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IGCSE

London Examinations IGCSE

Science (Double Award) (4437)

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delivered locally, recognised globally

Specification

London Examinations IGCSE

Science (Double Award) (4437)

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Authorised by Elizabeth Blount

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Contents

Introduction

The London Examinations IGCSE in Double Award Science is designed as a two-year course of study. It takes approximately two-thirds of the subject content of each of the London Examinations IGCSE single sciences (Biology 4325, Chemistry 4335 and Physics 4420), and combines them into an IGCSE Science specification worth two IGCSEs. It is designed to be an interesting and inspiring modern specification, suitable both for those for whom it is a final science qualification and also for those who require a sound foundation for further study.

Key features

- incorporates features of London Examinations IGCSE Biology, Chemistry and Physics, and elements of the Edexcel GCSE Double Award Science taught in the UK
- candidates are awarded two identical IGCSE grades, reflecting the amount of subject content prescribed for study
- two tiers of entry allow candidates to be entered at the appropriate level
- requires less curriculum time than teaching three individual sciences
- two routes of assessment: 100% examination or 80% examination and 20% coursework (only for specifically approved centres)
- assessment of practical work through 20% coursework (only for specifically approved centres) or through 20% written alternative papers in two of the three science subjects
- on the 80% examination 20% coursework route, candidates submit assignments in two of the three science subjects
- clear, detailed and comprehensive subject content with straightforward linear assessment
- a full range of teacher support
- provides a sound foundation for progression to Edexcel's GCE AS and Advanced level science specifications.

Availability of external assessment

The specification will be examined twice a year, in May and November.

Centres are asked to note that the coursework component of this specification is normally available only to candidates studying at centres that have been recognised by Edexcel International as International Teaching Institutions. For full details, see the section 'Availability of coursework to international centres'.

Centres should note the forbidden combinations which prevent candidates being entered for other IGCSE Science specifications in the same sessions as this specification. Full details are given in Appendix 1.

Specification aims and assessment objectives

Aims

This specification gives candidates opportunities to

- acquire a systematic body of scientific knowledge and facts and an understanding of scientific concepts, principles, themes and patterns
- appreciate the practical nature of science, acquiring experimental skills based on correct and safe laboratory techniques
- appreciate the importance of accurate experimental work to scientific method and reporting
- form hypotheses and design experiments to test them
- sustain and develop an enjoyment of, and interest in, the scientific world
- appreciate the significance of science in wider personal, social, environmental, economic and technological contexts, and consider ethical issues
- select, organise and present information clearly and logically, using appropriate scientific terms and conventions
- prepare for more advanced courses in each of the three scientific disciplines which comprise this specification.

Assessment objectives

This specification requires that all candidates demonstrate the following assessment objectives in the context of the content and skills prescribed.

AO1 Knowledge and understanding

In the examination, candidates will be tested on their ability to

- recognise, recall and show understanding of specific scientific facts, terminology, principles, concepts and practical techniques, including aspects of safety
- draw on existing knowledge to show understanding of the social, economic, environmental and technological applications and implications of Biology, Chemistry and Physics
- select, organise and present relevant information clearly and logically, using appropriate vocabulary.

AO2 Application of knowledge and understanding, analysis and evaluation

In the examination, candidates will be tested on their ability to

- describe, explain and interpret phenomena, effects and ideas in terms of the principles and concepts of Biology, Chemistry and Physics, presenting arguments and ideas clearly and logically
- interpret and translate, from one form into another, data presented as continuous prose or in tables, diagrams, drawings and graphs
- carry out relevant calculations
- apply the principles and concepts of Biology, Chemistry and Physics to unfamiliar situations, including those related to applications of these sciences in different domestic, industrial and environmental contexts
- evaluate scientific information and make informed judgements based on it.

AO3 Experimental and investigative skills

In the assessment of practical skills, candidates will be tested on their ability to

- devise and plan investigations, 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 a suitable form
- analyse and interpret data from experimental activities to draw conclusions which are consistent with the evidence, using scientific knowledge and understanding, and communicate these findings using appropriate specialist vocabulary
- evaluate data and methods.

Scheme of assessment

Tiers of entry

Candidates are entered at **either** Foundation Tier **or** Higher Tier.

Questions in the Foundation Tier paper are targeted at grades in the range C – G. The highest grade which will be awarded at Foundation Tier is grade C.

Questions in the Higher Tier paper are targeted at grades in the range A* – D. There is a 'safety net' grade E for candidates who narrowly fail to achieve grade D.

Candidates who fail to achieve grade G on Foundation Tier or grade E on Higher Tier will be awarded 'Ungraded'.

Some examination questions will be common to both tiers.

Weighting of assessment objectives

Assessment objective		Weighting
AO1	Knowledge and understanding (mainly assessed in Papers 1F, 2F and 3F or 4H, 5H and 6H)	45 – 55% (of which no more than half will be recall)
AO2	Application of knowledge and understanding, analysis and evaluation (mainly assessed in Papers 1F, 2F and 3F or 4H, 5H and 6H)	25 – 35% (evenly distributed across all aspects of the objective)
AO3	Experimental and investigative skills (mainly assessed in Papers 7, 8 and 9)	20%

The percentages are not intended to provide a precise statement of the number of marks allocated to particular assessment objectives.

Foundation tier summary

Foundation Tier candidates **must** take papers 1F, 2F and 3F assessing Biology, Chemistry and Physics respectively. In addition, Foundation Tier candidates are entered for either

(a) a choice of **two** of the three written papers testing practical skills

OR

(b) coursework (only available to centres approved by Edexcel International to offer coursework).

Paper / Component	Mode of assessment	Weighting and length
1	Examination Paper 1F (Biology), targeted at grades C – G (Foundation Tier).	The three equally weighted examination papers are worth 80% of the overall assessment. Each paper lasts 1 hour and 15 minutes.
AND		
2	Examination Paper 2F (Chemistry), targeted at grades C – G (Foundation Tier).	
AND		
3	Examination Paper 3F (Physics), targeted at grades C – G (Foundation Tier).	
AND		
7	Examination Paper 7 (Biology), targeted at grades A* – G (common to both tiers).	Candidates are entered for **two** of the three written alternative to practical coursework papers. Each paper lasts 1 hour and 15 minutes. The two papers account for 20% of the overall assessment.
AND / OR		
8	Examination Paper 8 (Chemistry), targeted at grades A* – G (common to both tiers).	
AND / OR		
9	Examination Paper 9 (Physics), targeted at grades A* – G (common to both tiers).	
OR		
10	Coursework, targeted at grades A* – G (common to both tiers). Assignments required in **two** science subjects.	20%

Higher tier summary

Higher Tier candidates **must** take papers 4H, 5H and 6H assessing Biology, Chemistry and Physics respectively. In addition, Higher Tier candidates are entered for either

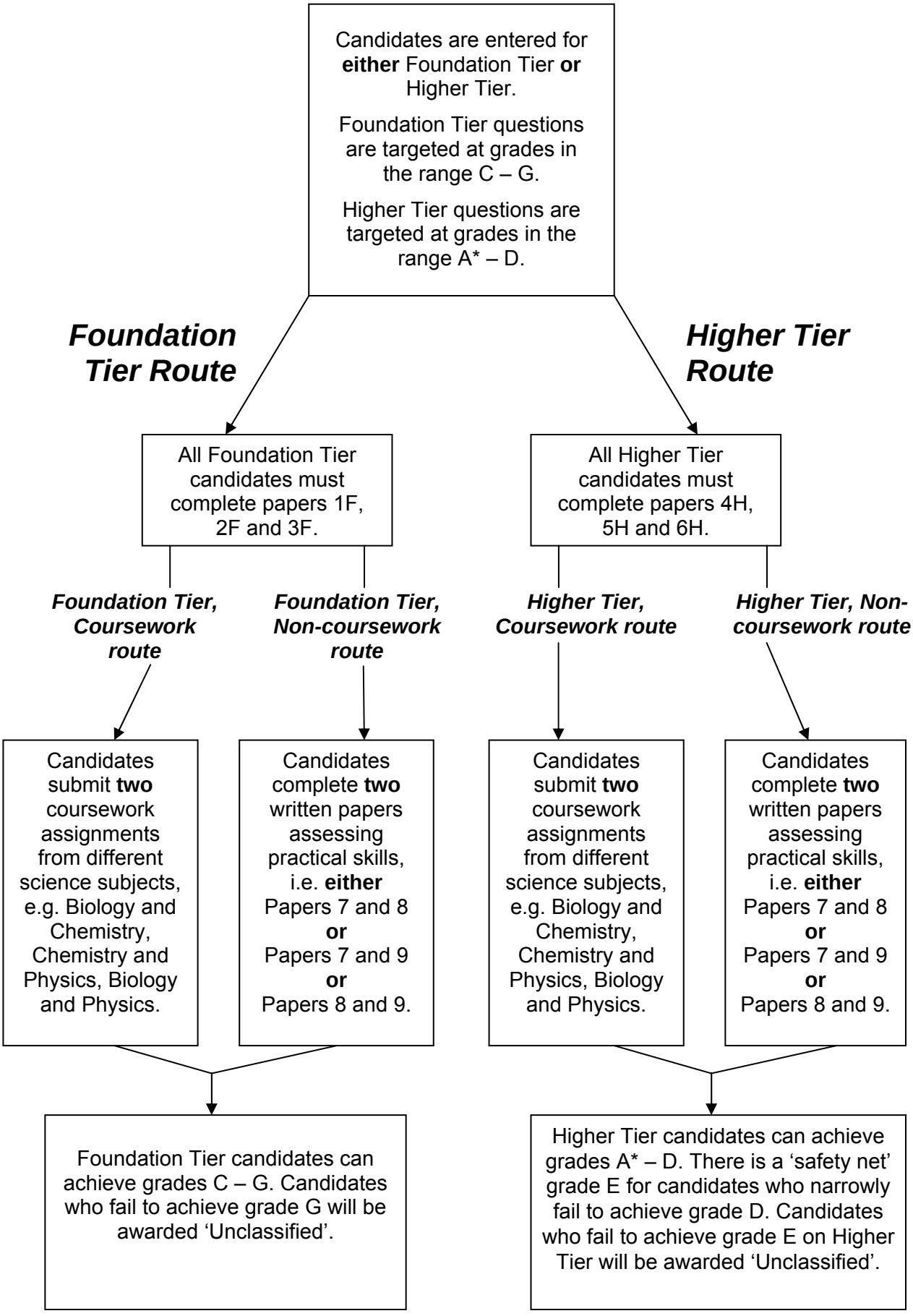
(a) a choice of **two** of the three written papers testing practical skills

OR

(b) coursework (only available to centres approved by Edexcel International to offer coursework).

