GCSE

in

Science: Double Award A (Non-Modular)
Double Award B (Modular)

S P E C I F I C A T I O N

(Amended June 2004)

For teaching from Autumn 2004

For examination in 2004

Subject Code 1370

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CONTENTS

KEY FEATURES

- Two tiers of assessment: Foundation (Grades C–G) and Higher (Grades A*–D(E).

- Available by Non-Modular assessment (Science: Double Award A) or Modular assessment (Science: Double Award B).

- Ability to re-sit modules in Modular assessment.

- Provides a basis for the study of science related courses at GCE Advanced, Advanced Subsidiary and Advanced VCE Level.

- Opportunities highlighted for developing evidence for assessment of Key Skills.

- Meets the requirements of the GCSE Regulations, Subject Criteria for Science and Northern Ireland Programme of Study for Science at Key Stage 4.

- Allows pupils to acquire a systematic body of knowledge in science, including an appreciation of its power and limitations.

- Experimental and investigative skills assessed by internal assessment.

SUMMARY OF ASSESSMENT INFORMATION SCIENCE: DOUBLE AWARD A (NON-MODULAR)

Tiers	Foundation	Higher
Target Grades	C–G	A*–D(E)
Assessment Components	4	4
Paper 1 (Biology)	12–15 short-answer questions and three structured questions.	Eight short-answer questions and four structured questions.
Time	1 hour 30 minutes	1 hour 45 minutes
Percentage assessment weighting	25%	25%
Paper 2 (Chemistry)	12–15 short-answer questions and three structured questions.	Eight short-answer questions and four structured questions.
Time	1 hour 30 minutes	1 hour 45 minutes
Percentage assessment weighting	25%	25%
Paper 3 (Physics)	12–15 short-answer questions and three structured questions.	Eight short-answer questions and four structured questions.
Time	1 hour 30 minutes	1 hour 45 minutes
Percentage assessment weighting	25%	25%
Internal Assessment	Evidence of investigative work carried out in the context of at least two of the sections of the Programme of Study.	Evidence of investigative work carried out in the context of at least two of the sections of the Programme of Study.
Percentage Weighting	25%	25%
Documentation	Candidate Record Sheet EAD85(a)	Candidate Record Sheet EAD85(a)

SUMMARY OF ASSESSMENT INFORMATION SCIENCE: DOUBLE AWARD B (MODULAR)

Tiers	Foundation	Higher
Target Grades	C–G	A*–D(E)
Assessment Components	4	4
Module Tests Time Percentage assessment weighting	Three module tests each 12–15 short-answer questions. 45 minutes each 25% (8.33% per module)	Three module tests each 12–15 short-answer questions. 45 minutes each 25% (8.33% per module)
Paper 1 (Biology) Time Percentage assessment weighting	Four structured questions. 1 hour 16.7%	Five or six structured questions. 1 hour 30 minutes 16.7%
Paper 2 (Chemistry) Time Percentage assessment weighting	Four structured questions. 1 hour 16.7%	Five or six structured questions. 1 hour 30 minutes 16.7%
Paper 3 (Physics) Time Percentage assessment weighting	Four structured questions. 1 hour 16.7%	Five or six structured questions. 1 hour 30 minutes 16.7%
Internal Assessment Percentage Weighting	Evidence of investigative work carried out in the context of at least two of the sections of the Programme of Study. 25%	Evidence of investigative work carried out in the context of at least two of the sections of the Programme of Study. 25%
Documentation	Candidate Record Sheet EAD85(a)	Candidate Record Sheet EAD85(a)

1 INTRODUCTION

1.1 RATIONALE

Science stimulates and excites pupils' curiosity and their interest in, and knowledge of, phenomena and events of the world around them. Through their work in science, pupils are helped to understand major scientific ideas, to appreciate how these develop and contribute to technological change, and to recognise the cultural significance of science and its worldwide development. Science offers a range of activities which can engage all learners by linking direct practical experience with ideas, developing key skills and encouraging critical and creative thought, through developing and evaluating explanations. Studying science enables pupils to understand the role of experimental evidence and models in evaluating explanations of phenomena and events. Pupils learn how technologies based on science have been used in industry, business and medicine, and how these developments have contributed greatly to the quality of life for most people. Pupils engage in questioning and discussion about science-based issues which affect their lives, the society in which they live and the world as a whole and, through this, become more confident in expressing views and evaluating decisions about such matters.

This specification is designed to promote continuity, coherence and progression within the study of Science: Double Award. The specification builds on the knowledge, understanding and skills developed within the Key Stage 3 Northern Ireland Curriculum Programme of Study for Science. It is assumed that students embarking on a course based on this specification should have followed the Northern Ireland Key Stage 3 Programme of Study for Science or an equivalent course of study.

This specification has been designed to meet the requirements of GCSE Criteria, the Science Subject Criteria and the Northern Ireland Programme of Study for Key Stage 4 Science: Double Award.

A course based on this specification should help to facilitate the study of Science, Physics, Chemistry, Biology and related subjects at a more advanced level, for example, AS and Advanced Physics, Chemistry, Biology or Advanced Vocational Certificate of Education courses in science related subjects.

The study of Science: Double Award can contribute to an understanding of spiritual, moral, ethical, social and cultural issues by promoting an awareness that the practice of science is a co-operative and cumulative activity and that it is subject to social, economic, technological, ethical and cultural influences and limitations. More detail on this is given in Appendix 1 on page 67.

This study of Science: Double Award can contribute to an awareness of environmental issues by promoting an awareness that the application of science may be both beneficial and detrimental to the individual, the community and the environment. The specification provides opportunities to describe the environmental implications of the use of a variety of energy resources and to

identify the socio-economic impact this activity can have on society. More detail on this is given in Appendix 2 on page 68.

In studying a course based on this specification, candidates should be encouraged to make appropriate use of information and communications technology (ICT), for example, the use of light gates and a data logger to measure acceleration or use of the internet to research topics. Further exemplification of opportunities for the use of ICT in Science: Double Award is provided in Appendix 3 on page 69 and Appendix 4 on page 71 which signpost opportunities to develop Key Skills, including that of Information Technology.

This specification has been designed to be as free as possible from ethnic, gender, religious, political or other forms of bias.

1.2 AIMS

A course based on this specification should give students opportunities to:

- acquire a systematic body of scientific knowledge, and the skills needed to apply this in new and changing situations in a range of domestic, industrial and environmental contexts;
- acquire an understanding of scientific ideas, how they develop, the factors which may affect their development and their power and limitations;
- plan and carry out a range of investigations, considering and evaluating critically their own data and that obtained from other sources, and using ICT where appropriate;
- evaluate in terms of their scientific knowledge and understanding, the benefits and drawbacks of scientific and technological developments, including those related to the environment, personal health and quality of life, and consider ethical issues where appropriate;
- select, organise and present information clearly and logically, using appropriate scientific terms and conventions, and using ICT where appropriate.

1.3 ASSESSMENT OBJECTIVES

The assessment objectives provide an indication of the skills and abilities which the assessment components are designed to assess, together with the knowledge and understanding specified in the subject content. It is not always possible to make a clear distinction between these different elements in constructing examination questions and therefore a particular question may test more than one assessment objective.

Candidates are required to demonstrate the following assessment objectives in the context of the content and skills prescribed. Within each of the assessment objectives the assessment must take account of candidates' ability to communicate clearly and logically, using specialist vocabulary and conventions where appropriate.

AO1 Knowledge and understanding

Candidates must be able to:

- recognise, recall and show understanding of specific scientific facts, terminology, principles, concepts and practical techniques;
- demonstrate understanding of the power and limitations of scientific ideas and factors affecting how these ideas develop;
- draw on existing knowledge to show understanding of the benefits and drawbacks of applications of science;
- select, organise and present relevant information.

AO2 Application of knowledge and understanding, analysis and evaluation

Candidates must be able to:

- describe, explain and interpret phenomena, effects and ideas in terms of scientific principles and concepts, presenting arguments and ideas clearly and logically;
- interpret and translate, from one form into another, data presented as continuous prose or in tables, diagrams and graphs;
- carry out relevant calculations;
- apply principles and concepts to unfamiliar situations, including those related to applications of science in a range of domestic, industrial and environmental contexts;
- evaluate scientific information and make informed judgments from it.

AO3 Investigative skills

Candidates must be able to:

- devise and plan investigations, drawing on scientific knowledge and understanding in selecting appropriate strategies;
- demonstrate appropriate investigative methods, including safe and skilful practical techniques, obtaining data which are sufficient and of appropriate precision, recording these methodically;
- interpret data to draw conclusions which are consistent with the evidence, using scientific knowledge and understanding, whenever possible, in explaining their findings;
- evaluate data and methods.

The weighting of the assessment objectives in the scheme of assessment for Science: Double Award A (Non-Modular) is shown in Table 1 on page 7.

The weighting of the assessment objectives in the Scheme of Assessment for Science: Double Award B (Modular) is shown in Table 5 on page 10.

1.4 SPECIFICATION STRUCTURE

The subject content is divided into six modules and these are listed below:

Unit Title	Attainment Target
Living Organisms and the Processes of Life; Environment, Reproduction and Genetics;	2
Using Materials and Understanding Reactions; Patterns, Problems, Processes;	3
Forces and Energy; Light, Sound and Waves, Electricity and Magnetism, Earth in Space.	4

The order in which the subject content is presented is not intended to imply a proposed teaching order. Teachers are free to organise the teaching of the content as they think appropriate. The content may be assessed by either a Modular or Non-Modular route. Full details are in Section 2A (Non-Modular) and Section 2B (Modular). The subject content is described in detail in Section 3 of this specification.

1.5 AWARDING AND CERTIFICATION

GCSE awards will be conducted in accordance with the relevant Code of Practice developed by the regulatory authorities and agreed with the awarding bodies.

This specification enables candidates from a wide ability range to demonstrate achievement. There are two tiers of entry: Foundation and Higher.

Candidates entering for the Foundation Tier are eligible for the award of Grades C–G. Candidates achieving less than the minimum mark required for a Grade G on the Foundation Tier will be recorded as unclassified and will not receive a certificate.

The Higher Tier is intended for candidates in the Grade range A*–D. However a "safety net" is provided for candidates entered for the Higher Tier by means of an allowed Grade E which is awarded to those candidates just failing to achieve a Grade D. Candidates achieving less than the minimum mark required for a Grade E on the Higher Tier will be recorded as unclassified and will not receive a certificate.

Differentiation in the written papers will be achieved by targeting of questions within each tier. In the Foundation Tier approximately 45% of marks will be targeted at Grades C–D and the remainder will be targeted at E–G. In the Higher Tier approximately 45% of the marks will targeted at C–D and the remainder targeted at A*–B.

Differentiation in internal assessment will be achieved by teachers setting activities appropriate to the candidates' differing levels of ability and by outcome.

Candidates entered for Science: Double Award A (Non-Modular) must enter at one tier only.

Candidates entered for Science: Double Award B (Modular) may enter modules at different tiers but must enter all terminal papers at either Foundation or Higher Tier.

In judging which is the more appropriate tier of entry for a candidate, centres should consider the candidate's performance throughout the course.

In order to obtain an award, candidates must normally complete all assessment components. The award will be based on the aggregation of the outcomes from each of the assessment components weighted accordingly as detailed in the Scheme of Assessment on page 7 (Non-Modular) and page 10 (Modular).

Candidates will be awarded a pair of identical grades.

1.6 CANDIDATES WITH PARTICULAR REQUIREMENTS

Details of arrangements for candidates with particular assessment requirements are provided in the Joint Council for General Qualifications GCSE and GCE Regulations and Guidance for Candidates with Special Assessment Needs.

Copies of the Regulations and Guidance can be obtained from CCEA on request.

1.7 KEY SKILLS

The Key Skill of Communication will contribute to the assessment of this specification through the assessment of candidates' quality of written communication as detailed on page 13.

This specification provides opportunities for developing and generating evidence for assessing the following nationally specified Key Skills at the levels indicated:

- Communication – Levels 1 and 2;
- Application of Number – Levels 1 and 2;
- Information Technology – Levels 1 and 2;
- Working with Others – Levels 1 and 2;
- Improving Your Own Learning and Performance – Levels 1 and 2;
- Problem Solving – Level 1 and 2.

The opportunities provided are referenced to the relevant Key Skills specifications and exemplified in Appendix 4 on page 71.

1.8 OVERLAP AND EQUIVALENCE WITH OTHER QUALIFICATIONS

There is significant content overlap between this specification and GCSE Biology, Chemistry, Physics and GCSE Science: Single Award.

The following is an indication of the broad equivalence of GCSE and General National Vocational Qualifications (GNVQ):

- Two GCSEs at grades D–G are equivalent to one three-unit GNVQ at foundation level;
- Two GCSEs at grades A*–C are equivalent to one three-unit GNVQ at intermediate level;
- Four GCSEs at grades D–G are equivalent to one six-unit GNVQ at foundation level;
- Four GCSEs at grades A*–C are equivalent to one six-unit GNVQ at intermediate level.

1.9 RESTRICTIONS ON CANDIDATE ENTRY

In any one series of examinations a candidate may not take examinations on this specification together with GCSE examinations in Biology, Chemistry, Physics and Science: Single Award.

2A SCHEME OF ASSESSMENT – SCIENCE: DOUBLE AWARD A (NON-MODULAR)

2A.1 RELATIONSHIP BETWEEN ASSESSMENT COMPONENTS AND ASSESSMENT OBJECTIVES

The relationship between the assessment components and the assessment objectives is set out in Table 1.

