Pearson Edexcel

International GCSE

Science (Single Award) (9–1)

Specification

Pearson Edexcel International GCSE in Science (Single Award) (4SS0)

First teaching September 2017

First examination June 2019

Issue 4

About Pearson

We are the world's leading learning company operating in countries all around the world. We provide content, assessment and digital services to learners, educational institutions, employers, governments and other partners globally. We are committed to helping equip learners with the skills they need to enhance their employability prospects and to succeed in the changing world of work. We believe that wherever learning flourishes so do people.

References to third party materials made in this specification are made in good faith. Pearson does not endorse, approve or accept responsibility for the content of materials, which may be subject to change, or any opinions expressed therein. (Materials may include textbooks, journals, magazines and other publications and websites.)

All information in this specification is correct at time of publication.

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Summary of Pearson Edexcel International GCSE in Science (Single Award) (4SS0) specification

Issue 3 changes

Summary of changes made between previous issue and this current issue	Page number
Appendix 5: Command word taxonomy "Which" added to the command word taxonomy	68

If you need further information on these changes or what they mean, contact us via our website at: qualifications.pearson.com/en/support/contact-us.html.

Contents

1 About this specification

The Pearson Edexcel International GCSE in Science (Single Award) is part of a suite of International GCSE qualifications offered by Pearson.

This qualification is not accredited or regulated by any UK regulatory body.

This specification includes the following key features.

Structure: the Pearson Edexcel International GCSE in Science (Single Award) is a linear qualification. Three written examinations must be taken in the same series at the end of the course of study.

Content: relevant, engaging, up to date and of equivalent standard to Pearson Edexcel's International GCSE in Science (Double Award).

Assessment: untiered, written examinations with questions designed to be accessible to students of all abilities.

Approach: a solid basis for students wishing to progress to vocational education or work.

Specification updates

This specification is Issue 3 and is valid for the Pearson Edexcel International GCSE in Science (Single Award) examined from 2019. If there are any significant changes to the specification Pearson will inform centres. Changes will also be posted on our website.

For more information, please visit qualifications.pearson.com

Using this specification

This specification has been designed to give guidance to teachers and encourage effective delivery of the qualification. The following information will help you get the most out of the content and guidance.

Content: this is arranged as separate biology, chemistry and physics topics in *2: Science content*. A summary of sub-topics is included at the start of each topic. As a minimum, all the bullet points in the content must be taught. The word 'including' in the content helps specify the detail of what must be covered.

Examples: throughout the content, we have included examples of what could be covered or what might support teaching and learning. It is important to note that examples are for illustrative purposes only and that centres can use other examples. We have included examples that are easily understood and recognised by international centres.

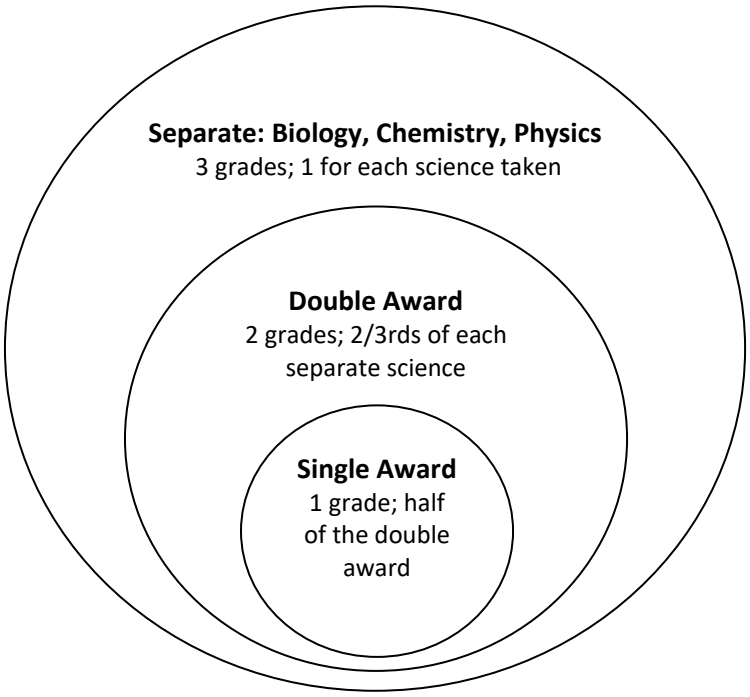
Practical investigations: these are included in *2: Science content* as specification points in italics. Students will develop knowledge and understanding of experimental skills through the context of the science they are learning. Experimental skills are assessed through written examinations.

Referencing: notation at the end of each sub-topic in the biology, chemistry and physics topics show statements that are in the Pearson Edexcel International GCSE in Biology, Pearson Edexcel International GCSE in Chemistry, Pearson Edexcel International GCSE in Physics and Pearson Edexcel International GCSE in Science (Double Award) specifications.

Course introduction

The Pearson Edexcel International GCSE in Science (Single Award) is designed for use in schools and colleges. It is part of a suite of International GCSE qualifications offered by Pearson.

The course gives students the opportunity to experience science within the context of their general education.



The Pearson Edexcel International GCSE in Science (Double Award) qualification is also available. The Pearson Edexcel International GCSE in Science (Single Award) covers half of the specification content of the International GCSE in Science (Double Award), while still having a comparable level of rigour and demand.

Qualification aims and objectives

The aims and objectives of this qualification are to enable students to:

- learn about unifying patterns and themes in science and use them in new and changing situations
- acquire knowledge and understanding of scientific facts, terminology, concepts, principles and practical techniques
- apply the principles and concepts of science, including those related to the applications of science, to different contexts
- evaluate scientific information, making judgements on the basis of this information
- appreciate the practical nature of science, developing experimental and investigative skills based on correct and safe laboratory techniques
- analyse, interpret and evaluate data and experimental methods, drawing conclusions that are consistent with evidence from experimental activities
- recognise the importance of accurate experimental work and reporting as scientific methods in science
- select, organise and present relevant information clearly and logically using appropriate vocabulary, definitions and conventions
- develop a logical approach to problem solving in a wider context
- select and apply appropriate areas of mathematics relevant to science as set out under each topic.

Why choose Edexcel qualifications?

Pearson – the world's largest education company

Edexcel academic qualifications are from Pearson, the UK's largest awarding organisation. With over 3.4 million students studying our academic and vocational qualifications worldwide, we offer internationally recognised qualifications to schools, colleges and employers globally.

Pearson is recognised as the world's largest education company, allowing us to drive innovation and provide comprehensive support for Edexcel students to acquire the knowledge and skills they need for progression in study, work and life.

A heritage you can trust

The background to Pearson becoming the UK's largest awarding organisation began in 1836, when a royal charter gave the University of London its first powers to conduct exams and confer degrees on its students. With over 150 years of international education experience, Edexcel qualifications have firm academic foundations, built on the traditions and rigour associated with Britain's education system.

Results you can trust

Pearson's leading online marking technology has been shown to produce exceptionally reliable results, demonstrating that, at every stage, Edexcel qualifications maintain the highest standards.

Developed to Pearson's world class qualifications standards

Pearson's world-class standards mean that all Edexcel qualifications are developed to be rigorous, demanding, inclusive and empowering. We work collaboratively with a panel of educational thought leaders and assessment experts to ensure that Edexcel qualifications are globally relevant, represent world-class best practice and maintain a consistent standard.

For more information on the world class qualification process and principles, please go to *Appendix 2: Pearson World Class Qualification design principles* or visit our website: uk.pearson.com/about-us/news-and-policy/reports-and-campaigns/world-class-qualifications/design-principles.html

Why choose Pearson Edexcel International GCSE in Science (Single Award)?

We have listened to feedback from all parts of the international and UK school subject community, including a large number of teachers. We have made changes that will engage students and give them skills that will support progression to further study or employment. Our content and assessment approach has been designed to meet students' needs and be consistent with our approach across the sciences.

At Pearson, we offer separate science qualifications in Biology, Human Biology, Chemistry and Physics, as well as Double Award and Single Award Science qualifications – these have been designed to meet different students' needs. The content and assessment approach in all our science qualifications has been designed to meet students' needs in the following ways:

- Content that is interesting and engaging for students but also provides a solid foundation for those continuing on with further study or employment.
- There are opportunities to 'localise' the content to make it more relevant for students in their own country.
- Question papers are clear and straightforward – our question papers are clear and accessible for all students of all ability ranges and learning styles. Our mark schemes are straightforward, so that the assessment requirements are clear.
- Students' skills are broadly developed – we have designed the International GCSE to extend students' knowledge by broadening and deepening skills, for example:
  - developing students' practical skills by including a number of practicals in the specification content. These can be supplemented with other suggested practicals. The skills developed will be assessed through questions in written examinations
  - improving students' analytical and logic skills by applying understanding of scientific concepts and principles to a range of situations. This will include some examination questions that are more problem solving in style
  - addressing the need for mathematical skills to complement students' science skills by covering a range of mathematical areas.

Progression – the Pearson Edexcel International GCSE in Science (Single Award) qualification is not expected to lead directly to further study in Level 3 science qualifications such as the International Advanced Levels. It provides a solid understanding and appreciation of science that supports further Level 1/2 study or employment opportunities.

Courses to suit your students' needs and interests – teachers of science have a choice of International GCSE courses to deliver, each giving different levels of depth to meet students' needs. Students can be taught our Pearson Edexcel International GCSE in Biology, International GCSE in Human Biology, International GCSE in Chemistry, International GCSE in Physics or our International GCSE in Science (Double Award). The double award offers greater content compared to the single award, but is assessed to the same standard. Progression routes for these courses may vary slightly from those for the Pearson Edexcel International GCSE in Science (Single Award).

More information about all our qualifications can be found on our Edexcel International GCSE pages at qualifications.pearson.com

Supporting you in planning and implementing this qualification

Teaching and learning

- Our *Getting Started Guide* gives you an overview of the Pearson Edexcel International GCSE in Science (Single Award) to help you understand the content and assessment.
- We will give you a course planner and editable schemes of work.

Preparing for exams

We will also give you a range of resources to help you prepare your students for the assessments, including specimen papers to support formative assessments and mock exams.

ResultsPlus

ResultsPlus provides the most detailed analysis available of your students' exam performance. It can help you to identify the topics and skills where further learning would benefit your students.

examWizard

This is a free online data bank of past exam questions designed to support students and teachers with exam preparation and assessment.

Training events

In addition to online training, we host a series of training events each year (both online and face-to-face) that give teachers a deeper understanding of our qualifications.

Get help and support

Our subject advisor service ensures that you receive help and guidance from us. You can sign up to receive the Edexcel newsletter to keep up to date with our qualifications and receive product and service news.

