CAMBRIDGE
UNIVERSITY PRESS & ASSESSMENT

GCSE

Science

Session: 2000
Type: Syllabus
Code: 1794

OCR

RECOGNISING ACHIEVEMENT

Science: Double Award

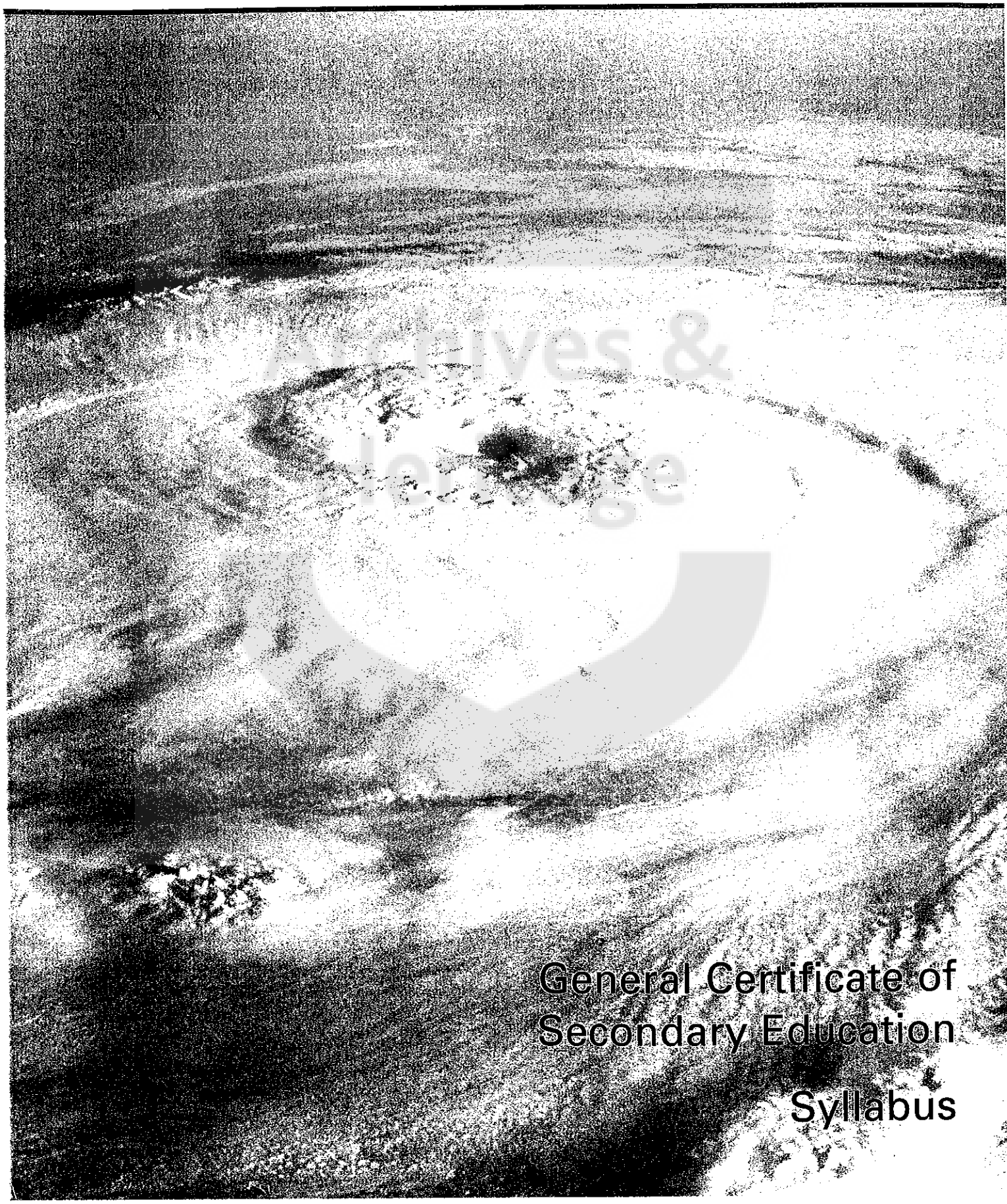
Syllabus A

(Co-ordinated)

1794

2000

former MEG syllabus



General Certificate of Secondary Education

Syllabus

OCR is a unitary examining body, established by the University of Cambridge Local Examinations Syndicate and the RSA Examinations Board in January 1998. OCR provides a full range of GCSE, A level, GNVQ, Key Skills and other qualifications for schools and colleges in the United Kingdom, including those previously provided by MEG and OCEAC.