Table 1: Assessment Weightings

Assessment Component	Nature of Assessment	Assessment Objectives			Component Weighting %
		AO1 %	AO2 %	AO3 %	
Paper 1	External	15–18	8–12	–	25%
Paper 2	External	15–18	8–12	–	25%
Paper 3	External	15–18	8–12	–	25%
Practical investigative work	Internal	–	–	25%	25%
	Totals	**45–55**	**25–35**	**25**	**100%**

2A.2 NATURE OF ASSESSMENT COMPONENTS

The assessment components which make up the GCSE award are described below.

Candidates will take three terminal papers, which are attainment target dedicated, at each tier of entry. The relationship between paper numbers, syllabus area, attainment targets and weightings are shown in Table 2 below.

Table 2

Paper Number	Syllabus Area	Attainment Target	Weighting
1	Living Organisms and Life Processes Environment, Reproduction and Genetics	2	25%
2	Using Materials and Understanding Reactions; Patterns, Problems, Processes	3	25%
3	Forces and Energy Light, Sound and Waves; Electricity and Magnetism, Earth in Space	4	25%

The number and type of questions within a paper and paper duration is given in Table 3 below.

Table 3

Paper Number	Foundation			Higher		
	Short Answer	Structured	Duration	Short Answer	Structured	Duration
1	12–15	3	1 hour 30 mins	8	4	1 hour 45 mins
2	12–15	3	1 hour 30 mins	8	4	1 hour 45 mins
3	12–15	3	1 hour 30 mins	8	4	1 hour 45 mins

A significant portion of the total available credit will be allocated to assessment relating to technological application and social, economic and environmental implications.

No more than 20% of the total available credit is allocated to the assessment of recall of knowledge.

All written papers may contain questions/parts of questions on practical aspects of science which students are likely to have covered during the course.

Internal Assessment (25%)

For the purpose of internal assessment, Attainment Target 1 is divided into three assessment categories. These categories and their approximate weightings are shown in Table 4.

Table 4

Assessment Category	Weighting
A Planning experimental procedures	7%
B Obtaining evidence	7%
C Interpreting and evaluating	11%

Further details on the assessment of the skills and abilities of the internally assessed component may be found in the section of the specification on internal assessment.

2A.3 QUALITY OF WRITTEN COMMUNICATION

The specification and associated assessment materials are provided in English and Irish, as required. CCEA may provide operational assessment materials in Irish on request from centres if prior approval has been given by the Department of Education. Assessment will take into account candidates' quality of written communication where they are required to produce extended written material. Quality of written communication refers to candidates' ability to:

- present relevant information in a form that suits its purpose;
- ensure text is legible and that spelling, grammar and punctuation are accurate so that meaning is clear;
- use a suitable structure and style of writing.

Quality of written communication will be assessed within the written papers and in the internally assessed component.

The question in which the assessment is made will be indicated in each examination paper.

2B SCHEME OF ASSESSMENT – SCIENCE: DOUBLE AWARD B (MODULAR)

2B.1 RELATIONSHIP BETWEEN ASSESSMENT COMPONENTS AND ASSESSMENT OBJECTIVES

The relationship between the assessment components and the assessment objectives is set out in Table 5.

Table 5: Assessment Weightings

Assessment Component	Nature of Assessment	Assessment Objectives			Component Weighting %
		AO1 %	AO2 %	AO3 %	
Paper 1	External	10–11	6–7		16.7
Paper 2	External	10–11	6–7		16.7
Paper 3	External	10–11	6–7		16.7
Modules	External	15–17	8–10		25
Practical investigative work	Internal	–	–	25	25
	Totals	**45–50**	**25–30**	**25**	**100%**

2B.2 NATURE OF ASSESSMENT COMPONENTS

The assessment components which make up the GCSE award are described below.

The scheme of assessment consists of end of module tests, a terminal examination and internal assessment as shown in Table 6 below.

Table 6

Component	Weighting
End of Module Tests	25%
Terminal Examination	50%
Practical investigative work	25%

Of the six modules presented in the syllabus, three will be assessed through end of module tests as follows:

- Living Organisms and the Processes of Life;
- Using Materials and Understanding Reactions;
- Forces and Energy;

Candidates may enter different end of module tests at either Foundation or Higher Tier.

Re-sitting of module tests

Candidates may re-sit module tests once only and the better result will count. The results of individual assessment components prior to certification of the qualification, have a shelf-life limited only by the shelf-life of the qualification when they are used to contribute to the qualification.

These tests may be taken within a schedule produced by the Council up to and including June of year 12 (Form 5).

The duration of the written papers and their relative weightings are shown in Table 7 below.

Table 7

Paper	Foundation	Weighting (%)	Higher (%)	Weighting
Module A	45 mins	8.3	45 mins	8.3
Module B	45 mins	8.3	45 mins	8.3
Module C	45 mins	8.3	45 mins	8.3
Terminal Paper 1	1 hour	16.6	1 hour 30 mins	16.7
Terminal Paper 2	1 hour	16.6	1 hour 30 mins	16.7
Terminal Paper 3	1 hour	16.6	1 hour 30 mins	16.7
Internal assessment	–	25	–	25
	5 hours 15 mins	100%	6 hour 45 mins	100%

The syllabus area and number and type of question for each paper are given in Table 8 below.

Table 8

Paper	Foundation	Higher
	Syllabus area and number of questions	**Syllabus area and number of questions**
Module A	Living Organisms and Processes of Life: 12–15 short answer	Living Organisms and Processes of Life: 12–15 short answer
Module B	Using Materials and Understanding Reactions: 12–15 short answer	Using Materials and Understanding Reactions: 12–15 short answer
Module C	Forces and Energy: 12–15 short answer	Forces and Energy: 12–15 short answer
Terminal Paper 1	Living Organisms and Processes of Life, Environment, Reproduction and Genetics Four structured questions with 25% of the marks available being allocated to content from module Living Organisms and Processes of Life	Living Organisms and Processes of Life, Environment, Reproduction and Genetics Four structured questions with 25% of the marks available being allocated to content from module Living Organisms and Processes of Life
Terminal Paper 2	Using Materials and Understanding Reactions, Patterns, Problems, Processes Four structured questions with 25% of the marks available being allocated to content from module Using Materials and Understanding Reaction	Using Materials and Understanding Reactions, Patterns, Problems, Processes Four structured questions with 25% of the marks available being allocated to content from module Using Materials and Understanding Reaction
Terminal Paper 3	Forces and Energy, Electricity and Magnetism, Sound, Light and Waves, Earth in Space Four structured questions with 25% of the marks available being allocated to the content from Module Forces and Energy	Forces and Energy, Electricity and Magnetism, Sound, Light and Waves, Earth in Space Four structured questions with 25% of the marks available being allocated to the content from Module Forces and Energy

Questions set on the Foundation Tier will be confined to syllabus content at that level only. Questions set on the Higher Tier will sample all the syllabus content.

A significant portion of the total available credit will be allocated to assessment relating to technological application and social, economic and environmental implications.

No more than 20% of the total available credit is allocated to the assessment of recall of knowledge.

All written papers may contain questions/parts of questions on practical aspects of science which students are likely to have covered during the course.

Internal Assessment (25%)

For the purpose of internal assessment Attainment Target 1 is divided into three assessment categories. These categories and their approximate weightings are shown below.

Assessment Category	Weighting
A Planning experimental procedures	7%
B Obtaining evidence	7%
C Interpreting and evaluating	11%

Further details on the skills and abilities of the internally assessed component may be found in the section of the specification on internal assessment.

2B.3 QUALITY OF WRITTEN COMMUNICATION

The specification and associated assessment materials are provided in English and Irish as required. CCEA may provide operational assessment materials in Irish on request from centres if prior approval has been given by the Department of Education. Assessment will take into account candidates' quality of written communication where they are required to produce extended written material. Quality of written communication refers to candidates' ability to:

- present relevant information in a form that suits its purpose;
- ensure text is legible and that spelling, grammar and punctuation are accurate so that meaning is clear;
- use a suitable structure and style of writing.

Quality of written communication will be assessed within the written papers and in the internally assessed component.

3 SUBJECT CONTENT

The subject content is organised into six teaching and learning modules. The content of these is set out below and for each module the major topics to be covered are listed, together with related guidance notes. The notes provide further detail of the content required but they are not intended to be exhaustive descriptions of the topics to which they relate.

The content should be read in conjunction with the relevant aims and assessment objectives set out in Section 1 of this specification.

Specification content for the Foundation Tier is laid out in normal type. Questions in Foundation Tier papers will be set only in this content.

Specification content for the ***Higher Tier only*** is laid out in ***bold italics.*** Questions in Higher Tier papers may be set on any content in the specification.

3.1 LIVING ORGANISMS AND LIFE PROCESSES

Candidates should:

The Cell 3.1.1 *The Cell*

know that plants and animals are composed of cells:

- use a microscope and slide to study the structure and function of a typical plant and animal cell including nucleus, cytoplasm, cell membrane, nuclear membrane, cell wall, chloroplast, permanent vacuole and chromosomes;
- know the similarities: cytoplasm, nucleus and membranes as features common to most cells;
- know the differences: cell wall and large vacuole as distinguishing features of most plant cells;
- understand that cancer is abnormal cell division.

Specialisation

- understand that cells become specialised to carry out different functions to include the root hair, palisade mesophyll in plants; sperm cell, ciliated epithelium in animals.

Nutrition

3.1.2 *Plants*

know that photosynthesis is a key process which is essential to life including:

- that oxygen and starch are produced by photosynthesis;
- investigations which show that light, carbon dioxide, and chlorophyll are needed for photosynthesis to take place;
- the word equation for photosynthesis;
- factors affecting the rate of photosynthesis;
- that plants require specific minerals for healthy growth limited to calcium for cell walls, magnesium for chlorophyll formation and nitrogen as nitrates for amino acids and protein formation.

3.1.3 explain how the products of photosynthesis are used by a plant.

3.1.4 ***describe the economic implications in crop production of enhancing environmental factors, for example, carbon dioxide, light intensity, temperature and fertilizer application.***

3.1.5 *Animals*

Diet

- know the functions of food – energy, growth and protection;
- recall the main dietary sources and roles of carbohydrates, fats, proteins, fibre, vitamins (C and D only) minerals (calcium and iron only) and water in a balanced diet;
- health dangers associated with obesity and lack of exercise;
- use simple tests for each of the following: starch, (iodine), simple sugar, (Benedict's reagent), protein, (Biuret test) and vitamin C (DCPIP test);

- compare energy content of carbohydrates, fats and proteins in different foods;
- know about variation in energy required, with respect to age, gender, activity.

3.1.6 Digestive System

know the basic function of the digestive system – where large molecules are broken down to simple soluble molecules which are absorbed into and transported by the blood.

know the structure and functions of the component parts of the digestive system in humans, including: buccal cavity, oesophagus, stomach, small intestine (ileum), large intestine (colon), rectum and anus.

identify parts of the human alimentary canal, in relation to ingestion, digestion and egestion, absorption and assimilation.

3.1.7 describe the action of amylase, lipase and protease in saliva, gastric, pancreatic and intestinal juice, (specific names of enzymes not required).

the source and action of bile;

the significance of a large surface area for absorption; folds and villi;

the absorption of water in the colon;

the role of the liver in the assimilation of glucose.

3.1.8 ***understand the role of enzymes as biological catalysts in cellular activity involving both breaking down and building up of molecules (illustrated by reference to starch metabolism). The effects of temperature and pH on enzyme action. The principle of substrate specificity.***

Respiration 3.1.9 *Plants*

understand that plants respire, including:

- the exchange of oxygen and carbon dioxide through the stomata of the leaf of a plant during the day and during the night.

3.1.10 *Animals*

know the function of the respiratory system as one of gas exchange (oxygen for carbon dioxide in the lungs).

understand the structure and function of the component parts of the respiratory system, including:

- identification and function of the major organs of the respiratory system – nasal cavity, trachea, bronchus, bronchioles, lungs, alveolus, diaphragm and ribs and intercostal muscles;
- mechanism of breathing (the role of the intercostal muscles and diaphragm);
- investigation of the composition of inhaled and exhaled air; (gas analysis not required).

3.1.11 understand that respiratory surfaces are adapted for their function in both plants and animals, including large surface area, thin, moist and permeable.

3.1.12 *Anaerobic*

understand that respiration may be aerobic or anaerobic depending on the availability of oxygen.

compare anaerobic respiration with aerobic respiration in terms of energy released and the production of ethanol by yeast (word equations only required).

3.1.13 *Smoking and Health*

describe how cigarette smoke affects health, including:

- tar as a trigger for lung cancer;
- nicotine contributing to heart disease, irregular and increasing heartbeat;
- carbon monoxide displacement of O_2 in red blood cells;
- passive smoking – arguments relating to smoking in public places.

Transport

3.1.14 understand that substances pass into and out of cells in a number of ways, including:

- diffusion – as the means by which gases move in and out of cells;
- osmosis – as a special case of diffusion where water passes through a partially permeable membrane (details of osmotic, water and pressure potential are not required). The role of the cell wall in limiting entry of water into a plant cell;
- ***active uptake – understand as a process involving the expenditure of energy and the transport of substances against a concentration gradient as exemplified by the absorption of ions by an epidermal cell of the root of a plant***.

3.1.15 *Plants*

know how substances are transported in plants, including:

- water and mineral salts in xylem from root to all parts of plants;
- food from leaves, in phloem to all parts of plants.

3.1.16 understand the role of water in plants, including transport, support and transpiration;

know how to use the potometer to measure water uptake;

know the factors affecting the rate of transpiration;

temperature, wind speed, humidity and surface area.