Qualification at a glance

The Pearson Edexcel International GCSE in Science (Single Award) comprises three externally-assessed papers:

- Paper 1
- Paper 2
- Paper 3.

Paper overview

Paper 1	*Paper code 4SS0/1B
• Externally assessed • Availability: June • First assessment: June 2019	33.3% of the total International GCSE
Content summary Topics covering core biology content areas: 1 The nature and variety of living organisms 2 Structures and functions in living organisms 3 Reproduction and inheritance 4 Ecology and the environment 5 Use of biological resources	
Assessment • The paper is assessed through a 1-hour and 10-minute written examination paper set and marked by Pearson. • The total number of marks is 60. • A mixture of different question styles, including multiple-choice questions, short-answer questions, calculations and extended open-response questions. • A calculator may be used in the examinations.	

Paper 2	*Paper code 4SS0/1C
• Externally assessed • Availability: June • First assessment: June 2019	33.3% of the total International GCSE

Content summary

Topics covering core chemistry content areas:

1 Principles of chemistry

2 Inorganic chemistry

3 Physical chemistry

4 Organic chemistry

Assessment

- The paper is assessed through a 1-hour and 10-minute written examination paper set and marked by Pearson.
- The total number of marks is 60.
- A mixture of different question styles, including multiple-choice questions, short-answer questions, calculations and extended open-response questions.
- A calculator may be used in the examinations.

Paper 3	*Paper code 4SS0/1P
• Externally assessed • Availability: June • First assessment: June 2019	33.3% of the total International GCSE

Content summary

Topics covering core physics content areas:

1 Forces and motion

2 Electricity

3 Waves

4 Energy resources and energy transfers

5 Solids, liquids and gases

6 Magnetism and electromagnetism

7 Radioactivity and particles

8 Astrophysics

Assessment

- The paper is assessed through a 1-hour and 10-minute written examination paper set and marked by Pearson.
- The total number of marks is 60.
- A mixture of different question styles, including multiple-choice questions, short-answer questions, calculations and extended open-response questions.
- A calculator may be used in the examinations.

* See *Appendix 1* for a description of this code and all the other codes relevant to this qualification.

2 Science content

Biology content

1 The nature and variety of living organisms

The following sub-topics are covered in this section.

(a) Characteristics of living organisms

(b) Variety of living organisms

(a) Characteristics of living organisms
Students should:
1.1 understand how living organisms share the following characteristics: • they require nutrition • they respire • they excrete their waste • they respond to their surroundings • they move • they control their internal conditions • they reproduce • they grow and develop.

(b) Variety of living organisms
Students should:
1.2 describe the common features shown by eukaryotic organisms: plants, animals, fungi and protoctists Plants: these are multicellular organisms; their cells contain chloroplasts and are able to carry out photosynthesis; their cells have cellulose cell walls; they store carbohydrates as starch or sucrose. Examples include flowering plants, such as a cereal (for example, maize), and a herbaceous legume (for example, peas or beans). Animals: these are multicellular organisms; their cells do not contain chloroplasts and are not able to carry out photosynthesis; they have no cell walls; they usually have nervous co-ordination and are able to move from one place to another; they often store carbohydrate as glycogen. Examples include mammals (for example, humans) and insects (for example, housefly and mosquito). Fungi: these are organisms that are not able to carry out photosynthesis; their body is usually organised into a mycelium made from thread-like structures called hyphae, which contain many nuclei; some examples are single-celled; their cells have walls made of chitin; they feed by extracellular secretion of digestive enzymes onto food material and absorption of the organic products; this is known as saprotrophic nutrition; they may store carbohydrate as glycogen. Examples include *Mucor*, which has the typical fungal hyphal structure, and yeast, which is single-celled. Protoctists: these are microscopic single-celled organisms. Some, like *Amoeba*, that live in pond water, have features like an animal cell, while others, like *Chlorella*, have chloroplasts and are more like plants. A pathogenic example is *Plasmodium*, responsible for causing malaria.

Students should:	
1.3	describe the common features shown by prokaryotic organisms such as bacteria Bacteria: these are microscopic single-celled organisms; they have a cell wall, cell membrane, cytoplasm and plasmids; they lack a nucleus but contain a circular chromosome of DNA; some bacteria can carry out photosynthesis but most feed off other living or dead organisms. Examples include *Lactobacillus bulgaricus*, a rod-shaped bacterium used in the production of yoghurt from milk, and *Pneumococcus*, a spherical bacterium that acts as the pathogen causing pneumonia.
1.4	understand the term pathogen and know that pathogens may include fungi, bacteria, protoctists or viruses. Viruses: these are not living organisms. They are small particles, smaller than bacteria; they are parasitic and can reproduce only inside living cells; they infect every type of living organism. They have a wide variety of shapes and sizes; they have no cellular structure but have a protein coat and contain one type of nucleic acid, either DNA or RNA. Examples include the tobacco mosaic virus that causes discolouring of the leaves of tobacco plants by preventing the formation of chloroplasts, the influenza virus that causes 'flu' and the HIV virus that causes AIDS.

2 Structure and functions in living organisms

The following sub-topics are covered in this section.

(a) Level of organisation

(b) Cell structure

(c) Biological molecules

(d) Movement of substances into and out of cells

(e) Nutrition

(f) Respiration

(g) Gas exchange

(h) Transport

(a)	**Level of organisation**
Students should:	
2.1	describe the levels of organisation in organisms: organelles, cells, tissues, organs and systems

(b)	**Cell structure**
Students should:	
2.2	describe cell structures, including the nucleus, cytoplasm, cell membrane, cell wall, mitochondria, chloroplasts and vacuole
2.3	describe the functions of the nucleus, cytoplasm, cell membrane, cell wall, mitochondria, chloroplasts and vacuole
2.4	know the similarities and differences in the structure of plant and animal cells

Specification points 2.5 and 2.6 are in the Pearson Edexcel International GCSE in Biology only.

There is a small change to specification points 2.2 and 2.3 from the Pearson Edexcel International GCSE in Science (Double Award).

(c)	Biological molecules
Students should:	
2.7	identify the chemical elements present in carbohydrates, proteins and lipids (fats and oils)
2.8	describe the structure of carbohydrates, proteins and lipids as large molecules made up from smaller basic units: starch and glycogen from simple sugars, protein from amino acids, and lipid from fatty acids and glycerol
2.9	*practical: investigate food samples for the presence of glucose, starch, protein and fat*
2.10	understand the role of enzymes as biological catalysts in metabolic reactions
2.11	understand how temperature changes can affect enzyme function, including changes to the shape of active site
2.12	*practical: investigate how enzyme activity can be affected by changes in temperature*
2.13	understand how enzyme function can be affected by changes in pH altering the active site

(d)	Movement of substances into and out of cells
Students should:	
2.15	understand the processes of diffusion, osmosis and active transport by which substances move into and out of cells
2.16	understand how factors affect the rate of movement of substances into and out of cells, including the effects of surface area to volume ratio, distance, temperature and concentration gradient

Specification point 2.14 is in the Pearson Edexcel International GCSE in Biology only.

Specification point 2.17 is in the Pearson Edexcel International GCSE in Biology and Pearson Edexcel International GCSE in Science (Double Award).

(e)	Nutrition
Students should:	
Flowering plants	
2.18	understand the process of photosynthesis and its importance in the conversion of light energy to chemical energy
2.19	know the word equation and the balanced chemical symbol equation for photosynthesis
2.20	understand how varying carbon dioxide concentration, light intensity and temperature affect the rate of photosynthesis
2.21	describe the structure of the leaf and explain how it is adapted for photosynthesis
2.23	*practical: investigate photosynthesis, showing the evolution of oxygen from a water plant, the production of starch and the requirements of light, carbon dioxide and chlorophyll*
Humans	
2.27	describe the structure and function of the human alimentary canal, including the mouth, oesophagus, stomach, small intestine (duodenum and ileum), large intestine (colon and rectum) and pancreas
2.29	understand the role of digestive enzymes, including the digestion of starch to glucose by amylase and maltase, the digestion of proteins to amino acids by proteases and the digestion of lipids to fatty acids and glycerol by lipases

(f)	Respiration
Students should:	
2.34	understand how the process of respiration produces ATP in living organisms
2.35	know that ATP provides energy for cells
2.36	describe the differences between aerobic and anaerobic respiration
2.37	know the word equation and the balanced chemical symbol equation for aerobic respiration in living organisms
2.38	know the word equation for anaerobic respiration in plants and in animals

Specification point 2.33 is in the Pearson Edexcel International GCSE in Biology only.

Specification points 2.22, 2.24, 2.25, 2.26, 2.28, 2.30, 2.31, 2.32 and 2.39 are in the Pearson Edexcel International GCSE in Biology and Pearson Edexcel International GCSE in Science (Double Award).

(g)	Gas exchange
Students should:	
Humans	
2.46	describe the structure of the thorax, including the ribs, intercostal muscles, diaphragm, trachea, bronchi, bronchioles, alveoli and pleural membranes
2.47	understand the role of the intercostal muscles and the diaphragm in ventilation
2.48	explain how alveoli are adapted for gas exchange by diffusion between air in the lungs and blood in capillaries

(h)	Transport
Students should:	
2.51	understand why simple, unicellular organisms can rely on diffusion for movement of substances in and out of the cell
2.52	understand the need for a transport system in multicellular organisms
Humans	
2.59	describe the composition of the blood: red blood cells, white blood cells, platelets and plasma
2.60	understand the role of plasma in the transport of carbon dioxide, digested food, urea, hormones and heat energy
2.61	understand how adaptations of red blood cells make them suitable for the transport of oxygen, including shape, the absence of a nucleus and the presence of haemoglobin
2.62	understand how the immune system responds to disease using white blood cells, illustrated by phagocytes ingesting pathogens and lymphocytes releasing antibodies specific to the pathogen
2.65	describe the structure of the heart and how it functions
2.68	understand how the structure of arteries, veins and capillaries relates to their function
2.69	understand the general structure of the circulation system, including the blood vessels to and from the heart and the lungs

Specification points 2.40, 2.41, 2.42, 2.43, 2.44, 2.45, 2.55, 2.56, 2.57, 2.58, 2.63, 2.64, 2.72, 2.73, 2.74, 2.75, 2.76, 2.77, 2.78, 2.79 and 2.95 are in the Pearson Edexcel International GCSE in Biology only.