GENERAL INFORMATION

AVAILABILITY

This syllabus will be examined by OCR in the Summer of the year(s) shown on the cover.

Details of the provision of Autumn examinations are given in the GCSE Syllabus Synopses booklet.

EXCLUSIONS

In any one examination series, candidates entering for this syllabus may not in addition enter for any other OCR GCSE examination with the same certification title.

Details of any other exclusions are given in the syllabus.

ENTRIES

All candidates, including private candidates, must be entered by a Centre registered with OCR.

All candidates must meet the full requirements of this syllabus and must therefore have any coursework/assessed practical work authenticated and assessed by an approved Centre.

RESULTS

Results will be reported on the 8-point scale of grades A*, A, B, C, D, E, F and G.

SPELLING, PUNCTUATION AND GRAMMAR

The assessment of spelling, punctuation and grammar is a requirement of most syllabuses. Where components are affected, details are given in an appendix to the syllabus.

COURSEWORK ASSESSMENT

Where the syllabus includes assessment of coursework, in accordance with the GCSE & A/AS Code of Practice, teachers are required to show how the marks have been awarded in relation to the marking criteria defined in the syllabus.

OTHER PUBLICATIONS

Other publications such as past papers and mark schemes can be purchased from OCR. A copy of the publications order form is available on request.

SCIENCE: DOUBLE AWARD (CO-ORDINATED)
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CONTENTS

APPENDICES

This syllabus has been designed to meet the requirements of the Northern Ireland GCSE Regulations and criteria for Science. It also meets the requirements of the Northern Ireland programme of study for Science at Key Stage 4.
In developing schemes of work for this syllabus, teachers are encouraged to address the statutory objectives of the educational (cross-curricular) themes.

SCIENCE: DOUBLE AWARD (CO-ORDINATED) (1794) SYLLABUS SUMMARY

This syllabus meets the requirements of Key Stage 4 (KS4) of the National Curriculum and offers the opportunity for Centres to use a co-ordinated teaching approach. The layout is similar to that used in the Science: Single Award syllabus, and also to both the 'Traditional' and to the 'Nuffield' Physics, Chemistry and Biology syllabuses.

This common approach to the teaching, which utilises the maximum of common material, combined with similar styles of examination questions, represents a linked suite of syllabuses which allows Centres the maximum flexibility for GCSE courses in Science and the separate Sciences.

Scheme of Assessment

<table>
<tr><th>Grades</th><th>Foundation Tier
GG-CC</th><th>Higher Tier
DD-A*A*</th></tr>
<tr><td>A*A*</td><td rowspan="3"></td><td rowspan="3">Candidates take components
2, 4, 6 and 7</td></tr>
<tr><td>AA</td></tr>
<tr><td>BB</td></tr>
<tr><td>CC</td><td rowspan="4">Candidates take components
1, 3, 5 and 7</td><td rowspan="4"></td></tr>
<tr><td>DD</td></tr>
<tr><td>EE</td></tr>
<tr><td>FF</td></tr>
<tr><td>GG</td><td></td><td></td></tr>
</table>

Examination Components

Component	Title	Duration	Weighting
1	Paper 1 (Sc 2)	1 hour 30 minutes	25%
2	Paper 2 (Sc 2)	1 hour 45 minutes	25%
3	Paper 3 (Sc 3)	1 hour 30 minutes	25%
4	Paper 4 (Sc 3)	1 hour 45 minutes	25%
5	Paper 5 (Sc 4)	1 hour 30 minutes	25%
6	Paper 6 (Sc 4)	1 hour 45 minutes	25%
7	Coursework	–	25%

Summary of Content

The content is arranged in twenty eight Teaching Blocks which show the National Curriculum Programme of Study statements and the associated Learning Outcomes.

This content is designed to be completed in a realistic teaching time to allow for the development of aspects of Sc1 as well as other activities.

Support Material

OCR has produced Teacher Support Booklets containing suggested teaching activities and background information designed to support the conversion of each syllabus into an operational Scheme of Work. One booklet supports a 'traditional' approach whilst another allows Centres to adopt a 'Nuffield' approach. These will not be compulsory activities, and will not extend the examinable content of each syllabus.