3.1.17 *Animals*

Circulatory System

understand the function of the circulatory system – transport of materials, protection and maintaining body temperature;

know the structure and functions of the component parts of the circulatory system in humans, including:

- structure of the blood: red blood cells (transport of oxygen), white blood cells (defence), plasma (transport of food, waste in solution), platelets (blood clotting);
- the heart, limited to names of the four chambers and the direction of blood flow; double circulation;
- blood vessels – arteries carrying blood away from the heart and veins carrying blood to the heart;
- heart attack as reduced coronary circulation.

the names of the main blood vessels entering and leaving the heart and the main organs of the body, limited to the lungs, kidney, liver and intestine.

3.1.18 *Defence*

understand that disease can be caused by viruses, eg AIDS (HIV), bacteria, eg Gonorrhoea, Salmonella, fungi, eg Athlete's foot;

understand the defence mechanisms of the body including the role of the skin;

blood-clotting; antibodies and antigens; active and passive immunity;

mucous membranes in the respiratory system;

3.1.19 know the work of Jenner limited to the development of smallpox vaccine;

know the work of Pasteur, limited to spontaneous generation and the Swan Neck experiment;

Excretion

3.1.20 *Excretory System*

know excretion as the elimination of metabolic waste products and toxic materials taken in from the environment;

recall the structure of the human urinary system to include: kidney, ureter, bladder, sphincter muscle, urethra, renal artery and vein;

know that excess amino acids break down to urea in the liver;

know how these toxic products of metabolism are removed by ultrafiltration from the blood at the kidneys (no detail of nephron required);

recall that the kidney has a role in maintaining the internal environment (homeostasis) in humans limited to osmoregulation (no detail of nephron or ADH required);

understand that dialysis is a life supporting mechanism using an artificial method of filtration in cases of kidney failure;

appreciate the advantages and disadvantages of dialysis and kidney transplants.

Sensitivity and response

3.1.21 *Plants*

understand the role of hormones in plants, including:

- phototropism as a growth movement in the response to light.

3.1.22 *Animals*

know that behaviour can be explained in terms of receptors, coordinators and effectors, including:

- receptors – the eye; structure and function of the conjunctiva, cornea, pupil, iris, lens, retina and optic nerve;

- skin, including temperature control; (details of skin structure not required);
- coordinators – the simple function of the brain and spinal cord in coordinating responses; a reflex arc; ***voluntary and reflex actions; reflex arc in terms of sensory association and motor neurones;***
- effectors – the antagonistic action and function of muscles at a joint, limited to the elbow joint.

3.1.23 understand the function and role of hormones in coordination in humans, including:

- insulin control of blood sugar levels; (diabetes as a condition in which this mechanism breaks down);
- ***adrenaline in preparation for flight or fight.***

3.1.24 *Drugs*

discuss the effects of alcohol, drug and solvent abuse including antibiotics, painkillers, stimulants, depressants and hallucinogens on individuals and the cost to society.

3.2 ENVIRONMENT, REPRODUCTION AND GENETICS

Candidates should;

Habitat study 3.2.1 carry out fieldwork, including the use of sampling techniques, eg quadrats and pitfall traps, to investigate the physical factors affecting the distribution and type of living organism found in a local habitat, including:

- changes in seasonal temperature;
- availability of light;
- availability of water;
- extent of cultivation.

Food chains and webs	3.2.2	understand the components of food chains and food webs, including: • Sun as a primary source of energy; • producers; • consumers (primary, secondary and tertiary); • decomposers (the role of bacteria and fungi); • nature of energy flow.
	3.2.3	explain the meaning of the terms pyramid of numbers and pyramid of biomass;
Cycles	3.2.4	understand that materials are recycled to maintain the balance in the environment, including: carbon cycle; photosynthesis, respiration, combustion and fossilisation; ***understand the nitrogen cycle – cycling of protein, to include decay and decomposition, nitrification, nitrogen fixation and denitrification (no specific name of bacteria required)***.
Pollution	3.2.5	describe ways that human activity can damage the environment and affect the plants and animals living there, including: • air – effects of pollution by soot and sulphur dioxide on plants; • land – deforestation; – waste management; (land fill versus incineration as a means of disposal); – biodegradable and non biodegradable materials; • water – sewage treated and untreated, eutrophication; – effluent from water cooling processes.

Conservation

3.2.6 describe ways of improving the environment including:

- air – smokeless fuels, alternative fuels, catalytic converters;
- land – reafforestation;
- water – sewage disposal (detail of plant treatment not required).

3.2.7 explain how materials for growth and energy are transferred through an ecosystem, including assigning organisms to their trophic level;

energy losses between trophic levels;

the advantages of short food chains in relation to the feeding of man.

3.2.8 ***understand how food production involves the management of ecosystems to improve the efficiency of energy transfer, including the management of fish stocks, eg herring stock in the North Sea.***

3.2.9 understand how population growth and decline are related to environmental resources including the effects of birth rate, death rate, emigration, immigration, food supply, predation and diseases.

3.2.10 *Animals*

Reproductive System

know the structure and functions of the component parts of the reproductive systems in humans, including:

- the male system – testes, scrotum, sperm ducts, prostate gland, urethra and penis;
- the female system – ovaries, oviducts, uterus, cervix, vagina and vulva;
- fertilization in the oviduct;

- development, by cell division, into a ball of cells which implants in the uterus lining;
- the placenta, umbilical cord, amnion and amniotic fluid;
- birth limited to contraction of the uterus, dilation of the cervix and rupture of the amniotic membrane.

3.2.11 understand the need for a responsible attitude to sexual behaviour, including:

- interpersonal relationships;
- prevention of sexually transmitted diseases – the cause, transmission, treatment and prevention of AIDS and gonorrhoea;
- contraception – natural, mechanical, chemical and surgical methods.

Genetics

3.2.12 recall that genetic information is carried in the form of genes on chromosomes in the nucleus of cells, eg eye colour and tongue rolling;

know that genes are short lengths of DNA.

3.2.13 ***understand how genetic information is passed from cell to cell and generation to generation, including:***

- ***mitosis; outline in terms of the exact duplication of chromosomes (names of phases and details of DNA replication not required);***
- ***meoisis as reduction division (diploid to haploid) and as a process which re-assorts the chromosomes (omitting crossing over and names of phases);***
- ***fertilization as a means of restoring the diploid number and combining different sets of chromosomes.***

	3.2.14	understand the principles of a simple monohybrid cross (co-dominance not required). Use of Punnett squares to determine genotype frequencies. Distinction between genotype and phenotype, heterozygous and homozygous, dominant and recessive alleles. ***Use of backcross to determine genotype.***
	3.2.15	explain the way in which sex is determined in humans. (No detail of sex linked characters required.)
	3.2.16	know that some diseases can be inherited, limited to cystic fibrosis and Downs syndrome: no details of symptoms required.
	3.2.17	know that radiation can cause genetic mutation to include the role of UV light and skin cancer.
	3.2.18	***understand how DNA controls protein synthesis, (limited to DNA as a double helix linked by base pairs and lengths of DNA which code for specific proteins).***
		understand how proteins can be obtained from genetically engineered bacteria, eg human insulin.
		discuss two approaches to discovery of DNA structure, eg Watson, Crick and R Franklin and Wilkins.
Selection	3.2.19	know that variation in living organisms has both a genetic and environmental basis, eg height in humans.
	3.2.20	understand that sexual reproduction is a source of genetic variation, while asexual reproduction produces clones.
	3.2.21	***know that cloning results in genetically identical offspring, for example, cuttings and runners in asexual reproduction in plants, tissue culture and splitting of early embryos in agricultural animals; (no details of experimental technique required).***

3.2.22 understand how variation and selection may lead to evolution or extinction;

natural selection as variation within phenotypes and competition for resources leading to differential survival.

3.2.23 ***understand the use of artificial selection in plant and animal breeding leading to increased yield, food value.***

3.3 USING MATERIALS AND UNDERSTANDING REACTIONS

Candidates should:

Hazard symbols

3.3.1 recognise and know the value of common hazard symbols on containers, ie flammable, toxic, corrosive, explosive, harmful/irritant (distinction between supply symbols, convenience labels and safety signs not required).

Man-made materials

3.3.2 relate knowledge of the properties of the different classes of man-made materials to everyday use.

Specific examples of man-made materials should include: metals – iron, aluminium, copper, lead and zinc; ceramics – pottery, tiles; glass – soda glass, heat resistant glass; plastics – thermosetting, eg melamine, bakelite, epoxy resins, thermo softening, eg polythene, PVC, polystyrene; fibres – nylon.

Structures and methods of manufacture are not required unless specifically mentioned elsewhere in the specification.

Composite materials

3.3.3 ***evaluate the relative advantages and disadvantages of composite materials, eg glass fibre (boats, car bodies), reinforced glass (windows), reinforced concrete (beams), glass-reinforced plastic and bone.***

3.3.4 ***describe a composite material as one which combines the properties of more than one material to produce a more useful material for particular purposes.***

Gases	3.3.5	recognise that gases have weight and that they spread out to fill the space available, eg diffusion of bromine.
	3.3.6	give examples which show that gases are compressible and how this characteristic is used in everyday life, eg fire extinguishers, aerosol sprays.
Solubility	3.3.7	understand the terms: solvent, solute, solution, saturated, hydrated and dehydration.
	3.3.8	recognise the factors affecting solution, ie heat, surface area, stirring, volume of solvent.
	3.3.9	understand the qualitative effect of temperature on the solubility of solids and gases in water.
	3.3.10	***carry out simple quantitative determination of solubility of solids in water leading to an understanding of solubility curves.***
Particles and Bonds		Candidates should:
Kinetic theory	3.3.11	explain changes of state, including sublimation and energy changes associated with them, diffusion and dissolving, in terms of simple kinetic theory.
	3.3.12	recognise that the volume of a gas depends upon pressure and temperature. (Qualitative treatment only.)
	3.3.13	***use the relationship between the volume of a gas and its pressure and temperature to solve simple problems, ie PV/T = constant (conversion to STP not required). Quantitative practical details not required.***
Atomic structure	3.3.14	understand the terms: elements, compounds, atoms, ions and molecules and their interrelation.
	3.3.15	describe the structure of atoms and ions in terms of protons, electrons and neutrons limited to elements 1–20 in the Periodic Table.
	3.3.16	state the relative charge and relative mass of a proton, an electron and a neutron.
	3.3.17	understand the terms atomic number and mass number.

	3.3.18	explain the existence of isotopes and distinguish between isotopes, eg ^{35}Cl and ^{37}Cl.
Elements, compounds and mixtures	3.3.19	classify substances as elements (metallic or non-metallic), compounds or and mixtures and distinguish between them according to their properties.
Ionic bonding	3.3.20	describe the formation of an ionic bond in terms of electron transfer and recognise that bond formation is the result of attraction between ions of opposite charge and is typical of metal compounds. Examples should include MgO, NaCl and $CaCl_2$.
Covalent bonding	3.3.21	describe the formation of a covalent bond in terms of sharing electron pairs. ***Examples should include Cl_2, O_2, H_2O and CH_4.***
	3.3.22	***recognise covalent bonding as typical of non-metal elements and compounds.***
Bonding in metals	3.3.23	***describe in simple terms, the bonding in metals.***
Bonding and structure	3.3.24	***classify substances in terms of their properties as metallic; ionic; covalent molecular or giant covalent (including graphite, diamond and quartz).***
	3.3.25	***explain the properties and uses of typical ionic, covalent (simple and giant) and metallic substances in terms of their chemical bonding and structures.***
	3.3.26	***relate the properties of thermosoftening plastics, thermosetting plastics and fibres to simple models of their structures.***
Understanding Chemical Reactions		Candidates should:
Chemical nomenclature	3.3.27	recognise and use symbols for common elements.
	3.3.28	use chemical names for simple compounds.
	3.3.29	construct simple word equations to describe the range of reactions covered in this specification.

	3.3.30	give symbolic representations for some elements and deduce the formulae of simple compounds, limited to elements both of whose valencies in the compound can be established from their positions in the Periodic Table and those groups (hydroxide, sulphate, nitrate, carbonate, hydrogen carbonate, ammonium) whose symbols and valencies are given in a Data Leaflet provided for candidates.
	3.3.31	use state symbols (s, l, g and aq).
	3.3.32	represent chemical reactions by balanced symbolic equations.
	3.3.33	***write ionic equations, eg to describe electrolysis processes.***
Rusting	3.3.34	***understand rusting as the reaction of iron with a combination of water and air to produce hydrated iron(III) oxide. Sacrificial protection related to the reactivity series.***
Redox	3.3.35	relate important oxidation and reduction reactions to everyday examples ***and manufacturing processes***, limited to rusting, combustion of fuels, ***aluminium and iron manufacture, Haber Process. (Iron manufacture, Haber Process in terminal papers only).***
Hard water	3.3.36	identify a sample of water as being hard or soft.
	3.3.38	describe the effects of hard water on soap and detergents.
	3.3.39	recognise characteristics of a hard water region including advantages associated with hard water.
	3.3.40	give examples of advantages and disadvantages associated with hard water.
	3.3.41	explain the differences between temporary and permanent hardness.
	3.3.42	recognise methods of water softening, ie by boiling, addition of washing soda and by ion exchange.