Specification points 2.49, 2.50, 2.53, 2.54, 2.66, 2.67, part of 2.69, 2.70, 2.71, 2.80, 2.81, 2.82, 2.83, 2.84, 2.85, 2.86, 2.87, 2.88, 2.89, 2.90, 2.91, 2.92, 2.93 and 2.94 are in the Pearson Edexcel International GCSE in Biology and Pearson Edexcel International GCSE in Science (Double Award).

3 Reproduction and inheritance

The following sub-topics are covered in this section.

(a) Reproduction

(b) Inheritance

(a)	**Reproduction**
Students should:	
3.1	understand the differences between sexual and asexual reproduction
3.2	understand that fertilisation involves the fusion of a male and female gamete to produce a zygote that undergoes cell division and develops into an embryo
Flowering plants	
3.3	describe the structures of an insect-pollinated and a wind-pollinated flower and explain how each is adapted for pollination
3.4	understand that the growth of the pollen tube followed by fertilisation leads to seed formation
Humans	
3.8	understand how the structure of the male and female reproductive systems are adapted for their functions
3.13	understand the roles of oestrogen and testosterone in the development of secondary sexual characteristics

(b)	**Inheritance**
Students should:	
3.15	understand that the nucleus of a cell contains chromosomes on which genes are located
3.19	understand how genes exist in alternative forms called alleles which give rise to differences in inherited characteristics
3.20	understand the meaning of the terms: dominant, recessive, homozygous, heterozygous, phenotype, and genotype
3.23	describe patterns of monohybrid inheritance using a genetic diagram
3.25	predict probabilities of outcomes from monohybrid crosses
3.26	understand how the sex of a person is controlled by one pair of chromosomes, XX in a female and XY in a male
3.27	describe the determination of the sex of offspring at fertilisation, using a genetic diagram
3.31	understand how random fertilisation produces genetic variation of offspring
3.33	understand that variation within a species can be genetic, environmental, or a combination of both
3.38	explain Darwin's theory of evolution by natural selection

Specification points 3.10, 3.16, 3.17, 3.18, 3.21, 3.35, 3.36 and 3.37 are in the Pearson Edexcel International GCSE in Biology only.

Specification points 3.5, 3.6, 3.7, 3.9, 3.11, 3.12, 3.14, 3.22, 3.24, 3.28, 3.29, 3.30, 3.32, 3.34 and 3.39 are in the Pearson Edexcel International GCSE in Biology and Pearson Edexcel International GCSE in Science (Double Award).

There is a small change to specification point 3.4 from the Pearson Edexcel International GCSE in Science (Double Award).

4 Ecology and the environment

The following sub-topics are covered in this section.

(a) The organism in the environment

(b) Feeding relationships

(c) Cycles within ecosystems

	(a) The organism in the environment
Students should:	
4.1	understand the terms population, community, habitat and ecosystem
4.2	*practical: investigate the population size of an organism in two different areas using quadrats*
4.5	understand how abiotic and biotic factors affect the population size and distribution of organisms

	(b) Feeding relationships
Students should:	
4.6	understand the names given to different trophic levels, including producers, primary, secondary and tertiary consumers, and decomposers
4.7	understand the concepts of food chains, food webs, pyramids of number, pyramids of biomass and pyramids of energy transfer
4.8	understand the transfer of substances and energy along a food chain
4.9	understand why only about 10% of energy is transferred from one trophic level to the next

	(c) Cycles within ecosystems
Students should:	
4.10	describe the stages in the carbon cycle, including respiration, photosynthesis, decomposition and combustion

Specification points 4.3, 4.4, 4.11 and 4.18 are in the Pearson Edexcel International GCSE in Biology only.

Specification points 4.12, 4.13, 4.14, 4.15, 4.16 and 4.17 are in the Pearson Edexcel International GCSE in Biology and Pearson Edexcel International GCSE in Science (Double Award).

5 Use of biological resources

The following sub-topics are covered in this section.

(a) Food production

(b) Genetic modification (genetic engineering)

(a)	**Food production**
Students should:	
Crop plants	
5.1	describe how glasshouses and polythene tunnels can be used to increase the yield of certain crops
5.2	understand the effects on crop yield of increased carbon dioxide and increased temperature in glasshouses
Micro-organisms	
5.5	understand the role of yeast in the production of food including bread
5.6	*practical: investigate the role of anaerobic respiration by yeast in different conditions*

(b)	**Genetic modification (genetic engineering)**
Students should:	
5.12	understand how restriction enzymes are used to cut DNA at specific sites and ligase enzymes are used to join pieces of DNA together
5.13	understand how plasmids and viruses can act as vectors, which take up pieces of DNA, and then insert this recombinant DNA into other cells
5.14	understand how large amounts of human insulin can be manufactured from genetically modified bacteria
5.15	understand how genetically modified plants can be used to improve food production
5.16	understand that the term transgenic means the transfer of genetic material from one species to a different species

Specification points 5.9, 5.17, 5.18, 5.19 and 5.20 are in the Pearson Edexcel International GCSE in Biology only.

Specification points 5.3, 5.4, 5.7, 5.8, 5.10 and 5.11 are in the Pearson Edexcel International GCSE in Biology and Pearson Edexcel International GCSE in Science (Double Award).

There is a small change to specification point 5.14 from the Pearson Edexcel International GCSE in Science (Double Award).

Chemistry content

1 Principles of chemistry

The following sub-topics are covered in this section.

(a) States of matter

(b) Elements, compounds and mixtures

(c) Atomic structure

(d) The Periodic Table

(e) Chemical formulae and equations

(f) Ionic bonding

(g) Covalent bonding

(a)	**States of matter**
Students should:	
1.1	understand the three states of matter in terms of the arrangement, movement and energy of the particles
1.2	understand the interconversions between the three states of matter in terms of: • the names of the interconversions • how they are achieved • the changes in arrangement, movement and energy of the particles.
1.3	understand how the results of experiments involving the dilution of coloured solutions and diffusion of gases can be explained

Specification points 1.5, 1.6 and 1.7 are in the Pearson Edexcel International GCSE in Chemistry only.

Specification point 1.4 is in the Pearson Edexcel International GCSE in Chemistry and Pearson Edexcel International GCSE in Science (Double Award).

(b)	Elements, compounds and mixtures
Students should:	
1.8	understand how to classify a substance as an element, compound or mixture
1.9	understand that a pure substance has a fixed melting and boiling point, but that a mixture may melt or boil over a range of temperatures
1.10	describe these experimental techniques for the separation of mixtures: • simple distillation • fractional distillation • filtration • crystallisation • paper chromatography.
1.11	understand how a chromatogram provides information about the composition of a mixture
1.12	understand how to use the calculation of R_f values to identify the components of a mixture
1.13	*practical: investigate paper chromatography using inks/food colourings*

(c)	Atomic structure
Students should:	
1.14	know what is meant by the terms atom and molecule
1.15	know the structure of an atom in terms of the positions, relative masses and relative charges of sub-atomic particles
1.16	know what is meant by the terms atomic number, mass number, isotopes and relative atomic mass (A_r)
1.17	be able to calculate the relative atomic mass of an element (A_r) from isotopic abundances

(d)	The Periodic Table
Students should:	
1.18	understand how elements are arranged in the Periodic Table: • in order of atomic number • in groups and periods.
1.21	identify an element as a metal or a non-metal according to its position in the Periodic Table

Specification points 1.19, 1.20, 1.22, 1.23 and 1.24 are in the Pearson Edexcel International GCSE in Chemistry and Pearson Edexcel International GCSE in Science (Double Award).

(e)	Chemical formulae and equations
Students should:	
1.25	write word equations and balanced chemical equations (including state symbols): • for reactions studied in this specification • for unfamiliar reactions where suitable information is provided.
1.26	calculate relative formula masses (including relative molecular masses) (M_r) from relative atomic masses (A_r)

(f)	Ionic bonding
Students should:	
1.37	understand how ions are formed by electron loss or gain
1.38	know the charges of these ions: • metals in Groups 1, 2 and 3 • non-metals in Groups 5, 6 and 7 • hydrogen (H^+), hydroxide (OH^-), ammonium (NH_4^+), carbonate (CO_3^{2-}), nitrate (NO_3^-), sulfate (SO_4^{2-}).
1.39	write formulae for compounds formed between the ions listed above
1.41	understand ionic bonding in terms of electrostatic attractions
1.42	understand why compounds with giant ionic lattices have high melting and boiling points

(g)	Covalent bonding
Students should:	
1.44	know that a covalent bond is formed between atoms by the sharing of a pair of electrons
1.47	explain why substances with a simple molecular structure are gases or liquids, or solids with low melting and boiling points *the term intermolecular forces of attraction can be used to represent all forces between molecules*
1.49	explain why substances with giant covalent structures are solids with high melting and boiling points

Specification points 1.34, 1.35, 1.52, 1.53, 1.54, 1.55, 1.56, 1.57, 1.58, 1.59 and 1.60 are in the Pearson Edexcel International GCSE in Chemistry only.

Specification points 1.27, 1.28, 1.29, 1.30, 1.31, 1.32, 1.33, 1.36, 1.40, 1.43, 1.45, 1.46, 1.48, 1.50 and 1.51 are in the Pearson Edexcel International GCSE in Chemistry and Pearson Edexcel International GCSE in Science (Double Award).

There is a small change to specification point 1.38 from the Pearson Edexcel International GCSE in Science (Double Award).

2 Inorganic chemistry

The following sub-topics are covered in this section.

(a) Group 1 (alkali metals) – lithium, sodium and potassium

(b) Group 7 (halogens) – chlorine, bromine and iodine

(c) Gases in the atmosphere

(d) Reactivity series

(e) Acids and alkalis

(f) Chemical tests

(a)	**Group 1 (alkali metals) – lithium, sodium and potassium**
Students should:	
2.1	understand how the similarities in the reactions of these elements with water provide evidence for their recognition as a family of elements
2.2	understand how the differences between the reactions of these elements with air and water provide evidence for the trend in reactivity in Group 1
2.3	use knowledge of trends in Group 1 to predict the properties of other alkali metals

(b)	**Group 7 (halogens) – chlorine, bromine and iodine**
Students should:	
2.5	know the colours, physical states (at room temperature) and trends in physical properties of these elements
2.6	use knowledge of trends in Group 7 to predict the properties of other halogens

(c)	**Gases in the atmosphere**
Students should:	
2.9	know the approximate percentages by volume of the four most abundant gases in dry air
2.10	understand how to determine the percentage by volume of oxygen in air using experiments involving the reactions of metals (e.g. iron) and non-metals (e.g. phosphorus) with air
2.11	describe the combustion of elements in oxygen, including magnesium, hydrogen and sulfur
2.13	know that carbon dioxide is a greenhouse gas and that increasing amounts in the atmosphere may contribute to climate change
2.14	*practical: determine the approximate percentage by volume of oxygen in air using a metal or a non-metal*

Specification points 2.4 and 2.8 are in the Pearson Edexcel International GCSE in Chemistry only.

