in ropes, springs and by experiments using water waves</td>
<td></td>
</tr>
<tr>
<td>3. Use the term wavefront</td>
<td></td>
</tr>
<tr>
<td>4. State the meaning of speed, frequency, wavelength and amplitude</td>
<td>8. Recall and use the equation ( v = f \lambda )</td>
</tr>
<tr>
<td>6. Describe how waves can undergo:</td>
<td>9. Understand that refraction is caused by a change in speed as a wave moves from one medium to another</td>
</tr>
<tr>
<td>– reflection at a plane surface</td>
<td>10. Describe how waves can undergo diffraction through a narrow gap</td>
</tr>
<tr>
<td>– refraction due to a change of speed</td>
<td>11. Describe the use of water waves to demonstrate diffraction</td>
</tr>
<tr>
<td>7. Describe the use of water waves to demonstrate reflection and refraction</td>
<td></td>
</tr>
</tbody>
</table>
0652  Physics

P3.2  Light

P3.2.1  Reflection of light

Core
1. Describe the formation of an optical image by a plane mirror and give its characteristics.
2. Recall and use the law of reflection: $\text{angle of incidence } i = \text{angle of reflection } r$, recognising these angles are measured to the normal.
3. Give the meaning of critical angle.
4. Describe internal and total internal reflection.
5. Perform simple constructions, measurements and calculations for reflection by plane mirrors.

Supplement
6. Recall that the image in a plane mirror is virtual.
7. Describe and explain the action of optical fibres, particularly in medicine and communications technology.

P3.2.2  Refraction of light

Core
1. Interpret and describe an experimental demonstration of the refraction of light.
2. Use the terminology for the angle of incidence $i$ and angle of refraction $r$ and describe the passage of light through parallel-sided transparent material.

Supplement
2. Recall and use the definition of refractive index $n$ in terms of speed.
4. Recall and use the equation for refractive index: $n = \frac{\sin i}{\sin r}$.

P3.2.3  Thin converging lens

Core
1. Describe the action of a thin converging lens on a beam of light.
2. Use the terms principal focus and focal length.
3. Draw ray diagrams for the formation of a real image by a single lens.

Supplement
4. Show understanding of the terms real image and virtual image.
5. Draw and use ray diagrams for the formation of a virtual image by a single converging lens.
6. Describe the nature of an image using the terms enlarged/same size/diminished and upright/inverted.

7. Use and describe the use of a single lens as a magnifying glass.

continued
## P3.2 Light continued

### P3.2.4 Electromagnetic spectrum

<table>
<thead>
<tr>
<th>Core</th>
<th>Supplement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Describe the main features of the electromagnetic spectrum in order of frequency, from radio waves to gamma radiation (γ)</td>
<td>3 State that the speed of electromagnetic waves in a vacuum is $3.0 \times 10^8$ m/s and is approximately the same in air</td>
</tr>
<tr>
<td>2 State that all electromagnetic waves travel with the same high speed in a vacuum</td>
<td></td>
</tr>
<tr>
<td>4 Describe typical properties and uses of radiations in all the different regions of the electromagnetic spectrum including:</td>
<td></td>
</tr>
<tr>
<td>- radio and television communications (radio waves)</td>
<td></td>
</tr>
<tr>
<td>- satellite television and telephones (microwaves)</td>
<td></td>
</tr>
<tr>
<td>- electrical appliances, remote controllers for televisions and intruder alarms (infrared)</td>
<td></td>
</tr>
<tr>
<td>- medicine and security (X-rays)</td>
<td></td>
</tr>
</tbody>
</table>

### P3.3 Sound

<table>
<thead>
<tr>
<th>Core</th>
<th>Supplement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Describe how vibrating objects produce sound waves, and how sound waves can cause objects to vibrate, including the eardrum</td>
<td>2 Describe the longitudinal nature of sound waves</td>
</tr>
<tr>
<td>4 State that the approximate range of audible frequencies for a healthy human ear is 20 Hz to 20 000 Hz</td>
<td>3 Describe the transmission of sound waves in air in terms of compressions and rarefactions</td>
</tr>
<tr>
<td>5 Show an understanding that a medium is needed to transmit sound waves</td>
<td></td>
</tr>
</tbody>
</table>
## 0652 Physics

### P4 Electricity and magnetism

#### P4.1 Simple phenomena of magnetism

<table>
<thead>
<tr>
<th>Core</th>
<th>Supplement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Describe the forces between magnets, and</td>
<td>2 Give an account of induced magnetism</td>
</tr>
<tr>
<td>between magnets and magnetic materials</td>
<td></td>
</tr>
<tr>
<td>3 Distinguish between magnetic and non-magnetic materials</td>
<td></td>
</tr>
<tr>
<td>4 Draw and describe the pattern and direction of</td>
<td></td>
</tr>
<tr>
<td>magnetic field lines around a bar magnet</td>
<td></td>
</tr>
<tr>
<td>5 Distinguish between the magnetic properties of</td>
<td></td>
</tr>
<tr>
<td>soft iron and steel</td>
<td></td>
</tr>
<tr>
<td>6 Recognise that an electric current has an associated magnetic</td>
<td></td>
</tr>
<tr>
<td>field</td>
<td></td>
</tr>
<tr>
<td>7 Distinguish between the design and use of</td>
<td></td>
</tr>
<tr>
<td>permanent magnets and electromagnets</td>
<td></td>
</tr>
<tr>
<td>8 Describe methods of magnetisation to include stroking with a</td>
<td>9 Describe methods of demagnetisation to</td>
</tr>
<tr>
<td>magnet, use of d.c. in a coil and hammering in a magnetic field</td>
<td>include hammering, heating and use of</td>
</tr>
<tr>
<td></td>
<td>alternating current (a.c.) in a coil</td>
</tr>
</tbody>
</table>

