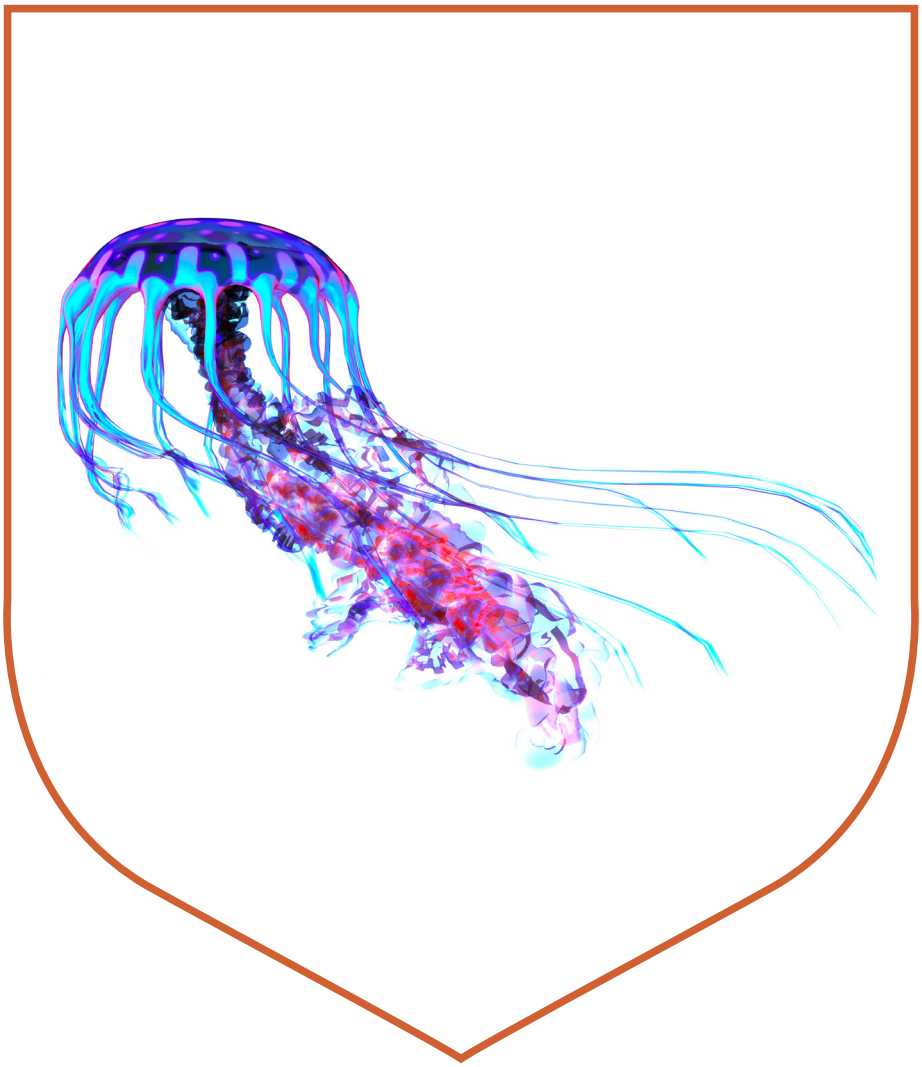
CAMBRIDGE
International Education

Syllabus

Cambridge IGCSE™
Marine Science 0697

Use this syllabus for exams in 2027, 2028 and 2029.
Exams are available in the June and November series.



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?

We work with schools worldwide to build an education that shapes knowledge, understanding and skills. Together, we give learners the confidence they need to thrive and make a positive impact in a changing world.

As part of the University of Cambridge, we offer a globally trusted and flexible framework for education from age 3 to 19, informed by research, experience, and listening to educators.

With recognised qualifications, high-quality resources, comprehensive support and valuable insights, we help schools prepare every student for the opportunities and challenges ahead.

Qualifications that are recognised and valued worldwide

From the world's top-ranked universities to local higher education institutions, Cambridge qualifications open doors to a world of opportunities.

Setting a global standard

With over 160 years of experience in delivering fair, valid and reliable assessments to students worldwide, we offer a global, recognised performance standard for international education.

Your path, your way

Schools can adapt our curriculum, high-quality teaching and learning resources and flexible assessments to their local context. Our aligned offer helps Cambridge schools support every learner to reach their potential and thrive.

Learning with lasting impact

Cambridge learners build subject knowledge and conceptual understanding, and develop a broad range of skills, learning habits and attributes to help make them ready for the world.

Improving learning outcomes through data-led insight and action

Our trusted baseline and diagnostic assessments, together with our insights and evaluation service, help schools turn data into knowledge and actionable insights, to inform teaching decisions and improve learner outcomes.

Bringing together a community of experts

We bring together the collective knowledge of experts and our diverse community of educators worldwide, supporting them to learn from one another and share ideas and information.

Tackling the climate crisis together

We believe that education is key to tackling the climate crisis. Together with Cambridge schools, we can empower young people with the skills and knowledge to take action on climate change, helping them be ready for the world.

School feedback: 'We think the Cambridge curriculum is superb preparation for university.'

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

Contents

Important: Changes to this syllabus

The latest syllabus is version 1, published September 2024. There are no significant changes which affect teaching.

Any textbooks endorsed to support the syllabus for examination from 2024 are still suitable for use with this syllabus.

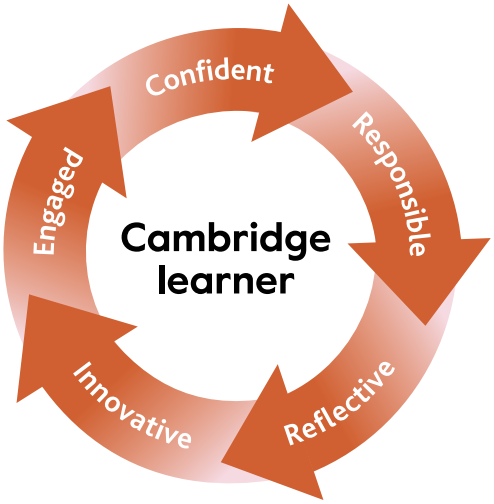
1 Why choose this syllabus?

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 at any age. Taught by over 5000 schools in 150 countries, it is tried, tested and trusted.

Students can choose from 70 subjects in any combination, including 30 languages.

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 Marine Science develops a set of transferable skills including handling data, using the scientific method and applying knowledge and understanding of scientific facts and concepts to solve problems. 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 Marine Science 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 and developing an appreciation of responsibilities towards the community and marine environment

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, being 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

Qualifications that are recognised and valued worldwide

Cambridge qualifications prepare and equip learners with the skills they need to thrive at university and beyond. The world's best higher education institutions recognise our qualifications and value the critical thinking skills, independent research abilities and deep subject knowledge that Cambridge learners bring.

We continually work with universities and colleges in every part of the world to ensure that they understand and accept our qualifications. Cambridge IGCSE provides a springboard to the Cambridge Advanced stage, as well as other post-16 routes. The combination of knowledge and skills in Cambridge IGCSE Marine Science gives learners a solid foundation for further study. Candidates who achieve grades A* to C are well prepared to follow a wide range of courses including Cambridge International AS & A Level Marine Science.

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 works best when teaching and learning are closely aligned to the curriculum, resources and assessment. Our high-quality teaching support helps to maximise teaching time and enables teachers to engage learners of all backgrounds and abilities.