Specification points 2.7 and 2.12 are in the Pearson Edexcel International GCSE in Chemistry and Pearson Edexcel International GCSE in Science (Double Award).

(d)	Reactivity series
Students should:	
2.15	understand how metals can be arranged in a reactivity series based on their reactions with: • water • dilute hydrochloric or sulfuric acid.
2.17	know the order of reactivity of these metals: potassium, sodium, lithium, calcium, magnesium, aluminium, zinc, iron, copper, silver, gold
2.18	know the conditions under which iron rusts
2.19	understand how the rusting of iron may be prevented by: • barrier methods • galvanising.

(e)	Acids and alkalis
Students should:	
2.28	describe the use of litmus to distinguish between acidic and alkaline solutions
2.29	understand how the pH scale, from 0–14, can be used to classify solutions as strongly acidic (0–3), weakly acidic (4–6), neutral (7), weakly alkaline (8–10) and strongly alkaline (11–14)
2.30	describe the use of universal indicator to measure the approximate pH value of an aqueous solution
2.31	know that acids in aqueous solution are a source of hydrogen ions and alkalis in a aqueous solution are a source of hydroxide ions
2.32	know that alkalis can neutralise acids

Specification points 2.22, 2.23, 2.24, 2.25, 2.26, 2.27, 2.33, 2.40, 2.41 and 2.43 are in the Pearson Edexcel International GCSE in Chemistry only.

Specification points 2.16, 2.20, 2.21, 2.34, 2.35, 2.36, 2.37, 2.38, 2.39 and 2.42 are in the Pearson Edexcel International GCSE in Chemistry and Pearson Edexcel International GCSE in Science (Double Award).

There is a small change to specification points 2.19 and 2.28 from the Pearson Edexcel International GCSE in Science (Double Award).

(f)	Chemical tests
Students should:	
2.44	describe tests for these gases: • hydrogen • oxygen • carbon dioxide • ammonia • chlorine.
2.45	describe how to carry out a flame test
2.46	know the colours formed in flame tests for these cations: • Li^+ is red • Na^+ is yellow • K^+ is lilac • Ca^{2+} is orange-red • Cu^{2+} is blue-green.
2.48	describe a test for CO_3^{2-} using hydrochloric acid and identifying the gas evolved
2.49	describe a test for the presence of water using anhydrous copper(II) sulfate

Specification points 2.47 and 2.50 are in the Pearson Edexcel International GCSE in Chemistry and Pearson Edexcel International GCSE in Science (Double Award).

There is a small change to specification point 2.48 from the Pearson Edexcel International GCSE in Science (Double Award).

3 Physical chemistry

The following sub-topics are covered in this section.

(a) Energetics

(b) Rates of reaction

(a)	**Energetics**
Students should:	
3.1	know that chemical reactions in which heat energy is given out are described as exothermic, and those in which heat energy is taken in are described as endothermic
3.2	describe simple calorimetry experiments for reactions such as combustion, displacement, dissolving and neutralisation
3.3	calculate the heat energy change from a measured temperature change using the expression $Q = mc\Delta T$
3.8	*practical: investigate temperature changes accompanying some of the following types of change:* • *salts dissolving in water* • *neutralisation reactions* • *displacement reactions* • *combustion reactions.*

(b)	**Rates of reaction**
Students should:	
3.9	describe experiments to investigate the effects of changes in surface area of a solid, concentration of a solution, temperature and the use of a catalyst on the rate of a reaction
3.10	describe the effects of changes in surface area of a solid, concentration of a solution, pressure of a gas, temperature and the use of a catalyst on the rate of a reaction
3.12	know that a catalyst is a substance that increases the rate of a reaction but is chemically unchanged at the end of the reaction
3.15	*practical: investigate the effect of changing the surface area of marble chips and of changing the concentration of hydrochloric acid on the rate of reaction between marble chips and dilute hydrochloric acid*

Specification points 3.5, 3.6, 3.7, 3.14, 3.19, 3.20, 3.21 and 3.22 are in the Pearson Edexcel International GCSE in Chemistry only.

Specification points 3.4, 3.11, 3.13, 3.16, 3.17 and 3.18 are in the Pearson Edexcel International GCSE in Chemistry and Pearson Edexcel International GCSE in Science (Double Award).

4 Organic chemistry

The following sub-topics are covered in this section.

(a) Introduction

(b) Crude oil

(c) Alkanes

(d) Alkenes

(e) Synthetic polymers

	(a) Introduction
Students should:	
4.1	know that a hydrocarbon is a compound of hydrogen and carbon only
4.2	understand how to represent organic molecules using molecular formulae, general formulae, structural formulae and displayed formulae

	(b) Crude oil
Students should:	
4.7	know that crude oil is a mixture of hydrocarbons
4.9	know the names and uses of the main fractions obtained from crude oil: refinery gases, gasoline, kerosene, diesel, fuel oil and bitumen
4.10	know the trend in colour, boiling point and viscosity of the main fractions
4.11	know that a fuel is a substance that, when burned, releases heat energy
4.12	know the possible products of complete and incomplete combustion of hydrocarbons with oxygen in the air
4.13	understand why carbon monoxide is poisonous, in terms of its effect on the capacity of blood to transport oxygen *references to haemoglobin are not required*
4.14	know that, in car engines, the temperature reached is high enough to allow nitrogen and oxygen from air to react, forming oxides of nitrogen
4.15	explain how the combustion of some impurities in hydrocarbon fuels result in the formation of sulfur dioxide
4.16	understand how sulfur dioxide and oxides of nitrogen contribute to acid rain

Specification points 4.3, 4.4, 4.5, 4.6, 4.8, 4.17 and 4.18 are in the Pearson Edexcel International GCSE in Chemistry and Pearson Edexcel International GCSE in Science (Double Award).

There is a small change to specification point 4.2 from the Pearson Edexcel International GCSE in Science (Double Award).

(c)	Alkanes
Students should:	
4.19	know the general formula for alkanes
4.20	explain why alkanes are classified as saturated hydrocarbons
4.21	understand how to draw the structural and displayed formulae for alkanes with up to five carbon atoms in the molecule, and to name the unbranched-chain isomers

(d)	Alkenes
Students should:	
4.23	know that alkenes contain the functional group >C=C<
4.24	know the general formula for alkenes
4.25	explain why alkenes are classified as unsaturated hydrocarbons
4.26	understand how to draw the structural and displayed formulae for alkenes with up to four carbon atoms in the molecule, and name the unbranched-chain isomers *knowledge of cis/trans or E/Z notation is not required*
4.28	describe how bromine water can be used to distinguish between an alkane and an alkene

(e)	Synthetic polymers
Students should:	
4.44	know that an addition polymer is formed by joining up many small molecules called monomers
4.45	understand how to draw the repeat unit of the addition polymer poly(ethene)
4.46	understand how to deduce the structure of a monomer from the repeat unit of an addition polymer and vice versa
4.47	explain problems in the disposal of addition polymers, including: • their inertness and inability to biodegrade • the production of toxic gases when they are burned.

Specification points 4.29, 4.30, 4.31, 4.32, 4.33, 4.34, 4.35, 4.36, 4.37, 4.38, 4.39, 4.40, 4.41, 4.42, 4.43, 4.48, 4.49 and 4.50 are in the Pearson Edexcel International GCSE in Chemistry only.

Specification points 4.22 and 4.27 are in the Pearson Edexcel International GCSE in Chemistry and Pearson Edexcel International GCSE in Science (Double Award).

There is a small change to specification point 4.45 from the Pearson Edexcel International GCSE in Science (Double Award).

Physics content

1 Forces and motion

The following sub-topics are covered in this section.

(a) Units

(b) Movement and position

(c) Forces and movement

(a)	**Units**
Students should:	
1.1	use the following units: kilogram (kg), metre (m), metre/second (m/s), metre/second^2 (m/s^2), newton (N), second (s) and newton/kilogram (N/kg)

(b)	**Movement and position**
Students should:	
1.3	plot and explain distance–time graphs
1.4	know and use the relationship between average speed, distance moved and time taken: $\text{average speed} = \frac{\text{distance moved}}{\text{time taken}}$
1.5	*practical: investigate the motion of everyday objects such as toy cars or tennis balls*
1.6	know and use the relationship between acceleration, change in velocity and time taken: $\text{acceleration} = \frac{\text{change in velocity}}{\text{time taken}}$ $a = \frac{(v-u)}{t}$
1.7	plot and explain velocity-time graphs
1.8	determine acceleration from the gradient of a velocity–time graph
1.9	determine the distance travelled from the area between a velocity–time graph and the time axis

Specification point 1.2 is in the Pearson Edexcel International GCSE in Physics only.

Specification point 1.10 is in the Pearson Edexcel International GCSE in Physics and Pearson Edexcel International GCSE in Science (Double Award).

(c)	Forces and movement
Students should:	
1.11	describe the effects of forces between bodies such as changes in speed, shape or direction
1.12	identify different types of force such as gravitational or electrostatic
1.16	know that friction is a force that opposes motion
1.17	know and use the relationship between unbalanced force, mass and acceleration: force = mass × acceleration $F = m \times a$
1.18	know and use the relationship between weight, mass and gravitational field strength: weight = mass × gravitational field strength $W = m \times g$
1.19	know that the stopping distance of a vehicle is made up of the sum of the thinking distance and the braking distance
1.20	describe the factors affecting vehicle stopping distance, including speed, mass, road condition and reaction time

Specification points 1.25, 1.26, 1.27, 1.28, 1.29, 1.30, 1.31, 1.32 and 1.33 are in the Pearson Edexcel International GCSE in Physics only.

Specification points 1.13, 1.14, 1.15, 1.21, 1.22, 1.23 and 1.24 are in the Pearson Edexcel International GCSE in Physics and Pearson Edexcel International GCSE in Science (Double Award).

2 Electricity

The following sub-topics are covered in this section.

(a) Units

(b) Mains electricity

(c) Current and voltage in circuits

(a)	**Units**
Students should:	
2.1	use the following units: ampere (A), coulomb (C), joule (J), ohm (Ω), second (s), volt (V) and watt (W)

(b)	**Mains electricity**
Students should:	
2.4	know and use the relationship between power, current and voltage: power = current × voltage $P = I \times V$
2.6	know the difference between mains electricity being alternating current (a.c.) and direct current (d.c.) being supplied by a cell or battery

(c)	**Current and voltage in circuits**
Students should:	
2.8	understand how the current in a series circuit depends on the applied voltage and the number and nature of other components
2.9	describe how current varies with voltage in wires, resistors and metal filament lamps, and how to investigate this experimentally

Specification points 2.2, 2.3, 2.5 and 2.7 are in the Pearson Edexcel International GCSE in Physics and Pearson Edexcel International GCSE in Science (Double Award).