	3.3.43	***explain in terms of ions the causes and effects of water hardness.***
	3.3.44	***outline methods of softening water.***
	3.3.45	***explain precipitation in terms of ions and relate this to processes of separation and purification, eg use of washing soda to soften water.***
Acids and bases	3.3.46	recognise that acids dissolve in water, producing hydrogen ions (H^+), that alkalis dissolve in water producing hydroxide ions (OH^-) and that neutralisation is the combination of these ions to form water. ***This can be represented by the ionic equation:*** $H^+(aq) + OH^-(aq) \rightarrow H_2O\ (l)$
	3.3.47	recognise that a base is a metal oxide or hydroxide and that an alkali is a soluble base.
	3.3.48	recognise that metal oxides are basic and that non-metal oxides are acidic, but understand that there are limitations to different systems of classification, for example, oxide classification in terms of acid/base behaviour.
	3.3.49	give examples of reactions of acids with: metals, bases (including sodium hydroxide and copper(II) oxide) and metal carbonates to form salts. Examples limited to those reactions mentioned elsewhere in the syllabus.
Electrolysis	3.3.50	give a simple explanation of electrolysis and examples of its use, ie recognize that some substances can be broken down into simpler substances by an electric current. This is called electrolysis and can happen when the substance is molten or dissolved in water.
	3.3.51	understand the terms anode, cathode and electrolyte.
	3.3.52	***predict the products of simple electrolytic reactions. Examples should include the molten halide salts LiCl and $PbBr_2$ and solutions limited to sulphuric acid (dilute) and sodium chloride (concentrated). (inert electrodes in all above.)***

3.3.53 describe and explain the processes involved in the purification of copper by electrolysis of copper sulphate solution using copper electrodes and the extraction of aluminium from pure aluminium oxide. (Details of processes required but no details of plant.)

3.3.54 ***recognise that, in electrolysis, conduction occurs through the movement of ions, that positive ions are discharged at the cathode and that negative ions are discharged at the anode. The idea of preferential discharge is limited to the electrolysis of sulphuric acid (dilute) and sodium chloride (concentrated).***

3.3.55 ***describe electrolysis in terms of ionic reactions. Any stoichiometrically correct equations for cathode and anode reactions will be accepted. Examples should be drawn from electrolytic processes specifically covered in the syllabus.***

3.4 PATTERNS, PROBLEMS, PROCESSES

Candidates should:

Energetics

3.4.1 demonstrate a knowledge that materials can be decomposed by heat including the effect of heat on hydrated copper(II) sulphate, thermal decomposition of metal carbonates, decomposition of limestone and ***thermal cracking of hydrocarbons (details of plant not required).***

3.4.2 give and recognise examples of simple exothermic and endothermic reactions, eg combustion, photosynthesis, dissolving, displacement, hydration of $CuSO_4$, neutralisation.

3.4.3 ***recognise that the energy transferred in a chemical reaction is associated with breaking and making of chemical bonds. (Qualitative treatment only.)***

Reactivity series

3.4.4 make predictions from the reactivity series of metals, ie K, Na, Ca, Mg, Al, Zn, Fe, Cu based on reactions with oxygen, water/steam, and dilute acids (hydrochloric and sulphuric) as appropriate, displacement reactions.

	3.4.5	predict where an unfamiliar element should be placed in the series based on comparative information.
Reaction rates	3.4.6	describe the qualitative effects of temperature, concentration, particle size, catalysis and, as appropriate, light on the rate of chemical reactions.
	3.4.7	***identify the significant factors which control the rates of reaction and, where appropriate, their quantitative effects. Quantitative effects limited to the interpretation of data, eg drawing graphs and making predictions about how the rate may change when the factors listed are altered. Give a simple explanation of how the factors identified above influence the rate in terms of collisions and the energies of the reacting particles*** .
	3.4.8	***relate the factors which control rates of chemical reactions to practical problems associated with manufacturing processes in industry.***
Periodic Table	3.4.9	demonstrate a knowledge that the Periodic Table groups together elements with similar properties, eg the Alkali metals as a group of reactive metals, the Halogens as a group of reactive non-metals, the Noble gases as a group of unreactive non-metals.
	3.4.10	outline the work of Mendeleev in the development of the Periodic Table.
	3.4.11	relate the position of selected elements in the Periodic Table and their properties to their electronic structure (limited to the first 20 elements).
	3.4.12	describe simple trends in the properties of elements within Groups (I, II,VII) and across Periods (2 and 3) of the Periodic Table.
	3.4.13	***use the Periodic Table to predict the properties of certain unfamiliar elements, limited to Groups I, II,VII and properties to relative atomic mass, atomic size, metallic and non-metallic characteristics, valency and chemical reactivity with oxygen, water and dilute acids, as appropriate.***

Chemical calculations	3.4.14	understand the term relative atomic mass and use this to determine relative formula masses (relative molecular masses).
	3.4.15	***understand that one mole of different substances contains equal numbers of specified particles.***
	3.4.16	***use relative formula mass to determine the number of moles present in a given mass of material.***
	3.4.17	***carry out calculations involving reaction masses from given balanced equations. Calculations relating to moles will be limited to use of the relationship: mass(m) = number of moles(n) × relative molecular (atomic) mass (RMM or RAM).***
	3.4.18	***understand the term concentration of a solution expressed in moles per litre (mol/dm^3). Questions on titrations will not be asked. Calculations on molarity will not be asked but concentrations of chemicals in solution may be given in moles per litre if this is appropriate, eg in work relating to rates of reaction.***

Metals, Non-Metals and their Compounds

Metals		Candidates should:
Physical properties of metals	3.4.19	describe the important physical properties of a range of metals: sodium, calcium, magnesium, iron and copper. Physical properties of metals to include electrical and thermal conductivity, malleability, ductility, lustre, strength, melting point (qualitative treatment).
Chemical properties of metals	3.4.20	describe the important chemical properties of a range of metals: sodium, calcium, magnesium, iron and copper. Limited to their reactions with oxygen, water/steam, dilute hydrochloric and sulphuric acids as appropriate.
Physical properties of metal compounds	3.4.21	describe the typical properties of ionic solids, ie hard, brittle, high melting, crystalline solids which conduct electricity when molten or in solution, to include solubilities of chlorides,

		nitrates, sulphates, carbonates, hydroxides and oxides as provided in the data leaflet supplied to candidates.
Chemical properties of metal compounds	3.4.22	recognise oxides and hydroxides as bases (NaOH, CaO, $Ca(OH)_2$, CuO and describe their reactions with water and with dilute hydrochloric and sulphuric acids as appropriate.
	3.4.23	describe the reactions of carbonates ($CaCO_3$, Na_2CO_3) with acid and the thermal composition of carbonates ($CaCO_3$, $CuCO_3$).
Uses of metals	3.4.24	recall important uses of metals including: • magnesium: high strength alloys for aircraft, flares; • aluminium: electrical wiring, saucepans, alloys; • zinc: galvanising, brass; • iron: steel manufacture, steel structures, ornamental gates, cookers, nails; • copper: electrical wiring, plumbing, brass, coinage; • lead: roofing, batteries, solder, anti-knock.

Non-Metals

Gases	3.4.25	describe tests to identify the gases hydrogen, oxygen and carbon dioxide and recognise the diatomicity of hydrogen, oxygen, nitrogen and chlorine gases.
Hydrogen	3.4.26	describe the physical properties and reactions of hydrogen with oxygen forming water, as a reducing agent, eg with copper(II) oxide ***and with nitrogen forming ammonia.***
Carbon	3.4.27	describe the combustion of carbon to CO and CO_2 and recognise in simple terms the toxic effects of incomplete combustion of fuels.

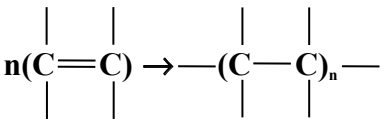
Nitrogen	3.4.28	describe the physical properties and lack of reactivity of nitrogen ***and its reaction with hydrogen in the manufacture of ammonia (Haber-Bosch Process), ie name of catalyst, approximate temperature and pressure. Equilibrium aspects will not be examined***.
Oxygen	3.4.29	describe the physical properties of oxygen and recognise its importance in combustion and respiration.
Sulphur	3.4.30	describe the physical properties of sulphur, its combustion to form SO_2 and the reaction of sulphur with iron. Causes and effects of SO_2 pollution (acid rain) and its control.
Noble gases	3.4.31	recognise that helium, neon and argon are chemically inert gases.
Chlorine	3.4.32	describe the physical properties and poisonous nature of chlorine. Describe displacement reactions of chlorine with bromides and iodides (and recognise aqueous bromine and iodine solutions by their colour).
Water	3.4.33	describe the physical properties of water, its use as a common solvent, the use of anhydrous copper(II) sulphate to test for the presence of water and understand the term "water of crystallisation" and its removal by action of heat.
	3.4.34	recognise the pollution of water by detergents (phosphates)and fertilizers (nitrates and phosphates). Describe the role of filtration and chlorination in water treatment.
Carbon dioxide	3.4.35	describe the physical properties of carbon dioxide, the causes and effects of carbon dioxide pollution (green house effect), its reactions with water ***and sodium hydroxide***.
Uses of non-metals	3.4.36	recall important uses of non-metals and their compounds to include: • hydrogen: meteorological balloons, rocket engines, potential as a clean fuel;

- carbon: as a fuel, electrodes in aluminium manufacture;
- nitrogen: coolant, food packaging;
- oxygen: hospitals – breathing, welding, steel making;
- sulphur: vulcanising of rubber, fungicide; chlorine: PVC manufacture, water, sterilisation;
- carbon dioxide: fire extinguishers, carbonated drinks, dry ice;
- ammonia: fertilizers, nitric acid manufacture, nylon;
- sulphuric acid: car batteries, manufacture of detergents, fibres; pigments.

Organic Chemistry

Sources of organic chemicals	3.4.37	recall that fossil fuels and biological substances are carbon-based compounds. Recall that oil is the major source of organic chemicals and that chemicals obtained from oil are hydrocarbons.
	3.4.38	give examples of fossil fuels: natural gas, LPG, petrol, diesel, paraffin, candle wax, peat, lignite, coal, coke. Recognise that fossil fuels are non-renewable resources and describe the combustion of fossil fuel as: fossil fuel + oxygen → carbon dioxide + water + heat energy.
	3.4.39	explain how chemicals are obtained from oil by fractional distillation.
	3.4.40	***recall the conditions used to crack fractions obtained from crude oil and understand that cracking involves breaking large hydrocarbon chains into smaller ones, some of which have C=C bonds.***
Homologous series	3.4.41	***recognise an homologous series as one in which the chemicals have: the same general formula, similar chemical properties and a gradation their physical properties.***

Alkanes	3.4.42	***recall the names, molecular and structural formulae, and physical state of first four alkanes. Describe the complete combustion of alkanes and recognise their use as fuels.***
Alkenes	3.4.43	***recall the names, molecular and structural formulae, and physical state of first two alkenes. Describe the complete combustion of alkenes and the manufacture of ethanol from ethene and steam.***
	3.4.44	***describe the use of bromine water to distinguish alkanes/alkenes (equations not required). Understand that alkanes are saturated and that alkenes are unsaturated.***
	3.4.45	***recognise examples of the use of alkenes in the manufacture of commercially important addition polymers, (specific conditions not required)and to the social, cultural, economic, environmental, health and safety factors involved, limited to polythene, PVC, polypropene. Give uses of these polymers. Represent addition polymerisation as:***



Ethanol	3.4.46	***recall the molecular and structural formula and physical state of ethanol. Describe the complete combustion of ethanol and its formation by fermentation (equation not required). Give uses for ethanol as a fuel, in alcoholic beverages and as a solvent.***
Ethanoic acid	3.4.47	***recall the molecular and structural formula of ethanoic acid. Give examples of reactions of ethanoic acid as a typical dilute acid, ie with metals, bases and carbonates. Reaction with ethanol to form an ester. (Test-tube scale.) Formula and structure of ethyl ethanoate.***

Science at Work

Pupils should:

Human influences	3.4.48	identify the positive and negative effects of the exploitation of raw materials, including the harmful effects on the physical and living environments.

		Limited to limestone quarrying, peat cutting, lignite mining and solution mining of salt.
	3.4.49	explain how the impact of human activity on the Earth is related to economic factors and industrial requirements and recognise pollution control as a national and international responsibility.
Industrial processes	3.4.50	***use scientific knowledge and information to evaluate the social, economic and environmental factors associated with the manufacturing processes involved in cracking oil, the chlor-alkali industry, the production of plastics and fertilizers and the manufacture of aluminium and iron. Specific chemistry limited to that given elsewhere in the syllabus.***
Manufacture of iron	3.4.51	***describe the production of iron in the blast furnace. outline the essential chemistry and conditions of the process and demonstrate an understanding of the energy factors involved. Details of plant not required.***
Radioactivity	3.4.52	describe the properties of different types of ionising radiation and relate these to their uses. Alpha decay illustrated by uranium-238 and beta decay illustrated by carbon-14. Properties of alpha and beta particles and gamma rays to include their charge, mass and relative penetrating power in air.
	3.4.53	***describe radioactivity and nuclear fission in terms of the atomic model, eg recognise the products formed on alpha or beta decay of given radioactive isotopes and write simple nuclear equations to illustrate alpha and beta decay.***
	3.4.54	***demonstrate an understanding of half-life including simple calculations.***

3.5 FORCES AND ENERGY

		Candidates should:
Forms of energy	3.5.1	describe energy transfers involving the following forms of energy; chemical, heat, electrical, sound, light, magnetic, nuclear, kinetic and potential (gravitational and strain).