Paper / Component	Mode of assessment	Weighting and length
4	Examination Paper 4H (Biology), targeted at grades A* – D (Higher Tier).	The three equally weighted examination papers are worth 80% of the overall assessment. Each paper lasts 1 hour and 30 minutes.
AND		
5	Examination Paper 5H (Chemistry), targeted at grades A* – D (Higher Tier).	
AND		
6	Examination Paper 6H (Physics), targeted at grades A* – D (Higher Tier).	
AND		
7	Examination Paper 7 (Biology), targeted at grades A* – G (common to both tiers).	Candidates are entered for **two** of the three written alternative to practical coursework papers. Each paper lasts 1 hour and 15 minutes. The two papers account for 20% of the overall assessment.
AND / OR		
8	Examination Paper 8 (Chemistry), targeted at grades A* – G (common to both tiers).	
AND / OR		
9	Examination Paper 9 (Physics), targeted at grades A* – G (common to both tiers).	
OR		
10	Coursework, targeted at grades A* – G (common to both tiers). Assignments required in **two** science subjects.	20%

An explanation of the routes of assessment



Foundation tier assessment components

Content printed in **bold** will **not** be assessed at Foundation Tier. Candidates must also be entered for the assessment components common to both tiers, see page 10.

Paper 1F (Foundation Tier, 1 hour 15 minutes)

This paper will assess **Biology** in the context of AO1 and AO2.

The first questions on this paper will be multiple-choice. These will be followed by a range of compulsory shorter and longer answer questions.

Candidates may be required to perform simple calculations, draw graphs in which the axes are given, and describe, explain and interpret biological phenomena. Some of the question content will be unfamiliar to candidates; these questions are designed to assess simple data-processing skills and the ability to apply biological principles to unfamiliar information.

The maximum mark for this paper will be 75. Approximately 30 of these marks will be common with Paper 4H.

Paper 2F (Foundation Tier, 1 hour 15 minutes)

This paper will assess **Chemistry** in the context of AO1 and AO2.

There will be a range of compulsory shorter and longer answer questions. Candidates may be required to describe, explain and interpret chemical phenomena. Some of the question content will be unfamiliar to candidates; these questions are designed to assess simple data-processing skills and the ability to apply chemical principles to unfamiliar information.

The maximum mark for this paper will be 75. Approximately 30 of these marks will be common with Paper 5H.

Paper 3F (Foundation Tier, 1 hour 15 minutes)

This paper will assess **Physics** in the context of AO1 and AO2.

There will be a range of compulsory shorter and longer answer questions. Candidates may be required to perform calculations, draw graphs in which the axes are given and describe, explain and interpret physics phenomena.

The maximum mark for this paper will be 75. Approximately 30 of these marks will be common with Paper 6H.

Papers 1F, 2F and 3F are equally weighted and account for 80% of the overall assessment at Foundation Tier.

Higher tier assessment components

The entire specification content, including the content printed in **bold**, will be assessed at the Higher Tier. Candidates must also be entered for the assessment components common to both tiers, see page 10.

Paper 4H (Higher Tier, 1 hour 30 minutes)

This paper will assess **Biology** in the context of AO1 and AO2.

There will be a range of compulsory short-answer structured questions.

Candidates may be required to perform calculations, draw graphs and describe, explain and interpret biological phenomena. Some of the question content will be unfamiliar to candidates; these questions are designed to assess data-handling skills and the ability to apply biological principles to unfamiliar information. Questions targeted at grades A* – B will include questions designed to test knowledge, understanding and skills at a higher level, including some questions requiring longer prose answers.

The maximum mark for this paper will be 90. Approximately 30 of these marks will be common with Paper 1F.

Paper 5H (Higher Tier, 1 hour 30 minutes)

This paper will assess **Chemistry** in the context of AO1 and AO2.

There will be a range of compulsory short-answer structured questions.

The maximum mark for this paper will be 90. Approximately 30 of these marks will be common with Paper 2F.

Paper 6H (Higher Tier, 1 hour 30 minutes)

This paper will assess **Physics** in the context of AO1 and AO2.

There will be a range of compulsory short-answer structured questions.

Candidates may be required to perform calculations, draw graphs and describe, explain and interpret physics phenomena. Candidates may be required to describe, explain and interpret chemical phenomena. Some of the question content will be unfamiliar to candidates; these questions are designed to assess simple data-processing skills and the ability to apply chemical principles to unfamiliar information.

The maximum mark for this paper will be 90. Approximately 30 of these marks will be common with Paper 3F.

Papers 4H, 5H and 6H are equally weighted and account for 80% of the overall assessment at Higher Tier.

Assessment components common to both tiers

Centres should refer also to the section of this specification regarding Investigative skills.

Papers 7, 8 and 9 (Common to both tiers, each paper being 1 hour and 15 minutes)

Paper 7 is a written paper assessing practical skills associated with Biology
Paper 8 is a written paper assessing practical skills associated with Chemistry
Paper 9 is a written paper assessing practical skills associated with Physics.

Candidates for both tiers will choose **two** of the thee papers above. **This choice is made at the time when the centre makes candidate entries with London Examinations.** All three of these written papers are alternatives to practical coursework (Component 10, see below).

There will be a range of compulsory questions based on Assessment Objective AO3, targeted at grades A* – G. The questions will test the investigative skills gained by candidates from practical work undertaken during the course. Some questions will require recognition and understanding of practical tests arising from study of the specification.

The four skill areas (P, O, A and E) that will be assessed are described later under 'Investigative Skills'. Candidates will be required to show the ability to: plan experimental procedures (P), describe practical techniques and take measurements (O), analyse evidence and draw conclusions communicating findings using calculations, tables and graphs (A), and evaluate evidence (E).

Each paper carries a total of 50 marks. The two papers will be equally weighted and, combined, they will be scaled to 20% of the overall assessment at either tier.

Component 10, Coursework (common to both tiers)

Candidates are required to submit **up to four** coursework assignments which will be assessed by teachers in the centre and moderated by Edexcel International. **At least two science subjects (i.e. Biology, Chemistry and Physics) must be represented.**

Candidates will be required to show the ability to: plan experimental procedures (P), obtain evidence (O), analyse this evidence and draw conclusions (A), and evaluate evidence (E). These four skill areas (P, O, A and E) are described later under 'Investigative Skills'.

The component is targeted at grades A* – G. The maximum total mark for coursework is 60, which will be scaled to 20% of the assessment at either tier.

The coursework, Component 10 of this specification, is normally available only to candidates studying at centres that have been recognised by Edexcel International as International Teaching Institutions. See full details under section 'Availability of coursework to international centres'.

Specification content

Summary

The content for this specification provides equal coverage of Biology, Chemistry and Physics. Centres will find comparisons of this specification content with similar Science qualifications (e.g. London Examinations IGCSEs in Biology, Chemistry and Physics, and the Edexcel UK GCSE) in the Teacher's Guide, publication code UG014357, and also posted on the Edexcel International website as Frequently Asked Questions (FAQs).

Biology

Section B1: Nature and variety of living organisms

Section B2: Structures and functions in living organisms

Section B3: Reproduction and inheritance

Section B4: Ecology and the environment

Section B5: Use of biological resources

Chemistry

Section C1: Principles of chemistry

Section C2: Chemistry of the elements

Section C3: Organic chemistry

Section C4: Physical chemistry

Section C5: Chemistry in society

Physics

Section P1: Forces and motion

Section P2: Electricity and electromagnetism

Section P3: Waves

Section P4: Energy resources and energy transfer

Section P5: Solids, liquids and gases

Section P6: Radioactivity and particles

In the following description of the specification content, statements in **bold type** are for **Higher Tier** only and will not be assessed at Foundation Tier. Higher Tier candidates must, therefore, study **all** of the following specification content.

In addition, students will be assessed on the investigative skills described on pages 37 to 44, either through written assessment (Papers 7, 8 and 9) or by teacher-assessed coursework (Component 10).

Specification content for Biology

Practical work for Biology is printed in *italics*. This content may be assessed in any of the papers assessing Biology, i.e. papers 1F, 4H and 7.

Section B1: The nature and variety of living organisms

Candidates will be assessed on their ability to

- understand that there is a wide variety of living organisms including plants, animals, fungi, bacteria, and viruses (B1.1).

Section B2: Structures and functions in living organisms

(a) Cell structure

Candidates will be assessed on their ability to

- recognise cell structures, including the nucleus, cytoplasm, cell membrane, cell wall, chloroplast and vacuole (B2.1)
- describe the functions of the nucleus, cytoplasm, cell membrane, cell wall, chloroplast and vacuole (B2.2)
- describe the differences between plant and animal cells and understand how different cells carry out different functions (B2.3).

(b) Biological molecules

Candidates will be assessed on their ability to

- *describe the tests for glucose and starch (B2.4)*
- understand the role of enzymes as biological catalysts and understand how their functioning can be affected by changes in temperature (B2.5)
- *describe how to carry out simple controlled experiments to illustrate how enzyme activity can be affected by changes in temperature (B2.6)*.

(c) Movement of substances into and out of cells

Candidates will be assessed on their ability to

- recall simple definitions of diffusion, osmosis and active transport (B2.7)
- understand that movement of substances into and out of cells can be by diffusion, osmosis and active transport (B2.8)
- **understand the factors that affect the rate of movement of substances into and out of cells to include the effects of surface area to volume ratio, temperature and concentration gradient (B2.9)**
- *describe simple experiments on diffusion and osmosis using living and non-living systems (B2.10)*.

(d) Nutrition

Candidates will be assessed on their ability to

Flowering plants

- describe the process of photosynthesis and understand its importance in conversion of light energy to chemical energy (B2.11)
- recall the word equation **and the balanced chemical symbol equation** for photosynthesis (B2.12)
- understand how carbon dioxide concentration, light intensity and temperature affect the rate of photosynthesis (B2.13)
- explain how the structure of the leaf is adapted for photosynthesis (B2.14)
- recall that plants require mineral ions for growth and that magnesium ions are needed for chlorophyll and nitrate ions are needed for amino acids (B2.15)
- *describe simple controlled experiments to investigate photosynthesis, showing the evolution of oxygen from a water plant, the production of starch and the requirements of light, carbon dioxide and chlorophyll (B2.16)*.

Humans

- recall sources and describe functions of carbohydrate, protein, lipid (fats and oils), vitamins A and C, the mineral ions calcium and iron, water and dietary fibre as components of the diet (B2.17)
- recognise the structures of the human alimentary canal and describe in outline the functions of the mouth, oesophagus, stomach, small intestine, large intestine, and pancreas (B2.18)
- understand the processes of ingestion, digestion, absorption, assimilation and egestion (B2.19)
- explain how and why food is moved through the gut by peristalsis (B2.20)
- understand the role of digestive enzymes in breaking down large molecules to small molecules, to include the digestion of starch to glucose by amylase, the digestion of proteins to amino acids by proteases and the digestion of lipids to fatty acids and glycerol by lipases (B2.21)
- recall that bile is produced by the liver and stored in the gall bladder, and understand the role of bile in neutralising stomach acid and emulsifying lipids; explain how the structure of a villus helps absorption of the products of digestion in the small intestine (B2.22).

(e) Respiration

Candidates will be assessed on their ability to

- recall that the process of respiration releases energy in living organisms (B2.23)
- describe the differences between aerobic and anaerobic respiration (B2.24)
- recall the word equation **and the balanced chemical symbol equation** for aerobic respiration in living organisms (B2.25)
- recall the word equation for anaerobic respiration in plants and in animals (B2.26).