There is a small change to specification point 2.4 and 2.9 from the Pearson Edexcel International GCSE in Science (Double Award).

Students should:	
2.10	describe the qualitative effect of changing resistance on the current in a circuit
2.12	know that lamps and LEDs can be used to indicate the presence of a current in a circuit
2.13	know and use the relationship between voltage, current and resistance: voltage = current × resistance $V = I \times R$
2.14	know that current is the rate of flow of charge
2.16	know that electric current in solid metallic conductors is a flow of negatively charged electrons
2.19	calculate the currents, voltages and resistances of two resistive components connected in a series circuit

Specification points 2.22, 2.23, 2.24, 2.25, 2.26, 2.27 and 2.28 are in the Pearson Edexcel International GCSE in Physics only.

Specification points 2.11, 2.15, 2.17, 2.18, 2.20 and 2.21 are in the Pearson Edexcel International GCSE in Physics and Pearson Edexcel International GCSE in Science (Double Award).

3 Waves

The following sub-topics are covered in this section.

(a) Units

(b) Properties of waves

(c) The electromagnetic spectrum

(d) Light and sound

(a)	**Units**
Students should:	
3.1	use the following units: degree (°), hertz (Hz), metre (m), metre/second (m/s) and second (s)

(b)	**Properties of waves**
Students should:	
3.3	know the definitions of amplitude, wavefront, frequency, wavelength and period of a wave
3.4	know that waves transfer energy and information without transferring matter
3.5	know and use the relationship between the speed, frequency and wavelength of a wave: wave speed = frequency × wavelength $v = f \times \lambda$
3.7	use the above relationships in different contexts including sound waves and electromagnetic waves
3.9	explain that all waves can be reflected and refracted

Specification points 3.2, 3.6 and 3.8 are in the Pearson Edexcel International GCSE in Physics and Pearson Edexcel International GCSE in Science (Double Award).

(c)	The electromagnetic spectrum
Students should:	
3.10	know that light is part of a continuous electromagnetic spectrum that includes radio, microwave, infrared, visible, ultraviolet, x-ray and gamma ray radiations and that all these waves travel at the same speed in free space
3.11	know the order of the electromagnetic spectrum in terms of decreasing wavelength and increasing frequency, including the colours of the visible spectrum
3.12	explain some of the uses of electromagnetic radiations, including: • radio waves: broadcasting and communications • microwaves: cooking and satellite transmissions • infrared: heaters and night vision equipment • visible light: optical fibres and photography • ultraviolet: fluorescent lamps • x-rays: observing the internal structure of objects and materials, including for medical applications • gamma rays: sterilising food and medical equipment.
3.13	explain the detrimental effects of excessive exposure of the human body to electromagnetic waves, including: • microwaves: internal heating of body tissue • infrared: skin burns • ultraviolet: damage to surface cells and blindness • gamma rays: cancer, mutation and describe simple protective measures against the risks

(d)	Light and sound
Students should:	
3.14	know that light waves can be reflected and refracted
3.15	use the law of reflection (the angle of incidence equals the angle of reflection)
3.17	*practical: investigate the refraction of light, using rectangular blocks, semi-circular blocks and triangular prisms*
3.20	describe the role of total internal reflection in transmitting information along optical fibres and in prisms
3.21	explain what is meant by critical angle c
3.23	know that sound waves can be reflected and refracted

Specification points 3.24, 3.25, 3.26, 3.27, 3.28 and 3.29 are in the Pearson Edexcel International GCSE in Physics only.

Specification points 3.16, 3.18, 3.19 and 3.22 are in the Pearson Edexcel International GCSE in Physics and Pearson Edexcel International GCSE in Science (Double Award).

There is a small change to specification points 3.14, 3.21 and 3.23 from the Pearson Edexcel International GCSE in Science (Double Award).

4 Energy resources and energy transfers

The following sub-topics are covered in this section.

(a) Units

(b) Energy transfers

(c) Work and power

(a)	**Units**
Students should:	
4.1	use the following units: kilogram (kg), joule (J), metre (m), metre/second (m/s), metre/second^2 (m/s^2), newton (N), second (s) and watt (W)

(b)	**Energy transfers**
Students should:	
4.2	describe energy transfers involving energy stores: • energy stores: chemical, kinetic, gravitational, elastic, thermal, magnetic, electrostatic, nuclear • energy transfers: mechanically, electrically, by heating, by radiation (light and sound)
4.3	use the principle of conservation of energy
4.4	know and use the relationship between efficiency, useful energy output and total energy output: $\text{efficiency} = \frac{\text{useful energy output}}{\text{total energy output}} \times 100\%$
4.5	describe a variety of everyday and scientific devices and situations, explaining the transfer of the input energy in terms of the above relationship, including their representation by Sankey diagrams

Specification points 4.6, 4.7, 4.8, 4.9 and 4.10 are in the Pearson Edexcel International GCSE in Physics and Pearson Edexcel International GCSE in Science (Double Award).

(c)	**Work and power**
Students should:	
4.11	know and use the relationship between work done, force and distance moved in the direction of the force: work done = force × distance moved $W = F \times d$
4.12	know that work done is equal to energy transferred
4.13	know and use the relationship between gravitational potential energy, mass, gravitational field strength and height: gravitational potential energy = mass × gravitational field strength × height $GPE = m \times g \times h$
4.14	know and use the relationship: kinetic energy = $\frac{1}{2}$ × mass × speed^2 $KE = \frac{1}{2} \times m \times v^2$
4.15	understand how conservation of energy produces a link between gravitational potential energy, kinetic energy and work
4.16	describe power as the rate of transfer of energy or the rate of doing work
4.17	use the relationship between power, work done (energy transferred) and time taken: $\text{power} = \frac{\text{work done}}{\text{time taken}}$ $P = \frac{W}{t}$

Specification points 4.18 and 4.19 are in the Pearson Edexcel International GCSE in Physics only.

5 Solids, liquids and gases

The following sub-topics are covered in this section.

(a) Units

(b) Density and pressure

(c) Ideal gas molecules

(a)	**Units**
Students should:	
5.1	use the following units: degree Celsius (°C), Kelvin (K), joule (J), kilogram (kg), metre (m), metre^2 (m^2), metre^3 (m^3), metre/second (m/s), metre/second^2 (m/s^2), newton (N) and pascal (Pa)

(b)	**Density and pressure**
Students should:	
5.5	know and use the relationship between pressure, force and area: $\text{pressure} = \frac{\text{force}}{\text{area}}$ $p = \frac{F}{A}$
5.6	understand how the pressure at a point in a gas or liquid at rest acts equally in all directions

Specification points 5.2, 5.8, 5.9, 5.10, 5.11, 5.12, 5.13 and 5.14 are in the Pearson Edexcel International GCSE in Physics only.

Specification points 5.3, 5.4 and 5.7 are in the Pearson Edexcel International GCSE in Physics and Pearson Edexcel International GCSE in Science (Double Award).

Change to specification point 5.1 from the Pearson Edexcel International GCSE in Science (Double Award).

(c)	Ideal gas molecules
Students should:	
5.15	explain how molecules in a gas have random motion and that they exert a force and hence a pressure on the walls of a container
5.16	understand why there is an absolute zero of temperature which is –273 °C
5.17	describe the Kelvin scale of temperature and be able to convert between the Kelvin and Celsius scales
5.18	understand why an increase in temperature results in an increase in the average speed of gas molecules
5.19	know that the Kelvin temperature of a gas is proportional to the average kinetic energy of its molecules
5.20	explain, for a fixed amount of gas, the qualitative relationship between: • pressure and volume at constant temperature • pressure and Kelvin temperature at constant volume.

Specification points 5.21 and 5.22 are in the Pearson Edexcel International GCSE in Physics and Pearson Edexcel International GCSE in Science (Double Award).

6 Magnetism and electromagnetism

The following sub-topics are covered in this section.

(a) Units

(b) Magnetism

(c) Electromagnetism

(a)	**Units**
Students should:	
6.1	use the following units: ampere (A), volt (V) and watt (W)

(b)	**Magnetism**
Students should:	
6.4	understand the term magnetic field line
6.6	*practical: investigate the magnetic field pattern for a permanent bar magnet and between two bar magnets*
6.7	describe how to use two permanent magnets to produce a uniform magnetic field pattern

(c)	**Electromagnetism**
Students should:	
6.8	know that an electric current in a conductor produces a magnetic field around it
6.12	understand why a force is exerted on a current-carrying wire in a magnetic field, and how this effect is applied in simple d.c. electric motors and loudspeakers
6.13	use the left-hand rule to predict the direction of the resulting force when a wire carries a current perpendicular to a magnetic field
6.14	describe how the force on a current-carrying conductor in a magnetic field changes with the magnitude and direction of the field and current

Specification points 6.9, 6.10, 6.11, 6.17, 6.18, 6.19 and 6.20 are in the Pearson Edexcel International GCSE in Physics only.

Specification points 6.2, 6.3, 6.5, 6.15 and 6.16 are in the Pearson Edexcel International GCSE in Physics and Pearson Edexcel International GCSE in Science (Double Award).

7 Radioactivity and particles

The following sub-topics are covered in this section.

(a) Units

(b) Radioactivity

(c) Fission and fusion

(a)	**Units**
Students should:	
7.1	use the following units: becquerel (Bq), centimetre (cm), hour (h), minute (min) and second (s)

(b)	**Radioactivity**
Students should:	
7.2	describe the structure of an atom in terms of protons, neutrons and electrons and use symbols such as $^{14}_{6}C$ to describe particular nuclei
7.3	know the terms atomic (proton) number, mass (nucleon) number and isotope
7.4	know that alpha (α) particles, beta (β^-) particles and gamma (γ) rays are ionising radiations emitted from unstable nuclei in a random process
7.5	describe the nature of alpha (α) particles, beta (β^-) particles and gamma (γ) rays, and recall that they may be distinguished in terms of penetrating power and ability to ionise
7.6	*practical: investigate the penetration powers of different types of radiation using either radioactive sources or simulations*
7.10	explain the sources of background (ionising) radiation from Earth and space
7.12	know the definition of the term half-life and understand that it is different for different radioactive isotopes
7.14	describe uses of radioactivity in industry and medicine
7.15	describe the difference between contamination and irradiation
7.16	describe the dangers of ionising radiations, including: • that radiation can cause mutations in living organisms • that radiation can damage cells and tissue • the problems arising from the disposal of radioactive waste and how the associated risks can be reduced.