A comprehensive set of test papers and mark schemes to support the syllabus content for use within Centres is available.

Regional consultants will be appointed to advise on science syllabuses and on coursework.

Question Paper Requirements

The written examinations will consist of three question papers, each of which will assess a specific Attainment Target.

Structured questions will be used across all question papers and there will be no choice of questions.

Coursework

All OCR science syllabuses use the common scheme for the assessment of coursework. Marks are awarded for candidate performance in each of the four Skill Areas of science investigations contained in the National Curriculum Order for Science. The total mark for assessment is made up of marks obtained from each of these Skill Areas.

In three of these Skill Areas an eight point mark scale is used, with defined hierarchical criteria provided for a performance worthy of 2, 4, 6 or 8 marks. In the Skill Area of Evaluation a six point mark scale is used with defined criteria provided at 2, 4 and 6 marks. Teachers will be able to award intermediate levels of performance.

Not all the marks need to be derived from whole investigations.

SCIENCE: DOUBLE AWARD (CO-ORDINATED)
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1 INTRODUCTION

This syllabus has been designed to fulfil the requirements of Science: Double Award as specified in the National Curriculum Orders. It provides for complete coverage of the Programme of Study for KS4 for Double Science and meets the requirements of both the General Criteria and the Science Criteria for GCSE.

Fundamental to the design of the syllabus is a recognition of the importance of the National Curriculum statements relating to aspects of Systematic Enquiry, the Application of Science, the Nature of Scientific Ideas, Communication and Health and Safety. These statements, which appear on pages 24/25 of the KS4 Programme of Study, are printed at the start of the defined syllabus content. The over-arching philosophy pervading the whole of the syllabus ensures that all of these statements are addressed whenever relevant, and the assessment reflects them.

This syllabus forms part of a linked suite comprising :

Science : Double Award	Syllabus Code 1794
Science : Single Award	Syllabus Code 1795
Science : Biology	Syllabus Code 1780
Science : Chemistry	Syllabus Code 1781
Science : Physics	Syllabus Code 1782
Science : Biology (Nuffield)	Syllabus Code 1785
Science : Chemistry (Nuffield)	Syllabus Code 1786
Science : Physics (Nuffield)	Syllabus Code 1787

The syllabus is presented in a co-ordinated fashion and the material from Sc2, Sc3 and Sc4 is shown as a number of separate Teaching Blocks containing Learning Outcomes which will be assessed by means of written papers taken at the end of the course.

A flexible approach to the syllabus has been adopted. The Learning Outcomes have been grouped in two different ways which will allow teachers to adopt either a 'traditional' approach or a 'Nuffield' approach to the course. Teacher Support booklets, reflecting these alternative approaches, are available and provide guidance to teachers preparing candidates for the examination.

Each of the Teaching Blocks represents a coherent unit of work, and the presentation in this format allows either a co-ordinated approach or an integrated approach to be used in teaching the content.

The content of the Teaching Blocks in each of Sc2, Sc3 and Sc4 is designed to be completed in approximately 100 hours of teaching time. This total of 300 hours for the course allows sufficient time both for the development and assessment of Sc1 as well as allowing time for other activities.

An identical format is used in the other syllabuses which form part of this suite. This common approach which utilises the maximum amount of common material, combined with similar styles of examination questions, represents a linked suite of syllabuses which allows Centres the maximum flexibility for GCSE courses in science and the separate sciences.

Assessment of Sc1 will be by coursework, using a scheme common to all National Curriculum Science and separate science syllabuses. Mark descriptions, designed to be used hierarchically to award marks, will be used to determine achievements of candidates.

Syllabus Exclusions

A candidate entered for Science: Double Award may not in the same examination series enter for any one of the following subjects:

Science : Single Award **Science : Biology**
Science : Chemistry **Science : Physics**

2 SYLLABUS AIMS

- To stimulate curiosity, interest and enjoyment in science and its methods of enquiry.
- To acquire a systematic body of scientific knowledge and to develop an understanding of science, including its power and limitations.
- To develop abilities and skills that are relevant to the study, practice and application of science, which are useful in everyday life, and which encourage safe practice.
- To develop experimental and investigative abilities.
- To develop an understanding of the nature of scientific ideas and activity and the basis for scientific claims.
- To develop an understanding of the technological and environmental applications of science and of the economic, ethical and social implications of these.

