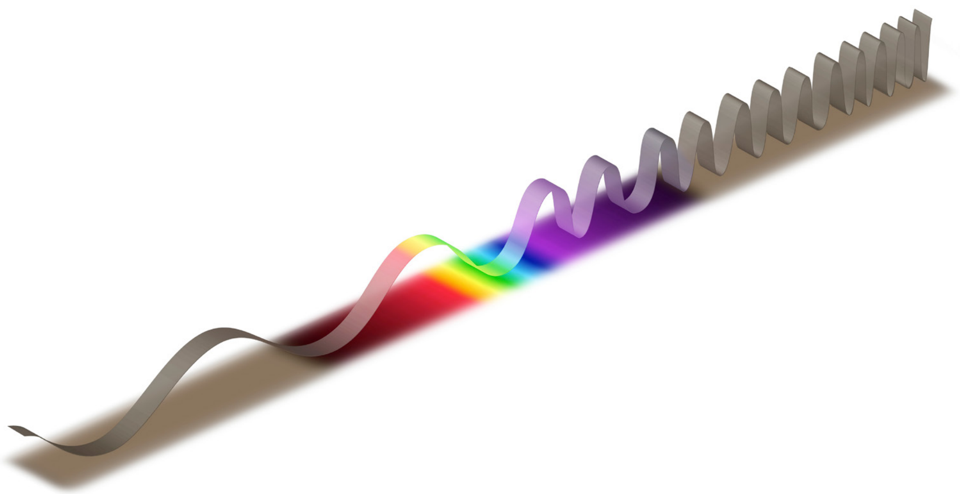
Cambridge Assessment International Education

Syllabus

Cambridge IGCSE™
Physics 0625

Use this syllabus for exams in 2026, 2027 and 2028.
Exams are available in the June and November series.
Exams are also available in the March series in India.



Version 1

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

Cambridge Pathway

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 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, are 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. Learn more about our research at **www.cambridgeassessment.org.uk/our-research/**

We believe education works best when curriculum, teaching, learning and assessment are closely aligned. Our programmes develop deep knowledge, conceptual understanding and higher-order thinking skills, to prepare students for their future. 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 education programmes and qualifications for students aged 5 to 19 is independently certified as meeting the internationally recognised standard, ISO 9001:2015. Learn more at **www.cambridgeinternational.org/about-us/our-standards/**

Contents

Why choose Cambridge International? 2

1 Why choose this syllabus? 4

2 Syllabus overview 7

Aims 7
Content overview 8
Assessment overview 9
Assessment objectives 10

3 Subject content 12

4 Details of the assessment 42

Core assessment 42
Extended assessment 42
Practical assessment 43
Language of measurement 45
Apparatus 46
Safety in the laboratory 48
Electrical symbols 49
Symbols and units for physical quantities 50
Mathematical requirements 52
Presentation of data 53
Conventions (e.g. signs, symbols, terminology and nomenclature) 54
Command words 55

5 What else you need to know 56

Before you start 56
Making entries 57
Accessibility and equality 57
After the exam 58
How students and teachers can use the grades 59
Changes to this syllabus for 2026, 2027 and 2028 60

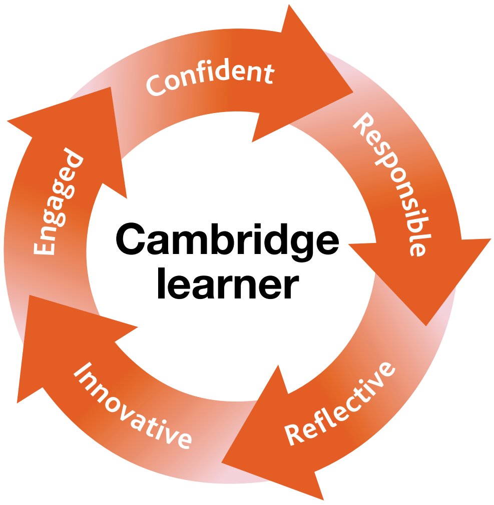
Important: Changes to this syllabus

The latest syllabus is version 1, published September 2023. There are no significant changes which affect teaching.

Any textbooks endorsed to support the syllabus for examination from 2023 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 5000 schools in 150 countries.

Our programmes promote 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 Physics develops a set of transferable skills including handling data, practical problem-solving and applying the scientific method. Learners develop relevant attitudes, such as concern for accuracy and precision, objectivity, integrity, enquiry, initiative and inventiveness. They acquire the essential scientific skills required for progression to further studies or employment.

Our approach in Cambridge IGCSE Physics encourages learners to be:

confident, interested in learning about science, questioning ideas and using scientific language to communicate their views and opinions

responsible, working methodically and safely when working alone or collaboratively with others

reflective, learning from their experiences and interested in scientific issues that affect the individual, the community and the environment

innovative, solving unfamiliar problems confidently and creatively

engaged, keen to develop scientific skills, curious about scientific principles and their application in the world.

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 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 Physics 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 Physics.

Cambridge IGCSEs are accepted and valued by leading universities and employers around the world as evidence of academic achievement. Cambridge students can be confident that their qualifications will be understood and valued throughout their education and career, in their home country and internationally. Many universities require a combination of Cambridge International AS & A Levels and Cambridge IGCSEs or equivalent to meet their entry requirements.

UK ENIC, 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.

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 believe education is most effective when curriculum, teaching and learning, and assessment are closely aligned. We provide a wide range of resources, detailed guidance, innovative training and targeted 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			
Planning and preparation	**Teaching and assessment**	**Learning and revision**	**Results**
• Syllabuses • Schemes of work • Specimen Question Papers and Mark Schemes • Teacher guides	• Endorsed resources • Online forums • Support for coursework and speaking components • Resource Plus • Everyday Science	• Example candidate responses • Past papers and mark schemes • Specimen paper answers • Test Maker	• Candidate Results Service • Principal examiner reports for teachers • Results Analysis

Sign up for email notifications about changes to syllabuses, including new and revised products and services, at **www.cambridgeinternational.org/syllabusupdates**

Syllabuses and specimen materials represent the final authority on the content and structure of all of our assessments.

Professional development

Find the next step on your professional development journey.

- Introductory Professional Development – An introduction to Cambridge programmes and qualifications.
- Extension Professional Development – Develop your understanding of Cambridge programmes and qualifications to build confidence in your delivery.
- Enrichment Professional Development – Transform your approach to teaching with our Enrichment workshops.
- Cambridge Professional Development Qualifications (PDQs) – Practice-based programmes that transform professional learning for practising teachers. Available at Certificate and Diploma level.

Find out more at:
www.cambridgeinternational.org/support-and-training-for-schools/professional-development/

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 practical work.

The aims are to enable students to:

- acquire scientific knowledge and understanding of scientific theories and practice
- develop a range of experimental skills, including handling variables and working safely
- use scientific data and evidence to solve problems and discuss the limitations of scientific methods
- communicate effectively and clearly, using scientific terminology, notation and conventions
- understand that the application of scientific knowledge can benefit people and the environment
- enjoy science and develop an informed interest in scientific matters which support further study.

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

Candidates study the following topics:

1 Motion, forces and energy
2 Thermal physics
3 Waves
4 Electricity and magnetism
5 Nuclear physics
6 Space physics

Assessment overview

All candidates take three papers.

Candidates who have studied the Core syllabus 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 syllabus 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 Paper 1 and Paper 3. The questions are based on the Core subject content only:

Paper 1: Multiple Choice (Core)		Paper 3: Theory (Core)	
45 minutes		1 hour 15 minutes	
40 marks	30%	80 marks	50%
40 four-option multiple-choice questions		Short-answer and structured questions	
Externally assessed		Externally assessed	

Extended assessment

Extended candidates take Paper 2 and Paper 4. The questions are based on the Core and Supplement subject content:

Paper 2: Multiple Choice (Extended)		Paper 4: Theory (Extended)	
45 minutes		1 hour 15 minutes	
40 marks	30%	80 marks	50%
40 four-option multiple-choice questions		Short-answer and structured questions	
Externally assessed		Externally assessed	

Practical assessment

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

Paper 5: Practical Test			Paper 6: Alternative to Practical	
1 hour 15 minutes			1 hour	
40 marks	20%		40 marks	20%
Questions will be based on the experimental skills in Section 4		**OR**	Questions will be based on the experimental skills in Section 4	
Externally assessed			Externally assessed	

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.

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 form conclusions
- present reasoned explanations for phenomena, patterns and relationships
- make predictions based on relationships and patterns
- 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.

AO3 Experimental skills and investigations

Candidates should be able to:

- demonstrate knowledge of how to select and 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

Assessment objective	Weighting in IGCSE %
AO1 Knowledge with understanding	50
AO2 Handling information and problem-solving	30
AO3 Experimental skills and investigations	20
Total	100

Assessment objectives as a percentage of each component

Assessment objective	Weighting in components %		
	Papers 1 and 2	Papers 3 and 4	Papers 5 and 6
AO1 Knowledge with understanding	63	63	0
AO2 Handling information and problem-solving	37	37	0
AO3 Experimental skills and investigations	0	0	100
Total	100	100	100

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.