Specification points 7.7, 7.8, 7.9, 7.11 and 7.13 are in the Pearson Edexcel International GCSE in Physics and Pearson Edexcel International GCSE in Science (Double Award).

(c)	Fission and fusion
Students should:	
7.17	know that nuclear reactions, including fission, fusion and radioactive decay can be a source of energy
7.18	understand how a nucleus of U-235 can be split (the process of fission) by collision with a neutron, and that this process releases energy as kinetic energy of the fission products
7.19	know that the fission of U-235 produces two radioactive daughter nuclei and a small number of neutrons
7.22	understand the role of shielding around a nuclear reactor
7.25	know that fusion is the energy source for stars

Specification points 7.20, 7.21, 7.23, 7.24 and 7.26 are in the Pearson Edexcel International GCSE in Physics and Pearson Edexcel International GCSE in Science (Double Award).

8 Astrophysics

The following sub-topics are covered in this section:

(a) Units

(b) Motion in the universe

(c) Stellar evolution

(a)	**Units**
Students should:	
8.1	use the following units: kilogram (kg), metre (m), metre/second (m/s), metre/second^2 (m/s^2), newton (N), second (s), newton/kilogram (N/kg)

(b)	**Motion in the universe**
Students should:	
8.2	know that: • the universe is a large collection of billions of galaxies • a galaxy is a large collection of billions of stars • our solar system is in the Milky Way galaxy.
8.3	understand why gravitational field strength, g, varies and know that it is different on other planets and the Moon from that on the Earth.
8.4	explain that gravitational force: • causes moons to orbit planets • causes the planets to orbit the Sun • causes artificial satellites to orbit the Earth • causes comets to orbit the Sun.
8.5	describe the differences in the orbits of comets, moons and planets

(c)	**Stellar evolution**
Students should:	
8.7	understand how stars can be classified according to their colour
8.8	know that a star's colour is related to its surface temperature
8.9	describe the evolution of stars of similar mass to the Sun through the following stages: • nebula • star (main sequence) • red giant • white dwarf.

Specification points 8.11, 8.12, 8.13, 8.14, 8.15, 8.16, 8.17 and 8.18 are in the Pearson Edexcel International GCSE in Physics only.

Specification points 8.6 and 8.10 are in the Pearson Edexcel International GCSE in Physics and Pearson Edexcel International GCSE in Science (Double Award).

3 Assessment information

Assessment requirements

Paper number	Level	Assessment information	Number of marks allocated in the paper
Paper 1	1/2	Assessed through a 1-hour and 10-minute written examination paper set and marked by Pearson. The paper is weighted at 33.3% of the qualification. A mixture of different question styles, including multiple-choice questions, short-answer questions, calculations and extended open-response questions.	60
Paper 2	1/2	Assessed through a 1-hour and 10-minute written examination paper set and marked by Pearson. The paper is weighted at 33.3% of the qualification. A mixture of different question styles, including multiple-choice questions, short-answer questions, calculations and extended open-response questions.	60
Paper 3	1/2	Assessed through a 1-hour and 10-minute written examination paper set and marked by Pearson. The paper is weighted at 33.3% of the qualification. A mixture of different question styles, including multiple-choice questions, short-answer questions, calculations and extended open-response questions.	60

The total number of marks for this qualification is 180. This total is obtained by adding up the marks for Paper 1B, Paper 1C and Paper 1P (each out of 60 marks). The marks for the papers are not scaled.

Based on the overall mark, students will be awarded a grade. The grades available range from 9 to 1, where 9 is the highest grade.

Sample assessment materials

Sample papers and mark schemes can be found in the *Pearson Edexcel International GCSE in Science (Single Award) Sample Assessment Materials (SAMs)* document.

Experimental skills

The best way to develop experimental skills is to embed practical investigations in teaching or theory. The development of knowledge and experimental skills can then happen together, leading to secure acquisition of both knowledge and skills.

Our practical investigations are embedded within *2: Science content* as specification points in italics. The skills developed through these and other practicals will be assessed through written examinations.

In the assessment of experimental skills, students may be tested on their ability to:

- solve problems set in a practical context
- apply scientific knowledge and understanding in questions with a practical context
- devise and plan investigations, using scientific knowledge and understanding when selecting appropriate techniques
- demonstrate or describe appropriate experimental and investigative methods, including safe and skilful practical techniques
- make observations and measurements with appropriate precision, record these methodically and present them in appropriate ways
- identify independent, dependent and control variables
- use scientific knowledge and understanding to analyse and interpret data to draw conclusions from experimental activities that are consistent with the evidence
- communicate the findings from experimental activities, using appropriate technical language, relevant calculations and graphs
- assess the reliability of an experimental activity
- evaluate data and methods taking into account factors that affect accuracy and validity.

Calculators

Students will be expected to have access to a suitable electronic calculator for all examination papers. Calculators that allow for the retrieval of text or formulae or QWERTY keyboards will not be allowed for use in examinations.

Assessment objectives and weightings

		International GCSE
AO1	Knowledge and understanding of science	38–42%
AO2	Application of knowledge and understanding, analysis and evaluation of science	38–42%
AO3	Experimental skills, analysis and evaluation of data and methods in science	19–21%
		100%

Relationship of assessment objectives to units

Unit number	**Assessment objective**		
	AO1	**AO2**	**AO3**
Paper 1	12.7–14.0%	12.7–14.0%	6.3–7.0%
Paper 2	12.7–14.0%	12.7–14.0%	6.3–7.0%
Paper 3	12.7–14.0%	12.7–14.0%	6.3–7.0%
Total for International GCSE	38–42%	38–42%	19–21%

All components will be available for assessment from June 2019.

4 Administration and general information

Entries

Details of how to enter students for the examinations for this qualification can be found in our *International information manual*. A copy is made available to all examinations officers and is also available on our website.

Students should be advised that if they take two qualifications in the same subject, colleges, universities and employers are very likely to take the view that they have achieved only one of the two GCSEs/International GCSEs. Students or their advisers who have any doubts about subject combinations should check with the institution to which they wish to progress before embarking on their programmes.

Forbidden combinations

There are no forbidden combinations with this qualification.

Access arrangements, reasonable adjustments, special consideration and malpractice

Equality and fairness are central to our work. Our Equality Policy requires all students to have equal opportunity to access our qualifications and assessments, and our qualifications to be awarded in a way that is fair to every student.

We are committed to making sure that:

- students with a protected characteristic (as defined by the UK Equality Act 2010) are not, when they are undertaking one of our qualifications, disadvantaged in comparison to students who do not share that characteristic
- all students achieve the recognition they deserve for undertaking a qualification and that this achievement can be compared fairly to the achievement of their peers.

Language of assessment

Assessment of this qualification will only be available in English. All student work must be in English.

We recommend that students are able to read and write in English at Level B2 of the Common European Framework of Reference for Languages.

Access arrangements

Access arrangements are agreed before an assessment. They allow students with special educational needs, disabilities or temporary injuries to:

- access the assessment
- show what they know and can do without changing the demands of the assessment.

The intention behind an access arrangement is to meet the particular needs of an individual student with a disability without affecting the integrity of the assessment. Access arrangements are the principal way in which awarding bodies comply with the duty under the UK Equality Act 2010 to make 'reasonable adjustments'.

Access arrangements should always be processed at the start of the course. Students will then know what is available and have the access arrangement(s) in place for assessment.

Reasonable adjustments

The UK Equality Act 2010 requires an awarding organisation to make reasonable adjustments where a student with a disability would be at a substantial disadvantage in undertaking an assessment. The awarding organisation is required to take reasonable steps to overcome that disadvantage.

A reasonable adjustment for a particular student may be unique to that individual and therefore might not be in the list of available access arrangements.

Whether an adjustment will be considered reasonable will depend on a number of factors, including:

- the needs of the student with the disability
- the effectiveness of the adjustment
- the cost of the adjustment
- the likely impact of the adjustment on the student with the disability and other students.

An adjustment will not be approved if it involves unreasonable costs to the awarding organisation or unreasonable timeframes or if it affects the security or integrity of the assessment. This is because the adjustment is not 'reasonable'.

Special consideration

Special consideration is a post-examination adjustment to a student's mark or grade to reflect temporary injury, illness or other indisposition at the time of the examination/ assessment, which has had, or is reasonably likely to have had, a material effect on a candidate's ability to take an assessment or demonstrate their level of attainment in an assessment.

Further information

Please see our website for further information about how to apply for access arrangements and special consideration.

For further information about access arrangements, reasonable adjustments and special consideration, please refer to the JCQ website: www.jcq.org.uk

Candidate malpractice

Candidate malpractice refers to any act by a candidate that compromises or seeks to compromise the process of assessment, or undermines the integrity of the qualifications or the validity of results/certificates.

Candidate malpractice in examinations **must** be reported to Pearson using a *JCQ Form M1* (available at www.jcq.org.uk/exams-office/malpractice). The form can be emailed to pqsmalpractice@pearson.com or posted to: Investigations Team, Pearson, 190 High Holborn, London, WC1V 7BH. Please provide as much information and supporting documentation as possible. Note that the final decision regarding appropriate sanctions lies with Pearson.

Failure to report malpractice constitutes staff or centre malpractice.

Staff/centre malpractice

Staff and centre malpractice includes both deliberate malpractice and maladministration of our qualifications. As with candidate malpractice, staff and centre malpractice is any act that compromises or seeks to compromise the process of assessment, or undermines the integrity of the qualifications or the validity of results/certificates.

All cases of suspected staff malpractice and maladministration **must** be reported immediately, before any investigation is undertaken by the centre, to Pearson on a *JCQ Form M2* (available at www.jcq.org.uk/exams-office/malpractice).

The form, supporting documentation and as much information as possible can be emailed to pqsmalpractice@pearson.com or posted to: Investigations Team, Pearson, 190 High Holborn, London, WC1V 7BH. Note that the final decision regarding appropriate sanctions lies with Pearson.

Failure to report malpractice itself constitutes malpractice.

More-detailed guidance on malpractice can be found in the latest version of the document *General and Vocational Qualifications Suspected Malpractice in Examinations and Assessments,* available at www.jcq.org.uk/exams-office/malpractice

Awarding and reporting

The International GCSE qualification will be graded and certificated on a nine-grade scale from 9 to 1 using the total subject mark where 9 is the highest grade. Individual papers are not graded. The first certification opportunity for the Pearson Edexcel International GCSE in Science (Single Award) will be in June 2019. Students whose level of achievement is below the minimum judged by Pearson to be of sufficient standard to be recorded on a certificate will receive an unclassified U result.