We aim to provide the following support for each Cambridge qualification:

- Syllabus
- Specimen question papers and mark schemes
- Specimen paper answers
- Schemes of Work
- Example candidate responses
- Past papers and mark schemes
- Principal examiner reports for teachers

These resources are available on the School Support Hub at **www.cambridgeinternational.org/support**, our secure online site for Cambridge teachers. Your exams officer can provide you with a login.

Additional teaching & learning resources are also available for many syllabuses and vary according to the nature of the subject and the structure of the assessment of each syllabus. These can include ready-built lesson materials, digital resources and multimedia for the classroom and homework, guidance on assessment and much more. Beyond the resources available on the Schools Support Hub, a wide range of endorsed textbooks and associated teaching and learning support are available from Cambridge at **www.cambridge.org/education** and from other publishers. Resources vary according to the nature of the subject and the structure of the assessment of each syllabus.

You can also contact our global Cambridge community or talk to a senior examiner on our discussion forums.

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

Professional development

Find the next step on your professional development journey.

- **Introduction courses** – An introduction to Cambridge programmes and qualifications. For teachers who are new to Cambridge programmes or new to a specific syllabus.
- **Focus on Teaching courses** – These are for teachers who want to explore a specific area of teaching and learning within a syllabus or programme.
- **Focus on Assessment courses** – These are for teachers who want to understand the assessment of a syllabus in greater depth.
- **Marking workshops** – These workshops help you become more familiar with what examiners are looking for, and provide an opportunity to raise questions and share your experiences of the syllabus.
- **Enrichment Professional Development** – Transform your approach to teaching with our Enrichment workshops. Each workshop focuses on a specific area of teaching and learning practice.
- **Cambridge Professional Development Qualifications (PDQs)** – Practice-based programmes that transform professional learning for practicing teachers. Available at Certificate and Diploma level.

For more information visit **www.cambridgeinternational.org/support-for-teachers**

Supporting exams officers

We provide comprehensive support and guidance for all Cambridge exams officers.
Find out more at: **www.cambridgeinternational.org/eoguide**

2 Syllabus overview

Aims

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

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

The aims are to enable students to:

- acquire scientific knowledge and understanding of scientific theories and practice
- develop a range of practical skills, including working safely with consideration for the environment
- use scientific data and evidence to solve problems and discuss the limitations of scientific methods
- communicate effectively and clearly, using appropriate terminology and scientific conventions
- develop an understanding of responsibility to society and a concern for the environment
- enjoy science and develop an informed interest in the subject that may lead to further study.

We are 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 The Earth and its oceans
2 Sea water
3 Marine organisms
4 Nutrients and energy
5 Marine ecology
6 Human influences on the marine environment

Assessment overview

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

All candidates take:	
Paper 1	1 hour 45 minutes
Theory and Data Handling	50%
80 marks	
Short-answer and structured questions	
Externally assessed	

and:	
Paper 2	1 hour 45 minutes
Theory and Practical Skills	50%
80 marks	
Short-answer and structured questions	
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, definitions, concepts and theories
- scientific vocabulary, terminology and conventions (including symbols, quantities and units)
- scientific and technological applications with their social, economic and environmental implications.

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 experimental techniques, apparatus and materials and how to use them safely
- 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 %	
	Paper 1	Paper 2
AO1 Knowledge with understanding	65	35
AO2 Handling information and problem-solving	35	25
AO3 Experimental skills and investigations	0	40
Total	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.

Practical work is an essential part of the course and it underpins many of the topic areas. Candidates are expected to undertake all of the practical activities included within the learning outcomes of this syllabus, as a minimum. Candidates' experience of practical activities and the skills gained will be assessed through knowledge and understanding of the practicals themselves and through application of the skills gained from these practicals to a new context.

The practical activities are indicated by the practical activity (**PA**) symbol.

Teachers should ensure that candidates are prepared for the assessment of both the theory and the practical learning outcomes.

1 The Earth and its oceans

1.1 Structure of the Earth

Candidates should be able to:	Further guidance and exemplification:
1 describe the Earth as a planet orbiting the Sun, and the Moon as a natural satellite orbiting the Earth	
2 state that gravity keeps the Earth in orbit around the Sun, and the Moon in orbit around the Earth	
3 describe the structure of the Earth	limited to: (a) the core made of iron, forming a solid inner core and a liquid outer core (b) the mantle made of solid rock, which can melt to form a viscous liquid called magma (c) the crust made of solid rock
4 state that the iron core creates a magnetic field around the Earth	

1.2 Plate tectonics

Candidates should be able to:	Further guidance and exemplification:
1 explain that the Earth's crust is made up of a number of tectonic plates	
2 outline the theory that tectonic plates float on the mantle, and move as a result of convection currents	
3 outline how the present-day continents and oceans are the result of the break-up of supercontinents and the movement of tectonic plates over hundreds of millions of years	
4 describe convergent, divergent and transform plate boundaries	
5 explain how movement of plates at different types of plate boundary can give rise to earthquakes and volcanoes	
6 describe how a tsunami can be formed	
7 outline the effects of tsunamis on marine ecosystems and human coastal communities	

1.3 Oceans and seas

Candidates should be able to:	Further guidance and exemplification:
1 identify the Earth's oceans as the Arctic, Atlantic, Pacific, Indian and Southern	
2 identify and describe the location of oceans and other features on maps, diagrams and other images	use the terms: • latitude • longitude • coordinates • equator • tropical • polar • temperate
3 explain that oceans are interconnected and encircle the Earth as a World Ocean	
4 describe the extent and depth of the oceans	limited to: (a) the oceans cover 71% of the Earth's surface and contain 97% of the Earth's water (b) the Pacific Ocean is the largest ocean (c) the Mariana Trench is the deepest point in the oceans, with a maximum depth of approximately 11 000 metres

1.3 Oceans and seas continued

Candidates should be able to:	Further guidance and exemplification:
5 describe seas as smaller areas of water, sometimes within oceans, often partially enclosed by land, e.g. the Bering Sea in the Pacific Ocean and the Mediterranean Sea	
6 describe, and identify from maps, diagrams and other images, the geomorphology of the oceans	limited to: (a) continental shelf (b) continental slope (c) abyssal plain (d) mid-ocean ridge (e) ocean trench (f) volcanic island

1.4 Tides and currents

Candidates should be able to:	Further guidance and exemplification:
1 outline how high and low tides, and spring and neap tides, are produced by the gravitational effects of the Moon and Sun on the bodies of water on the Earth	
2 describe how to measure tidal amplitude	
3 describe oceanic currents as the continuous movement of sea water in a particular direction	
4 state that oceanic currents are caused by prevailing winds, the spinning of the Earth, tides and changes in water density	
5 describe a gyre as a large system of circular oceanic currents	
6 state the locations of the five main oceanic gyres	
7 state that oceanic currents and gyres circulate water around the World Ocean	
8 describe the formation of rip currents and the dangers they present to swimmers	
9 describe how to measure current speed and direction	

2 Sea water

2.1 The water cycle

Candidates should be able to:	Further guidance and exemplification:
1 describe and explain the properties of solids, liquids and gases, using particle theory	
2 state that temperature is a measure of the kinetic energy of particles and is measured in °C	
3 use particle theory to describe how diffusion takes place by the net movement of particles from a region of their higher concentration to a region of lower concentration, as a result of their random movement	
4 explain changes of state, using the terms evaporation, condensation, freezing and melting	
5 describe the energy changes that occur during changes of state	
6 (**PA**) investigate and compare the effect on water level of melting of floating ice and land-based ice	
7 describe and interpret the water cycle, with reference to evaporation, condensation, precipitation and surface run-off	
8 describe the factors affecting the rate of evaporation of water from the oceans	