(f) Gas exchange

Candidates will be assessed on their ability to

Flowering plants

- understand gas exchange in a leaf (of carbon dioxide and oxygen) in relation to respiration and photosynthesis (B2.27)
- **understand that respiration continues during the day and night, but that the net exchange of carbon dioxide and oxygen depends on the intensity of light (B2.28)**
- describe the role of stomata in leaves (B2.29).

Humans

- describe the structure of the thorax, including the ribs, intercostal muscles, diaphragm, trachea, bronchi, bronchioles, alveoli and pleural membranes (B2.30)
- understand the role of the intercostal muscles and the diaphragm, in ventilation (B2.31)
- explain how alveoli are adapted for gas exchange by diffusion between air in the lungs and blood in capillaries (B2.32)
- understand the biological consequences of smoking in relation to the lungs and the circulatory system (B2.33)
- describe a simple experiment to investigate the effect of exercise on breathing in humans (B2.34).

(g) Transport

Candidates will be assessed on their ability to

Flowering plants

- describe the role of phloem in transporting sucrose and amino acids between the leaves and other parts of the plant, and the role of xylem in transporting water and mineral salts from the roots to other parts of the plant (B2.35)
- explain how water is absorbed by root hair cells (B2.36)
- recall that transpiration is the evaporation of water from the surface of a plant (B2.37)
- **explain how the rate of transpiration is affected by changes in humidity, wind speed, temperature and light intensity (B2.38)**
- *describe experiments that investigate the role of environmental factors in determining the rate of transpiration from a leafy shoot (B2.39)*.

Humans

- recall the composition of the blood: red blood cells, white blood cells, platelets and plasma (B2.40)
- understand the role of plasma in the transport of carbon dioxide, digested food, urea, hormones and heat energy (B2.41)
- describe the adaptations of red blood cells for the transport of oxygen, including shape, structure and the presence of haemoglobin (B2.42)
- describe the role of white blood cells in preventing disease by ingestion of microorganisms and the production of antibodies to destroy microorganisms (B2.43)
- describe the structure of the heart and how it functions (B2.44)
- understand reasons for the change in heart rate during exercise (B2.45)
- describe the structure of arteries, veins and capillaries and understand their roles (B2.46)
- recall the general plan of the circulation system to include the blood vessels to and from the heart, the lungs, the liver and the kidneys (B2.47).

(h) Excretion

Candidates will be assessed on their ability to

Flowering plants

- recall the origin of carbon dioxide and oxygen as waste products of metabolism and their loss from the stomata of a leaf (B2.48).

Humans

- recall that the lungs and kidneys are organs of excretion (B2.49)
- understand how the kidney carries out its roles of excretion and of osmoregulation (B2.50)

- describe the structure of the urinary system, including the kidneys, ureters, bladder and urethra (B2.51)
- describe the structure of a nephron, to include Bowman's capsule and glomerulus, convoluted tubules, loop of Henlé and collecting duct (B2.52)
- describe ultrafiltration in the Bowman's capsule and the composition of the glomerular filtrate (B2.53)
- understand that water is reabsorbed into the blood from the collecting duct (B2.54)
- **understand that selective reabsorption of glucose occurs at the proximal convoluted tubule (B2.55)**
- **describe the role of ADH in regulating the water content of the blood (B2.56)**
- recall that urine contains water, urea and salts (B2.57).

(i) Coordination and response

Candidates will be assessed on their ability to

- understand that organisms are able to respond to changes in their environment and that a coordinated response requires a stimulus, a receptor and an effector (B2.58)
- understand that homeostasis is the maintenance of a constant internal environment and that examples of it include body water content and body temperature (B2.59)

Flowering plants

- understand that plants respond to light stimuli and describe positive phototropism of stems (B2.60)
- **understand that phototropic responses in stems are the result of differential growth caused by auxin (B2.61)**
- *recall a controlled experiment to demonstrate phototropic plant growth response (B2.62).*

Humans

- understand that stimulation of receptors in the sense organs sends electrical impulses along nerves into and out of the central nervous system, resulting in rapid responses (B2.63)
- **describe the structure and functioning of a simple reflex arc illustrated by the withdrawal of a finger from a hot object (B2.64)**
- describe the structure and function of the eye as a receptor (B2.65)
- understand the function of the eye in focusing near and distant objects, and in responding to changes in light intensity (B2.66)
- **describe the role of the skin in temperature regulation, with reference to sweating, vasoconstriction and vasodilation (B2.67)**
- understand the sources, roles and effects of the following hormones: **ADH**, insulin, testosterone, progesterone and oestrogen (B2.68).

Section B3: Reproduction and inheritance

(a) Reproduction

Candidates will be assessed on their ability to

- describe the differences between sexual and asexual reproduction (B3.1)
- 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 (B3.2).

Flowering plants

- describe pollination and the structure of an insect-pollinated flower and explain how it is adapted for pollination (B3.3)
- understand that the growth of the pollen tube followed by fertilisation leads to seed formation (B3.4)
- understand that plants can reproduce asexually by natural methods (illustrated by runners), and by artificial methods (illustrated by cuttings) (B3.5).

Humans

- recall the structure and function of the male and female reproductive systems (B3.6)
- understand the roles of oestrogen and progesterone in the menstrual cycle (B3.7).

(b) Inheritance

- recall that the nucleus of a cell contains chromosomes on which genes are located (B3.8)
- understand that a gene is a section of a molecule of DNA (B3.9)
- understand that genes exist in alternative forms called alleles which give rise to differences in inherited characteristics (B3.10)
- recall the meaning of the terms dominant, recessive, homozygous, heterozygous, phenotype and genotype (B3.11)
- describe patterns of monohybrid inheritance using a genetic diagram (B3.12)
- **understand how to interpret family pedigrees (B3.13)**
- **predict probabilities of outcomes from monohybrid crosses (B3.14)**
- recall that the sex of a person is controlled by one pair of chromosomes, XX in a female and XY in a male, and describe the determination of the sex of offspring at fertilisation, using a genetic diagram (B3.15)
- understand that division of a diploid cell by mitosis produces two cells which contain identical sets of chromosomes, and that mitosis occurs during growth, repair, cloning and asexual reproduction (B3.16)
- understand that division of a cell by meiosis produces four cells, each with half the number of chromosomes, and that this results in the formation of genetically different haploid gametes (B3.17)
- recall that mutation is a rare, random change in genetic material that can be inherited (B3.18)
- understand that many mutations are harmful but some are neutral and a few are beneficial, **and that mutant organisms can increase in a population by natural selection (B3.19).**

Section B4: Ecology and the environment

(a) The organism in the environment

Candidates will be assessed on their ability to

- describe the use of quadrats as a technique for sampling the distribution of organisms in their habitats (B4.1)
- *recall the use of quadrats to estimate the population size of an organism in two different areas (B4.2).*

(b) Feeding relationships

Candidates will be assessed on their ability to

- recall the names given to different trophic levels to include producers, primary, secondary and tertiary consumers and decomposers (B4.3)
- understand the concepts of food chains, food webs, pyramids of number, pyramids of biomass and **pyramids of energy transfer (B4.4)**
- understand the transfer of substances and of energy along a food chain (B4.5)
- **explain why only about 10% of energy is transferred from one trophic level to the next (B4.6).**

(c) Cycles within ecosystems

Candidates will be assessed on their ability to

- describe the stages in the carbon cycle, including respiration, photosynthesis, decomposition and combustion (B4.7)
- **describe the stages in the nitrogen cycle, including the roles of nitrogen fixing bacteria, decomposers, nitrifying bacteria and denitrifying bacteria (specific names of bacteria are not required) (B4.8).**

(d) Human influences on the environment

Candidates will be assessed on their ability to

- understand the biological consequences of pollution of air by sulphur dioxide and by carbon monoxide (B4.9)
- understand the biological consequences of pollution of water by sewage including increases in the number of microorganisms causing depletion of oxygen (B4.10)
- **understand that eutrophication can result from leached minerals from fertiliser (B4.11)**
- understand the effects of deforestation, including leaching, soil erosion, patterns of rainfall and of the balance in atmospheric oxygen and carbon dioxide (B4.12).

Section B5: Use of biological resources

(a) Food production

Candidates will be assessed on their ability to

Crop plants

- understand the effects on crop yield of increased carbon dioxide and increased temperature in glasshouses and the use of fertiliser (B5.1)
- understand the reasons for pest control and the advantages and disadvantages of using pesticides and biological control with crop plants (B5.2).

Microorganisms

- understand the role of yeast in the production of beer (B5.3)
- *describe a simple experiment to investigate carbon dioxide production by yeast (B5.4)*.

Fish farming

- **explain the methods which are used to farm large numbers of fish to provide a source of protein, including maintenance of water quality, control of predation, control of disease, removal of waste products and quality of feeding (B5.5).**

(b) Selective breeding

Candidates will be assessed on their ability to

- understand that plants with desired characteristics can be developed by selective breeding (illustrated by increased yield and reduction of stem length in wheat) (B5.6)
- understand that animals with desired characteristics can be developed by selective breeding (illustrated by increased yield of meat and milk in cattle) (B5.7).

(c) Genetic Modification (Genetic engineering)

Candidates will be assessed on their ability to

- **describe the use of restriction enzymes to cut DNA molecules at specific sites and ligase enzymes to join pieces of DNA together (B5.8)**
- **describe how plasmids and viruses can act as vectors, which take up pieces of DNA, then insert this recombinant DNA into other cells (B5.9)**
- understand that large amounts of human insulin can be manufactured from genetically modified bacteria that are grown in a fermenter (B5.10)
- evaluate the potential for using genetically modified plants to improve food production (illustrated by plants with improved resistance to disease) (B5.11).

(d) Cloning

Candidates will be assessed on their ability to

- describe the process of tissue culture in which small pieces of plants are grown *in vitro* using nutrient media, and that this is used to produce commercial quantities of identical plants (clones) with desirable characteristics (B5.12)
- describe the stages in the production of cloned mammals involving the introduction of a diploid nucleus from a mature cell into an enucleated egg cell, illustrated by Dolly the sheep (B5.13).

Specification content for Chemistry

Section C1: Principles of Chemistry

(a) Atoms

Candidates will be assessed on their ability to

- recall simple experiments leading to the idea of the smallness of particles and to their motion including
    - dilution of coloured solutions
    - diffusion experiments
    - Brownian motion (C1.1)
- define an element, and an atom as the particle of which elements are composed (C1.2).

(b) Atomic structure

Candidates will be assessed on their ability to

- recall that atoms consist of a central nucleus, composed of protons and neutrons, surrounded by orbiting electrons (C1.3)
- state the relative mass and relative charge of a proton, neutron and electron (C1.4)
- explain the terms atomic number, mass number, isotopes and relative atomic mass (A_r) (C1.5)
- **calculate the relative atomic mass of an element from the relative abundances of its isotopes (C1.6)**
- recall the electronic configurations of the first twenty elements of the Periodic Table (C1.7)
- relate periodicity to electronic configuration (C1.8)
- relate similarity of electronic configuration to similarity of the chemical properties of the Group 1 elements and the Group 7 elements (C1.9)
- appreciate the importance of the noble gas electronic configurations (C1.10).