Energy resources	3.5.2	recall that there is a variety of energy resources, to include: oil, gas, coal, nuclear, biomass, wind, wave, solar, geothermal, tidal and hydroelectric, and distinguish between renewable and non-renewable resources.
	3.5.3	explain how energy sources, such as wind and fossil fuels, are ultimately dependent on the sun's energy.
	3.5.4	describe the environmental implications of the use of energy resources, limited to generation of electricity by fossil fuels, nuclear fuel, wind farms, waves and tides. Appreciate the effect on the environment of the use of these energy resources limited to the contribution of burning fossil fuels to the greenhouse effect, nuclear waste, effect on the use of land and sea.
	3.5.5	***evaluate the advantages and disadvantages of using various energy resources to generate electricity. This should take into consideration: reliability, how quickly the different types of power station can respond to changes in demand, the costs of building, operating and de-commissioning power stations and any additional information, including quantitative information with which they are provided.***
Work and power	3.5.6	recall and use the relationship; work = force × distance moved in the same direction as the force, and that work is measured in joules.
	3.5.7	recall and use the formula; power = work done/time taken.
Conservation of energy	3.5.8	understand that energy is conserved and describe energy changes in terms of the principle of conservation of energy.
	3.5.9	understand that energy may be dissipated and become less useful and appreciate the role that friction plays in this.
	3.5.10	***recall and use the quantitative relationships for kinetic energy (½ mv^2), gravitational potential energy (mgh) and power, in the context of the conservation of energy.***

	3.5.11	recall that efficiency is a measure of how much energy is transferred in an intended way and calculate as the ratio of useful output energy to input energy.
Heat transfer	3.5.12	describe the thermal conduction in good conductors and in insulators in terms of the movement of electrons and vibrational movement of atoms/molecules.
	3.5.13	describe convection in liquids and gases in terms of the movement of the molecules of the liquid or gas.
	3.5.14	describe the effect that the nature of a surface has on the emission and absorption of radiant heat, including some applications.
	3.5.15	describe methods of reducing heat loss from the home.
Effects of a force	3.5.16	understand Newton's first law, ie that change in movement or direction results from unbalanced forces and that balanced forces produce no change.
	3.5.17	appreciate that friction is a force that opposes motion.
Mass and weight	3.5.18	distinguish between mass and weight, in that, mass is an unchanging property of an object whereas weight is a force that depends on how strong gravity is.
	3.5.19	recall that, on the Earth, gravity exerts a force of 10 N on every kilogramme of mass and be able to carry out simple calculations involving mass and weight.
Hooke's Law	3.5.20	investigate experimentally the relationship between force and the extension of a helical spring.
	3.5.21	state and use Hooke's Law and use it to solve simple problems.
	3.5.22	understand the meaning of elastic limit.
Moments	3.5.23	calculate the moment of a force as force times perpendicular distance from the pivot.

	3.5.24	describe some practical applications of levers.
	3.5.25	***state the principle of moments and use it to solve simple problems. Calculations limited to two forces other than that acting at the pivot. Perpendicular distances only will be given.***
Centre of mass	3.5.26	understand the term centre of mass and how the stability of an object depends on the position of the centre of mass and the width of its base.
Pressure	3.5.27	recall and use the quantitative relationships between pressure, force and area; recall that pressure is measured in Pascals. (Problems may be set in which N/cm^2 and N/mm^2 are used. There will be no interchange of units.)
	3.5.28	recall and use the quantitative relationships between average speed, distance and time, including the calculation of average speed from linear distance-time graphs.
	3.5.29	distinguish between distance and displacement, speed and velocity.
	3.5.30	***recall and use the quantitative relationships between:*** ***(i) displacement, time and average velocity;*** ***(ii) initial velocity, final velocity, acceleration and time. (Problems will only be set on motion in one direction. Equations of motion will not be examined.)***
	3.5.31	use graphical methods to determine velocity, acceleration and displacement; recall that the slope of a displacement-time graph is the velocity and that the slope of a velocity-time graph is the acceleration and that the area under the graph is the displacement.
Displacement	3.5.32	***recall and use the quantitative relationships between force, mass and acceleration in the form F = ma, where F is the resultant force.***
Newton's 2nd Law	3.5.33	***appreciate that, in the absence of all other forces, objects near the surface of the earth fall with the same acceleration and recall that this acceleration is known as the acceleration of free fall.***

	3.5.34	***recognise and use the equation: weight = mass × acceleration of free fall. Experimental determination of acceleration of free fall is not required.***
	3.5.35	recall that momentum is the product of mass and velocity. Conservation of momentum is not required.
Momentum	3.5.36	describe some examples of circular motion.
Circular motion	3.5.37	recall that an object moving in a circle requires a force and that this force acts towards the centre of the circle.
	3.5.38	recall that if this force is removed the object will fly off at a tangent to the circle.

3.6 WAVES, LIGHT AND SOUND, ELECTRICITY AND MAGNETISM, EARTH IN SPACE

Candidates should:

Waves	3.6.1	understand that waves transfer energy from one point to another.
	3.6.2	distinguish between transverse and longitudinal waves in terms of the motion of the particles of the medium.
	3.6.3	recall examples of transverse and longitudinal waves.
	3.6.4	describe, using simple wavefront diagrams, how waves are reflected and refracted, restricted to plane wavefronts, plane barriers and plane boundaries. (Geometrical constructions not required.)
	3.6.5	recall the meaning of frequency, wavelength and amplitude of a wave.
	3.6.6	recall and use the quantitative relationship between frequency, wavelength and speed of a wave.
Sound	3.6.7	describe experiments to demonstrate that sound can travel through different materials at different speeds but cannot travel through a vacuum.

	3.6.8	relate pitch and loudness of sound to its waveform displayed on a CRO.
	3.6.9	recall that the range of human hearing is 20 Hz to 20 kHz and that the upper limit decreases with age.
	3.6.10	recall that frequencies greater than 20 kHz are called ultrasound.
	3.6.11	describe damaging effects of loud sounds on the ear and understand the need to control noise levels in the environment.
	3.6.12	recall that sound is reflected so that the angle of incidence = the angle of reflection.
	3.6.13	describe some application of echoes and carry out simple calculations on the echo principle.
	3.6.14	describe some applications of ultrasound in industry and medicine.
Light	3.6.15	recall that luminous objects are seen by the light they emit and that all other objects are seen by the light they reflect.
	3.6.16	explain with the help of ray diagrams the formation of shadows by point and extended sources of light.
	3.6.17	understand that light is reflected from plane surfaces so that the angle of incidence = the angle of reflection and apply in practical situations.
	3.6.18	understand that a change of speed causes light to be refracted at air/glass, glass/air, air/water, and water/air boundaries.
	3.6.19	recall that when light slows it is bent towards the normal and the converse. A knowledge of Snell's law or total internal reflection is not expected.
	3.6.20	***use a wave model to explain refraction of light at a plane surface using simple plane wavefront diagrams. (See also 3.6.4.)***
	3.6.21	describe how light is dispersed by prisms and understand that a spectrum can be produced because different colours of light are refracted by different amounts.

The electromagnetic spectrum	3.6.22	recall that the electromagnetic spectrum includes radio waves, microwaves, infrared, visible light ultraviolet waves, X-rays and gamma-rays and be able to arrange them in order of wavelength.
	3.6.23	describe some uses and dangers of microwaves, infrared and ultraviolet waves in domestic situations.
	3.6.24	describe some uses of X-rays and gamma-rays in medicine. (Excluding detection of various regions of the spectrum.)
	3.6.25	describe some uses of radiowaves, microwaves, infra red and visible light in communication.

Electricity and Magnetism

Static charge	3.6.26	recall that insulating materials can be charged by friction and explain this in terms of transfer of charge.
	3.6.27	understand that positively charged objects have a deficiency of electrons and negatively charged objects have a surplus of electrons.
	3.6.28	describe the dangers and use of electrostatic charge generated in everyday contexts.
Charge flow	3.6.29	understand that an electric current is a flow of electrons and that it is in the opposite direction to that of a conventional current.
	3.6.30	***recall that charge is measured in coulombs.***
	3.6.31	***recall and use the quantitative relationship between current, charge and time.***
Electric circuits	3.6.32	understand the role of conductors, insulators and switches in simple series and parallel circuits.
	3.6.33	describe the effects of varying the current on bulb brightness, motor speed and heater output.
	3.6.34	describe and record diagrammatically simple electric circuits.
	3.6.35	measure current and voltage in series and parallel circuits.

	3.6.36	recall that in a series circuit the current is the same everywhere.
	3.6.37	recall that in a series circuit the sum of the voltages is equal to the voltage across the whole circuit.
	3.6.38	recall that in a parallel circuit the sum of the currents in the branches is equal to the current entering the parallel section.
	3.6.39	recall that voltages across components in parallel are equal.
	3.6.40	calculate the total resistance of resistors in series.
	3.6.41	calculate the resistance of two equal resistors in parallel.
	3.6.42	***calculate simple combinations of resistors (no more than three resistors which may include two equal resistors in parallel).***
Ohm's Law	3.6.43	plot and interpret voltage – current graphs for metallic conductors at constant temperature.
	3.6.44	state and use Ohm's Law in the form V/I = R, where R is the resistance.
	3.6.45	plot and interpret voltage-current graphs for a filament bulb.
	3.6.46	recall how the resistance of a thermistor (n.t.c.) varies with temperature.
	3.6.47	***understand that voltage is the energy transferred per unit charge.***
	3.6.48	***recall and use the quantitative relationships between power, energy, current, voltage and time.***
Using electricity	3.6.49	understand one-way and two-way switching.
	3.6.50	describe how to wire a fused three pin plug.
	3.6.51	understand the functions of live and neutral wires and how the earth wire and fuse protect the user from electric shock.

	3.6.52	describe how double insulation protects the user.
	3.6.53	describe how circuit breakers protect the user.
	3.6.54	understand the positioning of switches and fuses on the live side of appliances.
	3.6.55	calculate the costs of using electricity from meter readings.
	3.6.56	understand the meaning of the kilowatt-hour and calculate the cost of using electrical appliances using their power rating.
Electromagnetic induction	3.6.57	***understand that current may be induced in a conductor by its motion relative to a magnet and by changing the current in a neighbouring conductor.***
	3.6.58	know the difference between a.c. and d.c.
	3.6.59	recall that a.c. generators are used in the generation of electricity. (Details of construction not required.)
	3.6.60	***describe how step-up and step-down transformers are used in the transmission of electricity, including the relationship between the number of turns and voltage across the coils.***
Generation and transmission of electricity	3.6.61	***understand that stepping up the voltage reduces energy losses in the grid.***

Earth in Space

Seasons	3.6.62	explain changes in day length, seasonal changes and changes in the elevation of the sun in terms of the tilt of the Earth's axis and its movement around the Sun.

Solar system	3.6.63	recall the position of the Sun and planets within the solar system and how they move relative to each other. Recall, evaluate and discuss the historical evidence for the heliocentric solar system as opposed to the geocentric.
Gravitation	3.6.64	***understand that gravitational force acts towards the centre of every astronomical object and that this force determines the motion of the planets and comets round the Sun and satellites round the planets.***
	3.6.65	***understand that gravitational forces act between all masses and know that the magnitude diminishes with distance and increases with mass.***
	3.6.66	***describe the nebular (gas cloud) model for the formation of the solar system.***
Galaxy Universe	3.6.67	recall that the Universe is made up of innumerable galaxies. A galaxy is a vast number of star systems held by gravitational forces. The Milky Way is the galaxy which contains our solar systems.
Big Bang and steady state	3.6.68	describe the Big Bang and steady state model for the formation of the universe.
	3.6.69	consider the possibilities and limitations of space exploration in terms of distances and speed of travel. Recall, evaluate and discuss evidence for life and planets outside our solar system.
Stars	3.6.70	describe how stars are formed (the life cycle of stars is not required).
	3.6.71	recall that stars are powered by nuclear fusion processes.

4 GRADE DESCRIPTIONS

The following grade descriptions indicate the level of attainment characteristic of the given grade at GCSE level. They give a general indication of the required learning outcomes at each specific grade. The descriptions should be interpreted in relation to the specified subject 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 examination may be balanced by better performance in others.

Grade F

Candidates recall a limited range of information. For example, they state the main functions of organs of the human body, describe some defence mechanisms of the body, state some uses of materials obtained from oil, suggests ways in which insulation is used in domestic contexts.

Candidates use and apply knowledge and understanding in some specific everyday contexts. For example, they describe how a reduction in the population of one organism in a habitat can affect another organism, suggest a way of speeding up a particular chemical reaction, explain that fuels are energy resources and that energy is sometimes "wasted". Candidates make some use of scientific and technical vocabulary and make simple generalisations from information.

Candidates relate scientific explanations to some experimental evidence and describe simple examples of benefits and drawbacks of scientific development.

Candidates devise fair tests in contexts which involve only a few factors. They use simple apparatus to make measurements appropriate to the task and record observations and measurements in tables and graphs. Candidates 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 recall a range of scientific information from all areas of the specification. For example, they describe how some organ systems in living things carry out life processes, recall simple chemical symbols and formulae, recall correct units for quantities.

Candidates use and apply scientific knowledge and understanding in some general contexts, for example, they describe how a cell is adapted to its functions, use simple balanced equations, use quantitative relationships between physical quantities to perform calculations. Candidates 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.

Candidates describe how evidence is used to test predictions made from scientific theories, and how different people may have different views on some aspects of science.

Candidates use scientific knowledge and understanding to identify an approach to a question, for example, identifying key factors to vary and control. Candidates use a range of apparatus to make careful and precise measurements and systematic observations and recognise when it is necessary to repeat measurements and observations. They present data systematically, in graphs where appropriate, and use lines of best fit. Candidates identify and explain patterns within data and draw conclusions consistent with the evidence. They explain these conclusions using scientific knowledge and understanding and evaluate how strongly their evidence supports the conclusions.