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 experimental skills by doing practical work and investigations.

Practical work helps students to:

- use equipment and materials accurately and safely
- develop observational and problem-solving skills
- develop a deeper understanding of the syllabus topics and the scientific approach
- appreciate how scientific theories are developed and tested
- transfer the experimental skills acquired to unfamiliar contexts
- develop positive scientific attitudes such as objectivity, integrity, cooperation, enquiry and inventiveness
- develop an interest and enjoyment in science.

1 Motion, forces and energy

1.1 Physical quantities and measurement techniques

Core	Supplement
1 Describe the use of rulers and measuring cylinders to find a length or a volume	
2 Describe how to measure a variety of time intervals using clocks and digital timers	
3 Determine an average value for a small distance and for a short interval of time by measuring multiples (including the period of oscillation of a pendulum)	
	4 Understand that a scalar quantity has magnitude (size) only and that a vector quantity has magnitude and direction
	5 Know that the following quantities are scalars: distance, speed, time, mass, energy and temperature
	6 Know that the following quantities are vectors: force, weight, velocity, acceleration, momentum, electric field strength and gravitational field strength
	7 Determine, by calculation or graphically, the resultant of two vectors at right angles, limited to forces or velocities only

1.2 Motion

Core

1 Define speed as distance travelled per unit time; recall and use the equation

$$v = \frac{s}{t}$$

2 Define velocity as speed in a given direction

3 Recall and use the equation

$$\text{average speed} = \frac{\text{total distance travelled}}{\text{total time taken}}$$

4 Sketch, plot and interpret distance–time and speed–time graphs

5 Determine, qualitatively, from given data or the shape of a distance–time graph or speed–time graph when an object is:

(a) at rest
(b) moving with constant speed
(c) accelerating
(d) decelerating

6 Calculate speed from the gradient of a straight-line section of a distance–time graph

7 Calculate the area under a speed–time graph to determine the distance travelled for motion with constant speed or constant acceleration

8 State that the acceleration of free fall g for an object near to the surface of the Earth is approximately constant and is approximately $9.8\,\text{m/s}^2$

Supplement

9 Define acceleration as change in velocity per unit time; recall and use the equation

$$a = \frac{\Delta v}{\Delta t}$$

10 Determine from given data or the shape of a speed–time graph when an object is moving with:

(a) constant acceleration
(b) changing acceleration

11 Calculate acceleration from the gradient of a speed–time graph

12 Know that a deceleration is a negative acceleration and use this in calculations

13 Describe the motion of objects falling in a uniform gravitational field with and without air/liquid resistance, including reference to terminal velocity

1.3 Mass and weight

Core

1 State that mass is a measure of the quantity of matter in an object at rest relative to the observer

2 State that weight is a gravitational force on an object that has mass

3 Define gravitational field strength as force per unit mass; recall and use the equation

$$g = \frac{W}{m}$$

and know that this is equivalent to the acceleration of free fall

4 Know that weights (and masses) may be compared using a balance

Supplement

5 Describe, and use the concept of, weight as the effect of a gravitational field on a mass

1.4 Density

Core

1 Define density as mass per unit volume; recall and use the equation

$$\rho = \frac{m}{V}$$

2 Describe how to determine the density of a liquid, of a regularly shaped solid and of an irregularly shaped solid which sinks in a liquid (volume by displacement), including appropriate calculations

3 Determine whether an object floats based on density data

Supplement

4 Determine whether one liquid will float on another liquid based on density data given that the liquids do not mix

1.5 Forces

1.5.1 Effects of forces

Core

1 Know that forces may produce changes in the size and shape of an object

2 Sketch, plot and interpret load–extension graphs for an elastic solid and describe the associated experimental procedures

3 Determine the resultant of two or more forces acting along the same straight line

4 Know that an object either remains at rest or continues in a straight line at constant speed unless acted on by a resultant force

5 State that a resultant force may change the velocity of an object by changing its direction of motion or its speed

Supplement

9 Define the spring constant as force per unit extension; recall and use the equation

$$k = \frac{F}{x}$$

10 Define and use the term 'limit of proportionality' for a load–extension graph and identify this point on the graph (an understanding of the elastic limit is **not** required)

11 Recall and use the equation $F = ma$ and know that the force and the acceleration are in the same direction

12 Describe, qualitatively, motion in a circular path due to a force perpendicular to the motion as:

(a) speed increases if force increases, with mass and radius constant

(b) radius decreases if force increases, with mass and speed constant

(c) an increased mass requires an increased force to keep speed and radius constant

($F = \frac{mv^2}{r}$ is **not** required)

continued

1.5 Forces continued

1.5.1 Effects of forces continued

Core

6 Describe solid friction as the force between two surfaces that may impede motion and produce heating

7 Know that friction (drag) acts on an object moving through a liquid

8 Know that friction (drag) acts on an object moving through a gas (e.g. air resistance)

Supplement

1.5.2 Turning effect of forces

Core

1 Describe the moment of a force as a measure of its turning effect and give everyday examples

2 Define the moment of a force as
moment = force × perpendicular distance from the pivot; recall and use this equation

3 Apply the principle of moments to situations with one force each side of the pivot, including balancing of a beam

4 State that, when there is no resultant force and no resultant moment, an object is in equilibrium

Supplement

5 Apply the principle of moments to other situations, including those with more than one force each side of the pivot

6 Describe an experiment to demonstrate that there is no resultant moment on an object in equilibrium

1.5.3 Centre of gravity

Core

1 State what is meant by centre of gravity

2 Describe an experiment to determine the position of the centre of gravity of an irregularly shaped plane lamina

3 Describe, qualitatively, the effect of the position of the centre of gravity on the stability of simple objects

Supplement

1.6 Momentum

Core

Supplement

1 Define momentum as mass × velocity; recall and use the equation

$p = mv$

2 Define impulse as force × time for which force acts; recall and use the equation

impulse = $F\Delta t = \Delta(mv)$

3 Apply the principle of the conservation of momentum to solve simple problems in one dimension

4 Define resultant force as the change in momentum per unit time; recall and use the equation

$F = \frac{\Delta p}{\Delta t}$

1.7 Energy, work and power

1.7.1 Energy

Core

1 State that energy may be stored as kinetic, gravitational potential, chemical, elastic (strain), nuclear, electrostatic and internal (thermal)

2 Describe how energy is transferred between stores during events and processes, including examples of transfer by forces (mechanical work done), electrical currents (electrical work done), heating, and by electromagnetic, sound and other waves

3 Know the principle of the conservation of energy and apply this principle to simple examples including the interpretation of simple flow diagrams

Supplement

4 Recall and use the equation for kinetic energy

$E_k = \frac{1}{2}mv^2$

5 Recall and use the equation for the change in gravitational potential energy

$\Delta E_p = mg\Delta h$

6 Know the principle of the conservation of energy and apply this principle to complex examples involving multiple stages, including the interpretation of Sankey diagrams

1.7 Energy, work and power continued

1.7.2 Work

Core

1 Understand that mechanical or electrical work done is equal to the energy transferred

2 Recall and use the equation for mechanical working

$W = Fd = \Delta E$

Supplement

1.7.3 Energy resources

Core

1 Describe how useful energy may be obtained, or electrical power generated, from:

(a) chemical energy stored in fossil fuels

(b) chemical energy stored in biofuels

(c) water, including the energy stored in waves, in tides and in water behind hydroelectric dams

(d) geothermal resources

(e) nuclear fuel

(f) light from the Sun to generate electrical power (solar cells)

(g) infrared and other electromagnetic waves from the Sun to heat water (solar panels) and be the source of wind energy

including references to a boiler, turbine and generator where they are used

2 Describe advantages and disadvantages of each method in terms of renewability, availability, reliability, scale and environmental impact

3 Understand, qualitatively, the concept of efficiency of energy transfer

Supplement

4 Know that radiation from the Sun is the main source of energy for all our energy resources except geothermal, nuclear and tidal

5 Know that energy is released by nuclear fusion in the Sun

6 Know that research is being carried out to investigate how energy released by nuclear fusion can be used to produce electrical energy on a large scale

7 Define efficiency as:

(a)

$$(\%)\ \text{efficiency} = \frac{(\text{useful energy output})}{(\text{total energy input})}\ (\times 100\%)$$