Student recruitment and progression

Pearson's policy concerning recruitment to our qualifications is that:

- they must be available to anyone who is capable of reaching the required standard
- they must be free from barriers that restrict access and progression
- equal opportunities exist for all students.

Prior learning and other requirements

The qualification builds on the content, knowledge and skills developed in the Key Stage 3 Programme of Study (ages 11–14) or international equivalences for science.

Progression

Students can progress from this qualification to:

- Pearson Edexcel International GCSE in Science (Double Award) (9–1)
- Pearson Edexcel International GCSE in Biology/Chemistry/Physics (9–1)
- Pearson Edexcel GCSE in Combined Science (9–1)
- Pearson Edexcel GCSE in Biology/Chemistry/Physics (9-1)
- other comparable, Level 1/2 science qualification
- Level 1/2 vocational qualification
- employment.

Appendices

Appendix 1: Codes

Type of code	Use of code	Code
Subject codes	The subject code is used by centres to enter students for a qualification.	Pearson Edexcel International GCSE in Science (Single Award) – 4SS0
Paper codes	These codes are provided for information. Students may need to be entered for individual papers.	Paper 1: 4SS0/1B Paper 2: 4SS0/1C Paper 3: 4SS0/1P

Appendix 2: Pearson World Class Qualification design principles

Pearson's World Class Qualification design principles mean that all Edexcel qualifications are developed to be **rigorous, demanding, inclusive and empowering**.

We work collaboratively to gain approval from an external panel of educational thought-leaders and assessment experts from across the globe. This is to ensure that Edexcel qualifications are globally relevant, represent world-class best practice in qualification and assessment design, maintain a consistent standard and support learner progression in today's fast changing world.

Pearson's Expert Panel for World Class Qualifications is chaired by Sir Michael Barber, a leading authority on education systems and reform. He is joined by a wide range of key influencers with expertise in education and employability.

"I'm excited to be in a position to work with the global leaders in curriculum and assessment to take a fresh look at what young people need to know and be able to do in the 21st century, and to consider how we can give them the opportunity to access that sort of education." Sir Michael Barber.

Endorsement from Pearson's Expert Panel for World Class Qualifications for the International GCSE development process

December 2015

"We were chosen, either because of our expertise in the UK education system, or because of our experience in reforming qualifications in other systems around the world as diverse as Singapore, Hong Kong, Australia and a number of countries across Europe.

We have guided Pearson through what we judge to be a rigorous world class qualification development process that has included:

- extensive international comparability of subject content against the highest-performing jurisdictions in the world
- benchmarking assessments against UK and overseas providers to ensure that they are at the right level of demand
- establishing External Subject Advisory Groups, drawing on independent subject-specific expertise to challenge and validate our qualifications.

Importantly, we have worked to ensure that the content and learning is future oriented, and that the design has been guided by Pearson's Efficacy Framework. This is a structured, evidenced process which means that learner outcomes have been at the heart of this development throughout.

We understand that ultimately it is excellent teaching that is the key factor to a learner's success in education but as a result of our work as a panel we are confident that we have supported the development of Edexcel International GCSE qualifications that are outstanding for their coherence, thoroughness and attention to detail and can be regarded as representing world-class best practice."

Sir Michael Barber (Chair)
Chief Education Advisor, Pearson plc

Professor Lee Sing Kong
Dean and Managing Director, National Institute of Education International, Singapore

Dr Peter Hill
Former Chief Executive ACARA

Bahram Bekhradnia
President, Higher Education Policy Institute

Professor Jonathan Osborne
Stanford University

Dame Sally Coates
Director of Academies (South), United Learning Trust

Professor Dr Ursula Renold
Federal Institute of Technology, Switzerland

Professor Bob Schwartz
Harvard Graduate School of Education

Professor Janice Kay
Provost, University of Exeter

Jane Beine
Head of Partner Development, John Lewis Partnership

Jason Holt
CEO, Holts Group

All titles correct as at December 2015

Appendix 3: Transferable skills

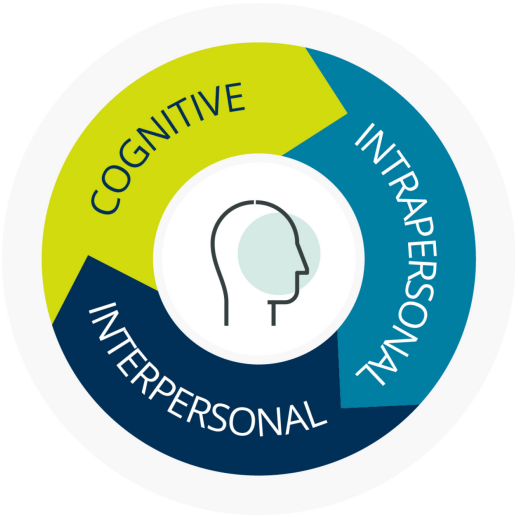
The need for transferable skills

In recent years, higher education institutions and employers have consistently flagged the need for students to develop a range of transferable skills to enable them to respond with confidence to the demands of undergraduate study and the world of work.

The Organisation for Economic Co-operation and Development (OECD) defines skills, or competencies, as 'the bundle of knowledge, attributes and capacities that can be learned and that enable individuals to successfully and consistently perform an activity or task and can be built upon and extended through learning'.[1]

To support the design of our qualifications, the Pearson Research Team selected and evaluated seven global 21st-century skills frameworks. Following on from this process, we identified the National Research Council's (NRC) framework[2] as being the most evidence-based and robust skills framework, and have used this as a basis for our adapted skills framework.

The framework includes cognitive, intrapersonal skills and interpersonal skills.



The skills have been interpreted for this specification to ensure that they are appropriate for the subject. All of the skills listed are evident or accessible in the teaching, learning and/or assessment of the qualification. Some skills are directly assessed. Pearson materials will support you in identifying these skills and developing these skills in students.

The table overleaf sets out the framework and gives an indication of the skills that can be found in science and indicates the interpretation of the skill in this area. A full subject interpretation of each skill, with mapping to show opportunities for students' development is provided on the subject pages of our website.

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1 OECD, *Better Skills, Better Jobs, Better Lives* (2012): skills.oecd.org/documents/OECDSkillsStrategyFINALENG.pdf

2 Koenig, J. A. *Assessing 21st Century Skills: Summary of a Workshop* (National Research Council, 2011)

Cognitive skills	Cognitive processes and strategies	• Critical thinking • Problem solving • Analysis • Reasoning/argumentation • Interpretation • Decision making • Adaptive learning • Executive function
	Creativity	• Creativity • Innovation
Intrapersonal skills	Intellectual openness	• Adaptability • Personal and social responsibility • Continuous learning • Intellectual interest and curiosity
	Work ethic/ conscientiousness	• Initiative • Self-direction • Responsibility • Perseverance • Productivity • Self-regulation (metacognition, forethought, reflection) • Ethics • Integrity
	Positive core self-evaluation	• Self-monitoring/self-evaluation/self-reinforcement
Interpersonal skills	Teamwork and collaboration	• Communication • Collaboration • Teamwork • Cooperation • Empathy/perspective taking • Negotiation
	Leadership	• Responsibility • Assertive communication • Self-presentation

Analyse and interpret data and experimental methods, drawing conclusions, which are consistent with evidence from experimental activities.

Planning and carrying out science based on problem solving under **own direction**.

Working with other students in a science-based problem-solving exercise.

Appendix 4: Mathematical skills

The table below identifies the mathematical skills that will be developed and assessed throughout this qualification. These are not explicitly referenced in the content.

		B	C	P
1	**Arithmetic and numerical computation**			
A	Recognise and use numbers in decimal form	✓	✓	✓
B	Recognise and use numbers in standard form	✓	✓	✓
C	Use ratios, fractions, percentages, powers and roots	✓	✓	✓
D	Make estimates of the results of simple calculations, without using a calculator	✓		✓
E	Use calculators to handle sin x and $\sin^{-1} x$, where x is expressed in degrees			✓
2	**Handling data**			
A	Use an appropriate number of significant figures	✓	✓	✓
B	Understand and find the arithmetic mean (average)	✓	✓	✓
C	Construct and interpret bar charts	✓	✓	✓
D	Construct and interpret frequency tables, diagrams and histograms	✓		✓
E	Understand the principles of sampling as applied to scientific data	✓		
F	Understand simple probability	✓	✓	✓
G	Understand the terms mode and median	✓		
H	Use a scatter diagram to identify a pattern or trend between two variables	✓	✓	✓
I	Make order of magnitude calculations	✓	✓	✓
3	**Algebra**			
A	Understand and use the symbols <, >, ∝, ~		✓	✓
B	Change the subject of an equation	✓	✓	✓
C	Substitute numerical values into algebraic equations using appropriate units for physical quantities	✓	✓	✓
D	Solve simple algebraic equations	✓	✓	✓
4	**Graphs**			
A	Translate information between graphical and numerical form	✓	✓	✓
B	Understand that $y = mx + c$ represents a linear relationship		✓	✓
C	Plot two variables (discrete and continuous) from experimental or other data	✓	✓	✓
D	Determine the slope and intercept of a linear graph	✓	✓	✓
E	Understand, draw and use the slope of a tangent to a curve as a measure of rate of change		✓	✓
F	Understand the physical significance of area between a curve and the x-axis, and measure it by counting squares as appropriate			✓

		B	C	P
5	**Geometry and trigonometry**			
A	Use angular measures in degrees			✓
B	Visualise and represent 2D and 3D objects, including two dimensional representations of 3D objects			✓
C	Calculate areas of triangles and rectangles, surface areas and volumes of cubes	✓		✓

Appendix 5: Command word taxonomy

The following table lists the command words used in the external assessments.