#### P4.2 Electrical quantities

##### P4.2.1 Electric charge

<table>
<thead>
<tr>
<th>Core</th>
<th>Supplement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 State that there are positive and negative charges</td>
<td>5 Describe an electric field as a region in</td>
</tr>
<tr>
<td>2 State that unlike charges attract and that like charges repel</td>
<td>which an electric charge experiences a force</td>
</tr>
<tr>
<td>3 Describe and interpret simple experiments to show the production</td>
<td></td>
</tr>
<tr>
<td>and detection of electrostatic charges by friction</td>
<td></td>
</tr>
<tr>
<td>4 State that charging a body involves the addition or removal of</td>
<td></td>
</tr>
<tr>
<td>electrons</td>
<td></td>
</tr>
<tr>
<td>6 Distinguish between electrical conductors and insulators and give</td>
<td></td>
</tr>
<tr>
<td>typical examples</td>
<td></td>
</tr>
</tbody>
</table>

##### P4.2.2 Current

<table>
<thead>
<tr>
<th>Core</th>
<th>Supplement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 State that current is related to the flow of charge</td>
<td>2 Show understanding that a current is a rate</td>
</tr>
<tr>
<td>4 Use and describe the use of an ammeter, both analogue and digital</td>
<td>of flow of charge and recall and use the</td>
</tr>
<tr>
<td>5 State that current in metals is due to a flow of electrons</td>
<td>equation $I = Q/t$</td>
</tr>
<tr>
<td>3 Distinguish between the direction of flow of electrons and</td>
<td>3 Distinguish between the direction of flow of</td>
</tr>
<tr>
<td>conventional current</td>
<td>electrons and conventional current</td>
</tr>
</tbody>
</table>

continued
0652 Physics

P4.2 Electrical quantities continued

P4.2.3 Electromotive force (e.m.f.) and potential difference (p.d.)

Core

1. State that the potential difference (p.d.) across a circuit component is measured in volts.
2. Use and describe the use of a voltmeter, both analogue and digital.
3. State that the electromotive force (e.m.f.) of an electrical source of energy is measured in volts.

Supplement

2. Show understanding that e.m.f. is defined in terms of energy supplied by a source in driving charge around a complete circuit.
5. Recall that 1 V is equivalent to 1 J/C.

P4.2.4 Resistance

Core

1. State that resistance = p.d./current and understand qualitatively how changes in p.d. or resistance affect current.
2. Recall and use the equation \( R = \frac{V}{I} \).
3. Describe an experiment to determine resistance using a voltmeter and an ammeter.
4. Relate (without calculation) the resistance of a wire to its length and to its diameter.
5. Demonstrate understanding of current, potential difference, e.m.f. and resistance.

Supplement

6. Recall and use quantitatively the proportionality between resistance and length, and the inverse proportionality between resistance and cross-sectional area of a wire.

P4.3 Electric circuits

P4.3.1 Circuit diagrams

Core

1. Draw and interpret circuit diagrams containing sources, switches, resistors (fixed and variable), lamps, ammeters, voltmeters and fuses.

(Symbols for other common circuit components will be provided in questions.)

continued
0652 Physics

P4.3 Electric circuits continued

P4.3.2 Series and parallel circuits

Core

1. Understand that the current at every point in a series circuit is the same
2. Calculate the combined resistance of two or more resistors in series
4. State that, for a parallel circuit, the current from the source is larger than the current in each branch
6. State that the combined resistance of two resistors in parallel is less than that of either resistor by itself
8. State the advantages of connecting components in parallel in a circuit

Supplement

3. Recall and use the fact that the sum of the p.d.s across the components in a series circuit is equal to the total p.d. across the supply
5. Recall and use the fact that the current from the source is the sum of the currents in the separate branches of a parallel circuit
7. Calculate the combined resistance of two resistors in parallel
9. Draw and interpret circuit diagrams containing NTC thermistors and light-dependent resistors (LDRs)
10. Describe the action of NTC thermistors and LDRs and show understanding of their use as input transducers

P4.4 Electrical energy

Supplement

1. Recall and use the equations \( P = IV \) and \( E = IVt \)

P4.5 Dangers of electricity

Core

1. State the hazards of:
   - damaged insulation
   - overheating of cables
   - damp conditions
2. State that a fuse protects a circuit
3. Explain the use of fuses and circuit breakers and choose appropriate fuse ratings and circuit-breaker ratings
4. Explain the benefits of earthing metal cases
0652  Physics

P4.6  Electromagnetic effects

P4.6.1  Electromagnetic induction

Supplement

1. Show understanding that a conductor moving across a magnetic field or a changing magnetic field linking with a conductor can induce an electromotive force (e.m.f.) in the conductor.
2. Describe an experiment to demonstrate electromagnetic induction.
3. State the factors affecting the magnitude of an induced e.m.f.
4. Show understanding that the direction of an induced e.m.f. opposes the change causing it.

P4.6.2  a.c. generator

Supplement

1. Distinguish between direct current (d.c) and alternating current (a.c).
2. Describe and explain the operation of a rotating-coil generator and the use of slip rings.
3. Sketch a graph of voltage output against time for a simple a.c. generator.

P4.6.3  Transformers

Supplement

1. Describe the construction of a basic transformer with a soft-iron core, as used for voltage transformations.
2. Describe the principle of operation of a transformer.
3. Use the terms step-up and step-down.
4. Recall and use the equation \( \frac{V_p}{V_s} = \frac{N_p}{N_s} \) (for 100% efficiency).
5. Recall and use the equation \( I_p \cdot V_p = I_s \cdot V_s \) (for 100% efficiency).
6. Describe the use of the transformer in high-voltage transmission of electricity.
7. Explain why power losses in cables are lower when the voltage is high.

continued
0652  Physics

P4.6  Electromagnetic effects continued

P4.6.4  Force on a current-carrying conductor

Core
1. Describe an experiment to show that a force acts on a current-carrying conductor in a magnetic field, including the effect of reversing:
   - the current
   - the direction of the field

P4.6.5  d.c.motor

Core
1. State that a current-carrying coil in a magnetic field experiences a turning effect and that the effect is increased by:
   - increasing the number of turns on the coil
   - increasing the current
   - increasing the strength of the magnetic field

Supplement
2. Relate this turning effect to the action of an electric motor including the action of a split-ring commutator

P5  Atomic physics

P5.1  The nuclear atom

Core
1. Describe the composition of the nucleus in terms of protons and neutrons
2. Use the terms proton number Z and nucleon number A
3. Use and interpret the term nuclide and use the nuclide notation \( A^Z_X \)
4. Use and explain the term isotope