Grade A

Candidates recall a wide range of knowledge from all areas of the specification.

Candidates use detailed scientific knowledge and understanding in a range of applications relating to scientific systems or phenomena. For example, they explain how temperature or water content is regulated in humans, routinely use a range of balanced chemical equations, use the particle model to explain variations in reaction rates, use a wide range of 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, use a wide range of scientific and technical vocabulary throughout their work.

Candidates explain how scientific theories can be changed by new evidence and identify some areas of uncertainty in science.

Candidates 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 use a range of apparatus with precision and skill to make appropriately precise measurements. They select a method of presenting data 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.

Candidates 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.

5 UNITS AND BACKGROUND SKILLS AND ABILITIES IN MATHEMATICS

The units, conventions, nomenclature, symbols and notation used in the examination papers will be in accord with those given in *Signs, Symbols and Systematics*, 16-19 published by the Association for Science Education (2000). Candidates taking the GCSE Science: Double Award examination will be expected to be familiar with the units and mathematical requirements appropriate to their selected tier of entry. Other units in common use may be included in the examination papers but candidates will not be required to convert between such units or from such units to SI units.

Units

Physical Quantity	Name of SI Base Unit	Symbol for Unit
length	metre	m
mass	kilogram	kg
time	second	s
electric current	ampere	A
temperature	kelvin	K

Derived Units

Physical Quantity	Name of SI Base Unit	Symbol for Unit
frequency	hertz	Hz
force	newton	N
pressure	pascal	Pa (or N/m^2)
work, energy, heat	joule	J
power	watt	W
electric potential difference, electromotive force	volt	V
electrical resistance	ohm	Ω
electrical charge	coul omb	C

Non-SI Units

Physical Quantity	Name of SI Base Unit	Symbol for Unit
energy	kilowatt hour	kWh
temperature	degree Celsius degree Centigrade	°C
volume	litre	l

Prefixes for SI Units

Sub-Multiple	Prefix	Symbol	Multiple	Prefix	Symbol
10^{-2}	centi	c	10^{3}	kilo	k
10^{-3}	milli	m	10^{6}	mega	M
10^{-6}	micro	μ			

5.1 MATHEMATICAL REQUIREMENTS

The mathematical skills required by candidates will be appropriate to the tier of entry and should include the following.

Table

Topic	Tier	Further Details
Number	F	Whole numbers (odd, even, multiple, factor and square). Vulgar and decimal fractions and percentages. (Candidates will be required to calculate percentages.)
Approximation	F	Estimation; approximation to obtain reasonable answers; limits of accuracy appropriate to given data.
Computation	F	The four rules of number applied to whole numbers and decimal fractions.
Proportion and Variation	F H	Elementary ideas and notation of rate. Scales. Elementary ideas and notation of rate. Inverse proportion.
Graphs	F F	Drawing, interpretation and use of graphs. Calculation of gradient.
Formulae	F H	The use of letters for generalised numbers. Substitution of numbers for words and letters in formulae. Transformation of simple formulae.
Equations	F H	Simple linear equations in one unknown. Rearrangement of equations.

Topic	Tier	Further Details
Statistics and Probability	F	Construction and interpretation of bar charts, pie charts and pictograms. Reading, interpreting and drawing simple inferences from tables.

6 FORMULAE FOR RELATIONSHIPS BETWEEN PHYSICAL QUANTITIES

The following relationships will not be provided to candidates in the form given or in re-arranged form.

the relationship between speed, distance and time:

$$\textit{speed} = \frac{\textit{distance}}{\textit{time taken}}$$

the relationship between force, mass and acceleration:

$$\textit{force} = \textit{mass} \times \textit{acceleration}$$

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

the relationship between density, mass and volume:

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

the relationship between force, distance and work:

$$\textit{work done} = \textit{force} \times \textit{distance moved in direction of force}$$

the energy relationships:

$$\textit{energy transferred} = \textit{work done}$$

$$\textit{kinetic energy} = \tfrac{1}{2} \times \textit{mass} \times \textit{speed}^2$$

$$\textit{change in potential energy} = \textit{mass} \times \textit{gravitational field strength} \times \textit{change in height}$$

the relationship between mass, weight and gravitational field strength:

$$\textit{weight} = \textit{mass} \times \textit{gravitational field strength}$$

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

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

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

$$\textit{moment} = \textit{force} \times \textit{perpendicular distance from pivot}$$

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

charge = current × time

voltage = current × resistance

electrical power = voltage × current

the relationship between speed, frequency and wavelength:

wave speed = frequency × wavelength

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

$$\frac{\textit{voltage across secondary}}{\textit{voltage across primary}} = \frac{\textit{number of turns in secondary}}{\textit{number of turns in primary}}$$

7 GUIDANCE FOR TEACHERS ON INTERNAL ASSESSMENT AND EXTERNAL MODERATION

7.1 INTRODUCTION

The scheme for internal assessment is based on the programme of study for experimental and investigative science at Key Stage 4.

Candidates will be assessed on three skill areas:

- Planning experimental procedure;
- Obtaining evidence;
- Interpreting and evaluating.

The internal assessment of candidates' performance in the three skills should be made as part of normal class routine and should be an integral part of the scheme of work. It is not necessary to assess all students at the same time nor when carrying out the same experiment or investigation.

Internal assessment is subject to moderation by the Council.

It is left to teachers to decide whether or not individual students should be informed that a particular assessment is being made, although it would seem to be appropriate to inform them at the start of a course that internal assessment of practical coursework will be undertaken. Teachers may give feedback on the results of assessments to their students. In such cases students should be informed that marks are subject to moderation and hence are subject to change.

Notes for guidance and exemplar material are published separately from this memorandum.

7.2 SKILL AREAS

Skill Area P – Planning experimental procedures

This concerns the ability of candidates to formulate questions which can be tested, predict the outcome of a set of experimental procedures and devise investigations to test their ideas. It includes the ability to decide on what measurements to take, how to take them, and on how to consider factors which need to be taken into account in order to ensure that their investigation is valid.

Skill Area O – Obtaining evidence

This concerns the extent to which candidates can use apparatus and materials safely and effectively to make observations and measurements with increasing levels of discrimination and precision. It also involves the ability to record data in a systematic manner using an appropriate range of forms. At the higher levels candidates should be aware of sources of error and limits of accuracy.

Skill Area I – Interpreting and evaluating

This concerns the ability of candidates to recognise and explain patterns in data, to handle data in an increasingly quantitative manner and to draw valid conclusions from the results of their investigations. It also involves the ability to report their experimental work systematically and with clarity, using scientific language and notation as appropriate. At the higher levels candidates should be able to account for anomalous results, evaluate their experiment or investigation and suggest improvements.

7.3 CONDUCT OF THE ASSESSMENT

Assessment must be carried out by the teacher in the context of experimental and investigative work which should arise naturally out of the normal teaching programme for a course.

The teacher must ensure that the work is that of the student(s) being assessed. In some instances where some unsupervised work may have to be carried out, the teacher must ensure and authenticate that it is the candidate's own work.

Assessment may take place in a variety of experimental situations, but at least one of the marks contributing to the final assessment must come from a whole investigation, that is, an activity which covers aspects of all three skills areas.

It is recognised that practical work is often carried out as a group activity. When assessments are being made during group activity the teacher will have to identify separately the contribution made by an individual student.

Experimental and investigative work should be carried out across the full range of contexts provided by Living Organisms and Life Processes, Materials and their Uses and Physical Processes.

All practical work should be conducted in accordance with current regulations and recommendations relating to safety in the laboratory and in the field.

7.4 ARRIVAL AT SKILL AREA MARKS

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 the phrase "where appropriate" and therefore may not apply to a particular activity.

Whenever assessments are made, the mark descriptions should be used to judge which mark best fits the candidate's performance.

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 which 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 (ie 3, 5 and 7) where performance exceeds one description and only partially satisfies the next.

A candidate who fails to meet the requirements for two marks, but who has made a creditworthy attempt in a skill area should be given one 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 judgements is important.

7.5 ARRIVAL AT THE FINAL MARK SUBMITTED

Centres are required to award each candidate **two** marks for each of the three skill areas. These marks should represent a candidate's best performance during the course.

To satisfy the GCSE Criteria for Science, the following requirements must be met:

- These marks should be drawn from **not more than four** pieces of work, of which at least one piece should be a practical based whole investigation.
- Marks must be drawn from work which is set in the context of more than one of Living Organisms and Life Processes, Materials and their Uses and Physical Processes.

In consequence, the minimum evidence is two pieces of work, each covering all three skill areas.

7.6 RECORDING ASSESSMENT

Teachers must keep a record of the assessment of the work of their students.

The Candidate Record Sheet must be used to record the marks for the skill areas being assessed.

When submitting candidates' work, teachers must clearly indicate those activities/investigations which were used for assessment purposes. Assessed work must be clearly annotated to identify, as precisely as possible, where in the work the relevant criteria have been satisfied so that the reasons why marks have been awarded are clear. An indication must also be given at the appropriate point in the evidence, or in accompanying information, of any further guidance given by the teacher which has significant assessment implications.

7.7 ASSESSMENT CRITERIA

The assessment criteria must be interpreted in the context of the programme of study for Key Stage 4.

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. The term "evidence" has been used consistently throughout the assessment scheme to mean observations, measurements or other data. Through the teaching of investigative skills, candidates should be given opportunities to apply and develop their ICT capability. In particular, candidates could:

- use data-handling software to analyse data from fieldwork;
- use data-handling software to create, analyse and evaluate charts and graphs;
- use data loggers in investigations;
- use spreadsheets for data analysis;
- use the internet or CD-ROM software as sources of secondary evidence.

In the mark descriptions (for the assessment of AT1), the use of terms such as "plan", "communicate", "record", "identify", "explain", "comment", "consider" and "describe" ensures that the quality of written communication will form part of the assessment of AT1.

Pupils should be encouraged to develop their experimental and investigative skills and their understanding of science through systematic experimentation and investigation. Work within Attainment Target 1 should be introduced through the knowledge and understanding covered within the specification. They should have opportunities to participate in increasingly complex activities which involve the application of scientific knowledge, understanding and skills. While there should be opportunities throughout the key stage for pupils to undertake complete investigations, it will be appropriate in some cases to focus on particular aspects of the investigative process. On some occasions, the whole process of investigating an idea should be carried out by the pupils working on their own.

Descriptions of the performance required for the award of marks in each of the skill areas are set out in the following tables. Criteria are specified for the award of 2, 4, 6 and 8 marks.

Skill Area P: Planning

Programme of Study Requirements
Candidates should be able to: (a) use their scientific knowledge and understanding to turn ideas into a form that can be investigated; (b) make predictions where appropriate to do so; (c) consider the factors which need to be taken into account in investigations; (d) draw up procedures for the investigation taking into account the observations or measurements which need to be made and how these are to be used; (e) select appropriate apparatus, instruments and techniques for the investigation, taking into account criteria, for example, the range and accuracy of the measurements and observations required, and the need for safe working procedures.

MARK DESCRIPTIONS		
The mark descriptions are designed to be hierarchical. All work should be assessed in the context of the syllabus.		
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 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 include a strategy for dealing with results	

Skill Area O: Obtaining evidence

Programme of Study Requirements
Candidates should be able to: (a) use apparatus and materials in a safe and competent manner; (b) use apparatus and instruments to make observations and measurements to an appropriate degree of accuracy; (c) understand the need, where appropriate, to repeat measurements; (d) record observations or measurements systematically using methods appropriate to the information collected and to the purpose of the investigation.

MARK DESCRIPTIONS			
The mark descriptions are designed to be hierarchical. All work should be assessed in the context of the syllabus.			
		Candidates:	Increasing demand of activity ↓
2 marks	O.2a	collect some evidence using a simple and safe procedure	
4 marks	O.4a	collect appropriate evidence which is adequate for the activity	
	O.4b	record the evidence	
6 marks	O.6a	collect sufficient systematic and accurate evidence and repeat/check where appropriate	
	O.6b	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 I: Interpreting and evaluating

Programme of Study Requirements
Candidates should be able to: (a) present results in ways appropriate to the data collected and the purpose of the investigation, including, where appropriate, the use of graphs; (b) interpret and evaluate results using, where appropriate, mathematical relationships; (c) identify any trends, patterns and conclusions emerging from consideration of the results; (d) draw valid conclusions and decide whether these conclusions agree with the original idea; (e) explain the conclusions in the light of their scientific knowledge and understanding; (f) consider their observations and measurements, including anomalies and sources of error, and suggest, where appropriate, improvements that could be made if they were to repeat their investigation; (g) produce a written report of their investigation, using appropriate scientific vocabulary.

MARK DESCRIPTIONS			
The mark descriptions are designed to be hierarchical. All work should be assessed in the context of the syllabus.			Increasing demand of activity
	Candidates:		
2 marks	I.2a	state simply what is shown by the evidence	
4 marks	I.4a	use simple diagrams, charts or graphs as a basis for explaining the evidence	
	I.4b	identify trends and patterns in the evidence	
6 marks	I.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	
	I.6b	draw a conclusion consistent with the evidence and explain it using scientific knowledge and understanding	
	I.6c	comment on the suitability of the procedure and, where appropriate, suggest changes to improve it	
8 marks	I.8a	use detailed scientific knowledge and understanding to explain a valid conclusion drawn from processed evidence	
	I.8b	explain to what extent the conclusion supports the prediction if one has been made	
	I.8c	consider critically the reliability of the evidence, and whether it is sufficient to support the conclusion accounting for any anomalies	

8 RESOURCE LIST

The following list is an indication of books and other resources which teachers and students may find useful in teaching and studying a course based on this specification. It is not intended to be a list of prescribed texts, nor is it intended to be an exhaustive list of all available resources.