(b)

$$(\%)\ \text{efficiency} = \frac{(\text{useful power output})}{(\text{total power input})}\ (\times 100\%)$$

recall and use these equations

1.7 Energy, work and power continued

1.7.4 Power

Core

1 Define power as work done per unit time and also as energy transferred per unit time; recall and use the equations

(a) $P = \frac{W}{t}$

(b) $P = \frac{\Delta E}{t}$

Supplement

1.8 Pressure

Core

1 Define pressure as force per unit area; recall and use the equation

$p = \frac{F}{A}$

2 Describe how pressure varies with force and area in the context of everyday examples

3 Describe, qualitatively, how the pressure beneath the surface of a liquid changes with depth and density of the liquid

Supplement

4 Recall and use the equation for the change in pressure beneath the surface of a liquid

$\Delta p = \rho g \Delta h$

2 Thermal physics

2.1 Kinetic particle model of matter

2.1.1 States of matter

Core

1 Know the distinguishing properties of solids, liquids and gases

2 Know the terms for the changes in state between solids, liquids and gases (gas to solid and solid to gas transfers are **not** required)

Supplement

2.1 Kinetic particle model of matter continued

2.1.2 Particle model

Core

1 Describe the particle structure of solids, liquids and gases in terms of the arrangement, separation and motion of the particles and represent these states using simple particle diagrams

2 Describe the relationship between the motion of particles and temperature, including the idea that there is a lowest possible temperature (–273 °C), known as absolute zero, where the particles have least kinetic energy

3 Describe the pressure and the changes in pressure of a gas in terms of the motion of its particles and their collisions with a surface

4 Know that the random motion of microscopic particles in a suspension is evidence for the kinetic particle model of matter

5 Describe and explain this motion (sometimes known as Brownian motion) in terms of random collisions between the microscopic particles in a suspension and the particles of the gas or liquid

Supplement

6 Know that the forces and distances between particles (atoms, molecules, ions and electrons) and the motion of the particles affects the properties of solids, liquids and gases

7 Describe the pressure and the changes in pressure of a gas in terms of the forces exerted by particles colliding with surfaces, creating a force per unit area

8 Know that microscopic particles may be moved by collisions with light fast-moving molecules and correctly use the terms atoms or molecules as distinct from microscopic particles

2.1.3 Gases and the absolute scale of temperature

Core

1 Describe qualitatively, in terms of particles, the effect on the pressure of a fixed mass of gas of:

(a) a change of temperature at constant volume

(b) a change of volume at constant temperature

2 Convert temperatures between kelvin and degrees Celsius; recall and use the equation

T (in K) = θ (in °C) + 273

Supplement

3 Recall and use the equation

pV = constant

for a fixed mass of gas at constant temperature, including a graphical representation of this relationship

2.2 Thermal properties and temperature

2.2.1 Thermal expansion of solids, liquids and gases

Core

1 Describe, qualitatively, the thermal expansion of solids, liquids and gases at constant pressure

2 Describe some of the everyday applications and consequences of thermal expansion

Supplement

3 Explain, in terms of the motion and arrangement of particles, the relative order of magnitudes of the expansion of solids, liquids and gases as their temperatures rise

2.2.2 Specific heat capacity

Core

1 Know that a rise in the temperature of an object increases its internal energy

Supplement

2 Describe an increase in temperature of an object in terms of an increase in the average kinetic energies of all of the particles in the object

3 Define specific heat capacity as the energy required per unit mass per unit temperature increase; recall and use the equation

$$c = \frac{\Delta E}{m\Delta\theta}$$

4 Describe experiments to measure the specific heat capacity of a solid and a liquid

2.2.3 Melting, boiling and evaporation

Core

1 Describe melting and boiling in terms of energy input without a change in temperature

2 Know the melting and boiling temperatures for water at standard atmospheric pressure

3 Describe condensation and solidification in terms of particles

4 Describe evaporation in terms of the escape of more-energetic particles from the surface of a liquid

5 Know that evaporation causes cooling of a liquid

Supplement

6 Describe the differences between boiling and evaporation

7 Describe how temperature, surface area and air movement over a surface affect evaporation

8 Explain the cooling of an object in contact with an evaporating liquid

2.3 Transfer of thermal energy

2.3.1 Conduction

Core

1 Describe experiments to demonstrate the properties of good thermal conductors and bad thermal conductors (thermal insulators)

Supplement

2 Describe thermal conduction in all solids in terms of atomic or molecular lattice vibrations and also in terms of the movement of free (delocalised) electrons in metallic conductors

3 Describe, in terms of particles, why thermal conduction is bad in gases and most liquids

4 Know that there are many solids that conduct thermal energy better than thermal insulators but do so less well than good thermal conductors

2.3.2 Convection

Core

1 Know that convection is an important method of thermal energy transfer in liquids and gases

2 Explain convection in liquids and gases in terms of density changes and describe experiments to illustrate convection

Supplement

2.3.3 Radiation

Core

1 Know that thermal radiation is infrared radiation and that all objects emit this radiation

2 Know that thermal energy transfer by thermal radiation does not require a medium

3 Describe the effect of surface colour (black or white) and texture (dull or shiny) on the emission, absorption and reflection of infrared radiation

Supplement

4 Know that for an object to be at a constant temperature it needs to transfer energy away from the object at the same rate that it receives energy

5 Know what happens to an object if the rate at which it receives energy is less or more than the rate at which it transfers energy away from the object

6 Know how the temperature of the Earth is affected by factors controlling the balance between incoming radiation and radiation emitted from the Earth's surface

continued

2.3 Transfer of thermal energy continued

2.3.3 Radiation continued

Core

Supplement

7 Describe experiments to distinguish between good and bad emitters of infrared radiation

8 Describe experiments to distinguish between good and bad absorbers of infrared radiation

9 Describe how the rate of emission of radiation depends on the surface temperature and surface area of an object

2.3.4 Consequences of thermal energy transfer

Core

1 Explain some of the basic everyday applications and consequences of conduction, convection and radiation, including:

(a) heating objects such as kitchen pans

(b) heating a room by convection

Supplement

2 Explain some of the complex applications and consequences of conduction, convection and radiation where more than one type of thermal energy transfer is significant, including:

(a) a fire burning wood or coal

(b) a radiator in a car

3 Waves

3.1 General properties of waves

Core

1 Know that waves transfer energy without transferring matter

2 Describe what is meant by wave motion as illustrated by vibrations in ropes and springs, and by experiments using water waves

3 Describe the features of a wave in terms of wavefront, wavelength, frequency, crest (peak), trough, amplitude and wave speed

4 Recall and use the equation for wave speed

$v = f\lambda$

5 Know that for a transverse wave, the direction of vibration is at right angles to the direction of propagation and understand that electromagnetic radiation, water waves and seismic S-waves (secondary) can be modelled as transverse

Supplement

continued

3.1 General properties of waves continued

Core	Supplement
6 Know that for a longitudinal wave, the direction of vibration is parallel to the direction of propagation and understand that sound waves and seismic P-waves (primary) can be modelled as longitudinal	
7 Describe how waves can undergo: (a) reflection at a plane surface (b) refraction due to a change of speed (c) diffraction through a narrow gap	9 Describe how wavelength and gap size affects diffraction through a gap
8 Describe the use of a ripple tank to show: (a) reflection at a plane surface (b) refraction due to a change in speed caused by a change in depth (c) diffraction due to a gap (d) diffraction due to an edge	10 Describe how wavelength affects diffraction at an edge

3.2 Light

3.2.1 Reflection of light

Core	Supplement
1 Define and use the terms normal, angle of incidence and angle of reflection	
2 Describe the formation of an optical image by a plane mirror and give its characteristics, i.e. same size, same distance from mirror, virtual	
3 State that for reflection, the angle of incidence is equal to the angle of reflection; recall and use this relationship	4 Use simple constructions, measurements and calculations for reflection by plane mirrors

3.2 Light continued

3.2.2 Refraction of light

Core

1. Define and use the terms normal, angle of incidence and angle of refraction
2. Describe an experiment to show refraction of light by transparent blocks of different shapes
3. Describe the passage of light through a transparent material (limited to the boundaries between two mediums only)
4. State the meaning of critical angle
5. Describe internal reflection and total internal reflection using both experimental and everyday examples

Supplement

6. Define refractive index, *n*, as the ratio of the speeds of a wave in two different regions
7. Recall and use the equation
   $$n = \frac{\sin i}{\sin r}$$
8. Recall and use the equation
   $$n = \frac{1}{\sin c}$$
9. Describe the use of optical fibres, particularly in telecommunications

3.2.3 Thin lenses

Core

1. Describe the action of thin converging and thin diverging lenses on a parallel beam of light
2. Define and use the terms focal length, principal axis and principal focus (focal point)
3. Draw and use ray diagrams for the formation of a real image by a converging lens
4. Describe the characteristics of an image using the terms enlarged/same size/diminished, upright/inverted and real/virtual
5. Know that a virtual image is formed when diverging rays are extrapolated backwards and does not form a visible projection on a screen