P5.2  Radioactivity

P5.2.1  Detection of radioactivity

Core
1. Demonstrate understanding of background radiation
2. Describe the detection of α-particles, β-particles and γ-rays (β\(^+\) are not included, β\(^-\) particles will be taken to refer to β\(^-\) )

continued
0652  Physics  

P5.2  Radioactivity continued  

P5.2.2 Characteristics of the three kinds of emission  

Core  
1. Describe the random nature of radioactive emission  
2. Identify alpha-, beta- and gamma- (α-, β- and γ-emissions) by recalling:  
   - their nature  
   - their relative ionising effects  
   - their relative penetrating abilities  

Supplement  
3. Describe deflection of α-, β- and γ-emissions in electric fields and in magnetic fields  
4. Give and explain examples of practical applications of α-, β- and γ-emissions  

P5.2.3 Radioactive decay  

Core  
1. State the meaning of radioactive decay  
2. Use word equations to represent changes in the composition of the nucleus when particles are emitted  

Supplement  
3. Use nuclide notation in equations to show the effect on the nucleus of α- and β-decay  

P5.2.4 Half-life  

Core  
1. Show an understanding of the term half-life and use the term in context  
2. Use the term half-life in simple calculations which may involve information in tables or decay curves  

Supplement  
3. Calculate half-life from data or decay curves, including curves from which background radiation has not been subtracted  

P5.2.5 Safety precautions  

Core  
1. Recall the effects of ionising radiations on living things  
2. Describe how radioactive materials are handled, used and stored in a safe way
4 Details of the assessment

All candidates take three papers.

Candidates who have studied the Core subject content, or who are expected to achieve a grade D or below, should be entered for Paper 1, Paper 3 and either Paper 5 or Paper 6. These candidates will be eligible for grades C to G.

Candidates who have studied the Extended subject content (Core and Supplement), and who are expected to achieve a grade C or above, should be entered for Paper 2, Paper 4 and either Paper 5 or Paper 6. These candidates will be eligible for grades A* to G.

Core assessment
Core candidates take the following papers that have questions based on the Core subject content only:

Paper 1 Multiple Choice (Core)
45 minutes, 40 marks
Forty compulsory multiple-choice items of the four-option type. This paper tests assessment objectives AO1 and AO2.

Paper 3 Theory (Core)
1 hour 15 minutes, 80 marks
Short-answer and structured questions testing assessment objectives AO1 and AO2.

Extended assessment
Extended candidates take the following papers that have questions based on the Core and Supplement subject content:

Paper 2 Multiple Choice (Extended)
45 minutes, 40 marks
Forty compulsory multiple-choice items of the four-option type. This paper tests assessment objectives AO1 and AO2.

Paper 4 Theory (Extended)
1 hour 15 minutes, 80 marks
Short-answer and structured questions testing assessment objectives AO1 and AO2.
Practical assessment

All candidates take one practical component from a choice of two:

Paper 5 Practical Test
1 hour 15 minutes, 40 marks

This paper tests assessment objective AO3 in a practical context.

OR

Paper 6 Alternative to Practical
1 hour, 40 marks

This paper tests assessment objective AO3 in a written paper.

Whichever practical paper you choose, please be aware that:

- they test the same assessment objective, AO3
- they require the same experimental skills to be learned and developed
- the same sequence of practical activities is appropriate.

Candidates must not use textbooks or any of their course notes in the practical component.

These papers are based on testing experimental skills. One question on each paper assesses the skill of planning. This question will be based on any one of the sciences, which could be: Chemistry or Physics.

Questions in the practical papers are structured to assess performance across the full grade range. The information candidates need to answer the questions is in the question paper itself or the experimental context and skills listed below. The questions do not assess specific subject content.

Experimental skills tested in Paper 5 Practical Test and Paper 6 Alternative to Practical

Candidates may be required to do the following:

- carefully follow a sequence of instructions
- describe, explain or comment on experimental arrangements and techniques
- select the most appropriate apparatus or method for a task and justify the choice made
- draw, complete or label diagrams of apparatus
- perform simple arithmetical calculations
- take readings from an appropriate measuring device or from an image of the device (e.g. thermometer, rule, protractor, measuring cylinder, ammeter, stop-watch), including:
  - reading analogue and digital scales with accuracy and appropriate precision
  - interpolating between scale divisions when appropriate
  - correcting for zero errors when appropriate
- plan to take a sufficient number and range of measurements, repeating where appropriate to obtain an average value
- describe or explain precautions taken in carrying out a procedure to ensure safety or the accuracy of observations and data, including the control of variables and repetition of measurements
• identify key variables and describe how, or explain why, certain variables should be controlled
• record observations systematically, for example in a table, using appropriate units and to a consistent and appropriate degree of precision
• process data, using a calculator where necessary
• present and analyse data graphically, including the use of best-fit lines where appropriate, interpolation and extrapolation, and the determination of a gradient, intercept or intersection
• interpret and evaluate observations and experimental data
• draw an appropriate conclusion, justifying it by reference to the data and using an appropriate explanation
• comment critically on a procedure or point of practical detail, and suggest an appropriate improvement
• evaluate the quality of data, identifying and dealing appropriately with any anomalous results
• identify possible causes of uncertainty, in data or in a conclusion
• make estimates or describe outcomes which demonstrate their familiarity with an experiment, procedure or technique
• plan an experiment or investigation, including making reasoned predictions of expected results and suggesting suitable apparatus and techniques.

Chemistry
Candidates may be asked questions on the following experimental contexts:
• simple quantitative experiments involving the measurement of volumes and/or masses
• rates (speeds) of reaction
• measurement of temperature based on a thermometer with 1 °C graduations and energetics
• problems of an investigatory nature, possibly including suitable organic compounds
• filtration
• electrolysis
• identification of ions and gases
• metals and the reactivity series
• acids, bases, oxides and preparation of salts
• redox reactions and rusting.