(c) Relative formula masses and molar volumes

Candidates will be assessed on their ability to

- calculate relative formula masses (M_r) from relative atomic masses (A_r) (C1.11)
- **recall that the mole is an amount of substance which can also be expressed as the Avogadro number of particles (atoms, molecules, formulae, ions or electrons) or as a relative formula mass in grams (C1.12)**
- **understand the significance of the molar volume of a gas and use the values of molar volume of a gas at room temperature and pressure (rtp) (C1.13).**

(d) Chemical formulae and chemical equations

Candidates will be assessed on their ability to

- **calculate empirical formulae and molecular formulae (C1.14)**
- write word equations to represent the reactions studied in this specification (C1.15)
- write chemical equations that do not require balancing to represent the reactions studied in this specification (C1.16)
- use the state symbols (l), (s), (g) and (aq) in chemical equations to represent liquids, solids, gases and aqueous solutions respectively (C1.17)
- **write balanced chemical equations to represent the reactions studied in this specification (C1.18)**.

(e) Ionic compounds

Candidates will be assessed on their ability to

- describe the formation of ions by gain or loss of electrons (C1.19)
- recall the charges on common ions met in the specification and link ionic charge with electronic configuration (C1.20)
- use the dot and cross model to explain the formation of an ionic compound by electron transfer, limited to combinations of Li^+, Na^+, Mg^{2+}, F^-, Cl^- and O^{2-} (C1.21)
- recognise oxidation as the loss of electrons and reduction as the gain of electrons (C1.22)
- recall that ionic compounds, such as NaCl and MgO, have high melting points and high boiling points because of strong electrostatic forces between ions (C1.23)
- **recall that there is a strong electrostatic attraction between oppositely charged ions, called an ionic bond, and this extends throughout the ionic structure (C1.24)**
- **describe an ionic crystal as a giant three-dimensional ionic structure held together by attraction between oppositely charged ions (C1.25)**
- **understand that ionic compounds conduct electricity when molten or in solution, in terms of movement of ions (C1.26)**
- **understand electrolysis as the formation of new substances when ionic compounds conduct electricity (C1.27)**.

(f) Covalent substances

Candidates will be assessed on their ability to

- describe how covalent bonds involve the sharing of electron pairs between outer electron shells of atoms, and that these bonds are strong (C1.28)
- use dot and cross diagrams to represent single covalent bonds in
    - hydrogen
    - water
    - methane
    - hydrogen chloride (C1.29)
- **use dot and cross diagrams to represent the electron arrangement in more complex covalent molecules such as**
    - **nitrogen**
    - **ethane**
    - **carbon dioxide (C1.30)**
- recall that substances with molecular structures are usually gases, liquids or solids with low melting points and boiling points and be able to explain this in terms of the relatively weak forces between the molecules (C1.31)
- describe and explain the physical properties of a typical simple covalent compound (C1.32)
- recall that diamond and graphite are allotropes of carbon (C1.33)
- **describe and explain the giant molecular covalent structures of diamond and graphite and relate their structures to their use – graphite as a lubricant and diamond in cutting (C1.34)**
- **understand that atoms in diamond and graphite are held together by strong covalent bonds which result in high sublimation points (C1.35).**

Section C2: Chemistry of the elements

(a) The Periodic Table

Candidates will be assessed on their ability to

- appreciate the Periodic Table as the arrangement of elements in a table according to atomic number (C2.1)
- classify elements as 'metals' and 'non-metals' on the basis of their properties and be aware that some elements exhibit a mixture of the properties of metals and non-metals (C2.2)
- recall families of elements including the alkali metals (Group 1) and the halogens (Group 7) (C2.3)
- recall the relative reactivities of the elements within Groups 1 and 7 (C2.4)
- recall the noble gases (Group 0) as a family of inert gases (C2.5)
- describe the correlation of charges of ions with the position of an element in the Periodic Table (C2.6)
- **understand the relationship between group number, number of outer electrons and metallic-nonmetallic character across periods (C2.7).**

(b) The Group 1 elements – lithium, sodium and potassium

Candidates will be assessed on their ability to

- describe the reactions of these elements with water and recognise that the reactivities of these elements with water provide a basis for their recognition as a family of elements (C2.8)
- recall that the hydroxides, halides, sulphates, nitrates and carbonates of these elements are soluble in water and that the oxides and hydroxides form alkaline solutions (C2.9)
- **make predictions about the properties of other elements and their compounds in this group (C2.10).**

(c) The Group 7 elements – chlorine, bromine and iodine

Candidates will be assessed on their ability to

- recall the colour and physical states of the elements at room temperature (C2.11)
- **describe the reaction of hydrogen with chlorine (C2.12)**
- understand the difference between hydrogen chloride and hydrochloric acid (C2.13)
- **describe the properties of solutions of hydrogen chloride in water and in methylbenzene (C2.14)**
- recall that a more reactive halogen will displace a less reactive halogen from a solution of one of its salts (C2.15)
- **make predictions about the properties of other halogens in this group (C2.16).**

(d) A transition metal – copper

Candidates will be assessed on their ability to

- recall the colour of copper(II) oxide, hydroxide, nitrate, sulphate, carbonate and chloride (C2.17)
- recall the existence of copper(I) compounds such as copper(I) oxide (C2.18)
- **understand that the study of copper and its compounds illustrates typical transition metal properties of variable valency, formation of coloured compounds and formation of complex ions (C2.19).**

(e) Reactivity series

Candidates will be assessed on their ability to

- understand that elements can be arranged in order of their reactivity (C2.20)
- relate the pattern in the reactions of the elements and their compounds, included elsewhere in the specification, to a reactivity series (C2.21)
- understand the reduction of oxides in terms of the reactivity of elements (C2.22)
- recall the reactions with oxygen, water and dilute acids used to establish the following order of reactivity: potassium, sodium, lithium, calcium, magnesium, aluminium, zinc, iron, (hydrogen) and copper (C2.23)
- establish position within the reactivity series using displacement reactions involving metals and their compounds in aqueous solutions (C2.24)
- recall the conditions under which iron rusts (C2.25)
- describe how rusting of iron and mild steel may be prevented by grease, oil, paint, plastic and galvanising (C2.26)
- **describe the sacrificial protection of iron and mild steel in terms of the reactivity series (C2.27).**

(f) Preparing and analysing

Candidates will be assessed on their ability to

- recall simple tests for the cations
    - Li^+ , Na^+, K^+, Ca^{2+} using flame tests
    - NH_4^+ using aqueous sodium hydroxide and identifying the ammonia evolved
    - Cu^{2+}, Fe^{2+} and Fe^{3+} using aqueous sodium hydroxide
    - **Cu^{2+}, Fe^{2+} and Fe^{3+} using aqueous ammonia**
    - **describe the reaction of copper(II) ions with ammonia to form the complex ion $[Cu(H_2O)_2(NH_3)_4]^{2+}$ (C2.28)**
- recall simple tests for the anions
    - chloride, bromide and iodide, using dilute nitric acid and silver nitrate solution
    - sulphate, using dilute hydrochloric acid and barium chloride solution
    - carbonate, using dilute hydrochloric acid and identifying the carbon dioxide evolved (C2.29)
- recall simple tests for
    - ammonia
    - carbon dioxide
    - chlorine
    - hydrogen
    - oxygen
    - water (C2.30)
- recall the general rules that describe the solubility of common types of salts in water
    - all common sodium, potassium and ammonium salts are soluble
    - all nitrates are soluble
    - common chlorides are soluble, except silver chloride
    - common sulphates are soluble, except those of barium and calcium
    - common carbonates and hydroxides are insoluble, except those of sodium, potassium and ammonium (C2.31)
- understand that insoluble salts can be formed as precipitates by the reaction of suitable reagents in solution (C2.32)
- use information on solubility to predict methods of preparing salts (C2.33).

Section C3: Organic chemistry

(a) Alkanes

Candidates will be assessed on their ability to

- recall that alkanes are saturated hydrocarbons (C3.1)
- explain the terms 'homologous series', 'general formula' and 'isomerism' (C3.2)
- draw displayed formulae for alkanes containing up to 4 carbon atoms in a molecule (C3.3)
- **draw displayed formulae of alkanes containing up to five carbon atoms, and name them (C3.4).**

(b) Alkenes

Candidates will be assessed on their ability to

- recall that alkenes are unsaturated hydrocarbons (C3.5)
- draw displayed formulae for alkenes containing up to 4 carbon atoms in a molecule (C3.6)
- describe the addition of bromine to alkenes, including the decolorising of bromine water as a test for alkenes (C3.7).

Section C4: Physical chemistry

(a) States of matter

Candidates will be assessed on their ability to

- understand the arrangement of particles in the three states of matter: gas, liquid and solid (C4.1)
- describe the interconversion of gas, liquid and solid (C4.2)
- understand the differences between mixtures and compounds (C4.3)
- recall techniques for separation, including distillation, fractional distillation, filtration, crystallisation, paper chromatography (C4.4).

(b) Acidity, alkalinity and neutralisation

Candidates will be assessed on their ability to

- recall how to test for acidity and alkalinity, using suitable indicators (C4.5)
- recall the colours produced by the following indicators in acidic solution and alkaline solution; litmus, phenolphthalein, methyl orange and universal indicator (C4.6)
- describe the pH scale, running from 0–14, as a scale of acidity and alkalinity (C4.7)
- describe solutions which have a pH value of less than 7 as acidic, those with a pH value of more than 7 as alkaline and those with a pH of 7 as neutral (C4.8)
- describe how to prepare salts using neutralisation reactions, including the reaction of excess metal oxide/metal carbonate and dilute acid (C4.9)
- **describe how to carry out acid–alkali titrations (C4.10).**

(c) Energetics

Candidates will be assessed on their ability to

- recall that chemical reactions are accompanied by an energy change which, in solution, may be detected as a temperature change (C4.11)
- recall that reactions may be described as exothermic when heat energy is given out and endothermic when heat energy is taken in (C4.12)
- recall that energy changes accompany combustion, solution and neutralisation (C4.13)
- recall the use of the Δ*H* notation to represent the heat energy change for a reaction (C4.14)
- **recall that the breaking of bonds is endothermic and that the making of bonds is exothermic (C4.15)**
- **understand that heats of reaction are the result of energy changes when bonds are broken and formed (C4.16).**

(d) Rates of reaction

Candidates will be assessed on their ability to

- describe the effect of surface area, concentration, temperature and the use of a catalyst on the rate of a reaction (C4.17)
- describe experiments to investigate the effects of temperature, concentration and surface area of a solid on the rate of reaction (C4.18)
- **explain the effects of particle size, concentration and temperature in terms of effective collisions, using a simple kinetic model (C4.19).**

(e) Equilibria

Candidates will be assessed on their ability to

- discuss the idea of a simple reversible reaction, such as the hydration of anhydrous copper(II) sulphate or the effect of heat on ammonium chloride (C4.20)
- **explain the concept of dynamic equilibrium and the use of the symbol ⇌ in equations (C4.21)**
- **predict the effects of changing the conditions (pressure and temperature) on reversible reactions including the industrial processes outlined in section 5(d) (C4.22).**

Section C5: Chemistry in society

(a) Extraction and uses of metals

Candidates will be assessed on their ability to

- understand oxidation and reduction as the addition and removal of oxygen respectively (C5.1)
- describe and explain the extraction of aluminium from purified aluminium oxide by electrolysis, including
    - use of molten cryolite
    - need to replace the positive electrodes
    - cost of the electricity as a major consideration (C5.2)
- **write ionic half-equations for the reactions at the electrodes in aluminium extraction (C5.3)**

- describe the reaction of carbon with metal oxides (C5.4)
- recall how iron is extracted from iron ore in a blast furnace using the raw materials iron oxide, coke, limestone and air (C5.5)
- describe and explain the main reactions involved in the extraction of iron, including the role of carbon dioxide and limestone (C5.6)
- explain how the methods of extraction of the metals in this section are related to their positions in the reactivity series (C5.7)
- describe and explain the purification of copper by electrolysis using impure copper as the positive electrode and pure copper as the negative electrode in a solution of copper(II) sulphate (C5.8)
- recall some important uses of the metals in this section and relate the uses to specified properties (C5.9).