Supplement

6. Draw and use ray diagrams for the formation of a virtual image by a converging lens
7. Describe the use of a single lens as a magnifying glass
8. Describe the use of converging and diverging lenses to correct long-sightedness and short-sightedness

3.2.4 Dispersion of light

Core

1. Describe the dispersion of light as illustrated by the refraction of white light by a glass prism
2. Know the traditional seven colours of the visible spectrum in order of frequency and in order of wavelength

Supplement

3. Recall that visible light of a single frequency is described as monochromatic

3.3 Electromagnetic spectrum

Core

1 Know the main regions of the electromagnetic spectrum in order of frequency and in order of wavelength

2 Know that all electromagnetic waves travel at the same high speed in a vacuum

3 Describe typical uses of the different regions of the electromagnetic spectrum including:

- (a) radio waves; radio and television transmissions, astronomy, radio frequency identification (RFID)
- (b) microwaves; satellite television, mobile phones (cell phones), microwave ovens
- (c) infrared; electric grills, short range communications such as remote controllers for televisions, intruder alarms, thermal imaging, optical fibres
- (d) visible light; vision, photography, illumination
- (e) ultraviolet; security marking, detecting fake bank notes, sterilising water
- (f) X-rays; medical scanning, security scanners
- (g) gamma rays; sterilising food and medical equipment, detection of cancer and its treatment

4 Describe the harmful effects on people of excessive exposure to electromagnetic radiation, including:

- (a) microwaves; internal heating of body cells
- (b) infrared; skin burns
- (c) ultraviolet; damage to surface cells and eyes, leading to skin cancer and eye conditions
- (d) X-rays and gamma rays; mutation or damage to cells in the body

Supplement

6 Know that the speed of electromagnetic waves in a vacuum is 3.0×10^8 m/s and is approximately the same in air

continued

3.3 Electromagnetic spectrum continued

Core

5 Know that communication with artificial satellites is mainly by microwaves:
 (a) some satellite phones use low orbit artificial satellites
 (b) some satellite phones and direct broadcast satellite television use geostationary satellites

Supplement

7 Know that many important systems of communications rely on electromagnetic radiation including:
 (a) mobile phones (cell phones) and wireless internet use microwaves because microwaves can penetrate some walls and only require a short aerial for transmission and reception
 (b) Bluetooth uses radio waves because radio waves pass through walls but the signal is weakened on doing so
 (c) optical fibres (visible light or infrared) are used for cable television and high-speed broadband because glass is transparent to visible light and some infrared; visible light and short wavelength infrared can carry high rates of data

8 Know the difference between a digital and analogue signal

9 Know that a sound can be transmitted as a digital or analogue signal

10 Explain the benefits of digital signalling including increased rate of transmission of data and increased range due to accurate signal regeneration

3.4 Sound

Core

1 Describe the production of sound by vibrating sources

2 Describe the longitudinal nature of sound waves

3 State the approximate range of frequencies audible to humans as 20 Hz to 20 000 Hz

4 Know that a medium is needed to transmit sound waves

5 Know that the speed of sound in air is approximately 330–350 m / s

Supplement

10 Describe compression and rarefaction

11 Know that, in general, sound travels faster in solids than in liquids and faster in liquids than in gases

continued

3.4 Sound continued

Core	Supplement
6 Describe a method involving a measurement of distance and time for determining the speed of sound in air	
7 Describe how changes in amplitude and frequency affect the loudness and pitch of sound waves	
8 Describe an echo as the reflection of sound waves	
9 Define ultrasound as sound with a frequency higher than 20 kHz	12 Describe the uses of ultrasound in non-destructive testing of materials, medical scanning of soft tissue and sonar including calculation of depth or distance from time and wave speed

4 Electricity and magnetism

4.1 Simple phenomena of magnetism

Core	Supplement
1 Describe the forces between magnetic poles and between magnets and magnetic materials, including the use of the terms north pole (N pole), south pole (S pole), attraction and repulsion, magnetised and unmagnetised	10 Explain that magnetic forces are due to interactions between magnetic fields
2 Describe induced magnetism	
3 State the differences between the properties of temporary magnets (made of soft iron) and the properties of permanent magnets (made of steel	
4 State the difference between magnetic and non-magnetic materials	
5 Describe a magnetic field as a region in which a magnetic pole experiences a force	
6 Draw the pattern and direction of magnetic field lines around a bar magnet	11 Know that the relative strength of a magnetic field is represented by the spacing of the magnetic field lines
7 State that the direction of a magnetic field at a point is the direction of the force on the N pole of a magnet at that point	
8 Describe the plotting of magnetic field lines with a compass or iron filings and the use of a compass to determine the direction of the magnetic field	
9 Describe the uses of permanent magnets and electromagnets	

4.2 Electrical quantities

4.2.1 Electric charge

Core

1 State that there are positive and negative charges

2 State that positive charges repel other positive charges, negative charges repel other negative charges, but positive charges attract negative charges

3 Describe simple experiments to show the production of electrostatic charges by friction and to show the detection of electrostatic charges

4 Explain that charging of solids by friction involves only a transfer of negative charge (electrons)

5 Describe an experiment to distinguish between electrical conductors and insulators

6 Recall and use a simple electron model to explain the difference between electrical conductors and insulators and give typical examples

Supplement

7 State that charge is measured in coulombs

8 Describe an electric field as a region in which an electric charge experiences a force

9 State that the direction of an electric field at a point is the direction of the force on a positive charge at that point

10 Describe simple electric field patterns, including the direction of the field:
(a) around a point charge
(b) around a charged conducting sphere
(c) between two oppositely charged parallel conducting plates (end effects will **not** be examined)

4.2.2 Electric current

Core

1 Know that electric current is related to the flow of charge

2 Describe the use of ammeters (analogue and digital) with different ranges

3 Describe electrical conduction in metals in terms of the movement of free electrons

4 Know the difference between direct current (d.c.) and alternating current (a.c.)

Supplement

5 Define electric current as the charge passing a point per unit time; recall and use the equation
$$I = \frac{Q}{t}$$

6 State that conventional current is from positive to negative and that the flow of free electrons is from negative to positive

4.2 Electrical quantities continued

4.2.3 Electromotive force and potential difference

Core

1. Define electromotive force (e.m.f.) as the electrical work done by a source in moving a unit charge around a complete circuit
2. Know that e.m.f. is measured in volts (V)
3. Define potential difference (p.d.) as the work done by a unit charge passing through a component
4. Know that the p.d. between two points is measured in volts (V)
5. Describe the use of voltmeters (analogue and digital) with different ranges

Supplement

6. Recall and use the equation for e.m.f.

   $E = \frac{W}{Q}$

7. Recall and use the equation for p.d.

   $V = \frac{W}{Q}$

4.2.4 Resistance

Core

1. Recall and use the equation for resistance

   $R = \frac{V}{I}$

2. Describe an experiment to determine resistance using a voltmeter and an ammeter and do the appropriate calculations
3. State, qualitatively, the relationship of the resistance of a metallic wire to its length and to its cross-sectional area

Supplement

4. Sketch and explain the current–voltage graphs for a resistor of constant resistance, a filament lamp and a diode
5. Recall and use the following relationship for a metallic electrical conductor:
   (a) resistance is directly proportional to length
   (b) resistance is inversely proportional to cross-sectional area

4.2.5 Electrical energy and electrical power

Core

1. Understand that electric circuits transfer energy from a source of electrical energy, such as an electrical cell or mains supply, to the circuit components and then into the surroundings
2. Recall and use the equation for electrical power

   $P = IV$

3. Recall and use the equation for electrical energy

   $E = IVt$

4. Define the kilowatt-hour (kWh) and calculate the cost of using electrical appliances where the energy unit is the kWh

Supplement

4.3 Electric circuits

4.3.1 Circuit diagrams and circuit components

Core

1 Draw and interpret circuit diagrams containing cells, batteries, power supplies, generators, potential dividers, switches, resistors (fixed and variable), heaters, thermistors (NTC only), light-dependent resistors (LDRs), lamps, motors, bells, ammeters, voltmeters, magnetising coils, transformers, fuses and relays and know how these components behave in the circuit

Supplement

2 Draw and interpret circuit diagrams containing diodes and light-emitting diodes (LEDs) and know how these components behave in the circuit

4.3.2 Series and parallel circuits

Core

1 Know that the current at every point in a series circuit is the same

2 Know how to construct and use series and parallel circuits

3 Calculate the combined e.m.f. of several sources in series

4 Calculate the combined resistance of two or more resistors in series

5 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

7 State the advantages of connecting lamps in parallel in a lighting circuit

Supplement

8 Recall and use in calculations, the fact that:

(a) the sum of the currents entering a junction in a parallel circuit is equal to the sum of the currents that leave the junction

(b) the total p.d. across the components in a series circuit is equal to the sum of the individual p.d.s across each component