2.2 pH and salinity

Candidates should be able to:	Further guidance and exemplification:
1 use and explain the terms element, compound and mixture	(a) element, with reference to oxygen (b) compound, with reference to calcium carbonate (c) mixture, with reference to sea water
2 describe neutrality, acidity and alkalinity in terms of pH	
3 (**PA**) investigate the pH of sea water, fresh water and rain water, using universal indicator	
4 (**PA**) investigate the effect on pH of adding carbon dioxide to sea water	
5 describe the composition of sea water, using the terms solvent, solute, solution, dissolve, soluble, insoluble and salts, with reference to sodium chloride, magnesium sulfate and calcium carbonate	

2.2 pH and salinity continued

Candidates should be able to:	Further guidance and exemplification:
6 (**PA**) investigate the effect of temperature on the solubility of a solute in water	
7 describe salinity as the concentration of dissolved salts, using units of parts per thousand (ppt)	
8 compare and explain the salinities of some of the world's oceans and seas	limited to: (a) the Pacific Ocean as having a typical salinity (b) the Baltic Sea as having a low salinity (c) the Red Sea as having a high salinity
9 explain how environmental factors affect salinity	limited to: (a) erosion of rocks on land (b) run-off (c) precipitation and evaporation (d) melting of ice sheets and glaciers (e) temperature
10 state that estuaries are partly enclosed bodies of water where a river flows into the sea	
11 describe estuaries as tidal bodies of water, where fresh water mixes with sea water, resulting in changes in salinity during the tidal cycle	

2.3 Dissolved gases

Candidates should be able to:	Further guidance and exemplification:
1 explain that the gases oxygen and carbon dioxide from the atmosphere dissolve in water, and that oxygen has a low solubility in water	
2 compare the relative concentrations of oxygen and carbon dioxide in the atmosphere and dissolved in sea water	
3 describe and explain how an increase in temperature reduces the solubility of oxygen and carbon dioxide in water	
4 (**PA**) investigate the effect of temperature on gas solubility	

2.4 Density

Candidates should be able to:	Further guidance and exemplification:
1 describe density as mass per unit volume and recall, manipulate and use the formula: $\text{density} = \frac{\text{mass}}{\text{volume}}$	
2 (**PA**) investigate the effect of temperature on density of water	
3 (**PA**) investigate the effect of salinity on density of water	
4 explain how changes in density of liquids result in the formation of convection currents	
5 explain the effect of temperature on water density and volume in terms of particle theory	
6 explain, in terms of density, why colder water generally lies beneath warmer water	

2.5 Effects of increasing depth

Candidates should be able to:	Further guidance and exemplification:
1 State conditions that change with depth	limited to: (a) light penetration (b) pressure (c) temperature (d) salinity (e) dissolved oxygen
2 describe how light penetration changes with depth	details of absorption of different wavelengths are **not** required
3 (**PA**) investigate light penetration through water using a Secchi disc	
4 describe and explain how pressure changes with depth	
5 describe how temperature changes with depth	
6 describe and explain how the concentration of dissolved oxygen changes with depth	

2.6 Upwelling

Candidates should be able to:	Further guidance and exemplification:
1 describe how winds can cause upwelling, in which nutrient-rich cold water rises to the surface	
2 outline the formation of El Niño	limited to: the reduction or reversal of trade winds, leading to: • increased surface water temperature in the eastern Pacific • reduced upwelling in the eastern Pacific
3 discuss the local effects of El Niño	limited to: (a) effects on water temperature (b) effects on nutrient availability (c) effects on rainfall in Australia and Asia compared to the eastern Pacific

3 Marine organisms

3.1 Cell structure and function

Candidates should be able to:	Further guidance and exemplification:
1 describe and compare the structures of plant cells and animal cells	limited to: (a) cell wall (b) cell membrane (c) nucleus (d) cytoplasm (e) chloroplast (f) mitochondria (g) vacuole
2 describe the structure of a bacterial cell	limited to: (a) cell wall (b) cell membrane (c) cytoplasm
3 identify the cell structures listed in 3.1.1 and 3.1.2 in diagrams and images of plant, animal and bacterial cells	
4 describe the functions of the structures listed in 3.1.1 and 3.1.2 in plant, animal and bacterial cells	

3.2 Reproduction

Candidates should be able to:	Further guidance and exemplification:
1 describe asexual reproduction as a single organism producing exact copies of itself	
2 describe sexual reproduction as organisms producing male and female sex cells, which fuse to produce offspring with characteristics from both parents	

3.3 Classification

Candidates should be able to:	Further guidance and exemplification:
1 state that marine organisms can be classified into groups by the features that they share	
2 describe the binomial system of naming species	• an internationally agreed system • the scientific name is made up of two parts showing the genus and species, e.g. *Orcinus orca*
3 state the three domains used in classification	• Bacteria • Archaea • Eukarya
4 state the main kingdoms of Eukarya found in marine habitats and know the main features used to place organisms into the appropriate kingdom, giving marine examples of each	limited to: (a) animals (b) plants (c) protoctists

3.4 The animal kingdom

Candidates should be able to:	Further guidance and exemplification:
1 identify and describe the main characteristic features used to place marine vertebrates into groups within the animal kingdom, with reference to mammals, birds, reptiles and fish	limited to: (a) skin covering (hair, feathers, scales) (b) reproductive method (internal or external fertilisation) (c) gills or lungs for gas exchange

3.4 The animal kingdom continued

Candidates should be able to:	Further guidance and exemplification:
2 state examples of each group of marine vertebrates	limited to: (a) mammals (cetaceans, pinnipeds, sirenians) (b) birds (pelagic birds, shorebirds) (c) reptiles (sea snakes, turtles) (d) fish (cartilaginous and bony)
3 identify and state the functions of the main external features of fish	limited to: (a) operculum, as a gill cover (b) scales, for protection (c) dorsal, pelvic, pectoral, anal, caudal fins, for control of pitching, rolling and yawing, directional changes and forward thrust (d) lateral line, to detect vibration (e) nares, to detect chemicals
4 identify and describe the main characteristic features used to place marine invertebrates into groups within the animal kingdom	limited to: (a) crustaceans • bilateral symmetry • exoskeleton • compound eyes • two pairs of antennae • abdominal segments with jointed legs (b) cnidaria • radial symmetry • tentacles with stinging cells (c) echinoderms • pentaradial symmetry • spiny skin • tube feet (d) molluscs • bilateral symmetry • unsegmented body • internal or external shell (e) annelids • bilateral symmetry • segmented • soft body • setae

3.4 The animal kingdom continued

Candidates should be able to:	Further guidance and exemplification:
5 (**PA**) identify and compare biological specimens, from cells to whole organisms, using hand lenses, light microscopes or photographs	
6 (**PA**) observe and draw structures or whole specimens from the groups listed in 3.4.1, 3.4.2, 3.4.3 and 3.4.4	
7 state, use and manipulate the formula: $\text{magnification} = \frac{\text{image size}}{\text{actual size}}$	
8 (**PA**) construct and use simple dichotomous keys based on easily identifiable external features of organisms	