(b) Natural oil and gas

Candidates will be assessed on their ability to

- recall that crude oil is a complex mixture of hydrocarbons (C5.10)
- describe how the process of fractional distillation can be used to separate the hydrocarbons in crude oil (C5.11)
- recall that the fractions obtained from crude oil are refinery gases, gasoline, kerosene, diesel, fuel oil and bitumen (C5.12)
- describe the uses of the main fractions (C5.13)
- recall that the complete combustion of hydrocarbon fuels produces carbon dioxide and water (C5.14)
- recall that incomplete combustion of fuels may produce carbon monoxide and that carbon monoxide is poisonous because it reduces the capacity of blood to carry oxygen (C5.15)
- recall that during the combustion of fuels, sulphur dioxide and nitrogen oxides may be formed as pollutant gases which contribute to acid rain (C5.16)
- **recall that fractional distillation of crude oil produces more long-chain and fewer short-chain hydrocarbons than required (C5.17)**
- **describe how long-chain hydrocarbons are cracked to give more short-chain hydrocarbons (C5.18).**

(c) Synthetic polymers

Candidates will be assessed on their ability to

- recall that a polymer is formed by joining up many small molecules of monomer (C5.19)
- recall that ethene is used in the manufacture of the addition polymer poly(ethene) and draw the structure of poly(ethene), showing the repeat unit (C5.20)
- **apply the principles of addition polymerisation to the addition polymers poly(propene) and poly(chloroethene) (C5.21)**
- recall the uses of polymers: poly(ethene), poly(propene) and poly(chloroethene) and link the properties of a polymer to its use (C5.22).

(d) The manufacture of some important chemicals

Candidates will be assessed on their ability to

- recall how nitrogen, from air, and hydrogen, from natural gas or the cracking of hydrocarbons, are used in the manufacture of ammonia (C5.23)
- recall the conditions used in the Haber process
    - a temperature of about 450 °C
    - a pressure of about 200 atmospheres
    - an iron catalyst
    - how the ammonia produced is liquefied and any unused hydrogen and nitrogen recycled (C5.24)
- recall important uses of ammonia, including the manufacture of nitric acid and the manufacture of nitrogenous fertilisers (C5.25)
- recall that sodium hydroxide and chlorine are manufactured by the electrolysis of sodium chloride solution (brine) (C5.26)
- recall important uses of sodium hydroxide (manufacture of soap, paper, ceramics) and chlorine (in bleach and for sterilising water supplies) (C5.27).

Specification content for Physics

Section P1: Forces and motion

(a) Units

Candidates will be assessed on their ability to

- use the following units: kilogram (kg), metre (m), metre/second (m/s), metre/second^2 (m/s^2), newton (N), second (s) (P1.1).

(b) Movement and position

Candidates will be assessed on their ability to

- understand and use distance–time graphs (P1.2)
- recall and use the relationship between average speed, distance moved and time

$$\text{average speed} = \frac{\text{distance moved}}{\text{time taken}} \quad \text{(P1.3)}$$

- recall and use the relationship between acceleration, velocity and time

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

$$a = \frac{(v-u)}{t} \quad \text{(P1.4)}$$

- interpret velocity–time graphs (P1.5)
- determine acceleration from the gradient of a velocity–time graph and the distance travelled from the area between the graph and the time axis (P1.6).

(c) Forces, movement and shape

Candidates will be assessed on their ability to

- express a force as a push or pull of one body on another (P1.7)
- identify various types of force (e.g. gravitational, electrostatic, etc.) (P1.8)
- understand that friction is a force that opposes motion (P1.9)
- **recall and use the relationship between unbalanced force, mass and acceleration:**

  force = mass × acceleration

  F* = *m* × *a **(P1.10)**

- recall and use the relationship between weight, mass and *g* :

  weight = mass × *g*

  $W = m \times g$ (P1.11)

- describe the forces acting on falling objects and explain why falling objects reach a terminal velocity (P1.12)
- describe the factors affecting vehicle stopping distance including speed, mass, road condition and reaction time (P1.13)

- recall and use the relationship between the moment of a force and its distance from the pivot:

  moment = force × perpendicular distance from pivot (P1.14)

- recall that the weight of a body acts through its centre of gravity (P1.15)
- describe how extension varies with applied force for helical springs, metal wires and rubber bands (P1.16)
- recall that the initial linear region of a force – extension graph is associated with Hooke's law (P1.17).

Section P2: Electricity and electromagnetism

(a) Units

Candidates will be assessed on their ability to

- use the following units: ampere (A), coulomb (C), joule (J), ohm (Ω), second (s), volt (V), watt (W) (P2.1).

(b) Mains electricity

Candidates will be assessed on their ability to

- identify common materials which are electrical conductors or insulators, including metals and plastics (P2.2)
- recall the hazards of electricity including frayed cables, long cables, damaged plugs, water around sockets, and pushing metal objects into sockets (P2.3)
- describe the uses of insulation, double insulation, earthing, fuses and circuit breakers in a range of domestic appliances (P2.4)
- know some of the different ways in which electrical heating is used in a variety of domestic contexts (P2.5)
- understand that a current in a resistor results in the electrical transfer of energy and an increase in temperature (P2.6)
- recall and use the relationship

  power = current × voltage

  $P = I \times V$

  and apply the relationship to the selection of appropriate fuses (P2.7)
- **use the relationship between energy transferred, current, voltage and time:**

  energy transferred = current × voltage × time

  $\boldsymbol{E = I \times V \times t}$ **(P2.8)**
- recall that mains electricity is alternating current (a.c.) and understand the difference between this and the direct current (d.c.) supplied by a cell or battery (P2.9).

(c) Energy and potential difference in circuits

Candidates will be assessed on their ability to

- explain why a series or parallel circuit is more appropriate for particular applications, including domestic lighting (P2.10)
- understand that the current in a series circuit depends on the applied voltage and the number and nature of other components (P2.11)

- describe how current varies with voltage in wires, resistors, metal filament lamps and diodes, and how this can be investigated experimentally (P2.12)
- describe the qualitative effect of changing resistance on the current in a circuit (P2.13)
- describe the qualitative variation of resistance of LDRs with illumination and of thermistors with temperature (P2.14)
- recall and use the relationship between voltage, current and resistance:

  voltage = current × resistance

  $V = I \times R$ (P2.15)
- understand that current is the rate of flow of charge (P2.16)
- recall and use the relationship between charge, current and time:

  charge = current × time

  $Q = I \times t$ (P2.17)
- **recall that electric current in solid metallic conductors is a flow of negatively charged electrons (P2.18)**.

(d) Magnetism and electromagnetism

Candidates will be assessed on their ability to

- understand the term 'magnetic field line' (P2.19)
- recall that an electric current in a conductor produces a magnetic field round it (P2.20)
- recall that 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 (P2.21)
- **predict the direction of the resulting force when a wire carries a current perpendicular to a magnetic field (P2.22)**
- **recall that the force on a current-carrying conductor in a magnetic field increases with the strength of the field and with the current (P2.23).**

(e) Electromagnetic induction

Candidates will be assessed on their ability to

- recall that a voltage is induced in a conductor when it moves through a magnetic field or when a magnetic field changes through a coil; also recall the factors which affect the size of the induced voltage (P2.24)
- describe the generation of electricity by the rotation of a magnet within a coil of wire and of a coil of wire within a magnetic field; also describe the factors which affect the size of the induced voltage (P2.25).

Section P3: Waves

(a) Units

Candidates will be assessed on their ability to

- use the following units: degree (^{o}), hertz (Hz), metre (m), metre/second (m/s), second (s) (P3.1).

(b) Properties of waves

Candidates will be assessed on their ability to

- describe longitudinal and transverse waves in ropes, springs and water where appropriate (P3.2)
- state the meaning of amplitude, frequency, wavelength and period of a wave (P3.3)

- recall that waves transfer energy and information without transferring matter (P3.4)
- recall and use the relationship between the speed, frequency and wavelength of a wave:

  wave speed = frequency × wavelength

  $v = f \times \lambda$ (P3.5)

- use the relationship between frequency and time period:

  $$\text{frequency} = \frac{1}{\text{time period}}$$

  $$f = \frac{1}{T}$$ (P3.6)

- use the above relationships in different contexts including sound waves and electromagnetic waves (P3.7).

(c) The electromagnetic spectrum

Candidates will be assessed on their ability to

- understand that light is part of a continuous electromagnetic spectrum which includes radio, microwave, infra-red, visible, ultraviolet, X-ray and gamma ray radiations and that all these waves travel at the same speed in free space (P3.8)
- recall the order of the electromagnetic spectrum in decreasing wavelength and increasing frequency, including the colours of the visible spectrum (P3.9)
- recall some of the uses of electromagnetic radiations, including
  - radio waves: broadcasting and communications
  - microwaves: cooking and satellite transmissions
  - infra-red: heaters and night-vision equipment
  - visible light: optical fibres and photography
  - ultraviolet: fluorescent lamps
  - X-rays: observing the internal structure of objects and materials and medical applications
  - gamma rays: sterilising food and medical equipment (P3.10)
- recall the detrimental effects of excessive exposure of the human body to electromagnetic waves, including
  - microwaves : internal heating of body tissue
  - infra-red : skin burns
  - ultraviolet : damage to surface cells and blindness
  - gamma rays : cancer, mutation (P3.11).

(d) Light and sound

Candidates will be assessed on their ability to

- recall that light waves are transverse waves which can be reflected and refracted (P3.12)
- recall that the angle of incidence equals the angle of reflection (P3.13)
- construct ray diagrams to illustrate the formation of a virtual image in a plane mirror (P3.14)
- describe experiments to investigate the refraction of light, using rectangular blocks, semicircular blocks and triangular prisms (P3.15)
- **recall and use the relationship between refractive index, angle of incidence and angle of refraction**

  $$\boldsymbol{n = \frac{\sin i}{\sin r}}$$ **(P3.16)**

- **describe an experiment to determine the refractive index of glass, using a glass block (P3.17)**
- describe the role of total internal reflection in transmitting information along optical fibres and in prisms (P3.18)
- **recall the meaning of critical angle *c* (P3.19)**
- **recall and use the relationship between critical angle and refractive index**

$$\sin c = \frac{1}{n} \qquad \textbf{(P3.20)}$$

- recall that sound waves are longitudinal waves which can be reflected (P3.21)
- recall that the frequency range for human hearing is 20 Hz – 20 000 Hz (P3.22)
- describe how to measure the speed of sound in air by a simple direct method (P3.23).