Physics
Candidates may be asked questions on the following experimental contexts:
• measurement of physical quantities such as length or volume or force or density
• cooling and heating
• springs and balances
• timing motion or oscillations
• electrical circuits, circuit diagrams and electrical symbols
• optics equipment such as mirrors, prisms and lenses
• procedures using simple apparatus, in situations where the method may not be familiar to the candidate
• use or describe the use of common techniques, apparatus and materials, e.g. ray-tracing equipment or the connection of electric circuits
• explain the manipulation of the apparatus to obtain observations or measurements, e.g.:
  – when determining a derived quantity, such as the extension per unit load for a spring
  – when testing/identifying the relationship between two variables, such as between the p.d. across a wire and its length
  – when comparing physical quantities, such as two masses, using a balancing method.
Teaching experimental skills

We expect you to look for suitable opportunities to embed practical techniques and investigative work throughout the course.

The best way to prepare candidates for these papers is to integrate practical work fully into the course so that it becomes a normal part of your teaching. Practical work helps candidates to:

- develop a deeper understanding of the syllabus topics
- learn to appreciate the way in which scientific theories are developed and tested
- develop experimental skills and positive scientific attitudes such as objectivity, integrity, cooperation, enquiry and inventiveness.

Note on taking readings

When approximate volumes are used, e.g. about 2 cm$^3$, it is expected that candidates will estimate this and not use measuring devices.

A measuring instrument should be used to its full precision. Thermometers may be marked in 1 °C intervals but it is often appropriate to interpolate between scale divisions and record a temperature to the nearest 0.0 °C or 0.5 °C. Measurements using a rule require suitable accuracy of recording, such as 15.0 cm rather than 15 cm; the use of millimetres when appropriate should be encouraged. Similarly, when measuring current, it is often more appropriate to use milliamperes rather than amperes.

Apparatus list

This list contains the items you are likely to need for teaching the experimental skills needed for both practical papers, as well as the Paper 5 exam. It is not exhaustive and does not include equipment commonly regarded as standard in a science laboratory. The Confidential Instructions we send you before the Paper 5 exam will give the detailed requirements for that exam.

- rulers capable of measuring to 1 mm
- metre rule
- means of writing on glassware
- beakers, 100 cm$^3$, 250 cm$^3$
- polystyrene or other plastic beakers of approximate capacity 150 cm$^3$
- test-tubes (Pyrex or hard glass), approximately 125 mm × 16 mm
- boiling tubes, approximately 150 mm × 25 mm
- delivery tubes
- conical flasks, within the range 150 cm$^3$ to 250 cm$^3$
- measuring cylinders, 100 cm$^3$, 50 cm$^3$, 25 cm$^3$, 10 cm$^3$
- dropping pipettes
- white tiles
- large containers (e.g. plastic bowl) to hold cold water
- thermometers, −10 °C to +110 °C with 1 °C graduations
- stop-clocks (or wall-clock or wrist-watch), to measure to an accuracy of 1 s
- glass rods
- spatulas
- wooden splints
- indicators (e.g. litmus paper, universal indicator paper, full range universal indicator)
• common reagents for tests (e.g. limewater test)
• burettes, 50 cm³
• pipettes, 25 cm³
• pipette fillers
• filter funnels and filter paper
• wash bottle
• ammeter FSD 1 A, 1.5 A
• voltmeter FSD 1 V, 5 V
• electrical cells (batteries) and holders to enable several cells to be joined
• connecting leads and crocodile clips
• d.c. power supply, variable to 12 V
• low-voltage filament lamps in holders
• various resistors and resistance wire
• switches
• good supply of masses and holders
• 2 cm expendable springs
• clamps and stands
• pendulum bobs
• newton meters
• Plasticine or modelling clay
• wooden boards
• converging lens with \( f = 15 \) cm
• glass or Perspex block, rectangular and semi-circular
• glass or Perspex prism, triangular
• optics pins
• plane mirrors
• ray box
Glossary of terms used in science papers

This glossary (which is relevant only to science subjects) will prove helpful to candidates as a guide, but it is neither exhaustive nor definitive. The glossary has been deliberately kept brief, not only with respect to the number of terms included, but also to the descriptions of their meanings. Candidates should appreciate that the meaning of a term must depend, in part, on its context.

1. Define (the term(s)…) is intended literally, only a formal statement or equivalent paraphrase being required.

2. What do you understand by/What is meant by (the term(s)…) normally implies that a definition should be given, together with some relevant comment on the significance or context of the term(s) concerned, especially where two or more terms are included in the question. The amount of supplementary comment intended should be interpreted in the light of the indicated mark value.

3. State implies a concise answer with little or no supporting argument (e.g. a numerical answer that can readily be obtained 'by inspection').

4. List requires a number of points, generally each of one word, with no elaboration. Where a given number of points is specified this should not be exceeded.

5. (a) Explain may imply reasoning or some reference to theory, depending on the context. It is another way of asking candidates to give reasons. The candidate needs to leave the examiner in no doubt why something happens.
   
   (b) Give a reason / Give reasons is another way of asking candidates to explain why something happens.

6. Describe requires the candidate to state in words (using diagrams where appropriate) the main points. Describe and explain may be coupled, as may state and explain.

7. Discuss requires the candidate to give a critical account of the points involved.

8. Outline implies brevity (i.e. restricting the answer to giving essentials).

9. Predict implies that the candidate is expected to make a prediction not by recall but by making a logical connection between other pieces of information.

10. Deduce implies that the candidate is not expected to produce the required answer by recall but by making a logical connection between other pieces of information.

11. Suggest is used in two main contexts, i.e. either to imply that there is no unique answer (e.g. in chemistry, two or more substances may satisfy the given conditions describing an ‘unknown’), or to imply that candidates are expected to apply their general knowledge of the subject to a ‘novel’ situation, one that may be formally ‘not in the syllabus’ – many data response and problem-solving questions are of this type.

12. Find is a general term that may variously be interpreted as calculate, measure, determine, etc.

13. Calculate is used when a numerical answer is required. In general, working should be shown, especially where two or more steps are involved.

14. Measure implies that the quantity concerned can be directly obtained from a suitable measuring instrument (e.g. length using a rule, or mass using a balance).

15. Determine often implies that the quantity concerned cannot be measured directly but is obtained from a graph or by calculation.

16. Estimate implies a reasoned order of magnitude statement or calculation of the quantity concerned, making such simplifying assumptions as may be necessary about points of principle and about the values of quantities not otherwise included in the question.