3.5 Plant and protoctist kingdoms

Candidates should be able to:	Further guidance and exemplification:
1 state that seagrasses are marine organisms that belong to the plant kingdom and identify the main features of seagrasses	limited to: • leaves that are organs of photosynthesis • roots that secure seagrasses into sediment and obtain minerals • rhizomes (underground stems) that connect individual seagrass plants, and for asexual reproduction • flowers for sexual reproduction
2 state that kelp is an example of a macroalga (seaweed) that belongs to the protoctist kingdom and identify the main features of kelp	limited to: • flat blades for photosynthesis • gas bladders in some species to float the blades • stipe that acts as a stem from which the blades develop • holdfast to anchor the kelp to the substrate • chloroplasts within cells for photosynthesis
3 state that dinoflagellates belong to the protoctist kingdom and identify the main features of dinoflagellates	limited to: • microscopic, single-celled organisms • presence of chloroplasts for photosynthesis • presence of two flagella for movement
4 state that diatoms belong to the protoctist kingdom and identify the main features of diatoms	limited to: • microscopic, single-celled organisms • presence of chloroplasts for photosynthesis • presence of a silica skeleton

3.6 Animal life cycles

Candidates should be able to:	Further guidance and exemplification:
1 describe the life cycle of the leatherback turtle	• females reproduce every 2–5 years • females return to the sandy shore where they hatched and excavate a nest in which they lay eggs • females repeat this egg-laying several times at 10-day intervals • females bury eggs and depart • temperature of incubation determines sex of offspring • eggs hatch after 55–60 days, after which the offspring go to sea, feed and grow, reaching maturity after 15–25 years • males live entirely at sea
2 describe the life cycle of a coral polyp	• polyps reproduce asexually and sexually • asexual reproduction occurs when a parent produces a new polyp next to itself by budding • sexual reproduction occurs through the synchronised release of a huge number of eggs and sperm into the water • fertilised eggs float to the surface to form planktonic larvae • larvae swim to the light, they feed and grow, and are moved by currents • larvae descend and attach to a hard surface, where they grow into polyps

3.7 Migration

Candidates should be able to:	Further guidance and exemplification:
1 describe migration and give reasons for it	including: • finding food • finding mates • moving to a different habitat to reproduce • avoiding predators
2 describe that migration of marine organisms occurs in a three-dimensional environment and can be horizontal or vertical, and can be over short or very long distances	
3 explain why many organisms, such as plankton, fish, squid and shrimp, undertake daily vertical migration between the twilight zone and sunlight zone	

3.7 Migration continued

Candidates should be able to:	Further guidance and exemplification:
4 explain why some organisms, such as tuna, turtles and whales, undertake very long horizontal migration	
5 outline the methods used by organisms during migration to find their way	including: • magnetic field of the Earth • location of the Sun, Moon and stars • olfaction • mental maps and landmarks

4 Nutrients and energy

4.1 Nutrients

Candidates should be able to:	Further guidance and exemplification:
1 describe nutrients as substances that are required by an organism for growth, repair and to provide chemical energy	including: • gases such as carbon dioxide • dissolved salts • organic compounds including carbohydrates (starch, and sugars such as glucose), lipids (fats and oils) and proteins
2 (**PA**) investigate a variety of foods to test for the presence of starch, sugars, proteins and lipids	(a) iodine solution test for starch (b) Benedict's solution test for reducing sugars (c) biuret solution test for proteins (d) ethanol emulsion test for lipids (fats and oils)
3 describe the functions of major nutrient groups	limited to: (a) protein used for tissue repair and growth, and energy supply (b) carbohydrate as an energy supply (c) lipids as insulation, energy supply, source of lipid-soluble vitamins (d) vitamins as micronutrients (e) mineral salts as micronutrients

4.1 Nutrients continued

Candidates should be able to:	Further guidance and exemplification:
4 state that some nutrients supply marine organisms with a source of essential elements and these elements have important biological roles	including: (a) nitrogen, which is used to make proteins (b) carbon, which is used to make organic compounds (c) magnesium, which is used to make chlorophyll (d) calcium, which is used to make bones, shells and coral skeletons (e) iron, which is used to make haemoglobin in the blood of vertebrates and some invertebrates, to carry oxygen around the body
5 explain how nutrients cycle through marine ecosystems	• taken up by organisms and passed up food chains • become available again after death and decay • sink through the water column as marine snow • return to the surface by upwelling
6 outline the role of bacteria as decomposers in cycling nutrients	

4.2 Respiration

Candidates should be able to:	Further guidance and exemplification:
1 describe respiration as chemical reactions in cells that break down nutrient molecules and release usable energy	
2 explain that all cells respire	
3 state the word equation for aerobic respiration	oxygen + glucose → carbon dioxide + water
4 describe the difference between respiration and gas exchange	
5 (**PA**) investigate the release of energy by burning samples of food	

4.3 Photosynthesis

Candidates should be able to:	Further guidance and exemplification:
1 describe photosynthesis as the process by which some organisms make glucose from carbon dioxide and water using energy from light, releasing oxygen as a by-product	
2 state that chlorophyll is a green pigment that transfers energy from light into energy in organic chemicals, for the synthesis of carbohydrates	
3 describe a producer as an organism that makes its own organic nutrients, generally using energy from sunlight, through photosynthesis	
4 state that, in the marine environment, photosynthesis takes place in different groups of organisms	limited to: (a) marine plants, e.g. seagrasses (b) some marine protoctists, e.g. microalgae, macroalgae, diatoms and some dinoflagellates (c) some marine bacteria, e.g. cyanobacteria
5 state the word equation for photosynthesis	carbon dioxide + water → glucose + oxygen
6 (**PA**) investigate the effect of light intensity on the rate of photosynthesis in an aquatic plant or macroalga	
7 state that productivity is the rate at which producers transfer energy into carbohydrates	
8 outline the importance of local upwellings to the productivity of organisms in coastal marine ecosystems	

4.4 Feeding relationships

Candidates should be able to:	Further guidance and exemplification:
1 state that the Sun is the principal source of energy input to biological systems	
2 describe a food chain as showing the transfer of energy from one organism to the next, beginning with a producer	
3 describe a food web as a network of interconnected food chains	
4 construct food chains and food webs to represent and interpret feeding relationships in marine ecosystems	
5 describe a trophic level as the position of an organism in a food chain, food web or ecological pyramid	

4.4 Feeding relationships continued

Candidates should be able to:	Further guidance and exemplification:
6 describe a consumer as an organism that gets its energy by feeding on other organisms	
7 state that consumers may be classed as primary, secondary and tertiary according to their position in a food chain, and that they can feed at different trophic levels in a food web	
8 describe different types of consumer	(a) a herbivore as an animal that gets its energy by eating producers (b) a carnivore as an animal that gets its energy by eating other animals (c) an omnivore as an animal that gets its energy by eating plants and other animals (d) a detritivore as an animal that gets its energy from eating dead or waste organic material
9 describe a decomposer as an organism that gets its energy by breaking down dead or waste organic material	
10 describe a predator as an animal that captures, kills and eats another animal, which is its prey	
11 describe biomass as the mass of living matter	
12 describe how energy is lost from a food chain	limited to: • respiration • movement • removal or harvesting • excretion
13 draw, describe and interpret pyramids of numbers, biomass and energy	