(c) the p.d. across an arrangement of parallel resistances is the same as the p.d. across one branch in the arrangement of the parallel resistances

9 Explain that the sum of the currents into a junction is the same as the sum of the currents out of the junction

10 Calculate the combined resistance of two resistors in parallel

4.3 Electric circuits continued

4.3.3 Action and use of circuit components

Core

1 Know that the p.d. across an electrical conductor increases as its resistance increases for a constant current

Supplement

2 Describe the action of a variable potential divider

3 Recall and use the equation for two resistors used as a potential divider

$$\frac{R_1}{R_2} = \frac{V_1}{V_2}$$

4.4 Electrical safety

Core

1 State the hazards of:

(a) damaged insulation

(b) overheating cables

(c) damp conditions

(d) excess current from overloading of plugs, extension leads, single and multiple sockets

when using a mains supply

2 Know that a mains circuit consists of a live wire (line wire), a neutral wire and an earth wire and explain why a switch must be connected to the live wire for the circuit to be switched off safely

3 Explain the use and operation of trip switches and fuses and choose appropriate fuse ratings and trip switch settings

4 Explain why the outer casing of an electrical appliance must be either non-conducting (double-insulated) or earthed

5 State that a fuse without an earth wire protects the circuit and the cabling for a double-insulated appliance

Supplement

4.5 Electromagnetic effects

4.5.1 Electromagnetic induction

Core

1 Know that a conductor moving across a magnetic field or a changing magnetic field linking with a conductor can induce an 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.

Supplement

4 Know that the direction of an induced e.m.f. opposes the change causing it

5 State and use the relative directions of force, field and induced current

4.5.2 The a.c. generator

Core

Supplement

1 Describe a simple form of a.c. generator (rotating coil or rotating magnet) and the use of slip rings and brushes where needed

2 Sketch and interpret graphs of e.m.f. against time for simple a.c. generators and relate the position of the generator coil to the peaks, troughs and zeros of the e.m.f.

4.5.3 Magnetic effect of a current

Core

1 Describe the pattern and direction of the magnetic field due to currents in straight wires and in solenoids

2 Describe an experiment to identify the pattern of the magnetic field (including direction) due to currents in straight wires and in solenoids

3 Describe how the magnetic effect of a current is used in relays and loudspeakers and give examples of their application

Supplement

4 State the qualitative variation of the strength of the magnetic field around straight wires and solenoids

5 Describe the effect on the magnetic field around straight wires and solenoids of changing the magnitude and direction of the current

4.5 Electromagnetic effects continued

4.5.4 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:
(a) the current
(b) the direction of the field

Supplement

2 Recall and use the relative directions of force, magnetic field and current

3 Determine the direction of the force on beams of charged particles in a magnetic field

4.5.5 The d.c. motor

Core

1 Know that a current-carrying coil in a magnetic field may experience a turning effect and that the turning effect is increased by increasing:
(a) the number of turns on the coil
(b) the current
(c) the strength of the magnetic field

Supplement

2 Describe the operation of an electric motor, including the action of a split-ring commutator and brushes

4.5.6 The transformer

Core

1 Describe the construction of a simple transformer with a soft-iron core, as used for voltage transformations

2 Use the terms primary, secondary, step-up and step-down

3 Recall and use the equation

$$\frac{V_p}{V_s} = \frac{N_p}{N_s}$$

where p and s refer to primary and secondary

4 Describe the use of transformers in high-voltage transmission of electricity

5 State the advantages of high-voltage transmission

Supplement

6 Explain the principle of operation of a simple iron-cored transformer

7 Recall and use the equation for 100% efficiency in a transformer

$$I_p V_p = I_s V_s$$

where p and s refer to primary and secondary

8 Recall and use the equation

$$P = I^2 R$$

to explain why power losses in cables are smaller when the voltage is greater

5 Nuclear physics

5.1 The nuclear model of the atom

5.1.1 The atom

Core

1 Describe the structure of an atom in terms of a positively charged nucleus and negatively charged electrons in orbit around the nucleus

2 Know how atoms may form positive ions by losing electrons or form negative ions by gaining electrons

Supplement

3 Describe how the scattering of alpha (α) particles by a sheet of thin metal supports the nuclear model of the atom, by providing evidence for:
  (a) a very small nucleus surrounded by mostly empty space
  (b) a nucleus containing most of the mass of the atom
  (c) a nucleus that is positively charged

5.1.2 The nucleus

Core

1 Describe the composition of the nucleus in terms of protons and neutrons

2 State the relative charges of protons, neutrons and electrons as +1, 0 and –1 respectively

3 Define the terms proton number (atomic number) *Z* and nucleon number (mass number) *A* and be able to calculate the number of neutrons in a nucleus

4 Use the nuclide notation $^{A}_{Z}\mathrm{X}$

5 Explain what is meant by an isotope and state that an element may have more than one isotope

Supplement

6 Describe the processes of nuclear fission and nuclear fusion as the splitting or joining of nuclei, to include the nuclide equation and qualitative description of mass and energy changes without values

7 Know the relationship between the proton number and the relative charge on a nucleus

8 Know the relationship between the nucleon number and the relative mass of a nucleus

5.2 Radioactivity

5.2.1 Detection of radioactivity

Core

1 Know what is meant by background radiation

2 Know the sources that make a significant contribution to background radiation including:
- (a) radon gas (in the air)
- (b) rocks and buildings
- (c) food and drink
- (d) cosmic rays

3 Know that ionising nuclear radiation can be measured using a detector connected to a counter

4 Use count rate measured in counts/s or counts/minute

Supplement

5 Use measurements of background radiation to determine a corrected count rate

5.2.2 The three types of nuclear emission

Core

1 Describe the emission of radiation from a nucleus as spontaneous and random in direction

2 Identify alpha (α), beta (β) and gamma (γ) emissions from the nucleus by recalling:
- (a) their nature
- (b) their relative ionising effects
- (c) their relative penetrating abilities (β^+ are **not** included, β-particles will be taken to refer to β^-)

Supplement

3 Describe the deflection of α-particles, β-particles and γ-radiation in electric fields and magnetic fields

4 Explain their relative ionising effects with reference to:
- (a) kinetic energy
- (b) electric charge

5.2 Radioactivity continued

5.2.3 Radioactive decay

Core

1 Know that radioactive decay is a change in an unstable nucleus that can result in the emission of α-particles or β-particles and/or γ-radiation and know that these changes are spontaneous and random

2 State that during α-decay or β-decay, the nucleus changes to that of a different element

Supplement

3 Know that isotopes of an element may be radioactive due to an excess of neutrons in the nucleus and/or the nucleus being too heavy

4 Describe the effect of α-decay, β-decay and γ-emissions on the nucleus, including an increase in stability and a reduction in the number of excess neutrons; the following change in the nucleus occurs during β-emission

neutron → proton + electron

5 Use decay equations, using nuclide notation, to show the emission of α-particles, β-particles and γ-radiation

5.2.4 Half-life

Core

1 Define the half-life of a particular isotope as the time taken for half the nuclei of that isotope in any sample to decay; recall and use this definition in simple calculations, which might involve information in tables or decay curves (calculations will **not** include background radiation)

Supplement

2 Calculate half-life from data or decay curves from which background radiation has not been subtracted

3 Explain how the type of radiation emitted and the half-life of an isotope determine which isotope is used for applications including:

(a) household fire (smoke) alarms

(b) irradiating food to kill bacteria

(c) sterilisation of equipment using gamma rays

(d) measuring and controlling thicknesses of materials with the choice of radiations used linked to penetration and absorption

(e) diagnosis and treatment of cancer using gamma rays

5.2 Radioactivity continued

5.2.5 Safety precautions

Core

1 State the effects of ionising nuclear radiations on living things, including cell death, mutations and cancer

2 Describe how radioactive materials are moved, used and stored in a safe way

Supplement

3 Explain safety precautions for all ionising radiation in terms of reducing exposure time, increasing distance between source and living tissue and using shielding to absorb radiation

6 Space physics

6.1 The Earth and the Solar System

6.1.1 The Earth

Core

1 Know that the Earth is a planet that rotates on its axis, which is tilted, once in approximately 24 hours, and use this to explain observations of the apparent daily motion of the Sun and the periodic cycle of day and night

2 Know that the Earth orbits the Sun once in approximately 365 days and use this to explain the periodic nature of the seasons

3 Know that it takes approximately one month for the Moon to orbit the Earth and use this to explain the periodic nature of the Moon's cycle of phases

Supplement

4 Define average orbital speed from the equation

$$v = \frac{2\pi r}{T}$$

where r is the average radius of the orbit and T is the orbital period; recall and use this equation

6.1 The Earth and the Solar System continued

6.1.2 The Solar System

Core

1 Describe the Solar System as containing:
   (a) one star, the Sun
   (b) the eight named planets and know their order from the Sun
   (c) minor planets that orbit the Sun, including dwarf planets such as Pluto and asteroids in the asteroid belt
   (d) moons, that orbit the planets
   (e) smaller Solar System bodies, including comets and natural satellites