17. Sketch, when applied to graph work, implies that the shape and/or position of the curve need only be qualitatively correct, but candidates should be aware that, depending on the context, some quantitative aspects may be looked for (e.g. passing through the origin, having an intercept).

In diagrams, sketch implies that simple, free-hand drawing is acceptable; nevertheless, care should be taken over proportions and the clear exposition of important details.
## 5 Appendix

### Electrical symbols

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Representation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>cell</td>
<td><img src="image" alt="cell" /></td>
<td>switch</td>
</tr>
<tr>
<td>battery of cells</td>
<td><img src="image" alt="battery of cells" /></td>
<td>earth or ground</td>
</tr>
<tr>
<td>or</td>
<td><img src="image" alt="or" /></td>
<td></td>
</tr>
<tr>
<td>power supply</td>
<td><img src="image" alt="power supply" /></td>
<td>electric bell</td>
</tr>
<tr>
<td>a.c. power supply</td>
<td><img src="image" alt="a.c. power supply" /></td>
<td>motor</td>
</tr>
<tr>
<td>junction of conductors</td>
<td><img src="image" alt="junction of conductors" /></td>
<td>generator</td>
</tr>
<tr>
<td>lamp</td>
<td><img src="image" alt="lamp" /></td>
<td>ammeter</td>
</tr>
<tr>
<td>fixed resistor</td>
<td><img src="image" alt="fixed resistor" /></td>
<td>voltmeter</td>
</tr>
<tr>
<td>variable resistor</td>
<td><img src="image" alt="variable resistor" /></td>
<td>oscilloscope</td>
</tr>
<tr>
<td>thermistor</td>
<td><img src="image" alt="thermistor" /></td>
<td>fuse</td>
</tr>
<tr>
<td>light dependent resistor</td>
<td><img src="image" alt="light dependent resistor" /></td>
<td>transformer</td>
</tr>
<tr>
<td>heater</td>
<td><img src="image" alt="heater" /></td>
<td></td>
</tr>
</tbody>
</table>
Symbols and units for physical quantities

Candidates should be able to give the symbols for the following physical quantities and, where indicated, state the units in which they are measured. The list for the Extended syllabus content includes both the Core and the Supplement.

Candidates should be familiar with the following multipliers: M mega, k kilo, c centi, m milli.

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Core</th>
<th>Supplement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Usual symbol</td>
<td>Usual unit</td>
</tr>
<tr>
<td>length</td>
<td>( l, h \ldots )</td>
<td>km, m, cm, mm</td>
</tr>
<tr>
<td>area</td>
<td>( A )</td>
<td>m², cm²</td>
</tr>
<tr>
<td>volume</td>
<td>( V )</td>
<td>m³, cm³</td>
</tr>
<tr>
<td>weight</td>
<td>( W )</td>
<td>N</td>
</tr>
<tr>
<td>mass</td>
<td>( m, M )</td>
<td>kg, g</td>
</tr>
<tr>
<td>density</td>
<td>( \rho )</td>
<td>g/cm³, kg/m³</td>
</tr>
<tr>
<td>speed</td>
<td>( u, v )</td>
<td>km/h, m/s, cm/s</td>
</tr>
<tr>
<td>acceleration</td>
<td>( a )</td>
<td>m/s²</td>
</tr>
<tr>
<td>acceleration of free fall</td>
<td>( g )</td>
<td>m/s²</td>
</tr>
<tr>
<td>force</td>
<td>( F )</td>
<td>N</td>
</tr>
<tr>
<td>gravitational field strength</td>
<td>( g )</td>
<td>N/kg</td>
</tr>
<tr>
<td>moment of a force</td>
<td>( N \ m )</td>
<td></td>
</tr>
<tr>
<td>energy</td>
<td>( E )</td>
<td>J, kJ, MJ</td>
</tr>
<tr>
<td>power</td>
<td>( P )</td>
<td>W, kW, MW</td>
</tr>
<tr>
<td>pressure</td>
<td>( p )</td>
<td>N/m²</td>
</tr>
<tr>
<td>temperature</td>
<td>( \theta, T )</td>
<td>°C</td>
</tr>
<tr>
<td>frequency</td>
<td>( f )</td>
<td>Hz, kHz</td>
</tr>
<tr>
<td>wavelength</td>
<td>( \lambda )</td>
<td>m, cm</td>
</tr>
<tr>
<td>focal length</td>
<td>( f )</td>
<td>cm</td>
</tr>
<tr>
<td>angle of incidence</td>
<td>( i )</td>
<td>degree (*)</td>
</tr>
<tr>
<td>angle of reflection, refraction</td>
<td>( r )</td>
<td>degree (*)</td>
</tr>
<tr>
<td>critical angle</td>
<td>( c )</td>
<td>degree (*)</td>
</tr>
</tbody>
</table>
### Quantity

<table>
<thead>
<tr>
<th>Core</th>
<th>Supplement</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Quantity</strong></td>
<td><strong>Usual symbol</strong></td>
</tr>
<tr>
<td>potential difference/voltage</td>
<td>$V$</td>
</tr>
<tr>
<td>current</td>
<td>$I$</td>
</tr>
<tr>
<td>e.m.f.</td>
<td>$E$</td>
</tr>
<tr>
<td>resistance</td>
<td>$R$</td>
</tr>
</tbody>
</table>

### Notes for use in qualitative analysis

#### Tests for anions

<table>
<thead>
<tr>
<th>anion</th>
<th>test</th>
<th>test result</th>
</tr>
</thead>
<tbody>
<tr>
<td>carbonate ($CO_3^{2-}$)</td>
<td>add dilute acid</td>
<td>effervescence, carbon dioxide produced</td>
</tr>
<tr>
<td>chloride ($Cl^-$) [in solution]</td>
<td>acidify with dilute nitric acid, then add aqueous silver nitrate</td>
<td>white ppt.</td>
</tr>
<tr>
<td>bromide ($Br^-$) [in solution]</td>
<td>acidify with dilute nitric acid, then add aqueous silver nitrate</td>
<td>cream ppt.</td>
</tr>
<tr>
<td>nitrate ($NO_3^-$) [in solution]</td>
<td>add aqueous sodium hydroxide, then aluminium foil; warm carefully</td>
<td>ammonia produced</td>
</tr>
<tr>
<td>sulfate ($SO_4^{2-}$) [in solution]</td>
<td>acidify, then add aqueous barium nitrate</td>
<td>white ppt.</td>
</tr>
</tbody>
</table>