5 Marine ecology

5.1 Components of ecosystems

Candidates should be able to:	Further guidance and exemplification:
1 describe the meanings of terms used in ecology	(a) a species as a group of organisms that can reproduce to produce fertile offspring (b) a population as a group of organisms of one species, living in the same area, at the same time (c) a community as all of the populations of different species in an area (d) a habitat as the area where an organism lives and interacts with its environment and other organisms (e) an environment as the external surroundings of an organism or population, including biotic (living) and abiotic (non-living) components (f) an ecosystem as a unit containing the community of organisms and their environment, interacting together, e.g. a rocky shore or a coral reef
2 identify and explain the factors that affect the rate of population growth for a population of a named organism	limited to: (a) food supply (b) disease (c) competition (d) predation
3 identify different types of marine ecosystem	(a) open-ocean ecosystem (b) coastal ecosystems, which are found along the continental shelf or continental slope and are affected by tides, including: • wetlands • coral reefs • sandy shores • muddy shores • rocky shores • kelp forests • seagrass beds • mangrove forests
4 explain that coastal ecosystems are more susceptible than the open-ocean ecosystem to human activity	
5 state that coastal ecosystems generally have a higher productivity than the open-ocean ecosystem, partly due to run-off carrying nutrients	

5.2 Investigating ecosystems

Candidates should be able to:	Further guidance and exemplification:
1 (**PA**) investigate population sizes and species richness by random sampling using quadrats	
2 (**PA**) investigate distribution of species by systematic sampling using line transects and belt transects	
3 (**PA**) use and describe a suitable method for measuring the profile of shore or slope	
4 (**PA**) use and describe a suitable method for measuring particle profiles in sand or sediments	
5 (**PA**) use and describe a suitable method for measuring moisture content of sand or sediments	

5.3 Open-ocean ecosystem

Candidates should be able to:	Further guidance and exemplification:
1 state that the pelagic zone includes the whole column of open water	
2 state that the benthic zone is the seabed	
3 describe the three zones in the open-ocean ecosystem	• the sunlight zone as the region of the ocean between 0 m and 200 m depth • the twilight zone as the region of the ocean between 200 m and 1000 m • the midnight zone as the region of the ocean below 1000 m
4 describe the conditions in the sunlight zone	• light available • high content of dissolved oxygen • high biomass • low pressure • variable temperature • presence of photosynthetic organisms
5 describe plankton as a collection of organisms that drift in water currents	
6 state that phytoplankton are microscopic producers, and include diatoms, dinoflagellates and cyanobacteria	
7 state that zooplankton are consumers, including larvae of fish and invertebrates (which can be microscopic), and also larger animals such as jellyfish	

5.3 Open-ocean ecosystem continued

Candidates should be able to:	Further guidance and exemplification:
8 explain why the sunlight zone contains a large mass of living organisms (biomass)	
9 describe the conditions in the twilight zone	• low light availability • some dissolved oxygen • stable temperature • higher pressure
10 describe adaptations of species in the sunlight and twilight zones	including: • migratory – for food or breeding ground • able to use a wide range of food sources • fast swimmers – no shelter available • countershaded for predator avoidance
11 describe the conditions in the midnight zone	• no light • little dissolved oxygen • very stable low temperature • very high pressure
12 describe adaptations of deep-sea species	including: • bioluminescence to attract mates or prey, or to illuminate predators • slow moving with a long lifespan due to low oxygen and low temperature • dark brown or black so not easily visible in light produced by bioluminescence • gelatinous bodies due to high pressure • many fish species have large backward-facing teeth so once caught prey cannot escape
13 describe adaptations of benthic species	including: • ability to camouflage on, or burrow into, the seabed to avoid predation • some invertebrates may move using legs or tube feet on their ventral surface, and have a hard spiny covering on the dorsal surface for protection from predators • flatfish lie flat on one side, one eye moves during development so both eyes are on the same side of the head and protrude so they can bury themselves and look for predators or prey • skates and rays are dorsally flattened, with elongated pectoral and pelvic fins around the edge of their body

5.4 Rocky shores

Candidates should be able to:	Further guidance and exemplification:
1 describe the zones of a typical rocky shore	limited to: (a) supratidal zone (b) intertidal zone (c) subtidal zone
2 state that environmental factors affect the distribution of organisms on a rocky shore	including: (a) biotic factors • predation • food availability (b) abiotic factors • exposure to air • wave action • oxygen • air temperature • water temperature
3 outline how biotic factors and abiotic factors affect the distribution of organisms on a rocky shore	including: (a) macroalgae (*Fucus* sp.) (b) cnidaria (sea anemone) (c) molluscs (limpet and mussel)
4 describe how organisms are adapted to live on a rocky shore	including: (a) molluscs (limpet and mussel) • close shells to prevent water loss • hard shells to protect against predators (b) cnidaria (sea anemone) • retract tentacles • live in rock pools or below macroalgae to retain moisture (c) macroalgae (*Fucus* sp.) • thick leathery fronds to avoid drying out • a holdfast to withstand currents and wave action

5.5 Sedimentary shores

Candidates should be able to:	Further guidance and exemplification:
1 describe the zones of typical sandy and muddy shores	limited to: (a) supratidal zone (b) intertidal zone (c) subtidal zone
2 compare the features of sandy and muddy shores	including: (a) sediment size (b) sedimentation rates compared to erosional rates (c) stability (d) gradient (e) water movement (f) oxygen availability
3 state that environmental factors affect the distribution of organisms on a sandy shore	including: (a) biotic factors • predation • food availability (b) abiotic factors • unstable substrate • air temperature • exposure (air and wind)
4 describe how organisms are adapted to live on a sandy shore	including: (a) clams • use muscular foot to burrow (b) lugworms • live in U-shaped burrows • specialised haemoglobin to absorb oxygen in a low-oxygen environment • ingest sand to digest the microorganisms within the sediment

5.6 Mangrove forest

Candidates should be able to:	Further guidance and exemplification:
1 describe the structure of a typical mangrove forest	limited to: • an intertidal zone often bordering a terrestrial forest • often estuarine
2 describe how the abiotic factors change in an estuary during a tidal cycle	limited to: • salinity • temperature • dissolved oxygen
3 explain how adaptations of mangrove trees enable them to live in waterlogged soil with low oxygen and tidal salt water	limited to: • aerial roots (pneumatophores) for gas exchange • prop roots for support • leaves can secrete salt
4 describe how organisms are adapted to live in a mangrove forest	including: (a) banded archerfish, limited to: • large, forward-set, movable eyes for binocular vision to target prey out of water • specialised mouth shape enables them to spit a jet of water up to 150 cm to knock insects into the water • dark bands form camouflage to provide protection from birds (b) mudskippers, limited to: • absorb oxygen through their skin and the lining of their mouth and throat when they are moist • enlarged gill chambers trap water so they can still obtain oxygen when on land • shape of pectoral and pelvic fins adapted for movement on land • large eyes set high for use out of water

5.7 Tropical coral reefs

Candidates should be able to:	Further guidance and exemplification:
1 describe corals as animals that form colonies of polyps, often having photosynthetic microorganisms living in their tissues	
2 describe the structure of a typical coral polyp	limited to: • tentacles • stinging cells • mouth • stomach • calcium carbonate skeleton
3 describe the functions of the structures listed in 5.7.2	
4 describe the mutualistic relationship between coral polyps and zooxanthellae	
5 explain how environmental factors affect the distribution of corals in the oceans	including: (a) biotic factors • parrot fish • crown-of-thorns starfish (b) abiotic factors • temperature • light intensity • clear water • hard substrate
6 state that the water around a coral reef is clear because it is low in nutrients, which are held within the organisms living there	
7 describe coral reefs as areas of high species richness	
8 describe the adaptations of organisms living around coral reefs	including: (a) trigger fish – adapted dorsal fin holds the fish tightly in crevices for protection from predators (b) parrot fish – have a specialised set of grinding teeth for eating coral (c) nudibranchs – absorb toxins from prey to become toxic to predators
9 describe the Darwin–Dana–Daly theory of atoll formation	