Section P4: Energy resources and energy transfer

(a) Units

Candidates will be assessed on their ability to

- use the following units: kilogram (kg), joule (J), metre (m), metre/second (m/s), metre/second^2 (m/s^2), newton (N), second (s), watt (W) (P4.1).

(b) Energy transfer

Candidates will be assessed on their ability to

- describe energy transfers involving the following forms of energy: thermal (heat), light, electrical, sound, kinetic, chemical, nuclear and potential (elastic and gravitational) (P4.2)
- understand that energy is conserved (P4.3)
- recall and use the relationship

$$\text{efficiency} = \frac{\text{useful energy output}}{\text{total energy output}} \qquad \text{(P4.4)}$$

- describe a variety of everyday and scientific devices and situations, explaining the fate of the input energy in terms of the above relationship, including their representation by flow diagrams (P4.5)
- recall that energy transfer may take place by conduction, convection and radiation (P4.6)
- describe the role of convection in everyday phenomena (P4.7)
- describe how insulation is used to reduce energy transfers from buildings and the human body (P4.8).

(c) Work and power

Candidates will be assessed on their ability to

- recall and use the relationship between work, force and distance moved (P4.9)

  work done = force × distance moved in the direction of the force

  $W = F \times d$ (P4.10)

- understand that work done is equal to energy transferred (P4.11)

- **recall and use the relationships:**

  gravitational potential energy = mass × *g* × height

  GPE = *m* × *g* × *h*

  kinetic energy = ½ × mass × speed^2

  KE = ½ × *m* × *v*^{2} **(P4.12)**

- **understand how conservation of energy produces a link between potential energy, kinetic energy and work (P4.13)**
- describe power as the rate of transfer of energy or the rate of doing work (P4.14)
- use the relationship between power, work done (energy transferred) and time taken

$$\text{power} = \frac{\text{work done}}{\text{time taken}}$$

$$P = \frac{W}{t} \qquad \text{(P4.15)}$$

(d) Energy resources and electricity generation

Candidates will be assessed on their ability to

- understand the energy transfers involved in generating electricity using:
  - wind
  - water
  - geothermal resources
  - solar heating systems
  - solar cells
  - fossil fuels
  - nuclear power (P4.16).

Section P5: Solids, liquids and gases

(a) Units

Candidates will be assessed on their ability to

- use the following units: degrees Celsius (^{o}C), joule (J), kelvin (K), kilogram (kg), kilogram/metre^3 (kg/m^3), metre (m), metre^2 (m^2), metre^3 (m^3), metre/second (m/s), metre/second^2 (m/s^2), newton (N), pascal (Pa) (P5.1).

(b) Density and pressure

Candidates will be assessed on their ability to

- recall and use the relationship between density, mass and volume

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

$$\rho = \frac{m}{V} \qquad \text{(P5.2)}$$

- describe how to determine density using direct measurements of mass and volume (P5.3)

- recall and use the relationship between pressure, force and area:

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

$$p = \frac{F}{A} \qquad \text{(P5.4)}$$

- understand that the pressure at a point in a gas or liquid which is at rest acts equally in all directions (P5.5).

(c) Ideal gas molecules

Candidates will be assessed on their ability to

- understand the significance of Brownian motion (P5.6)
- recall that molecules in a gas have a random motion and that they exert a force and hence a pressure on the walls of the container (P5.7)
- understand that there is an absolute zero of temperature which is – 273 ^{o}C (P5.8)
- describe the kelvin scale of temperature and be able to convert between the kelvin and Celsius scales (P5.9)
- understand that an increase in temperature results in an increase in the speed of gas molecules (P5.10)
- describe the qualitative relationship between pressure and kelvin temperature for a gas in a sealed container (P5.11)
- **use the relationship between pressure and volume of a fixed mass of gas at constant temperature**

$$p_1V_1 = p_2V_2 \qquad \textbf{(P5.12)}$$

Section P6: Radioactivity and particles

(a) Units

Candidates will be assessed on their ability to

- use the following units: becquerel (Bq), centimetre (cm), hour (h), minute (min), second(s) (P6.1).

(b) Radioactivity

Candidates will be assessed on their ability to

- describe the structure of an atom in terms of protons, neutrons and electrons and use symbols such as $^{14}_{6}\mathrm{C}$ to describe particular nuclei (P6.2)
- understand the terms atomic (proton) number, mass (nucleon) number and isotope (P6.3)
- understand that alpha and beta particles and gamma rays are ionising radiations emitted from unstable nuclei in a random process (P6.4)
- describe the nature of alpha and beta particles and gamma rays and recall that they may be distinguished in terms of penetrating power (P6.5)
- **describe the effects on the atomic and mass numbers of a nucleus of the emission of each of the three main types of radiation (P6.6)**
- **understand how to complete balanced nuclear equations (P6.7)**
- understand that ionising radiations can be detected using a photographic film or a Geiger-Muller detector (P6.8)
- recall the sources of background radiation (P6.9)

- understand that the activity of a radioactive source decreases over a period of time and is measured in becquerels (P6.10)
- recall the term 'half-life' and understand that it is different for different radioactive isotopes (P6.11)
- use the concept of half-life to carry out simple calculations on activity (P6.12)
- describe the uses of radioactivity in medical and non-medical tracers, in radiotherapy and in the radioactive dating of archaeological specimens and rocks (P6.13)
- describe the dangers of ionising radiations, including
    - radiation can cause mutations in living organisms
    - radiation can damage cells and tissue
    - the problems arising in the disposal of radioactive waste (P6.14).

(c) Particles

Candidates will be assessed on their ability to

- **describe the results of Geiger and Marsden's experiments with gold foil and alpha particles (P6.15)**
- **describe Rutherford's nuclear model of the atom and how it accounts for the results of Geiger and Marsden's experiment and understand the factors (charge and speed) which affect the deflection of alpha particles by a nucleus (P6.16)**
- **understand that a nucleus of U-235 can be split (the process of fission) by collision with a neutron, and that this process releases energy in the form of kinetic energy of the fission products (P6.17)**
- **recall that the fission of U-235 produces two daughter nuclei and a small number of neutrons (P6.18)**
- **understand that a chain reaction can be set up if the neutrons produced by one fission strike other U-235 nuclei (P6.19)**
- **understand the role played by the control rods and moderator when the fission process is used as an energy source to generate electricity (P6.20).**

Grade descriptions

Sample grade descriptions are provided below to give a general indication of the standards of achievement likely to have been shown by candidates awarded particular grades. The descriptions must be interpreted in relation to the specification content; they are not designed to define that content. The grade awarded will depend in practice upon the extent to which the candidate has met the assessment objectives overall. Shortcomings in some aspects of the assessment may be balanced by better performances in others.

Grade F

Candidates can

- recall a limited range of information. For example, they state the main functions of organs of the human body; they know that plants need light for photosynthesis; they state some uses of materials obtained from oil; they suggest ways in which insulation is used in domestic contexts

- use and apply knowledge and understanding in some specific everyday contexts, for example, they describe how the heart rate increases with exercise; they suggest a way of speeding up a particular chemical reaction; they explain that fuels are energy resources

- make some use of scientific and technical vocabulary and make simple generalisations from information

- devise fair tests in contexts which involve only a few factors. They recall or use simple apparatus to make measurements appropriate to the task and record observations and measurements in tables and graphs; they obtain information from simple tables, charts and graphs and identify simple patterns in information and observations; they offer explanations consistent with the evidence obtained.

Grade C

Candidates can

- recall a range of scientific information from all areas of the specification. For example, they can explain how the lungs are ventilated; they recall simple chemical symbols and physics formulae, including use of correct units

- use and apply scientific knowledge and understanding in some general contexts. For example, they describe how a leaf is adapted to its functions; they use simple balanced equations and they use quantitative relationships to perform calculations

- describe links between related phenomena in different contexts; use diagrams, charts and graphs to support arguments; use appropriate scientific and technical vocabulary in a range of contexts

- use scientific knowledge and understanding to identify an approach to a question. For example, they identify key factors which can be varied and controlled; they recall or use a range of apparatus to make careful and precise measurements and systematic observations; they recognise when it is necessary to repeat measurements and observations; they present data systematically, in graphs where appropriate, and use

lines of best fit; they identify and explain patterns within data and draw conclusions consistent with the evidence. They explain these conclusions on the basis of their scientific knowledge and understanding, and evaluate how strongly their evidence supports the conclusions.

Grade A

Candidates can

- recall a wide range of knowledge from all areas of the specification

- use detailed scientific knowledge and understanding in many different applications relating to scientific systems or phenomena. For example, they explain how temperature or water content is regulated in humans; they routinely use a range of balanced chemical equations and the particle model to explain variations in reaction rates; they use many different relationships between physical quantities to carry out calculations effectively. Candidates draw together and communicate knowledge from more than one area, routinely use scientific or mathematical conventions in support of arguments, and use a wide range of scientific and technical vocabulary throughout their work

- use scientific knowledge and understanding to select an appropriate strategy for a task, identifying the key factors to be considered. They make systematic observations in qualitative work and decide which observations are relevant to the task in hand. When making measurements they decide the level of precision needed and can recall or use a range of apparatus to make appropriately precise measurements. They select a method of presenting data which is appropriate to the task; they use information from a range of sources where it is appropriate to do so. They identify and explain anomalous observations and measurements and the salient features of graphs

- use scientific knowledge and understanding to identify and explain patterns and draw conclusions from the evidence by combining data of more than one kind or from more than one source. They identify shortcomings in the evidence, use scientific knowledge and understanding to draw conclusions from their evidence and suggest improvements to the methods used that would enable them to collect more reliable evidence.

Investigative skills

Experimental work is an integral part of the study of any scientific subject, and it is important that a candidate's practical investigative skills form part of the final assessment. To reflect this importance, the investigative skills described in Assessment Objective 3 carry 20% of the final mark for the subject. For the IGCSE, investigative skills may be assessed by two alternative routes, which allow all candidates access to the qualification. Candidates either take the written alternative to coursework examination (Paper 3), or submit internally assessed coursework, which is assessed by the teacher and moderated by Edexcel International. These alternatives are described below.

Written alternatives to coursework (Papers 7, 8, and 9)

Candidates must take **two** written alternatives to practical work as described on page 10. The two papers are equally weighted and each paper carries a maximum of 50 marks. Combined, these two papers will be scaled to 20% of the final assessment.

The examination papers will consist of a range of compulsory questions targeted at grades A* – G and based on the skills listed in Assessment Objective 3. The questions will be designed to test the four main skill areas P, O, A and E, described on pages 40-43.

Candidates will be assessed on the ability to

- plan experimental procedures (P)
- describe practical techniques and take measurements (O)
- analyse evidence and draw conclusions communicating findings using calculations, tables and graphs (A)
- evaluate evidence (E).