#### Tests for aqueous cations

<table>
<thead>
<tr>
<th>cation</th>
<th>effect of aqueous sodium hydroxide</th>
<th>effect of aqueous ammonia</th>
</tr>
</thead>
<tbody>
<tr>
<td>ammonium ($NH_4^+$)</td>
<td>ammonia produced on warming</td>
<td>–</td>
</tr>
<tr>
<td>calcium ($Ca^{2+}$)</td>
<td>white ppt., insoluble in excess</td>
<td>no ppt. or very slight white ppt.</td>
</tr>
<tr>
<td>copper(II) ($Cu^{2+}$)</td>
<td>light blue ppt., insoluble in excess</td>
<td>light blue ppt., soluble in excess, giving a dark blue solution</td>
</tr>
<tr>
<td>iron(II) ($Fe^{2+}$)</td>
<td>green ppt., insoluble in excess</td>
<td>green ppt., insoluble in excess</td>
</tr>
<tr>
<td>iron(III) ($Fe^{3+}$)</td>
<td>red-brown ppt., insoluble in excess</td>
<td>red-brown ppt., insoluble in excess</td>
</tr>
<tr>
<td>zinc ($Zn^{2+}$)</td>
<td>white ppt., soluble in excess, giving a colourless solution</td>
<td>white ppt., soluble in excess, giving a colourless solution</td>
</tr>
</tbody>
</table>
Tests for gases

<table>
<thead>
<tr>
<th>gas</th>
<th>test and test result</th>
</tr>
</thead>
<tbody>
<tr>
<td>ammonia (NH₃)</td>
<td>turns damp red litmus paper blue</td>
</tr>
<tr>
<td>carbon dioxide (CO₂)</td>
<td>turns limewater milky</td>
</tr>
<tr>
<td>chlorine (Cl₂)</td>
<td>bleaches damp litmus paper</td>
</tr>
<tr>
<td>hydrogen (H₂)</td>
<td>‘pops’ with a lighted splint</td>
</tr>
<tr>
<td>oxygen (O₂)</td>
<td>relights a glowing splint</td>
</tr>
</tbody>
</table>

Flame tests for metal ions

<table>
<thead>
<tr>
<th>metal ion</th>
<th>flame colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>lithium (Li⁺)</td>
<td>red</td>
</tr>
<tr>
<td>sodium (Na⁺)</td>
<td>yellow</td>
</tr>
<tr>
<td>potassium (K⁺)</td>
<td>lilac</td>
</tr>
<tr>
<td>copper(II) (Cu²⁺)</td>
<td>blue-green</td>
</tr>
</tbody>
</table>
The Periodic Table

<table>
<thead>
<tr>
<th>Group</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>VI</th>
<th>VII</th>
<th>VIII</th>
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<tbody>
<tr>
<td></td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
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<td>10</td>
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<tr>
<td></td>
<td>Li</td>
<td>Be</td>
<td>B</td>
<td>C</td>
<td>N</td>
<td>O</td>
<td>F</td>
<td>Ne</td>
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<td>9</td>
<td>11</td>
<td>12</td>
<td>14</td>
<td>16</td>
<td>19</td>
<td>20</td>
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<tr>
<td>helium</td>
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<td>4</td>
<td>13</td>
<td>14</td>
<td>15</td>
<td>16</td>
<td>17</td>
<td>18</td>
</tr>
<tr>
<td>Key</td>
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<td>atomic symbol</td>
<td>name</td>
<td>relative atomic mass</td>
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<td>12</td>
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<td>22</td>
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<td>24</td>
<td>25</td>
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</tr>
<tr>
<td>Na</td>
<td>Mg</td>
<td>K</td>
<td>Ca</td>
<td>Sc</td>
<td>Ti</td>
<td>V</td>
<td>Cr</td>
<td>Mn</td>
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<td>14</td>
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<td>28</td>
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<td>35.5</td>
<td>40</td>
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<tr>
<td></td>
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<td>Rb</td>
<td>Sr</td>
<td>Y</td>
<td>Zr</td>
<td>Nb</td>
<td>Mo</td>
<td>Tc</td>
<td>Ru</td>
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<tr>
<td>Cs</td>
<td>Ba</td>
<td>Hf</td>
<td>Ta</td>
<td>W</td>
<td>Re</td>
<td>Os</td>
<td>Ir</td>
<td>Pt</td>
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<tr>
<td>caesium</td>
<td>133</td>
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<td>178</td>
<td>181</td>
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<td>lanthanoids</td>
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<td>57–71</td>
<td>72</td>
<td>73</td>
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<td>75</td>
<td>76</td>
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<td>Fr</td>
<td>Ra</td>
<td>Fr</td>
<td>Ra</td>
<td>Ra</td>
<td>Ra</td>
<td>Ra</td>
<td>Ra</td>
<td>Ra</td>
</tr>
<tr>
<td>francium</td>
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<td>89–103</td>
<td>104</td>
<td>105</td>
<td>106</td>
<td>107</td>
<td>108</td>
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<td>lanthanoids</td>
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<td>59</td>
<td>60</td>
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</tr>
<tr>
<td>actinoids</td>
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<td>91</td>
<td>92</td>
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<tr>
<td>Ac</td>
<td>Th</td>
<td>Pa</td>
<td>U</td>
<td>Np</td>
<td>Pu</td>
<td>Am</td>
<td>Cm</td>
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<td>144</td>
<td>150</td>
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<td>lanthanum</td>
<td>163</td>
<td>165</td>
<td>167</td>
<td>169</td>
<td>173</td>
<td>175</td>
<td>–</td>
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</tr>
<tr>
<td>cerium</td>
<td>144</td>
<td>146</td>
<td>148</td>
<td>150</td>
<td>152</td>
<td>157</td>
<td>159</td>
<td>163</td>
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<td>promethium</td>
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<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>neodymium</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>lanthanum</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>cerium</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
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</tr>
<tr>
<td>promethium</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

at room temperature and pressure (r.t.p.)