6 Human influences on the marine environment

6.1 Overview of human interactions with marine ecosystems

Candidates should be able to:	Further guidance and exemplification:
1 outline the importance of different marine ecosystems to humans	including: (a) recreation and tourism (b) source of wood/building material (c) coastal protection (d) food supply (e) medicines (f) fisheries (g) nursery areas for juvenile organisms of commercially and ecologically important species (h) medicinal plants
2 outline the impacts of human activities on marine ecosystems	including: (a) recreational activities – noise and light pollution, litter and plastics, trampling of organisms, collection and removal of organisms as souvenirs (b) tourist boats and diving (c) land reclamation for resorts (d) building of infrastructure (e) removal of resources – dredging for sand and mud for building, logging of mangrove trees (f) blast fishing (g) shrimp farms (h) oil spills
3 explain that populations of some marine species are declining and may become extinct and these species are referred to as endangered species	
4 describe a sustainable resource or activity as one that we can continue to use or carry out at the current rate, without causing damage to the environment, and without the resource running out	

6.2 Tourism

Candidates should be able to:	Further guidance and exemplification:
1 describe tourism as of socio-economic importance, providing employment and income to the area leading to improved infrastructure for the local communities	
2 describe ecotourism as ecologically sustainable tourism with a focus on experiencing natural areas that encourages environmental and cultural understanding, appreciation and conservation	
3 discuss the positive and negative impacts of tourism, including ecotourism, on a marine area	including: (a) positive impacts • tourists appreciate the environment and want to preserve it for the future • development of Marine Protected Areas (MPAs) • involvement of conservation organisations (b) negative impacts • competition for land or resources • pollution • damage to sensitive ecosystems • removal of organisms to sell • interaction with organisms and behavioural consequences
4 describe the impacts of tourists on a named marine ecosystem	suitable examples include the Galapagos Islands or Australia's Great Barrier Reef, or local examples can be studied
5 describe methods of reducing negative impacts of tourism	including: (a) education (b) legislation (c) strategic planning
6 outline and evaluate strategies for limiting the impacts of tourists	including: (a) use of renewable energy and resources (b) limiting water use (c) banning single-use plastics (d) limiting motorised transport

6.3 Fisheries

Candidates should be able to:	Further guidance and exemplification:
1 outline the social and economic importance of marine organisms as a source of food and income	
2 describe different methods of fishing and evaluate their environmental impacts	including: (a) netting and trapping: • cast netting • trawling (pelagic, beam) • seine nets (purse seine) • tangle nets (gill nets, drift nets) • basket traps (b) angling: • line fishing (trolling, longlining) • rod fishing (pole and line, including bait fishing)
3 describe the uses of navigational aids	limited to: (a) chart (b) compass / compass rose (c) GPS (d) sonar (e) radar
4 state that the increase in human population means fisheries are in danger of being over-harvested and becoming unsustainable	
5 outline and evaluate strategies for the sustainable harvesting of marine species	limited to: (a) restricting boat size, net types and mesh size (b) quotas and licences (c) closed seasons (d) Marine Protected Areas (MPAs) (e) international agreements
6 explain that sustainable harvesting will contribute to fisheries being available for future generations and maintain fish stocks at levels that do not affect food chains	
7 explain the principle of fish aggregating devices (FADs) and discuss their ecological impacts	

6.4 Aquaculture

Candidates should be able to:	Further guidance and exemplification:
1 describe the social and economic importance of aquaculture	
2 explain that the pressure on fisheries can be reduced by aquaculture but that aquaculture can also impact marine ecosystems	
3 describe the range of species that can be produced through aquaculture and the contribution of aquaculture to global food production	limited to: (a) macroalgae (kelp) (b) fish (salmon, grouper) (c) crustaceans (shrimp) (d) molluscs (mussel, oyster) (e) echinoderms (sea cucumber)
4 state that fish can be produced in open (cages, nets) aquaculture systems and closed (tanks) systems	
5 outline methods of producing fish by aquaculture	including: • sourcing of initial broodstock • maintaining conditions required for the species (temperature, salinity, light, pH, oxygen) • food requirements vary by species (e.g. protein and lipid levels) • types of feed and their environmental impact (pelleted, other fresh fish or plant-based protein) • maintaining water quality by removal of waste products through adequate water flow rate and filtration of waste water, or moving cages • size sorting and regular feeding to prevent cannibalism • prevention of entry or spread of parasites, disease or predators by using low stocking densities, antibiotics, cleaner species • selection of fastest growing organisms as new broodstock
6 discuss the use of aquaculture of endangered species to restock areas where environmental damage has occurred	limited to: (a) mangrove forests (b) coral reefs

6.5 Energy from the oceans

Candidates should be able to:	Further guidance and exemplification:
1 state that oil can be found under the seabed	
2 describe oil as a non-renewable fossil fuel which is used in many ways	including: • combusted as a fuel, which releases carbon dioxide • made into plastics
3 state that oil is extracted and transported around the world, leading to a risk of oil spillage	
4 state that modern ships and oil tankers must be built in line with MARPOL (International Convention for the Prevention of Pollution from Ships) standards	including: • all oil tankers transporting oil should be fitted with double hulls to reduce the risk of oil leaks following a collision • tankers cannot wash out holds except at special collection sites at ports • sewage release must be controlled • garbage disposal must be controlled
5 describe the potential impacts of oil spills on marine ecosystems	limited to: • coating fur of mammals and feathers of birds • poisoning organisms that ingest the oil • disrupting food chains by affecting producers
6 discuss strategies for minimising the impacts of oil spills	limited to: • booms • skimmers • dispersant sprays • burning
7 discuss the environmental, economic and social advantages and disadvantages of using fossil fuels as an energy resource	limited to: • constant energy supply, unaffected by weather • energy dense (or high energy per gram of fuel) • relatively cheap • stable to transport and use • non-renewable • produce carbon dioxide and other damaging gases when combusted • environmental damage from extraction • becoming increasingly difficult to extract

6.5 Energy from the oceans continued

Candidates should be able to:	Further guidance and exemplification:
8 discuss the environmental, economic and social advantages and disadvantages of renewable energy obtained from the oceans through wind, wave and tidal applications	limited to: • renewables are an infinite energy source (a source that will not run out) • reduces production of carbon dioxide (reducing global warming) • reduces reliance on fossil fuels • high initial costs • limited locations available • underwater cables to carry energy to land • damage to seabed • weather damage to turbines • damage to marine life caught in turbines • maintenance costs • conflict with tourism if visible

6.6 Plastic pollution

Candidates should be able to:	Further guidance and exemplification:
1 explain that plastics are very slow to break down but can do so over very long time periods releasing toxins and tiny pieces of plastic called microplastics	
2 describe the potential impacts of plastics on marine ecosystems	limited to: • microplastics are taken up by plankton and enter food chains • large plastics are ingested by animals and can cause starvation • plastics can entangle animals and can cause death
3 explain how ocean gyres cause the formation of plastic garbage patches, of which the Great Pacific Garbage Patch is the largest	
4 describe and evaluate strategies for reducing the size of plastic garbage patches	
5 discuss strategies for limiting the impacts of plastics on marine ecosystems	including: (a) legislation – ban, charge for or tax single-use plastics (b) education (c) reduce, reuse, recycle plastic waste