It would be helpful for candidates preparing for the examination to carry out experimental work and investigations as described below for coursework. Candidates should be encouraged to become familiar with the criteria used to assess the coursework, as the examination questions will reward skills in a similar way. The Teacher's Guide (publication code UG014357) and the Coursework Guide (publication code UG014326) give further help and guidance about topics which could be used for investigation.

The specimen papers and mark schemes will illustrate the type of questions and the way in which they will be marked.

Coursework (Component 10)

The coursework option is normally available only to candidates studying at centres that have been recognised by Edexcel International as International Teaching Institutions. See full details under section 'Availability of coursework to international centres'.

Candidates who submit coursework are required to produce evidence in the four skill areas P, O, A and E, described in the next section, and on the Final Mark Aggregation Sheet (Appendix 5). Candidates must submit **two** marks for **each** skill area. Thus, **eight** marks are required in total to give a maximum mark of 60. These marks should be drawn from **not more than four** pieces of work. At least **two** science subjects (i.e. Biology, Chemistry and Physics) must be represented.

The coursework will be assessed by the school or college according to the principles described below and will be moderated by Edexcel International. The two coursework components, combined, carry a total of 60 marks which will be scaled to 20% of the assessment.

The evidence for assessment will be coursework carried out by the candidate, in the context of the specification content. The assessment scheme caters for a wide range of experimental and investigative work. Candidates should undertake experimental and investigative work during the course and be assessed on several occasions in both types of activity. The aim is to allow them to achieve their highest potential in such work. Candidates are required to produce the evidence for assessment based on the guidelines in the following pages.

- The term 'evidence' is used throughout the assessment scheme to mean data, observations or measurements.
- An activity can take the form of experimental work or an investigation. Experimental work may be used to assess one, two or three skill areas.
- An investigation consists of work that covers each of the four skill areas, although not all of these need to be used for assessment.

The scheme of internal assessment is designed to encourage a wide variety of activities. These include those based on the collection of first-hand evidence and those which depend on secondary evidence. Through the teaching of investigative skills, candidates may be given opportunities to apply and develop their ICT capability. For example, candidates could use data-handling software to analyse data from fieldwork or to create, analyse and evaluate charts and graphs; use dataloggers in investigations; use spreadsheets for data analysis; use the internet or CD-ROM software as sources of secondary evidence.

Assessment of investigative skills

Four skill areas are used to assess activities, as appropriate.

Candidates will be expected to

	Mark scale
Plan experimental procedures (P)	0 – 8
Obtain evidence (O)	0 – 8
Analyse this evidence and draw conclusions (A)	0 – 8
Evaluate evidence (E)	0 – 6

Mark descriptions are defined at steps 0, 2, 4, 6 and 8 as appropriate. Mark descriptions comprising a number of statements are provided in each skill area. Activities chosen for assessment should, wherever possible, provide opportunities for all the statements in a mark description to be addressed. It should be noted that some of the statements in a mark description contain a phrase such as 'where appropriate' and therefore may not apply to a particular activity.

Descriptions are provided for 2, 4, 6 and 8 marks in skill areas P, O and A and 2, 4 and 6 marks in skill area E. The performance needed to gain 6 marks in skill area E is commensurate with that for 8 marks in the other skill areas.

Whenever assessments are made, the mark descriptions should be used to judge which mark best fits the candidate's performance. The statements should not be taken as discrete and literal hurdles, all of which must be fulfilled for a mark to be awarded.

The mark descriptions within a skill area are designed to be hierarchical. This means that, in general, a description at a particular mark subsumes those at lower marks. It is assumed that activities that access higher marks will involve a more sophisticated approach and/or a more complex treatment. Adjacent descriptions should be considered when making judgements and use made of the intermediate marks (i.e. 3, 5 and 7) where performance exceeds one description and only partially satisfies the next.

A candidate who fails to meet the requirements for 2 marks but who has made a creditworthy attempt in a skill area should be given 1 mark for that skill. Zero marks should only be awarded for a skill area in the unlikely event of a candidate failing to demonstrate any achievement in that skill.

The professional judgement of the teacher in making these assessments is important. The marks are recorded on the Final Mark Aggregation Sheet (see Appendix 5).

Support is provided in the form of a Teacher's Guide (publication code UG014357) which contains suggested experiments and investigations, and also through a Coursework Guide (publication code UG014326) which contains exemplar assessed work.

Skill Area P: Planning

Skill Area P
Candidates should be encouraged to **a** use scientific knowledge and understanding to turn ideas into a form that can be investigated, and to plan an appropriate strategy **b** decide whether to use evidence from first-hand experience or secondary sources **c** carry out preliminary work and make predictions, where appropriate **d** consider key factors that need to be taken into account when collecting evidence, and how evidence can be collected in contexts in which the variables cannot readily be controlled **e** decide the extent and range of data to be collected, and the techniques, equipment and materials to use.

Mark descriptions for internal assessment			
The mark descriptions are designed to be hierarchical. All work should be assessed in the context of the specification content.			
	Candidates		Increasing demand of activity
2 marks	P.2a	outline a simple procedure	↓
4 marks	P.4a	plan to collect evidence which will be valid	
	P.4b	plan the use of suitable equipment or sources of evidence	
6 marks	P.6a	use scientific knowledge and understanding to plan and communicate a procedure, to identify key factors to vary, control or take into account, and to make a prediction where appropriate	
	P.6b	decide a suitable extent and range of evidence to be collected	
8 marks	P.8a	use detailed scientific knowledge and understanding to plan and communicate an appropriate strategy, taking into account the need to produce precise and reliable evidence, and to justify a prediction, when one has been made	
	P.8b	use relevant information from preliminary work, where appropriate, to inform the plan	

Skill Area O: Obtaining evidence

Skill Area O
Candidates should be encouraged to **f** use a wide range of equipment and materials appropriately, and manage their working environment to ensure the safety of themselves and others **g** make observations and measurements, to a degree of precision appropriate to the context **h** make sufficient observations and measurements to reduce error and obtain reliable evidence **i** judge the level of uncertainty in observations and measurements **j** represent and communicate qualitative and quantitative data using diagrams, tables, charts and graphs.

Mark descriptions for internal assessment

The mark descriptions are designed to be hierarchical.

All work should be assessed in the context of the specification content.

		Candidates	Increasing demand of activity
2 marks	O.2a	collect some evidence using a simple and safe procedure	↓
4 marks	O.4a O.4b	collect appropriate evidence which is adequate for the activity record the evidence	
6 marks	O.6a O.6b	collect sufficient systematic and accurate evidence and repeat or check where appropriate record clearly and accurately the evidence collected	
8 marks	O.8a	use a procedure with precision and skill to obtain and record an appropriate range of reliable evidence	

Skill Area A: Analysing and considering evidence

Skill Area A
Candidates should be encouraged to **k** use diagrams, tables, charts and graphs, and identify and explain patterns or relationships in data **l** present the results of calculations to an appropriate degree of accuracy **m** use observations, measurements or other data to draw conclusions **n** explain to what extent these conclusions support any predictions made, and enable further predictions to be made **o** use scientific knowledge and understanding to explain and interpret observations, measurements or other data, and conclusions.

Mark descriptions for internal assessment			
The mark descriptions are designed to be hierarchical. All work should be assessed in the context of the specification content.			
		Candidates	Increasing demand of activity
2 marks	A.2a	state simply what is shown by the evidence	↓
4 marks	A.4a	use simple diagrams, charts or graphs as a basis for explaining the evidence	
	A.4b	identify trends and patterns in the evidence	
6 marks	A.6a	construct and use suitable diagrams, charts, graphs (with lines of best fit, where appropriate), or use numerical methods, to process evidence for a conclusion	
	A.6b	draw a conclusion consistent with the evidence and explain it using scientific knowledge and understanding	
8 marks	A.8a	use detailed scientific knowledge and understanding to explain a valid conclusion drawn from processed evidence	
	A.8b	explain the extent to which the conclusion supports the prediction, if one has been made	

Skill Area E: Evaluating

Skill Area E
Candidates should be encouraged to **p** consider anomalous data, giving reasons for rejecting or accepting them, and consider the reliability of data in terms of uncertainty of measurements and observations **q** consider whether the evidence collected is sufficient to support any conclusions or interpretations made **r** suggest improvements to the methods used **s** suggest further investigations.

Mark descriptions for internal assessment

The mark descriptions are designed to be hierarchical.

All work should be assessed in the context of the specification content.

		Candidates	Increasing demand of activity
2 marks	E.2a	make a relevant comment about the procedure used or the evidence obtained	↓
4 marks	E.4a	comment on the quality of the evidence, identifying any anomalies	
	E.4b	comment on the suitability of the procedure and, where appropriate, suggest changes to improve it	
6 marks	E.6a	consider critically the reliability of the evidence and whether it is sufficient to support the conclusion, accounting for any anomalies	
	E.6b	describe, in detail, further work to provide additional relevant evidence	

Safe practice

Attention is drawn to the need for safe practice when candidates carry out laboratory investigations or observe demonstrations. Particular attention is drawn to the possible hazards associated with electrical equipment, the handling of micro-organisms, and ionising radiations. Strict aseptic conditions should be used when undertaking practical work. Reference must be made to local health and safety regulations, and to widely accepted publications such as:

COSHH; *Guidance for Schools* (HSC, 1989) (HMSO) ISBN 011 885 5115

Topics in Safety – Association for Science Education (ASE) 2001 3rd Edition
ISBN 086 357 3169

CLEAPSS Laboratory Handbook and Hazards, available from Consortium of Local Education Authorities for the Provision of Science Services (CLEAPSS) to members or associates only.

Textbooks and other resources

The following textbooks have been produced by Longman publishers with the specific aim of supporting London Examinations' IGCSEs in the three separate sciences on which this specification is based. A textbook designed specifically for this specification will be available in 2005.

Longman IGCSE Biology, by S. Potter and P. Bradfield, Longman (2004)
ISBN: 1405 802 065

Longman IGCSE Chemistry, by J. Clark, Longman (2005) ISBN: 1405 802 081

Longman IGCSE Physics, by S. Woolley, P. Johnson and B. Arnold, Longman (2004)
ISBN: 1405 802 138

Useful websites

The Internet provides a wealth of resources, from websites for learning resources through the corporate websites and the websites of scientific organisations. The list below is a selection but is by no means exhaustive.