2 Know that, in comparison to each other, the four planets nearest the Sun are rocky and small and the four planets furthest from the Sun are gaseous and large, and explain this difference by referring to an accretion model for Solar System formation, to include:
   (a) the model's dependence on gravity
   (b) the presence of many elements in interstellar clouds of gas and dust
   (c) the rotation of material in the cloud and the formation of an accretion disc

Supplement

7 Know that planets, minor planets and comets have elliptical orbits, and recall that the Sun is not at the centre of the elliptical orbit, except when the orbit is approximately circular

8 Analyse and interpret planetary data about orbital distance, orbital duration, density, surface temperature and uniform gravitational field strength at the planet's surface

continued

6.1 The Earth and the Solar System continued

6.1.2 The Solar System continued

Core

3 Know that the strength of the gravitational field
   (a) at the surface of a planet depends on the mass of the planet
   (b) around a planet decreases as the distance from the planet increases

4 Calculate the time it takes light to travel a significant distance such as between objects in the Solar System

5 Know that the Sun contains most of the mass of the Solar System and this explains why the planets orbit the Sun

6 Know that the force that keeps an object in orbit around the Sun is the gravitational attraction of the Sun

Supplement

9 Know that the strength of the Sun's gravitational field decreases and that the orbital speeds of the planets decrease as the distance from the Sun increases

10 Know that an object in an elliptical orbit travels faster when closer to the Sun and explain this using the conservation of energy

6.2 Stars and the Universe

6.2.1 The Sun as a star

Core

1 Know that the Sun is a star of medium size, consisting mostly of hydrogen and helium, and that it radiates most of its energy in the infrared, visible light and ultraviolet regions of the electromagnetic spectrum

Supplement

2 Know that stars are powered by nuclear reactions that release energy and that in stable stars the nuclear reactions involve the fusion of hydrogen into helium

6.2 Stars and the Universe continued

6.2.2 Stars

Core

1 State that:
   (a) galaxies are each made up of many billions of stars
   (b) the Sun is a star in the galaxy known as the Milky Way
   (c) other stars that make up the Milky Way are much further away from the Earth than the Sun is from the Earth
   (d) astronomical distances can be measured in light-years, where one light-year is the distance travelled in (the vacuum of) space by light in one year

Supplement

2 Know that one light-year is equal to 9.5×10^{15} m

3 Describe the life cycle of a star:
   (a) a star is formed from interstellar clouds of gas and dust that contain hydrogen
   (b) a protostar is an interstellar cloud collapsing and increasing in temperature as a result of its internal gravitational attraction
   (c) a protostar becomes a stable star when the inward force of gravitational attraction is balanced by an outward force due to the high temperature in the centre of the star
   (d) all stars eventually run out of hydrogen as fuel for the nuclear reaction
   (e) most stars expand to form red giants and more massive stars expand to form red supergiants when most of the hydrogen in the centre of the star has been converted to helium
   (f) a red giant from a less massive star forms a planetary nebula with a white dwarf star at its centre
   (g) a red supergiant explodes as a supernova, forming a nebula containing hydrogen and new heavier elements, leaving behind a neutron star or a black hole at its centre
   (h) the nebula from a supernova may form new stars with orbiting planets

6.2 Stars and the Universe continued

6.2.3 The Universe

Core

1 Know that the Milky Way is one of many billions of galaxies making up the Universe and that the diameter of the Milky Way is approximately 100 000 light-years

2 Describe redshift as an increase in the observed wavelength of electromagnetic radiation emitted from receding stars and galaxies

3 Know that the light emitted from distant galaxies appears redshifted in comparison with light emitted on the Earth

4 Know that redshift in the light from distant galaxies is evidence that the Universe is expanding and supports the Big Bang Theory

Supplement

5 Know that microwave radiation of a specific frequency is observed at all points in space around us and is known as cosmic microwave background radiation (CMBR)

6 Explain that the CMBR was produced shortly after the Universe was formed and that this radiation has been expanded into the microwave region of the electromagnetic spectrum as the Universe expanded

7 Know that the speed v at which a galaxy is moving away from the Earth can be found from the change in wavelength of the galaxy's starlight due to redshift

8 Know that the distance d of a far galaxy can be determined using the brightness of a supernova in that galaxy

9 Define the Hubble constant H_0 as the ratio of the speed at which the galaxy is moving away from the Earth to its distance from the Earth; recall and use the equation

$$H_0 = \frac{v}{d}$$

10 Know that the current estimate for H_0 is 2.2×10^{-18} per second

11 Know that the equation

$$\frac{d}{v} = \frac{1}{H_0}$$

represents an estimate for the age of the Universe and that this is evidence for the idea that all the matter in the Universe was present at a single point

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. The questions are based on the Core subject content only.

Paper 1: Multiple Choice (Core)		Paper 3: Theory (Core)
45 minutes 40 marks 40 compulsory multiple-choice items of the four-choice type. This paper tests assessment objectives AO1 and AO2 This paper assesses grades C to G Externally assessed	**AND**	1 hour 15 minutes 80 marks Compulsory short-answer and structured questions This paper tests assessment objectives AO1 and AO2 This paper assesses grades C to G Externally assessed

Extended assessment

Extended candidates take the following papers. The questions are based on the Core and Supplement subject content.

Paper 2: Multiple Choice (Extended)		Paper 4: Theory (Extended)
45 minutes 40 marks 40 compulsory multiple-choice items of the four-choice type This paper tests assessment objectives AO1 and AO2 This paper assesses grades A* to G Externally assessed	**AND**	1 hour 15 minutes 80 marks Compulsory short-answer and structured questions This paper tests assessment objectives AO1 and AO2 This paper assesses grades A* to G Externally assessed

Practical assessment

All candidates take one practical paper from a choice of two.

Paper 5: Practical Test		Paper 6: Alternative to Practical
1 hour 15 minutes 40 marks All items are compulsory This paper tests assessment objective AO3 Candidates will be required to do experiments in a laboratory as part of this test Externally assessed	**OR**	1 hour 40 marks All items are compulsory This paper tests assessment objective AO3 Candidates will not be required to do experiments as part of this test Externally assessed
Questions in the practical papers are structured to assess performance across the full grade range.		

The Practical Test and Alternative to Practical:

- require the same experimental skills to be developed and learned
- require an understanding of the same experimental contexts
- test the same assessment objective, AO3.

Candidates are expected to be familiar with and may be asked questions using the following experimental contexts:

- measurement of physical quantities such as length, volume or force
- measurement of small distances or short intervals of time
- determining a derived quantity such as the extension per unit load for a spring, the value of a known resistance or the acceleration of an object
- testing and identifying the relationship between two variables such as between the potential difference across a wire and its length
- comparing measured quantities such as angles of reflection
- comparing derived quantities such as density
- cooling and heating, including measurement of temperature
- experiments using springs and balances
- timing motion or oscillations
- electric circuits, including the connection and reconnection of these circuits, and the measurement of current and potential difference
- optics experiments using equipment such as optics pins, mirrors, prisms, lenses, glass or Perspex blocks (both rectangular and semicircular), including the use of transparent, translucent and opaque substances to investigate the transmission of light
- procedures using simple apparatus, in situations where the method may not be familiar to the candidate.

Candidates may be required to do the following:

- **demonstrate knowledge of how to select and safely use techniques, apparatus and materials (including following a sequence of instructions where appropriate):**
  - identify apparatus from diagrams or descriptions
  - draw, complete or label diagrams of apparatus
  - use, or explain the use of, common techniques, apparatus and materials
  - select the most appropriate apparatus or method for the task and justify the choice made
  - describe and explain hazards and identify safety precautions
  - describe and explain techniques used to ensure the accuracy of observations and data

- **plan experiments and investigations:**
  - identify the independent variable and dependent variable
  - describe how and explain why variables should be controlled
  - suggest an appropriate number and range of values for the independent variable
  - suggest the most appropriate apparatus or technique and justify the choice made
  - describe experimental procedures
  - identify risks and suggest appropriate safety precautions
  - describe how to record the results of an experiment
  - describe how to process the results of an experiment to form a conclusion or to evaluate a prediction
  - make reasoned predictions of expected results

- **make and record observations, measurements and estimates:**
  - take readings from apparatus (analogue and digital) or from diagrams of apparatus
  - take readings with appropriate precision, reading to the nearest half-scale division where required
  - correct for zero errors where required
  - make observations, measurements or estimates that are in agreement with expected results or values
  - take sufficient observations or measurements to be reliable
  - repeat observations or measurements where appropriate
  - record qualitative observations from tests
  - record observations and measurements systematically, for example in a suitable table, to an appropriate degree of precision and using appropriate units

- **interpret and evaluate experimental observations and data:**
  - process data, including for use in further calculations or for graph plotting, using a calculator as appropriate
  - present data graphically, including the use of best-fit lines where appropriate
  - analyse and interpret observations and data, including data presented graphically
  - use interpolation and extrapolation graphically to determine a gradient or intercept
  - form conclusions justified by reference to observations and data and with appropriate explanation
  - evaluate the quality of observations and data, identifying any anomalous results and taking appropriate action
  - comment on and explain whether results are equal within the limits of experimental accuracy (assumed to be ± 10% at this level of study)

- **evaluate methods and suggest possible improvements:**
  - evaluate experimental arrangements, methods and techniques, including the control of variables
  - identify sources of error, including measurement error, random error and systematic error
  - identify possible causes of uncertainty in data or in a conclusion
  - suggest possible improvements to the apparatus, experimental arrangements, methods or techniques

Language of measurement

The following definitions have been taken or adapted from *The Language of Measurement* (2010), a guide from the Association for Science Education (ASE).
www.ase.org.uk

The definitions in the table below should be used by teachers during the course to encourage students to use the terminology correctly and consistently.