Appendix

Cambridge IGCSE Physical Science 0652 syllabus for 2025 and 2026. Appendix
Safety in the laboratory
Responsibility for safety matters rests with centres. Further information can be found from the following UK
associations, publications and regulations.

Associations
CLEAPSS is an advisory service providing support in practical science and technology.
www.cleapss.org.uk

Publications
CLEAPSS Laboratory Handbook, updated 2009 (available to CLEAPSS members only)
CLEAPSS Hazcards, 2007 update of 1995 edition (available to CLEAPSS members only)

UK regulations
Control of Substances Hazardous to Health Regulations (COSHH) 2002 and subsequent amendment in 2004
A brief guide may be found at
www.hse.gov.uk/pubns/indg136.pdf

Mathematical requirements
Calculators may be used in all parts of the examination.
Candidates should be able to:
- add, subtract, multiply and divide
- use averages, decimals, fractions, percentages, ratios and reciprocals
- use standard notation, including both positive and negative indices
- understand significant figures and use them appropriately
- recognise and use direct and inverse proportion
- use positive, whole number indices in algebraic expressions
- draw charts and graphs from given data
- interpret charts and graphs
- determine the gradient and intercept of a graph
- select suitable scales and axes for graphs
- make approximate evaluations of numerical expressions
- recall and use equations for the areas of a rectangle, triangle and circle and the volumes of a rectangular
  block and a cylinder
- use mathematical instruments (ruler, compass, protractor and set square)
- understand the meaning of angle, curve, circle, radius, diameter, circumference, square, parallelogram,
  rectangle and diagonal
- solve equations of the form $x = y + z$ and $x = yz$ for any one term when the other two are known
- recognise and use clockwise and anticlockwise directions
- recognise and use points of the compass (N, S, E, W)
- use sines and inverse signs (Extended candidates only).
Presentation of data

The solidus (/) is to be used for separating the quantity and the unit in tables, graphs and charts, e.g. time/s for time in seconds.

(a) Tables
- Each column of a table should be headed with the physical quantity and the appropriate unit, e.g. time/s.
- The column headings of the table can then be directly transferred to the axes of a constructed graph.

(b) Graphs
- Unless instructed otherwise, the independent variable should be plotted on the x-axis (horizontal axis) and the dependent variable plotted on the y-axis (vertical axis).
- Each axis should be labelled with the physical quantity and the appropriate unit, e.g. time/s.
- The scales for the axes should allow more than half of the graph grid to be used in both directions, and be based on sensible ratios, e.g. 2 cm on the graph grid representing 1, 2 or 5 units of the variable.
- The graph is the whole diagrammatic presentation, including the best-fit line when appropriate. It may have one or more sets of data plotted on it.
- Points on the graph should be clearly marked as crosses (×) or encircled dots (○).
- Large ‘dots’ are penalised. Each data point should be plotted to an accuracy of better than one half of each of the smallest squares on the grid.
- A best-fit line (trend line) should be a single, thin, smooth straight-line or curve. The line does not need to coincide exactly with any of the points; where there is scatter evident in the data, examiners would expect a roughly even distribution of points either side of the line over its entire length. Points that are clearly anomalous should be ignored when drawing the best-fit line.
- The gradient of a straight line should be taken using a triangle whose hypotenuse extends over at least half of the length of the best-fit line, and this triangle should be marked on the graph.

(c) Numerical results
- Data should be recorded so as to reflect the precision of the measuring instrument.
- The number of significant figures given for calculated quantities should be appropriate to the least number of significant figures in the raw data used.

(d) Pie charts
- These should be drawn with the sectors in rank order, largest first, beginning at ‘noon’ and proceeding clockwise. Pie charts should preferably contain no more than six sectors.

(e) Bar charts
- These should be drawn when one of the variables is not numerical. They should be made up of narrow blocks of equal width that do not touch.

(f) Histograms
- These are drawn when plotting frequency graphs with continuous data. The blocks should be drawn in order of increasing or decreasing magnitude and they should touch.
ICT opportunities

In order to play a full part in modern society, candidates need to be confident and effective users of ICT. This syllabus provides candidates with a wide range of opportunities to use ICT in their study of chemistry and physics.

Opportunities for ICT include:

- gathering information from the internet, DVDs and CD-ROMs
- gathering data using sensors linked to data-loggers or directly to computers
- using spreadsheets and other software to process data
- using animations and simulations to visualise scientific ideas
- using software to present ideas and information on paper and on screen.

Conventions (e.g. signs, symbols, terminology and nomenclature)

Syllabuses and question papers conform with generally accepted international practice. In particular, the following document, produced by the Association for Science Education (ASE), should be used as a guideline.


Litre/dm$^3$

To avoid any confusion concerning the symbol for litre, dm$^3$ will be used in place of l or litre.

Decimal markers

In accordance with current ASE convention, decimal markers in examination papers will be a single dot on the line. Candidates are expected to follow this convention in their answers.

Numbers

Numbers from 1000 to 9999 will be printed without commas or spaces. Numbers greater than or equal to 10 000 will be printed without commas. A space will be left between each group of three whole numbers, e.g. 4 256 789.
6 What else you need to know

This section is an overview of other information you need to know about this syllabus. It will help to share the administrative information with your exams officer so they know when you will need their support. Find more information about our administrative processes at www.cambridgeinternational.org/eoguide

Before you start

Previous study
We recommend that learners starting this course should have studied a science curriculum such as the Cambridge Lower Secondary programme or equivalent national educational framework.

Guided learning hours
We design Cambridge IGCSE syllabuses to require about 130 guided learning hours for each subject. This is for guidance only. The number of hours a learner needs to achieve the qualification may vary according to each school and the learners’ previous experience of the subject.

Availability and timetables
All Cambridge schools are allocated to one of six administrative zones. Each zone has a specific timetable.

This syllabus is not available in all administrative zones. To find out about availability check the syllabus page at www.cambridgeinternational.org/0652

You can view the timetable for your administrative zone at www.cambridgeinternational.org/timetables

You can enter candidates in the November exam series.

Check you are using the syllabus for the year the candidate is taking the exam.