4Learning on the web http://www.4learning.co.uk
Aluminium Packaging Recycling Organisation http://www.alupro.org.uk/
Association of British Pharmaceutical Industry http://www.abpi.org.uk
Association for Science Education http://www.ase.org.uk
BBC Science http://www.bbc.co.uk/science
Biochemistry Society http://www.biochemistry.org
Biotechnology and Biological Research Council http://www.bbsrc.ac.uk
BP Amoco Educational Service http://www.bpes.com
British Aerosoles http://www.bama.co.uk
British Batteries Manufacturing Association http://www.bbma.co.uk
British Library http://www.bl.uk/
British Nutrition Foundation http://www.nutrition.org.uk
British Plastics Federation http://www.bpf.co.uk
Centre of Alternative Technology http://www.cat.org.uk
Chemdex http://www.chemdex.org/
Chemical Industry Education Centre (CIEC) http://www.york.ac.uk/org/ciec
Chemical Society Network http://www.chemsoc.org
Corus Education Support Service http://www.coruseducation.com
Dairy Council http://www.milk.co.uk
Esso http://www.esso.co.uk
Friends of the Earth http://www.foe.co.uk
GlaxoSmithKline www.gsk.com
ICI http://www.ici.com
Institute of Biology http://www.bio.org
Institute of Education (London) http://www.ioe.ac.uk
Institute of Electrical Engineers www.iee.org.uk
Institute of Physics http://www.iop.org
Laboratory of the Government Chemist http://www.lgc.co.uk
Merk, Shap and Dohme (Neuroscience) www.msd-nrc.co.uk
Multimedia – Key Concepts in Science http://www.new-media.co.uk
National Physics Laboratory http://www.npl.co.uk
Nature http://www.nature.com
New Scientist http://www.newscientist.com/
Philipallan updates/ Chemistry Review http://www.philipallan.co.uk
Physical Sciences Info. Gateway http://www.psigate.ac.uk
RECOUP – Recycling Used Plastic http://www.recoup.org
Recycling around the World http://www.recyclers-info.com
Research Machines Learning http://www.learningschools.net
Rod Beavon website http://www.rod.beavon.clara.net

Royal Society of Chemistry http://www.rsc.org
Schoolscience http://www.schoolscience.org.uk
School Science Service http://www.cleapss.org.uk
Science Consortium http://www.scienceconsortium.co.uk
Science Enhancement Programme http://www.sep.org.uk
Science Museum http://www.sciencemuseum.org.uk
Shell http://www.shell.co.uk
Society of Chemical Industry http://www.mond.org
Society of General Microbiology http://www.sgm.ac.uk
Steel Can Recycling http://www.scrib.org
The Biodiversity Association www.biodiversity.org
UK Cartridge Recyclers http://www.ukcra.com
Unilever http://www.unilever.com
Waste Book http://www.recycle.mcmail.com
Wellcome Trust http://www.wellcome.ac.uk/education
World Wide Website for Chemists http://www.ChemWeb.com

Support and training

Training

A programme of INSET courses covering various aspects of the specifications and assessment will be arranged by London Examinations on a regular basis. Full details may be obtained from

International Customer Relations Unit
Edexcel International
190 High Holborn
London
WC1V 7BE
UK

Tel: +44 (0) 190 884 7750
E-mail: international@edexcel.org.uk

Edexcel publications

Support materials and further copies of this specification can be obtained from

Edexcel Publications
Adamsway
Mansfield
Notts NG18 4LN
UK

Tel: +44 (0) 1623 450 781
Fax: +44 (0) 1623 450 481
E-mail: intpublications@linneydirect.com

The following support materials will be available from 2004 onwards

- Specimen papers and mark schemes (Publication code: UG014359)
- Teacher's Guide (Publication code: UG014357)
- Coursework Guide for all IGCSE Science specifications (Publication code: UG014326)

Appendices

Appendix 1 – Procedures and contact information

Awarding and reporting

Due to the Double Award nature of this specification, the grade reported on a candidate's final certificate will appear twice, e.g. A* A*; B B; D D. The reported grades will always be the same. They are awarded on a candidate's overall achievement in Double Award Science. The two IGCSE grades recognise the amount of subject content prescribed for study.

Assessment of this specification will be available in English only. All written work for examination must be submitted in English.

Forbidden combinations

Candidates entering for this specification may not, in the same series of examinations, enter for the following London Examinations IGCSEs

- Biology (4325)
- Chemistry (4335)
- Physics (4420).

Mathematical skills

Candidates need to have been taught and to have acquired competence in the areas of mathematics set out below in order to develop knowledge, understanding and skills in the subject content.

Candidates are permitted to use calculators in all written papers in accordance with the current regulations. For full details, please refer to the Teacher's Guide.

For the purpose of this course it will be assumed that candidates will be able to

- evaluate expressions incorporating the four operations, +, –, x, ÷, either singly or in conjunction with one another, quoting the answer to an appropriate number of significant figures
- use simple proportion, decimals, fractions and percentages
- understand and use compound measures such as speed
- manipulate formulae, equations and expressions
- plot and draw graphs from suitable data, selecting appropriate scales for the axes
- interpret graphs in terms of general trends and by interpolation
- interpret a range of graphs and diagrams
- use an electronic calculator in connection with any of the above as appropriate
- understand that a measurement given as a whole number may be imprecise by up to one-half in either direction.

In addition, Higher Tier candidates will be expected to be able to

- **understand and use direct and inverse proportion**
- **use numbers in standard form.**

Units and nomenclature

In the written papers and tests, the units and the nomenclature used will conform to the recommendations contained in the following booklet:

Signs, Symbols and Systematics, The ASE Companion to 16-19 Science – (1st Edition), (Association for Science Education (ASE), 2000).

www.ase.org.uk

Students with particular requirements

Regulation and guidance relating to students with special requirements are published annually by the Joint Council for General Qualifications and are circulated to examination officers. Further copies of guidance documentation may be obtained by contacting the International Customer Relations Unit (contact details below).

London Examinations will assess whether or not special consideration or concessions can be made for candidates with particular requirements. Requests should be addressed to the International Customer Relations Unit (contact details below).

Availability of coursework to international centres

Centres are asked to note that the coursework component of this specification is normally available only to candidates studying at centres that have been recognised by Edexcel International as International Teaching Institutions. Candidates studying on their own or at centres recognised as Private Centres are not normally permitted to enter for the coursework component of the specification.

Private Centres may not undertake school-based assessment without the written approval of Edexcel International. This will only be given to centres that satisfy Edexcel International's requirements concerning resources/facilities. Teachers at these centres will be required to undertake special training in assessment before entering candidates. Edexcel International offers centres in-service training in the form of courses and distance learning materials. Private Centres that would like to receive more information on school-based assessment should, in the first instance, contact the International Customer Relations Unit (contact details below).

Contact details of the International Customer Relations Unit (ICRU)

Address: International Customer Relations Unit (ICRU)
Edexcel International
190 High Holborn
London
WC1V 7BE
United Kingdom
Telephone: +44 (0) 190 884 7750
Email: international@edexcel.org.uk
Website: www.edexcel-international.org

Appendix 2 – Periodic table

THE PERIODIC TABLE

Group

Period	1	2											3	4	5	6	7	0
1							1 H Hydrogen 1											4 He Helium 2
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
3	23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulphur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
4	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
5	86 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	99 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
6	133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57	179 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Indium 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	210 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86
7	223 Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89															

Key

Relative atomic mass
Symbol
Name
Atomic number

Appendix 3 – Physics formulae for relationships

The relationships listed below will **not** be provided for IGCSE candidates either in the form given or in re-arranged form. Formulae needed only for Higher Tier candidates are printed in **bold type**.

(i) the relationship between speed, distance and time:

$$\text{speed} = \frac{\text{distance}}{\text{time}}$$

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

force = mass × acceleration

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

(iii) the relationship between density, mass and volume:

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

(iv) the relationship between force, distance and work:

work done = force × distance moved in direction of force

(v) the energy relationships:

energy transferred = work done

kinetic energy = ½ × mass × speed^2

change in potential energy = mass × gravitational field strength × change in height

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

weight = mass × gravitational field strength

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

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

(viii) the relationship between the moment of a force and its distance from the pivot:

moment = force × perpendicular distance from pivot

(ix) the relationships between charge, current, voltage, resistance and electrical power:

charge = current × time

voltage = current × resistance

electrical power = voltage × current

(x) the relationship between speed, frequency and wavelength:

wave speed = frequency × wavelength

(xi) the relationship between the voltage across the coils in a transformer and the number of turns in them:

$$\frac{\text{input (primary) voltage}}{\text{output (seconday) voltage}} = \frac{\text{primary turns}}{\text{secondary turns}}$$

(xii) The relationship between refractive index, angle of incidence and angle of refraction:

$$\boldsymbol{n = \frac{\sin i}{\sin r}}$$

(xiii) The relationship between refractive index and critical angle:

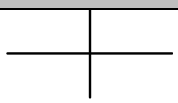
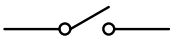
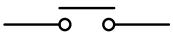
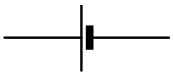
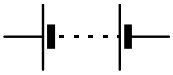
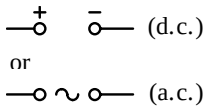
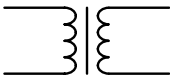
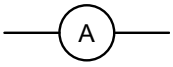
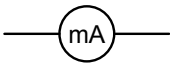
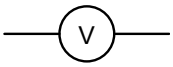
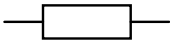
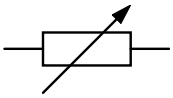
$$\boldsymbol{\sin c = \frac{1}{n}}$$

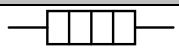
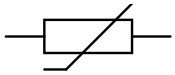
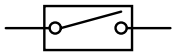
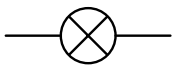
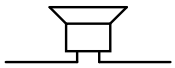
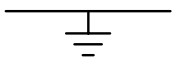
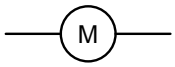
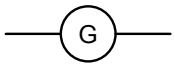
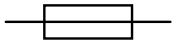
(xiv) The relationship for pressure difference

pressure difference = height × density × g

$p = h\rho g$

Appendix 4 – Electrical circuit symbols

Description	Symbol
Conductors crossing with no connection	
Junction of conductors	
Open switch	
Closed switch	
Open push switch	
Closed push switch	
Cell	
Battery of cells	
Power supply	
Transformer	
Ammeter	
Milliammeter	
Voltmeter	
Fixed resistor	
Variable resistor	

Description	Symbol
heater	
thermistor	
light-dependent resistor (LDR)	
relay	
diode	
light-emitting diode (LED)	
lamp	
loudspeaker	
microphone	
electric bell	
earth or ground	
motor	
generator	
fuse/circuit breaker	

Appendix 5 – Assessment of practical skills – final mark aggregation sheet

Month and year of examination:	Specification title:
Specification number:	
Centre:	Candidate name:
	Teaching group:
Centre number:	Candidate number:

Marks should be reported for each of the skill areas P, O, A and E.

Two marks are required for **each** skill area. Thus eight marks are required in total to give a maximum mark of 60. These marks should be drawn from **not more than four** pieces of work. At least **one** mark must be from a practically based whole investigation. At least **two** science subjects (i.e. Biology, Chemistry and Physics) **must** be represented.

The reported marks from each activity should be ringed.

Activity title(s)	P	O	A	E

Please indicate whether the reported mark(s) are taken from an investigation by putting an asterisk next to the appropriate mark(s).

The skill area marks are reported in the appropriate Centre Mark boxes in the table below and then aggregated to give a total reported mark.

	Skill area P		Skill area O		Skill area A		Skill area E		Total mark	Max mark
Centre mark										60
Moderator Mark										
Team leader Mark										

Declaration of Authentication

I declare that the work submitted for assessment has been carried out without assistance other than that which is acceptable under the scheme of assessment.

Candidate's signature……Date……

Teacher's signature……Date……

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