6.7 Eutrophication

Candidates should be able to:	Further guidance and exemplification:
1 state that modern land farming techniques increase food production through the use of fertilisers to improve yields	
2 state that fertilisers may be water soluble and run off into the ocean	
3 describe the effect of fertilisers on the marine environment	
4 state that untreated sewage released into the oceans can lead to eutrophication	
5 explain the process of eutrophication of water	including: • increased availability of nutrients including nitrogen and phosphorus • increased growth of producers leading to algal bloom • increased decomposition after death of producers • increased aerobic respiration by decomposers • reduction in dissolved oxygen • death of organisms requiring dissolved oxygen

6.8 Understanding climate change

Candidates should be able to:	Further guidance and exemplification:
1 state that the climate of different regions on Earth has changed significantly between 335 million years ago and the present day, with reference to carbon dioxide level and temperature	
2 describe the effects of present-day pollution of the air by methane and carbon dioxide	including: (a) enhanced greenhouse effect (b) climate change
3 describe the effects of increasing atmospheric carbon dioxide concentrations on sea water	limited to: (a) increasing temperature (b) decreasing pH
4 explain the role of the ocean in absorbing heat and the effect on the ocean of heat absorption	limited to: (a) thermal expansion (b) maintaining stability of global temperature

6.8 Understanding climate change continued

Candidates should be able to:	Further guidance and exemplification:
5 compare the effects of thermal expansion of sea water and melting of land-based ice on sea level rise	
6 describe possible impacts of increasing greenhouse gases on marine ecosystems	including: (a) increase in sea level, loss of habitat and land (b) coral bleaching (c) decreased dissolved oxygen in the oceans (d) changing distribution and migration patterns (e) loss of species (f) increase in extreme weather

6.9 Conservation strategies

Candidates should be able to:	Further guidance and exemplification:
1 describe species richness as the number of different species that live in an area	
2 describe and evaluate strategies for conserving species richness	including: (a) sustainable harvesting of wild macroalgae, plant and animal species (b) aquaculture of commercial species and endangered species (c) national marine parks and Marine Protected Areas (MPAs)
3 describe and evaluate conservation projects	including: (a) coral farming for introduction to artificial or damaged reefs (b) protecting turtle nest sites and rearing turtles for release (c) culling invasive species such as lionfish

Faculty feedback: 'Understanding how and why our climate is changing and providing the knowledge and skills to explore the challenges plays a key role in every student's education.'

Feedback from: Dr Amy Munro-Faure, Head of Education and Student Engagement of Cambridge Zero

4 Details of the assessment

Paper 1 – Theory and Data Handling

Written paper, 1 hour 45 minutes, 80 marks

This paper contains compulsory short-answer and structured questions.

Paper 1 tests assessment objectives AO1 and AO2.

Externally assessed.

Paper 2 – Theory and Practical Skills

Written paper, 1 hour 45 minutes, 80 marks

This paper contains compulsory short-answer and structured questions.

Paper 2 tests assessment objectives AO1, AO2 and AO3.

Externally assessed.

Practical requirements for Paper 2

Assessment objective AO3 (Experimental skills and investigations) assesses candidates' understanding of practical skills in both familiar and unfamiliar contexts. It is tested in Paper 2 and accounts for 40 per cent of the marks for Paper 2 and 20 per cent of the marks for the overall qualification.

Practical work is an important part of the Marine Science syllabus and should be fully integrated into the course. The subject content section of this syllabus lists several practical activities (**PA**) that candidates should complete. These are, however, the minimum requirement for practical work. Schools are encouraged to provide as many opportunities as possible for candidates to participate in practical science. Opportunities for the practice of experimental skills should be provided throughout the course of study. The practical work that candidates do during their course should:

- provide learning opportunities enabling candidates to develop the skills they need to carry out experimental and investigative work
- reinforce the learning of the theoretical subject content of the syllabus
- instil an understanding of the interplay of experiment and theory in scientific method
- be enjoyable, contributing to the motivation of the candidates.

Candidates should be able to do the following:

- **demonstrate knowledge of experimental techniques, apparatus and materials and how to use them safely:**
  - identify apparatus from diagrams or descriptions
  - draw, complete or label diagrams of apparatus
  - 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 safety precautions
  - describe and explain techniques used to ensure the accuracy of observations and data
- **plan experiments and investigations:**
  - suggest a testable hypothesis based on scientific understanding
  - identify the independent variable and dependent variable
  - identify important variables that should be kept constant
  - describe how and explain why variables should be kept constant
  - 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, including a suitable control experiment
  - identify risks and suggest 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 with appropriate precision
  - take sufficient observations or measurements, including repeats and replicates 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
  - draw whole organisms, cells and tissues accurately
- **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
  - analyse and interpret observations and data, including data presented graphically
  - use interpolation and extrapolation graphically to determine a gradient or intercept
  - form conclusions based on observations and data and with appropriate explanation and justification
  - evaluate the quality of observations and data, identifying any anomalous results and taking appropriate action
- **evaluate methods and suggest possible improvements:**
  - evaluate experimental arrangements, methods and techniques, including the use of a control
  - identify sources of error
  - suggest possible improvements to apparatus, experimental arrangements, methods and techniques.

Apparatus, materials and reagents

Candidates should be familiar with using the items listed.

Hazard codes are used where relevant and in accordance with information provided by CLEAPSS (**www.cleapss.org.uk**). Candidates should be familiar with the meanings of these codes and terms but will not be assessed on them.

C corrosive
HH health hazard
F flammable
N hazardous to the aquatic environment
MH moderate hazard
T acutely toxic
O oxidising

The attention of centres is drawn to any local regulations relating to safety, first aid and disposal of chemicals. 'Hazard Data Sheets' should be available from your chemical supplier.

Candidates must be provided with appropriate safety equipment, such as suitable eye protection and gloves, during practical work.

Chemicals, reagents and indicators

The list below is not intended to be comprehensive but shows the types of chemicals, reagents and indicators that candidates should be familiar with.

- Benedict's solution
- biuret reagent
- carbohydrates (starch, glucose, sucrose), proteins, lipids
- dilute acid
- dilute alkali
- distilled or deionised water
- ethanol
- indicators (universal indicator solution)
- iodine in potassium iodide solution (iodine solution)
- limewater
- sodium chloride
- sodium hydrogencarbonate (sodium bicarbonate)

Apparatus

This list below is not intended to be comprehensive but shows typical laboratory apparatus that candidates should be familiar with.

- balance to measure with precision of at least 0.1 g
- beakers (various sizes, e.g. 100 cm^3, 250 cm^3)
- water-bath, or means of making water-bath
- bungs to fit small test-tubes and large test-tubes
- filter funnels
- filter paper
- forceps
- glass rods
- hand lenses (at least ×6 magnification)
- lamps for photosynthesis experiments
- means of cutting biological materials (e.g. scalpels or sharp knives)
- means of labelling glassware (e.g. wax pencils or water-resistant markers)
- measuring cylinders (e.g. 10 cm^3, 25 cm^3 and 100 cm^3)
- mounted needles or seekers or long pins with large heads
- rulers, graduated in mm
- scissors
- Pasteur or dropping pipettes
- Petri dishes
- spotting tiles
- stop-watch or timers, reading to 1 s or better
- syringes (various sizes, e.g. 1 cm^3, 5 cm^3, 10 cm^3)
- test-tubes – small (125 mm × 15 mm) and large (150 mm × 25 mm)
- test-tube racks and test-tube holders
- thermometers, –10 °C to +110 °C, with 1 °C graduations
- wash bottles
- white tiles or other suitable cutting surfaces such as wooden boards

Ecological and fieldwork equipment

If possible, candidates should conduct some form of fieldwork exercise. Even if candidates are unable to carry out fieldwork, they should be aware of the equipment that is used. All outdoor fieldwork investigations should be thoroughly risk assessed.