Private candidates can enter for this syllabus. For more information, please refer to the Cambridge Guide to Making Entries.
Combining with other syllabuses

Candidates can take this syllabus alongside other Cambridge International syllabuses in a single exam series. The only exceptions are:

- Cambridge IGCSE Chemistry (0620)
- Cambridge IGCSE (9–1) Chemistry (0971)
- Cambridge IGCSE Physics (0625)
- Cambridge IGCSE (9–1) Physics (0972)
- Cambridge IGCSE Combined Science (0653)
- Cambridge IGCSE Co-ordinated Sciences (Double Award) (0654)
- Cambridge IGCSE (9–1) Co-ordinated Sciences (Double Award) (0973)
- Cambridge O Level Physics (5054)
- Cambridge O Level Chemistry (5070)
- Cambridge O Level Combined Science (5129)
- syllabuses with the same title at the same level.

Cambridge IGCSE, Cambridge IGCSE (9–1) and Cambridge O Level syllabuses are at the same level.

Group awards: Cambridge ICE

Cambridge ICE (International Certificate of Education) is a group award for Cambridge IGCSE. It allows schools to offer a broad and balanced curriculum by recognising the achievements of learners who pass exams in a range of different subjects.

Learn more about Cambridge ICE at www.cambridgeinternational.org/cambridgeice

Making entries

Exams officers are responsible for submitting entries to Cambridge International. We encourage them to work closely with you to make sure they enter the right number of candidates for the right combination of syllabus components. Entry option codes and instructions for submitting entries are in the Cambridge Guide to Making Entries. Your exams officer has a copy of this guide.

Exam administration

To keep our exams secure, we produce question papers for different areas of the world, known as administrative zones. We allocate all Cambridge schools to an administrative zone determined by their location. Each zone has a specific timetable. Some of our syllabuses offer candidates different assessment options. An entry option code is used to identify the components the candidate will take relevant to the administrative zone and the available assessment options.

Support for exams officers

We know how important exams officers are to the successful running of exams. We provide them with the support they need to make your entries on time. Your exams officer will find this support, and guidance for all other phases of the Cambridge Exams Cycle, at www.cambridgeinternational.org/eoguide
Retakes
Candidates can retake the whole qualification as many times as they want to. Information on retake entries is at www.cambridgeinternational.org/retakes

Language
This syllabus and the related assessment materials are available in English only.

Accessibility and equality
Syllabus and assessment design
Cambridge International works to avoid direct or indirect discrimination. We develop and design syllabuses and assessment materials to maximise inclusivity for candidates of all national, cultural or social backgrounds and candidates with protected characteristics; these protected characteristics include special educational needs and disability, religion and belief, and characteristics related to gender and identity. In addition, the language and layout used are designed to make our materials as accessible as possible. This gives all candidates the fairest possible opportunity to demonstrate their knowledge, skills and understanding and helps to minimise the requirement to make reasonable adjustments during the assessment process.

Access arrangements
Access arrangements (including modified papers) are the principal way in which Cambridge International complies with our duty, as guided by the UK Equality Act (2010), to make ‘reasonable adjustments’ for candidates with special educational needs (SEN), disability, illness or injury. Where a candidate would otherwise be at a substantial disadvantage in comparison to a candidate with no SEN, disability, illness or injury, we may be able to agree pre-examination access arrangements. These arrangements help a candidate by minimising accessibility barriers and maximising their opportunity to demonstrate their knowledge, skills and understanding in an assessment.

Important:
• Requested access arrangements should be based on evidence of the candidate’s barrier to assessment and should also reflect their normal way of working at school; this is in line with the Cambridge Handbook www.cambridgeinternational.org/eoguide
• For Cambridge International to approve an access arrangement, we will need to agree that it constitutes a reasonable adjustment, involves reasonable cost and timeframe and does not affect the security and integrity of the assessment.
• Availability of access arrangements should be checked by centres at the start of the course. Details of our standard access arrangements and modified question papers are available in the Cambridge Handbook www.cambridgeinternational.org/eoguide
• Please contact us at the start of the course to find out if we are able to approve an arrangement that is not included in the list of standard access arrangements.
• Candidates who cannot access parts of the assessment may be able to receive an award based on the parts they have completed.
After the exam

Grading and reporting

Grades A*, A, B, C, D, E, F or G indicate the standard a candidate achieved at Cambridge IGCSE.

A* is the highest and G is the lowest. ‘Ungraded’ means that the candidate’s performance did not meet the standard required for grade G. ‘Ungraded’ is reported on the statement of results but not on the certificate.

In specific circumstances your candidates may see one of the following letters on their statement of results:

- Q (PENDING)
- X (NO RESULT).

These letters do not appear on the certificate.

On the statement of results and certificates, Cambridge IGCSE is shown as INTERNATIONAL GENERAL CERTIFICATE OF SECONDARY EDUCATION (IGCSE).

How students and teachers can use the grades

Assessment at Cambridge IGCSE has two purposes:

1. to measure learning and achievement
   - The assessment confirms achievement and performance in relation to the knowledge, understanding and skills specified in the syllabus, to the levels described in the grade descriptions.

2. to show likely future success
   - The outcomes help predict which students are well prepared for a particular course or career and/or which students are more likely to be successful.
   - The outcomes help students choose the most suitable course or career.

Grade descriptions

Grade descriptions are provided to give an indication of the standards of achievement candidates awarded particular grades are likely to show. Weakness in one aspect of the examination may be balanced by a better performance in some other aspect.

Grade descriptions for Cambridge IGCSE Physical Science will be published after the first assessment of the syllabus in 20[XX].
Changes to this syllabus for 2025 and 2026

The syllabus has been updated. This is version 1, published September 2022.

You must read the whole syllabus before planning your teaching programme. We review our syllabuses regularly to make sure they continue to meet the needs of our schools. In updating this syllabus, we have made it easier for teachers and students to understand, keeping the familiar features that teachers and schools value.

Any textbooks endorsed to support the syllabus for examination from 2019 are still suitable for use with this syllabus.
School feedback: ‘While studying Cambridge IGCSE and Cambridge International A Levels, students broaden their horizons through a global perspective and develop a lasting passion for learning.’

Feedback from: Zhai Xiaoning, Deputy Principal, The High School Affiliated to Renmin University of China