Candidates will **not** be required to recall the specific definition of these terms in the examinations.

true value	the value that would be obtained in an ideal measurement
measurement error	the difference between a measured value and the true value of a quantity
accuracy	a measurement result is described as accurate if it is close to the true value
precision	how close the measured values of a quantity are to each other
repeatability	a measurement is repeatable if the same or similar result is obtained when the measurement is repeated under the same conditions, using the same method, within the same experiment
reproducibility	a measurement is reproducible if the same or similar result is obtained when the measurement is made under either different conditions or by a different method or in a different experiment
validity of experimental design	an experiment is valid if the experiment tests what it says it will test. The experiment must be a fair test where only the independent variable and dependent variable may change, and controlled variables are kept constant
range	the maximum and minimum value of the independent or dependent variables
anomaly	an anomaly is a value in a set of results that appears to be outside the general pattern of the results, i.e. an extreme value that is either very high or very low in comparison to others
independent variable	independent variables are the variables that are changed in a scientific experiment by the scientist. Changing an independent variable may cause a change in the dependent variable
dependent variable	dependent variables are the variables that are observed or measured in a scientific experiment. Dependent variables may change based on changes made to the independent variables

Apparatus

These lists give items that candidates should be familiar with using, whether they are taking the Practical Test or the Alternative to Practical.

These items should be available for use in the Practical Test. These lists are not exhaustive and we may also require other items to be sourced for specific examinations. The Confidential Instructions we send before the Practical Test will give the detailed requirements for the examination.

Every effort is made to minimise the cost to and resources required by centres. Experiments will be designed around basic apparatus and materials which should be available in most school laboratories or are easily obtainable.

Appropriate safety equipment must be provided to students and should at least include eye protection.

The following suggested equipment has been categorised, but equipment can be used in any topic.

General

- adhesive putty (e.g. Patafix, Blu Tack®)
- adhesive tape (e.g. Sellotape®)
- card
- dropping pipette ($2.5\,cm^3$) or small plastic syringe (e.g. $5\,cm^3$)
- ruler, 30 cm, graduated in mm
- S-hook
- scissors
- set square
- string
- thread
- top-pan (electronic) balance to measure up to 500 g, with precision of at least 0.1 g
- tracing paper
- wooden board, rigid, 150 cm × 20 cm × 1.5 cm

Mechanics

- expendable steel springs, with spring constant of approx. 0.25 N / cm
- force meter, with maximum reading or full scale deflection of between 1.0 N and 3.0 N
- G-clamp
- glass ball (marble), ball bearing (approx. 10 mm in diameter) and table tennis ball
- half-metre ruler, graduated in mm
- masses, 10 × 10 g, 10 × 100 g, including holders
- metre ruler, graduated in mm
- modelling clay (e.g. Plasticine®)
- pendulum bob
- pivots (e.g. 15 cm nails, triangular wooden blocks)
- retort stand, boss and clamp
- stop-watch, reading to 0.1 s or better

Thermal physics

- beakers, glass (borosilicate), 100 cm^3, 250 cm^3, 400 cm^3
- boiling tube, approx. 150 mm × 25 mm
- measuring cylinders, constant diameter, 50 cm^3, 100 cm^3, 250 cm^3
- plastic or polystyrene cup, approx. 200 cm^3
- thermometer, –10 °C to +110 °C, with 1 °C graduations

Optics

- converging lens, spherical, +10D (f = 10 cm)
- converging lens, spherical, +6.7D (f = 15 cm)
- diverging lens, spherical, –6.7D (f = –15 cm)
- lens holders
- glass or Perspex 60° prism
- glass or Perspex blocks, rectangular and semicircular
- optics pins, minimum length 75 mm
- plane mirror, approx. 75 mm × 25 mm
- pin board
- protractor

Electricity

Candidates or centres may need to join components, meters and cells together to make circuits. Connectors used will be 3.5 mm or 4 mm in diameter.

- ammeter, with full-scale deflection 1 A or 1.5 A and precision of at least 0.05 A (analogue, dedicated digital or multimeter)
- voltmeter, with full-scale deflection 5 V and precision of at least 0.1 V (analogue, dedicated digital or multimeter)
- cells, 1.5 V and holders to enable several cells to be joined
- connecting leads, 3.5 mm or 4 mm connectors
- crocodile clips
- d.c. power supply, variable to 12 V
- diodes
- filament lamps, low voltage (e.g. 2.5 V) and holders
- filament lamp, 12 V, 24 W and holder
- LDRs (suitable for use in 1–5 V circuits)
- push switch
- selection of resistors, values within range 5–50 Ω , power rating of 1–2 W
- thermistors (NTC only)
- wire, constantan (eureka), 0.38 mm diameter (28 swg), 0.32 mm diameter (30 swg)
- wire, nichrome, 0.38 mm diameter (28 swg), 0.32 mm diameter (30 swg)

Safety in the laboratory

Teachers should make sure that they do not contravene any school, education authority or government regulations. 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 2015 (available to CLEAPSS members only)

CLEAPSS Hazcards, 2019 update of 2016 edition (available to CLEAPSS members only)

UK regulations

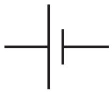
Control of Substances Hazardous to Health Regulations (COSHH) 2002 and subsequent amendment in 2004

www.legislation.gov.uk/uksi/2002/2677/contents/made

www.legislation.gov.uk/uksi/2004/3386/contents/made

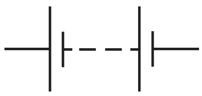
A brief guide may be found at **www.hse.gov.uk/pubns/indg136.pdf**

Electrical symbols

cell 

battery of cells 

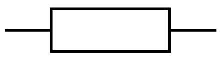
or

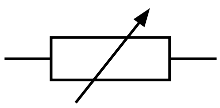


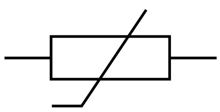
power supply 

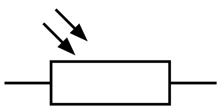
d.c. power supply 

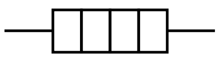
a.c. power supply 

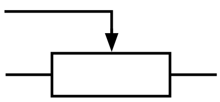
fixed resistor 

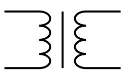
variable resistor 

thermistor 

light-dependent resistor 

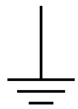
heater 

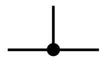
potential divider 

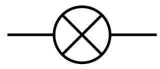
transformer 

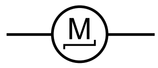
magnetising coil 

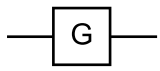
switch 

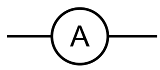
earth or ground 

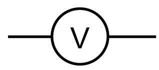
junction of conductors 

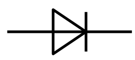
lamp 

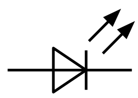
motor 

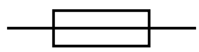
generator 

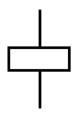
ammeter 

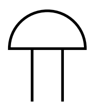
voltmeter 

diode 

light-emitting diode 

fuse 

relay coil 

electric bell 

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.