Command word	Definition
Add/Label	Requires the addition or labelling of a stimulus material given in the question, for example labelling a diagram or adding units to a table.
Calculate	Obtain a numerical answer, showing relevant working.
Comment on	Requires the synthesis of a number of variables from data/information to form a judgement.
Complete	Requires the completion of a table/diagram.
Deduce	Draw/reach conclusion(s) from the information provided.
Describe	To give an account of something. Statements in the response need to be developed, as they are often linked but **do not** need to include a justification or reason.
Determine	The answer must have an element that is quantitative from the stimulus provided, or must show how the answer can be reached quantitatively. To gain maximum marks, there must be a quantitative element to the answer.
Design	Plan or invent a procedure from existing principles/ideas.
Discuss	• Identify the issue/situation/problem/argument that is being assessed within the question. • Explore all aspects of an issue/situation/problem/argument. • Investigate the issue/situation etc. by reasoning or argument.
Draw	Produce a diagram either using a ruler or freehand.
Estimate	Find an approximate value, number or quantity from a diagram/given data or through a calculation.
Evaluate	Review information (e.g. data, methods) then bring it together to form a conclusion, drawing on evidence including strengths, weaknesses, alternative actions, relevant data or information. Come to a supported judgement of a subject's quality and relate it to its context.
Explain	An explanation requires a justification/exemplification of a point. The answer must contain some element of reasoning/justification – this can include mathematical explanations.
Give/State/Name	All of these command words are really synonyms. They generally all require recall of one or more pieces of information.
Give a reason/reasons	When a statement has been made and the requirement is only to give the reason(s) why.
Identify	Usually requires some key information to be selected from a given stimulus/resource.

Command word	Definition
Justify	Give evidence to support (either the statement given in the question or an earlier answer).
Plot	Produce a graph by marking points accurately on a grid from data that is provided and then draw a line of best fit through these points. A suitable scale and appropriately labelled axes must be included if these are not provided in the question.
Predict	Give an expected result.
Show that	Verify the statement given in the question.
Sketch	Produce a freehand drawing. For a graph, this would need a line and labelled axes with important features indicated. The axes are not scaled.
State what is meant by	When the meaning of a term is expected but there are different ways for how these can be described.
Suggest	Use your knowledge to propose a solution to a problem in a novel context.
Verb preceding a command word	
Analyse the data/graph to explain	Examine the data/graph in detail to provide an explanation.
Multiple choice questions	
What, Why, Which	Direct command words used for multiple-choice questions.

Appendix 6: Suggested practical investigations

The following suggestions are *additional* practical investigations that exemplify the scientific process. They can be used to supplement students' understanding of biology, chemistry and physics in addition to the practical investigations found in the main body of the content.

Biology

- Investigate human responses to external stimuli.
- Investigate reaction times.
- Investigate the effect of pollutants on plant germination and plant growth.
- Investigate inheritance using suitable organisms or models.
- Investigate the presence of glucose in simulated urine/body fluids.
- Investigate the effect of exercise on heart rate.
- Investigate the relationship between organisms and their environment using fieldwork techniques.
- Investigate the distribution of organisms in an ecosystem, using sampling techniques including:
  - pooters
  - sweep nets/pond nets
  - pitfall traps and measure environmental factors including:
    - temperature
    - light intensity
    - pH.
- Investigate plant and animal cells with a light microscope.
- Investigate the effect of glucose concentration on rate of anaerobic respiration in yeast.
- Investigate the effect of different factors on bread making.
- Investigate the use of enzymes in washing powders.
- Investigate temperature loss in beakers of hot water of different sizes.

Chemistry

- Investigate the ease of thermal decomposition of carbonates, including calcium carbonate, zinc carbonate and copper carbonate.
- Compare the temperature rise produced when the same volume of water is heated by different fuels.
- Investigate the volume of air used up and products formed when candles are burned.
- Carry out simple neutralisation reactions of acids, using metal oxides, hydroxides and/or carbonates.
- Investigate the rusting of iron.
- Investigate simple oxidation and reduction reactions, such as burning elements in oxygen or competition reactions between metals and metal oxides.
- Investigate the fractional distillation of synthetic crude oil and the ease of ignition and viscosity of the fractions.
- Investigate the products produced from the complete combustion of a hydrocarbon.
- Investigate the properties of a group of elements, e.g. Group 2.
- Investigate the properties of typical ionic compounds.
- Carry out a series of ion tests to identify unknown compounds.
- Build models of simple covalent molecules.
- Investigate the typical properties of simple and giant covalent compounds.
- Investigate the rate of reactions, such as magnesium and hydrochloric acid; or sodium thiosulfate and hydrochloric acid.

Physics

- Investigate the power consumption of low-voltage electrical items.
- Investigate models to show refraction, such as toy cars travelling into a region of sand.
- Investigate the areas beyond the visible spectrum, such as those found by Herschel and Ritter, who discovered infrared and ultraviolet (UV) respectively.
- Investigate the relationship between potential difference (voltage), current and resistance.
- Investigate the relationship between force, mass and acceleration.
- Investigate the forces required to slide blocks along different surfaces, with differing amounts of friction.
- Investigate how crumple zones can be used to reduce the forces in collisions.
- Investigate power by running up the stairs or lifting objects of different weights.
- Investigate the critical angle for Perspex®/air, glass/air or water/air boundaries.
- Investigate factors affecting the height of rebound of bouncing balls.
- Investigate the temperature and volume relationship for a gas.
- Investigate the volume and pressure relationship for a gas.
- Investigate the absorption of light by translucent materials in order to simulate the absorption of rays.

Safety is an overriding requirement for all practical work. Centres are responsible for ensuring that whenever their students complete practical work appropriate safety procedures are followed.

Appendix 7: The Periodic Table

The Periodic Table of the Elements

1	2											3	4	5	6	7	0
							1 H hydrogen 1										4 He helium 2
7 Li lithium 3	9 Be beryllium 4											11 B boron 5	12 C carbon 6	14 N nitrogen 7	16 O oxygen 8	19 F fluorine 9	20 Ne neon 10
23 Na sodium 11	24 Mg magnesium 12											27 Al aluminium 13	28 Si silicon 14	31 P phosphorus 15	32 S sulfur 16	35.5 Cl chlorine 17	40 Ar argon 18
39 K potassium 19	40 Ca calcium 20	45 Sc scandium 21	48 Ti titanium 22	51 V vanadium 23	52 Cr chromium 24	55 Mn manganese 25	56 Fe iron 26	59 Co cobalt 27	59 Ni nickel 28	63.5 Cu copper 29	65 Zn zinc 30	70 Ga gallium 31	73 Ge germanium 32	75 As arsenic 33	79 Se selenium 34	80 Br bromine 35	84 Kr krypton 36
85 Rb rubidium 37	88 Sr strontium 38	89 Y yttrium 39	91 Zr zirconium 40	93 Nb niobium 41	96 Mo molybdenum 42	[98] Tc technetium 43	101 Ru ruthenium 44	103 Rh rhodium 45	106 Pd palladium 46	108 Ag silver 47	112 Cd cadmium 48	115 In indium 49	119 Sn tin 50	122 Sb antimony 51	128 Te tellurium 52	127 I iodine 53	131 Xe xenon 54
133 Cs caesium 55	137 Ba barium 56	139 La* lanthanum 57	178 Hf hafnium 72	181 Ta tantalum 73	184 W tungsten 74	186 Re rhenium 75	190 Os osmium 76	192 Ir iridium 77	195 Pt platinum 78	197 Au gold 79	201 Hg mercury 80	204 Tl thallium 81	207 Pb lead 82	209 Bi bismuth 83	[209] Po polonium 84	[210] At astatine 85	[222] Rn radon 86
[223] Fr francium 87	[226] Ra radium 88	[227] Ac* actinium 89	[261] Rf rutherfordium 104	[262] Db dubnium 105	[266] Sg seaborgium 106	[264] Bh bohrium 107	[277] Hs hassium 108	[268] Mt meitnerium 109	[271] Ds darmstadtium 110	[272] Rg roentgenium 111							

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

Elements with atomic numbers 112-116 have been reported but not fully authenticated

**** The lanthanoids (atomic numbers 58-71) and the actinoids (atomic numbers 90-103) have been omitted.***

The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.

+

Appendix 8: Physics formulae for relationships

The relationships listed below will **not** be provided for students either in the form given or in rearranged form.

(1) the relationship between average speed, distance moved and time taken:

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

(2) the relationship between force, mass and acceleration:

force = mass × acceleration

(3) the relationship between acceleration, change in velocity and time taken:

$$\text{acceleration} = \frac{\text{change in velocity}}{\text{time taken}}$$

(4) the relationship between work done, force and distance moved:

work done = force × distance moved

(5) the energy relationships:

energy transferred = work done

kinetic energy = $\frac{1}{2}$ × mass × speed^2

gravitational potential energy = mass × g × height

(6) the relationship between mass, weight and gravitational field strength:

weight = mass × gravitational field strength

(7) the relationship between an applied force, the area over which it acts and the resulting pressure:

$$\text{pressure} = \frac{\text{force}}{\text{area}}$$

(8) the relationship between charge, current, voltage, resistance and electrical power:

charge = current × time

voltage = current × resistance

electrical power = voltage × current

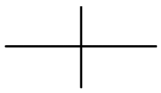
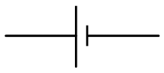
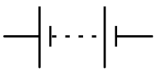
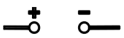
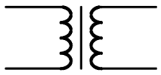
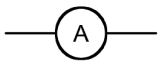
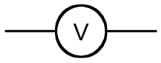
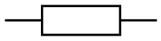
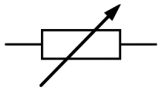
(9) the relationship between speed, frequency and wavelength of wave:

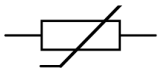
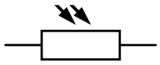
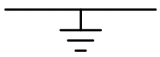
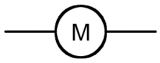
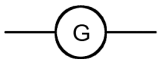
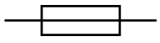
wave speed = frequency × wavelength

(14) the relationship for efficiency:

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

Appendix 9: Electrical circuit symbols

Description	Symbol
Conductors crossing with no connection	
Junction of conductors	
Open switch	
Cell	
Battery of cells	
Power supply (DC)	
Power supply (AC)	
Transformer	
Ammeter	
Voltmeter	
Fixed resistor	
Variable resistor	

Description	Symbol
Heater	
Thermistor	
Light-dependent resistor (LDR)	
Diode	
Light-emitting diode (LED)	
Lamp	
Loudspeaker	
Microphone	
Electric bell	
Earth or ground	
Motor	
Generator	
Fuse/circuit breaker	

Although these are the forms of circuit symbols that will be used in examination papers, there may be other internationally agreed symbols which are acceptable in student answers.

Appendix 10: Glossary

Term	Definition
Assessment objectives	The requirements that students need to meet to succeed in the qualification. Each assessment objective has a unique focus, which is then targeted in examinations or coursework. Assessment objectives may be assessed individually or in combination.
External assessment	An examination that is held at the same time and place in a global region.
JCQ	Joint Council for Qualifications. This is a group of UK exam boards that develop policy related to the administration of examinations.
Linear	Linear qualifications have all assessments at the end of a course of study. It is not possible to take one assessment earlier in the course of study.

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