- apparatus for sampling, e.g. 'open' and 'grid' quadrats
- long tape measures to make transects
- apparatus for measuring abiotic factors, e.g. hydrometer, oxygen meter, pH meter, light meter
- plankton net and dip net
- trays for hand-sorting
- non-toxic paint and brushes
- Secchi discs
- safety equipment, e.g. lifejacket, whistles

Specimens

- mollusc shells, e.g. mussel, clam
- aquatic plants
- specimens from some of the key groups listed in topic 3 Marine organisms for observation and drawing practice. (If live specimens are used, these can either be returned live to their habitat or kept ethically in a suitable aquarium.)

Safety

Teachers should make sure they do not contravene any school, education authority or government regulation. Responsibility for safety matters rests with centres.

Particular care should be taken with ecology work on coastal area. Teachers should ensure that this work is thoroughly risk assessed.

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, 2022 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**

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 exam.

Number

- add, subtract, multiply and divide
- use decimals, fractions, ratios and reciprocals
- calculate and use percentages and percentage change
- use standard form
- express answers to an appropriate or given number of significant figures
- express answers to an appropriate or given number of decimal places
- round answers appropriately

Algebra

- recognise and use direct and inverse proportion
- solve simple algebraic equations for any one term when the other terms are known
- substitute physical quantities into a formula

Geometry and measurements

- convert between units, including cm^3 and dm^3, mg, g and kg, µm, mm, cm and m
- understand the meaning of angle, curve, circle, radius, diameter, circumference, square, rectangle and diagonal
- use equations for the area of a rectangle, the area of a triangle and the area of a circle
- use equations for the volume of a rectangular block and the volume of a cylinder
- make estimates of numbers, quantities and lengths
- understand scale and the use of a scale line
- select and use the most appropriate units for recording data and the results of calculations

Graphs, charts and statistics

- draw charts and graphs from data
- interpret line graphs, bar charts, pie charts and histograms with equal intervals
- interpolate and extrapolate from data
- determine the gradient and intercept of a graph, including units where appropriate
- select suitable scales and axes for graphs
- recognise direct and inverse proportionality from a graph
- calculate the mean and range of a set of values
- use simple probability
- give direction in terms of a 16-point compass, e.g. north, north-north-east, north-east
- recognise and use latitude and longitude on a map (degrees and minutes)

Presentation of data

Taking and 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 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 observation or physical quantity and the unit where appropriate, e.g. time/s.
- Units should not be included with data in the body of a table.
- Data should be recorded to the appropriate number of significant figures.

Graphs

- The column headings of a correctly headed table can be directly transferred to the axes of a constructed graph.
- A graph should be drawn with a sharp pencil.
- Each axis should be labelled with the observation or physical quantity and the unit where appropriate, e.g. time/s.
- Unless instructed otherwise, the independent variable should be plotted on the *x*-axis (horizontal axis) and the dependent variable plotted on the *y*-axis (vertical axis).
- 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. The axes do not have to include (0, 0).
- Points on the graph should be clearly marked as 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. The line does not need to coincide exactly with any of the points; where there is scatter evident in the data, examiners would expect a roughly even distribution of points either side of the line over its entire length. Points that are clearly anomalous should be ignored when drawing the best-fit line.
- A best-fit line or curve should only be drawn if there is good reason to believe that the intermediate values can be predicted.
- Candidates should be able to take readings from the graph by extrapolation or interpolation and indicate on the graph how they determined the reading.
- Data values should be read from a graph to an accuracy of one half of the smallest square on the grid.

Drawings

- Drawings should be drawn using a sharp pencil to give fine lines that are clear and unbroken.
- Drawings should use most of the available space with no shading or use of colour.
- Label lines should be drawn with a ruler and touch the object or feature labelled.

Charts

- Pie charts are generally used to show percentage or proportionality.
- Bar charts should be drawn for categorical or discrete data. They should be made up of bars of equal width that do **not** touch.
- Histograms should be drawn for continuous data. They should have bars that touch.

Further guidance can be found in the following publications:

ASE, The Language of Mathematics in Science: A Guide for Teachers of 11–16 Science (2016).

ASE, The Language of Mathematics in Science: Teaching Approaches (2016).

www.ase.org.uk/mathsinscience

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.

Variables

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 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.

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.

The units for salinity, parts per thousand, may be represented as ppt or as ‰.

In practical work, candidates will be expected to use SI units or, where appropriate, units approved for use with the SI (e.g. minute).

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
Compare	identify/comment on similarities and/or differences
Define	give precise meaning
Describe	state the points of a topic / give characteristics and main features
Determine	establish an answer using the information available
Discuss	write about issue(s) or topic(s) in depth in a structured way
Evaluate	judge or calculate the quality, importance, amount, or value of something
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
Outline	set out the main points
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 marine science curriculum such as the Cambridge Lower Secondary programme or equivalent national educational framework.

Guided learning hours

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

Availability and timetables

All Cambridge schools are allocated to one of six administrative zones. Each zone has a specific timetable. Find your administrative zone at **www.cambridgeinternational.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.

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:

- 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. 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 we recognise that our candidates have highly diverse socio-economic, cultural and linguistic backgrounds, and may also have a variety of protected characteristics. Protected characteristics include special educational needs and disability (SEND), religion and belief, and characteristics related to gender and identity.

We follow accessible design principles to make our syllabuses and assessment materials as accessible and inclusive as possible. We review language accessibility, visual resources, question layout and the contexts used in questions. Using this approach means that we give all candidates the fairest possible opportunity to demonstrate their knowledge, skills and understanding.

Access arrangements

Our design principles aim to make sure our assessment materials are accessible for all candidates. To further minimise barriers faced by candidates with SEND, illness or injury, we offer a range of access arrangements and modified papers. This is the principal way in which we comply with our duty to make 'reasonable adjustments', as guided by the UK Equality Act 2010.

Important:

Requested access arrangements should be based on evidence of the candidate's barrier to taking an assessment and should also reflect their normal way of working. This is explained in section 1.3 of the *Cambridge Handbook* **www.cambridgeinternational.org/eoguide**

- For Cambridge to approve an access arrangement, we need to agree that it constitutes a reasonable adjustment and does not affect the security or integrity of the assessment.
- Details of our standard access arrangements and modified question papers are available in section 1.3 of the *Cambridge Handbook* **www.cambridgeinternational.org/eoguide**
- Centres are expected to check the availability of access arrangements and modified question papers at the start of the course. All applications should be made by the deadlines published in section 1.3 of the *Cambridge Handbook* **www.cambridgeinternational.org/eoguide**
- Contact us at the start of the course to find out if we can approve an access 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, Cambridge IGCSE is shown as INTERNATIONAL GENERAL CERTIFICATE OF SECONDARY EDUCATION (IGCSE).

On certificates, Cambridge IGCSE is shown as International General Certificate of Secondary Education.

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 or likely to be successful in a particular course or career.

The outcomes help students choose the most suitable course or career.

Changes to this syllabus for 2027, 2028 and 2029

The syllabus has been updated. This is version 1, published September 2024.

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 2024 are still suitable for use with this syllabus.

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

With a Customer Services team available 24 hours a day, 6 days a week, and dedicated regional teams supporting schools in 160 countries, we understand your local context and are here to guide you so you can provide your learners with everything they need to prepare for Cambridge IGCSE.

Quality management

We are 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/**

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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