All candidates should be able to use the following multipliers: M mega, k kilo, c centi, m milli

Extended candidates should also be able to use the following multipliers: G giga, µ micro, n nano

Core			Supplement		
Quantity	***Usual symbol***	***Usual unit***	***Quantity***	***Usual symbol***	***Usual unit***
length	l, h, d, s, x	km, m, cm, mm			
area	A	m^2, cm^2			
volume	V	m^3, cm^3, dm^3			
weight	W	N			
mass	m, M	kg, g	mass	m, M	mg
time	t	h, min, s	time	t	ms, µs
density	ρ	g/cm^3, kg/m^3			
speed	u, v	km/h, m/s, cm/s			
acceleration	a	m/s^2			
acceleration of free fall	g	m/s^2			
force	F	N			
gravitational field strength	g	N/kg			
			spring constant	k	N/m, N/cm
			momentum	p	kg m/s
			impulse		N s
moment of a force		N m			
work done	W	J, kJ, MJ			
energy	E	J, kJ, MJ, kWh			
power	P	W, kW, MW			
pressure	p	N/m^2, N/cm^2	pressure	p	Pa
temperature	θ, T	°C, K			

Core			Supplement		
Quantity	***Usual symbol***	***Usual unit***	***Quantity***	***Usual symbol***	***Usual unit***
			specific heat capacity	c	J/(g °C), J/(kg °C)
frequency	f	Hz, kHz			
wavelength	λ	m, cm	wavelength	λ	nm
focal length	f	m, cm			
angle of incidence	i	degree (°)			
angle of reflection	r	degree (°)			
angle of refraction	r	degree (°)			
critical angle	c	degree (°)			
			refractive index	n	
potential difference/ voltage	V	V, mV, kV			
current	I	A, mA			
e.m.f.	E	V			
resistance	R	Ω			
			charge	Q	C
count rate		counts/s, counts/min			
half-life		s, min, h, days, weeks, years			
			Hubble constant	H_0	s^{-1}

Mathematical requirements

It is expected that these requirements will be covered as part of a mathematics curriculum at this level of study.

Calculators may be used in all parts of the examination.

Numerical answers should be written as decimals (or percentages if appropriate).

Number

- add, subtract, multiply and divide
- use decimals, fractions, percentages, ratios and reciprocals
- convert between decimals, fractions and percentages
- understand and use the symbols: =, <, >
- understand the meaning of sum, difference and product
- use standard form (scientific notation)
- understand that only the final answer in a calculation should be rounded
- use decimal places and significant figures appropriately
- make approximations and estimates to obtain reasonable answers

Algebra

- use positive, whole number indices in algebraic expressions
- substitute values of quantities into equations, using consistent units
- solve simple algebraic equations for any one term when the other terms are known
- recognise and use direct and inverse proportion
- set up simple algebraic equations as mathematical models of physical situations and to represent information given in words
- use Δ (delta) in algebraic expressions and equations to represent changes in a variable

Geometry and trigonometry

- understand the meaning of angle, curve, circle, radius, diameter, circumference, square, parallelogram, rectangle and diagonal
- recall and use the equation for the circumference of a circle
- recall and use the equations for the area of a rectangle, area of a triangle and area of a circle
- recall and use the equations for the volume of a rectangular block and volume of a cylinder
- use scale diagrams
- apply Pythagoras' theorem to the calculation of a side of a right-angled triangle
- understand that a right angle is 90° and that the sum of the angles on a straight line is 180°
- use trigonometric functions (sine, cosine, tangent and their inverses)*
- use mathematical instruments (ruler, compasses, protractor, set square)
- recognise and use the points of the compass (N, S, E, W) and clockwise and anticlockwise directions
- convert between metric units, e.g. cm^3 and m^3; mg, g and kg

* *Extended candidates only*

Graphs, charts and statistics

- draw graphs and charts from data
- interpret graphs and charts, including interpolation and extrapolation of data
- determine the gradient (slope) of a line on a graph, including* by drawing a tangent to a curved line
- determine the intercept of the line on a graph, extending the line graphically (extrapolating) where appropriate
- select suitable scales and axes for graphs
- understand that $y = mx + c$ represents a linear relationship
- recognise direct proportionality from a graph
- calculate and use the average (mean) for a set of data

* *Extended candidates only*

Presentation of data

Taking readings

- Data values should be read from an instrument to an accuracy of one half of one of the smallest divisions on the scale.
- Interpolation between scale divisions should be to an accuracy of one half of a division. That is, where a reading lies between two scale marks, it should be interpolated to the nearest half division.

Recording readings

- Data should be recorded so as to reflect the precision of the measuring instrument, i.e. the smallest difference that can reliably be detected on the measuring instrument scale should be reflected by the number of decimal places and unit given in the measurement.
- A measurement or calculated quantity must be accompanied by a correct unit, where appropriate.
- Each column of a table should be headed with the name or symbol of the measured or calculated quantity and the appropriate unit, e.g. time / s. The solidus (/) is to be used for separating the quantity and the unit in tables, graphs and charts.
- Units should not be included with data in the body of a table.
- Each reading should be repeated, where appropriate, and recorded.
- The number of significant figures given for measured quantities should be appropriate to the measuring instrument used.
- The number of significant figures given for calculated quantities should be the same as the least number of significant figures in the raw data used in that specific calculation.
- A ratio should be expressed as $x : y$.

Drawing and analysing graphs

- The column headings of a table can be directly transferred to the axes of a constructed graph.
- A graph should be drawn with a sharp pencil.
- The axes should be labelled with the name or symbol of the measured or calculated quantity and the appropriate unit, e.g. time / s.

- Unless instructed otherwise, 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 (or 10, 20 or 50, etc.)
- Points on the graph should be clearly marked as plus signs (+), crosses (×) or encircled dots (⊙) of appropriate size.
- Each data point should be plotted to an accuracy of one half of one of the smallest squares on the grid.
- A best-fit line (trend line) should be a single, thin, smooth, straight line or curve, drawn by inspection. 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 and identified by the candidate should be ignored when drawing the best-fit line.
- Candidates should be able to take readings from the graph by extrapolation or interpolation.
- Data values should be read from a line on a graph to an accuracy of one half of one of the smallest squares on the grid. The same accuracy should be used in reading off an intercept.
- The gradient of a straight line should be taken using a triangle whose hypotenuse extends over at least half the length of the candidate's best-fit line, and this triangle should be marked on the graph.
- Calculation of the gradient should be to two or three significant figures.
- When the gradient or intercept of a graph is used in subsequent calculations, it will be assumed to have units consistent with the graph axes.

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

Candidates are expected to be familiar with the nomenclature used in the syllabus. The syllabus and question papers conform with accepted international practice. In particular, the following document, produced by the Association for Science Education (ASE), should be used as a guideline.

Signs, Symbols and Systematics: The ASE Companion to 16–19 Science (2000).

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 digits, e.g. 4 256 789.

Units

To avoid any confusion concerning the symbol for litre, the equivalent quantity, the cubic decimetre (dm^3) will be used in place of l or litre.

In practical work, candidates will be expected to use SI units or, where appropriate, units approved by the BIPM for use with the SI (e.g. minute). A list of SI units and units approved for use with the SI may be found in the SI brochure at **www.bipm.org**. The use of imperial/customary units such as the inch and degree Fahrenheit are not acceptable and should be discouraged.

In all examinations, where data is supplied for use in questions, candidates will be expected to use units that are consistent with the units supplied and should not attempt conversion to other systems of units unless this is a requirement of the question.

Command words

Command words and their meanings help candidates know what is expected from them in the exams. The table below includes command words used in the assessment for this syllabus. The use of the command word will relate to the subject context.

Command word	What it means
Calculate	work out from given facts, figures or information
Comment	give an informed opinion
Compare	identify/comment on similarities and/or differences
Deduce	conclude from available information
Define	give precise meaning
Describe	state the points of a topic / give characteristics and main features
Determine	establish an answer using the information available
Explain	set out purposes or reasons / make the relationships between things clear / say why and/or how and support with relevant evidence
Give	produce an answer from a given source or recall/memory
Identify	name/select/recognise
Justify	support a case with evidence/argument
Predict	suggest what may happen based on available information
Sketch	make a simple freehand drawing showing the key features, taking care over proportions
State	express in clear terms
Suggest	apply knowledge and understanding to situations where there are a range of valid responses in order to make proposals / put forward considerations

5 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 broad 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. Find your administrative zone at **www.cambridginternational.org/adminzone**

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

You can enter candidates in the June and November exam series. If your school is in India, you can also enter your candidates in the March 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 O Level Physics (5054)
- Cambridge IGCSE (9–1) Physics (0972)
- Cambridge IGCSE Physical Science (0652)
- 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 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 encourages 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 access to 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 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

At Cambridge International, we work to avoid direct or indirect discrimination in our syllabuses and assessment materials. We aim to maximise inclusivity for candidates of all national, cultural or social backgrounds and candidates with protected characteristics, which include special educational needs and disability, religion and belief, and characteristics related to gender and identity. We also aim to make our materials as accessible as possible by using accessible language and applying accessible design principles. 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 explained in 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.

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.

Changes to this syllabus for 2026, 2027 and 2028

The syllabus has been updated. This is version 1, published September 2023.

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.

There are no significant changes which affect teaching.

Any textbooks endorsed to support the syllabus for examination from 2023 are still suitable for use with this syllabus.

You should take account of the changes described above when using these textbooks.

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

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