ASE	**ISBN**
Signs Symbols and Systematics: The ASE Companion to 5–16 Science.	0 863 57232 4
Cambridge University Press	
Balanced Science 1, 2nd edition (Jones, Jones, Acaster and Marchington).	0 521 59979 2
Balanced Science 2, 2nd edition (Jones, Jones, Acaster and Marchington).	0 521 59980 6
Chemistry (Harwood).	0 521 57628 8
Chemistry, Co-ordinated Science, 2nd edition (Jones, Jones and Acaster).	0 521 59983 0
Science Foundations Chemistry (Milner and Evans).	0 521 55663 5
Science Foundations Extension Chemistry (Milner and Mills).	0 521 64918 8
Science Foundations Chemistry Supplementary Materials.	0 521 58853 7
Biology New Edition 1999 (M Jones and G Jones).	0 521 45618 5
Physics, Coordinated Science (Jones, Jones and Marchington).	0 521 45945 1
Collins Educational	
Chemistry (Morris).	0 00 322386 8
Hobson Publishing plc	
Biology Plus – Volume 1 1989 (P Robinson).	1 85324 032 X
Biology Plus – Teacher's Notes 1989 (P Robinson).	1 85324 226 8
Hodder & Murray	
GCSE Biology for CCEA (R. McIlwaine & J. Napier).	0 340 85825 7
GCSE Chemistry for CCEA (J. Johnston & T. Laverty).	0 340 85824 9
GCSE Physics for CCEA (F. McCauley & R.White).	0 340 85899 0
Chemistry Counts, 2nd edition (Hill).	0 340 63934 2
Progress with GCSE Structured Questions: Chemistry (Hills & Butler).	0 340 72041 7
Physics Matters (Nick England).	0 340 42943 7

Chemical Industry Education Centre, University of York, York YO1 5DD

Wearing Jeans.
Cash and Chemicals.

Letts	**ISBN**
Science Classbook (McDuell, Booth and Bayliss).	1 857 58416 3
Science Homework Book (McDuell, Booth and Bayliss).	1 857 58417 1
GCSE Science Study Guide (Hill).	1 857 58237 3
GCSE Chemistry Study Guide (McDuell).	1 857 58302 7
GCSE Science Questions and Answers (McDuell and Booth).	1 857 58322 1
GCSE Chemistry Questions and Answers (McDuell and Booth).	1 857 58316 7
Longman	
Materials at work.	0 582 29384 7
Making new materials.	0 582 29383 9
Pollution.	0 582 29386 3
Murray	
GCSE Chemistry (Earl and Wilford).	0 7195 5302 2
GCSE Biology 1999 (D G Mackean).	0 7195 5302 4
World of Science New Satis, Student's Book.	0 7195 7411 0
World of Science New Satis, Teacher's Book.	0 7195 7412 9
GCSE Physics (Tom Duncan).	0 7195 4380 0
Nelson	
Essential Science for GCSE (Lakin and Patefield).	0 17 438716 4
Nelson Balanced Science: The Material World, 2nd edition. (Holman).	0 17 438700 8
Nelson Science: Chemistry (Holman).	0 17 438678 8
Nelson Science: Chemistry (Hill and Holman).	0 17 448152 7
Nelson Science Biology 1995 (M Roberts)	0 1743 8677 X
The World of Physics, John Avison.	0 17 438238 3
Oxford University Press	
Complete Chemistry (Gallagher and Ingram).	0 1991 4799 X
Science to GCSE Book of Data Logging and Control.	0 19 914634 9
Pearson Publishing	
Using the Internet – Science.	1 85749 4172

Stanley Thornes	**ISBN**
Key Science Chemistry New Edition Student's Book (Ramsden).	0 7487 3009 5
Key Science Chemistry New Edition Extension File (Ramsden).	0 7487 3006 0
Calculations for GCSE Chemistry (Ramsden).	0 7487 1738 2
Basic Chemistry Questions for GCSE (Bernard Abrams).	0 7487 1724 2
Physics for You (Keith Johnson).	0 7487 0565 1
Key Science Physics (Jim Breithaupt).	0 7487 1674 2

Royal Society of Chemistry

Education Manager (Schools and Colleges), RSC, Burlington House, Piccadilly, London W1V 0BN.

Chemical Industry Education Centre

Department of Chemistry, University of York.

Schools Information Centre on the Irish Chemical Industry

Resources for Teaching Chemistry.

2nd edition (1994) – contains an extensive list of resources from companies and organisations in Ireland, the UK and Overseas, with a guide to museums, interactive centres, periodicals, videos, software, safety etc.

CD-ROM/packages

Science Series 1: Elements.
Science Series 2: Materials.
Inventors and Inventions.
Environment Series 1: Water.
Environment Series 2: Land and Air.

ADAM essentials: The ADAM Scholar Series.
ADAM Software Imc, Atlanta.
Interactive CD-ROM on human anatomy and physiology.
Balance.
AVP computing, Chepstow.
Diet analysis software
GCSE Biology.
Dorling Kindersley.
Revision Program Natural Selection Series – Peppered Moths.
Newbyte Educational Software.
Interactive software with students acting as predators.

Stanley Thornes

Compact Questions: Science CD-ROM (available for Science or separately for Physics, Chemistry and Biology).

Videos

University of York Science Education Group and Granada TV
Chemistry in Action:

Cracking the problem: manufacture of ethene and poly(ethene).
Salt Solution: chemicals from salt.
Rusting all over the world: iron and steel, properties of iron.
Aluminium can!: properties of aluminium.
Invergrog reservoir: purification of water.
Limestone: properties of lime.
Out of the air: air pollution.
Ways with coal: uses of coal and coke.

Useful websites

www.webelements.com	Elements database
www.chemsoc.org	For links to chemistry sites
www.ase.org.uk	
www.schoolzone.co.uk	For links to science sites
www.chemmybear.com	
www.schoolsscience.co.uk	Useful lesson plans and information
www.shu.ac.uk/schools/science/sol	Lesson plans
http://www.eibe.info	The European Initiative for Biotechnology Education. Includes a range of teaching materials for 16–19 year-olds but several are suitable for Key Stage 4: DNA model, Bread-making investigation, DNA extraction.
http://www.wildlifetrust.org.uk	The Wildlife Trust
http://www.wwf-uk-org	The World Wildlife Fund

Other

CD-ROMs available from New Media Press Limited cover a range of Chemistry topics, eg states of matter; elements, compounds and mixtures; electrochemistry; understanding reactions.

EXAMPRO: A software package giving access to CCEA past papers, mark schemes, Chief Examiners' Reports and information on grade boundaries.

APPENDIX 1

SPIRITUAL, MORAL, ETHICAL, SOCIAL AND CULTURAL ISSUES

The following table identifies a number of topics where these issues could be addressed. The list is by no means exhaustive. There are many other areas where these issues could be addressed, depending on the teaching approach adopted.

Topic	Reference
Disease and the treatment of disease, including AIDS, dialysis, transplants and the development of vaccines	3.1.18, 3.1.19, 3.1.20
Pollution and the control of pollution	3.2.5, 3.2.6, 3.4.30, 3.4.34, 3.4.48, 3.4.49
Sexual behaviour	3.2.11
Alcohol, drug and solvent abuse	3.1.24
Genetic engineering, cloning	3.2.20, 3.2.21
Uses of radiation	3.4.52
Development of the heliocentric model of the solar system	3.6.63
Possibility of life elsewhere in the Universe	3.6.69

APPENDIX 2

ENVIRONMENTAL ISSUES, HEALTH AND SAFETY CONSIDERATIONS AND EUROPEAN DEVELOPMENTS

The following table identifies a number of topics where these issues are addressed. The list is by no means exhaustive. There are many other areas where these issues could be addressed, depending on the teaching approach adopted.

Topic	Reference
Environmental Issues	
Effect of human activity on the environment	3.2.5, 3.2.6
Management of ecosystems	3.2.8
Genetic engineering, cloning	3.2.20, 3.2.21
Pollution and control of pollution including the greenhouse effect and acid rain	3.4.30, 3.4.34, 3.4.35, 3.4.49
Use of renewable and non-renewable energy resources and conservation of energy	3.4.38, 3.5.4, 3.5.5, 3.5.14, 3.5.15
Exploitation of raw materials	3.4.48, 3.4.50
Reducing domestic heat loss	3.5.15
Health and Safety	
Diet and fitness, smoking and health	3.1.5, 3.1.13
Defence against disease	3.1.18, 3.1.19
Alcohol, drug and solvent abuse	3.1.24
Hazard symbols	3.3.1
Effects of loud sounds	3.6.11
Dangers of electromagnetic radiation	3.6.23
Electrical safety	3.6.52, 3.6.53, 3.6.54
Laboratory safety	internal assessment
European Dimension	
Pollution control as an international responsibility	3.4.49

APPENDIX 3

APPLICATION OF ICT IN SCIENCE

During their study of science pupils should have opportunities to access information from a variety of sources, for example, books, videos, audio-tapes and databases, and to organise, analyse and present data using appropriate IT systems. Pupils could design a database for storing and analysing data generated in the course of their investigations. They could experience the use of software to demonstrate and explore relationships between variables. They could use sensors in experimental situations to measure and physical quantities.

Opportunities to do this are shown below.

Use of ICT	Specification Reference
Use of databases	Search and select relevant data from sources such as, textbooks, databases and CD-ROMs such as, Encarta, on topics including: • Relationships between diet, fitness and circulatory disorders (3.1.5) • Trends in properties of elements (3.4.12) • Implications of world-wide patterns of distribution and use of energy resources (3.5.4, 3.5.5)
Use of Sensors Use a temperature sensor to monitor energy changes during neutralisation (3.3.26)	Use a light sensor in a habitat study (3.2.1) Use a pH meter to investigate neutralisation (3.3.46) Use light gates to measure the speed of a trolley down a ramp (3.5.30) Use remote data logger to monitor the change in oxygen in a pond over time (3.2.1) Use a current sensor to plot current surges when a filament bulb is switched on (3.6.45)

Use of ICT	Specification Reference
Simulators	Model the behaviour of a gas with change in temperature and pressure (3.3.13) Use of software to investigate etc, factors affecting transpiration (3.1.16) Use of simulation to illustrate radioactive decay (3.4.54)
Presentation	Presentation of results of an investigation using word processing, diagrams and graphs

APPENDIX 4

OPPORTUNITIES FOR DEVELOPING AND GENERATING EVIDENCE FOR ASSESSING KEY SKILLS

The following table signposts and exemplifies the types of opportunity for developing and generating evidence for assessing Key Skills that may arise during a GCSE course in Double Award: Science. The opportunities are referenced to Section B of the relevant Key Skills specifications at Levels 1 and 2. The subject exemplifications illustrate typical opportunities which may arise during the normal teaching and learning process. These are only a small selection of such opportunities and are not part of the Key Skills specifications themselves. It is for teachers and students to decide which pieces of work, if any, to use to develop and assess Key Skills.

Key Skill: Communication

Key Skills Specification Part B Reference		Subject Exemplification
Level 1 Activity and Evidence	**Level 2 Activity and Evidence**	
C1.1 Take part in a one-to-one discussion and a group discussion about different, straightforward subjects. Provide information that is relevant to the subject and purpose of the discussion. Speak clearly in a way that suits the situation. Listen and respond appropriately to what others say.	C2.1a Contribute to a discussion about a straightforward subject. Make clear and relevant contributions in a way that suits your purpose and situation. Listen and respond appropriately to what others say. Help to move the discussion forward.	Discussion of topics such as: • sexual behaviour (3.2.11); and • drug, alcohol and solvent abuse (3.1.24). Relate properties of materials to their everyday use (3.3.2). Economic implications of the use of energy resources (3.5.5). Possibility of life on other planets (3.6.69).

Key Skills Specification Part B Reference		Subject Exemplification
Level 1 Activity and Evidence	**Level 2 Activity and Evidence**	
	C2.1b Give a short talk about a straightforward subject using an image. Speak clearly in a way that suits your subject, purpose and situation. Keep to the subject and structure your talk to help listeners follow what you are saying. Use an image to clearly illustrate your main points.	Relationship between diet fitness and circulatory disorders (3.1.5). Relate properties of different classes of materials to their uses (3.3.2). Difference between renewable and non-renewable energy resources (3.5.2).
C1.2 Read and obtain information about two different types of documents about straightforward subjects, including at least one image. Read relevant material. Identify accurately the main points and ideas in material. Use the information to suit your purpose.	C2.2 Read and summarise information from two extended documents about a straightforward subject. One of the documents should include at least one image. Select and read relevant material. Identify accurately the lines of reasoning and main points from texts and images. Summarise the information to suit your purpose.	Prepare notes from a variety of sources such as, text books, journals and CD-ROMs on: • Effect of cigarette smoke on health (3.1.13); • Development of the Periodic Table (3.4.10); • Economic implications of the use of energy resources (3.5.5).

Key Skills Specification Part B Reference		Subject Exemplification
Level 1 Activity and Evidence	**Level 2 Activity and Evidence**	
C1.3 Write two different types of documents about straightforward subjects. Include at least one image in one of the documents. Present relevant information in a form that suits your purpose. Ensure text is legible. Make sure that spelling, punctuation and grammar are accurate so your meaning is clear.	C2.3 Write two different types of documents about straightforward subjects. One piece of writing should be an extended document and include at least one image. Present relevant information in an appropriate form. Use a structure and style of writing to suit your purpose. Ensure text is legible and that spelling, punctuation and grammar are accurate, so the meaning is clear.	Write extended prose/essay on: • the diet required to maintain a healthy body (3.1.5); • positive and negative effects of the exploitation of raw materials (3.4.48); and also a report of an investigation.

Key Skill: Application of Number

Key Skills Specification Part B Reference		Subject Exemplification
Level 1 Activity and Evidence	**Level 2 Activity and Evidence**	
N1.1 Interpret straightforward information from two different sources. At least one source should be a table, chart, diagram or line graph. Obtain the information you need to meet the purpose of your task. Identify suitable calculations to get the results you need.	N2.1 Interpret information from two different sources including material containing a graph. Choose how to obtain the information needed to meet the purpose of your activity. Obtain the relevant information. Select appropriate methods to get the results you need.	Population growth and decline related to environmental resources (3.2.9). Factors affecting rate of reaction (3.4.6). Plot and interpret voltage-current graphs (3.6.43).
N1.2 Carry out straightforward calculations to do with: (a) amounts and sizes; (b) scales and proportions; (c) handling statistics; Carry out calculations, to the levels of accuracy you have been given. Check your results make sense.	N2.2 Carry out calculations to do with: (a) amounts and sizes; (b) scales and proportions; Work = Force × distance (d) using formulae. Carry out calculations, clearly showing your methods and levels of accuracy. Check your methods to identify and correct any errors, and make sure your results make sense.	Use Punnett Squares to determine gene type frequencies (3.2.14). Quantitative effects of rate of reaction (3.4.7). (3.5.6). Power = Work done/Time taken (3.5.7). Moments (3.5.23/3.5.25). P = F/A (3.5.27). Quantitative relationships for movement (3.5.30). Frequency wavelength and speed of light (3.6.6). V = IR (3.6.44). Calculate the cost of using electrical appliances (3.6.56).

Key Skills Specification Part B Reference		Subject Exemplification
Level 1 Activity and Evidence	**Level 2 Activity and Evidence**	
N1.3 Interpret the results of your calculations and present your findings. You must use one chart and one diagram. Choose suitable ways to present your findings. Present your findings clearly. Describe how the results of your calculations meet the purpose of your task.	N2.3 Interpret the results of your calculations and present your findings. You must use at least one graph, one chart and one diagram. Select effective ways to present your findings. Present your findings clearly and describe your methods. Explain how the results of your calculations meet the purpose of your activity.	Interpretation of results based on practical exercises, for example, from the quantitative work described above.

Key Skill: Information Technology

Key Skills Specification Part B Reference		Subject Exemplification
Level 1 Activity and Evidence	**Level 2 Activity and Evidence**	
IT1.1 Find, explore and develop information for two different purposes. Find and select relevant information. Enter and bring in information, using formats that help development. Explore and develop information to meet your purpose.	IT2.1 Search for and select information for two different purposes. Identify the information you need and suitable sources. Carry out effective searches. Select information that is relevant to your purpose.	Search and select relevant data from sources such as, textbooks, databases and CD-ROMs, such as Encarta, on topics including: Relationships between diet, fitness and circulatory disorders (3.1.5). Trends in properties of elements (3.4.12). Implications of world-wide patterns of distribution and use of energy resources (3.5.4, 3.5.5).
IT1.2 Present information for two different purposes. Your work must include at least one example of text, one example of images and one example of numbers. Use appropriate layouts for presenting information in a consistent way. Develop the presentation so it is accurate, clear and meets your purpose. Save information so it can be found easily.	IT2.2 Explore and develop information and derive new information for two different purposes. Enter and bring together information using formats that help development. Explore information as needed for your purpose. Develop information and derive new information as appropriate.	Understand how variation and selection may lead to evolution and extinction (3.2.22). Investigate everyday materials, both natural and man-made in terms of their properties (3.3.2). Investigate conditions on other planets and how this affects the possibility of life on other planets (3.6.69). Save and present information based on the above.

Key Skills Specification Part B Reference		Subject Exemplification
Level 1 Activity and Evidence	**Level 2 Activity and Evidence**	
	IT2.3 Present combined information for two different purposes. Your work must include at least one example of text, one example of images and one example of numbers. Select and use appropriate layouts for presenting combined information in a consistent way. Develop the presentation to suit your purpose and the types of information. Ensure your work is accurate, clear and saved appropriately.	Coursework can be collated in a spreadsheet for graphical and statistical analysis. Use of OHT/Powerpoint to present electronic configurations (3.3.20). Use appropriate techniques to illustrate: • Gravitation forces act towards the centre (3.6.64). • Magnitude of gravitational force diminishes with distance (3.6.65).

Key Skill: Working with Others

Key Skills Specification Part B Reference		Subject Exemplification
Level 1 Activity and Evidence	**Level 2 Activity and Evidence**	
WO1.1 Confirm what needs to be done to achieve given objectives, including your responsibilities and working arrangements. Check that you clearly understand the objectives you have been given for working together. Identify what needs to be done to achieve these objectives and suggest ways you could help. Make sure that you are clear about your responsibilities and working arrangements.	WO2.1 Plan straightforward work with others, identifying objectives and clarifying responsibilities, and confirm working arrangements. Identify the objectives of working together and what needs to be done to achieve these objectives. Exchange relevant information to clarify responsibilities. Confirm working arrangements with those involved.	Information research and presentation working in groups of 3–4 to produce and present a set of support notes for the class on, for example: • sexually transmitted diseases and contraception (3.2.11); • extraction of metals (3.3.53); • renewable and non-renewable energy resources (3.5.2–3.5.4). Carry out practical group work.
WO1.2 Work with others towards achieving given objectives, carrying out tasks to meet your responsibilities. Carry out tasks to meet your responsibilities. Work safely, and accurately follow the working methods you have been given. Ask for help and offer support to others, when appropriate.	WO2.2 Work co-operatively with others towards achieving identified objectives, organising tasks to meet your responsibilities. Organise your own tasks so you can be effective in meeting your responsibilities. Carry out tasks accurately and safely, using appropriate working methods. Support co-operative ways of working, seeking advice from an appropriate person when needed.	Carry out agreed shared responsibility in relation to a project based on the above. Complete the practical work safely and collate the information obtained.

Key Skills Specification Part B Reference		Subject Exemplification
Level 1 Activity and Evidence	**Level 2 Activity and Evidence**	
WO1.3 Identify progress and suggest ways of improving work with others to help achieve given objectives. Identify what has gone well in working with others. Report any difficulties in meeting your responsibilities and say what you did about them. Suggest ways of improving work with others to help achieve the objectives.	WO2.3 Exchange information on progress and agree ways of improving work with others to help achieve objectives. Provide relevant information on what has gone well and what has gone less well in working with others, including the quality of your work. Listen and respond appropriately to progress reports from others. Agree ways of improving work with others to help achieve the objectives.	Present the information obtained to the class, receive and analyse feedback from the class and review the performance with the teacher and group members.

Key Skill: Improving Own Learning and Performance

Key Skills Specification Part B Reference		Subject Exemplification
Level 1 Activity and Evidence	**Level 2 Activity and Evidence**	
LP1.1 Confirm understanding of your short-term targets, and plan how these will be met, with the person setting them. Make sure targets clearly show what you want to achieve. Identify clear action points and deadlines for each target. Identify how to get the support you need and the arrangements for reviewing your progress.	LP2.1 Help set short-term targets with an appropriate person and plan how these will be met. Provide accurate information to help set realistic targets for what you want to achieve. Identify clear action points for each target. Plan how you will use your time effectively to meet targets, including use of support and arrangements for reviewing your progress.	Set targets to improve note-taking skills and analysis of questions from exam papers. Prepare key points on each topic and learn these. Summarise aspects of the subject content in flow charts, for example: • carbon cycle/nitrogen cycle (3.2.4); • trends in the periodic table (3.4.12).
LP1.2 Follow your plan, using support given by others to help meet targets. Improve your performance by: • studying a straightforward subject; • learning through a straightforward practical activity.	LP2.2 Take responsibility for some decisions about your learning, using your plan and support from others to help meet targets. Improve your performance by: • studying a straightforward subject; • learning through a straightforward practical activity.	Set deadlines: • for completion of project/group work; • completion of key points/flow diagrams. Review questions from past papers and discuss your answers with the teacher.

Key Skills Specification Part B Reference		Subject Exemplification
Level 1 Activity and Evidence	**Level 2 Activity and Evidence**	
Work through your action points to complete tasks on time. Use support given by others to help you meet targets. Use different ways of learning suggested by your supervisor, and make changes, when needed, to improve your performance.	Use your action points to help manage your time well and complete tasks, revising your plan when needed. Identify when you need support and use this effectively to help you meet targets. Select and use different ways of learning to improve your performance, working for short periods without close supervision.	
LP1.3 Review your progress and achievements in meeting targets, with an appropriate person. Say what you learned and how you learned, including what has gone well and what has gone less well. Identify targets you have met and provide samples of evidence of your achievements. Identify what you need to do to improve your performance.	LP2.3 Review progress with an appropriate person and provide evidence of your achievements including how you have used learning from one task to meet the demands of a new task. Identify what and how you learned, including what has gone well and what has gone less well. Identify targets you have met and evidence of your achievements. Identify ways to further improve your performance.	Review progress by means of feedback from your teacher and your ability to prepare key points/flow charts unaided. Review learning with the teacher in charge of the project and participate in critical review of all aspects of the project.

Key Skill: Problem Solving

Key Skills Specification Part B Reference		Subject Exemplification
Level 1 Activity and Evidence	**Level 2 Activity and Evidence**	
PS1.1 Confirm your understanding of the given problem with an appropriate person and identify two options for solving it. Check that you are clear about the problem you have been given and how to show success in solving it. Identify different ways of tackling the problem. Decide, with help, which options are most likely to be successful.	PS2.1 Identify a problem and come up with two options for solving it. Identify the problem, accurately describing its main features, and how to show success in solving it. Come up with different ways of tackling the problem. Decide which options have a realistic chance of success using help from others when appropriate.	Devise a plan to find, for example: • factors affecting the rate of photosynthesis (3.1.2); • factors affecting the rate of reaction between calcium carbonate and hydrochloric acid (3.4.7); • factors affecting resistance in a wire (3.6.45).
PS1.2 Plan and try out a least one option for solving the problem, using advice and support given by others. Confirm with an appropriate person the option you will try for solving the problem. Plan how to carry out this option. Follow through your plan, making use of advice and support given by others.	PS2.2 Plan and try out at least one option for solving the problem obtaining support and making changes to your plan when needed. Confirm with an appropriate person the option you will try for solving the problem, and plan how to carry it out. Follow your plan, organising the relevant tasks and making changes to your plan when needed. Obtain and effectively use any support needed.	Carry out the plan by devising and completing a practical investigation to obtain the required data.

Key Skills Specification Part B Reference		Subject Exemplification
Level 1 Activity and Evidence	**Level 2 Activity and Evidence**	
PS1.3 Check if the problem has been solved by following given methods, and describe results, including ways to improve your approach to problem solving. Check if the problem has been solved by accurately applying the methods you have been given. Describe clearly the results of tackling the problem. Identify ways of improving your approach to problem solving.	PS2.3 Check if the problem has been solved by following given methods, describe results and explain your approach to problem solving. Check if the problem has been solved by accurately applying the methods you have been given. Describe clearly the results and explain the decisions you took at each stage of tackling the problem. Identify the strengths and weaknesses of your approach to problem solving, and describe what you would do differently if you met a similar problem.	Analyse the evidence obtained and draw conclusions based on the evidence. Evaluate the appropriateness or otherwise of the experiment and, if applicable, suggest improvements.

APPENDIX 5

ADDITIONAL CONTENT FOR ENGLAND AND WALES

This specification covers the Programme of Study for Northern Ireland for Key Stage 4 Science Double Award. There are differences in content between this Programme of Study and those for England and Wales.

Teachers in England and in Wales need to teach those parts of their respective Programmes of Study not covered in this specification.

These are as follows:

England

Useful products from metal ores and rocks	g	about the variety of useful substances (for example, chlorine, sodium hydroxide, glass, cement) that can be made from rocks and minerals.
	h	how the reactivity of a metal affects how it is extracted from its naturally occurring ores.
Useful products from air	m	how nitrogenous fertilisers are manufactured, their effect on plant growth, and the environmental consequences of over-use.
Changes to the Earth and atmosphere	p	how the Earth's atmosphere and oceans have changed over time.
	r	how the sequence of, and evidence for, rock formation and deformation is obtained from the rock record.
Forces and non-uniform motion	i	why falling objects may reach a terminal velocity.
Seismic waves	m	that longitudinal and transverse earthquake waves are transmitted through the Earth, and how their travel times and paths provide evidence for the Earth's layered structure.
	n	that the Earth's outermost layer, the lithosphere, is composed of plates in relative motion, and that plate tectonic processes result in the formation, deformation and recycling of rocks.
The Earth and beyond	The solar system and the wider universe.	
	d	origin and evolution of the universe.
	e	about the search for evidence of life elsewhere in the universe.
Radioactivity	f	some uses of radioactivity, including radioactive dating of rocks.

Wales

Changes to the Atmosphere	2.22	how the atmosphere and oceans evolved to their present composition.
Geological changes	2.24	how plate tectonic processes are involved in the formation, deformation and recycling of rocks.
	2.25	how the sequence of, and evidence for, these processes is obtained from the rock record.
Force and non-uniform motion	2.9	why moving objects may reach a terminal velocity.
Seismic waves	3.12	that longitudinal and transverse waves are transmitted through the Earth, producing wave records that provide evidence for the Earth's layered structure.
Radioactivity	6.2	some uses of radioactivity, including the radioactive dating of rocks.