3 ASSESSMENT OBJECTIVES

The Assessment Objectives describe the intellectual and practical skills which candidates should be able to demonstrate, and which will be assessed in the examination.

Objectives related to Sc1 : Scientific Investigation

Candidates must be able to:

- carry out experimental and investigative work in which they plan procedures, use precise and systematic ways of making measurements and observations, analyse and evaluate evidence, and relate this to scientific knowledge and understanding.

Objectives related to Sc2, 3 and 4 : Knowledge and Understanding of Science

Candidates must be able to:

- recall, understand, use and apply the scientific knowledge set out in the syllabus.
- communicate scientific observations, ideas and arguments using a range of scientific and technical vocabulary and appropriate scientific and mathematical conventions.
- evaluate relevant scientific information, and make informed judgements from it.

Weighting of Assessment Objectives

Assessment Objective	Attainment Target	Weighting
Experimental & investigative work	Sc1	25%
Recall, understand, use and apply knowledge in the syllabus (about one third recall)	Sc2, Sc3, Sc4	60%
Communication and evaluation	Sc2, Sc3, Sc4	15%

Each of the Attainment Targets, Sc1, Sc2, Sc3 and Sc4, will be weighted at 25%.

Assessment of Sc1 will be by coursework.

Assessment of Sc2, Sc3 and Sc4 will be by means of externally set and externally marked question papers to be taken at the end of the course.

4 SCHEME OF ASSESSMENT

4.1 Tiering

The scheme of assessment consists of two tiers: Foundation Tier and Higher Tier. The written papers will achieve differentiation by being offered at Foundation Tier, covering grades GG to CC inclusive, and at Higher Tier covering grades DD to A*A* inclusive. Each tier consists of three papers and coursework.

Under no circumstances will a candidate entered for the Foundation Tier be awarded grades higher than CC. Candidates entered for the Higher Tier who obtain insufficient marks to be awarded DD will be ungraded (U).

Tier	Component number	Type of assessment	AT	Grades available	Duration	% weighting
Foundation	1	Written	Sc2	GG - CC	1 hr 30 min	25
Higher	2	Written	Sc2	DD - A*A*	1 hr 45 min	25
Foundation	3	Written	Sc3	GG - CC	1 hr 30 min	25
Higher	4	Written	Sc3	DD - A*A*	1 hr 45 min	25
Foundation	5	Written	Sc4	GG - CC	1 hr 30 min	25
Higher	6	Written	Sc4	DD - A*A*	1 hr 45 min	25
Both	7	Coursework	Sc1	GG - A*A*	-	25

Candidates must be entered for one Tier only.
Candidates for Foundation Tier will take components 1, 3, 5 and 7.
Candidates for Higher Tier will take components 2, 4, 6 and 7

Advice on Entry Policy

The table shows the recommended tier of entry.

Expected Grades	Recommended Tier of entry
GG	Foundation
FF	Foundation
EE	Foundation
DD	Foundation
CC	Foundation/Higher
BB	Higher
AA	Higher
A*A*	Higher

4.2 Question Papers

Each question paper will cover a specific Attainment Target. Foundation Tier papers will assess the National Curriculum statements and the Learning Outcomes as printed in the Teaching Blocks, with the exception of those with a letter **H** against them. Higher Tier papers will assess all National Curriculum statements and Learning Outcomes.

Papers covering the same Attainment Target will be timetabled on the same day, and will commence at the same time. The papers timetabled simultaneously will contain common questions, or part questions, targeting the overlapping grades CC and DD.

All the papers will consist of structured questions containing an incline of difficulty. All questions will be compulsory and candidates will have no choice of questions.

No more than two thirds of the marks available in each question paper will be allocated to objective or short answer questions. On all question papers, a significant proportion of the questions will be concerned with the applications and implications of science.

A copy of the Periodic Table of the Elements [Appendix E] will be printed in Papers 3 and 4, and candidates will be expected to use it when necessary. A list of formulae which are included in Key Stage 4 of the National Curriculum is included as Appendix D. Candidates will be required to recall these formulae in the examination.

Units and Nomenclature

The units and nomenclature used within the question papers will normally conform to the recommendations contained in "Signs, Symbols and Systematics" [Association for Science Education (1995)].

4.3 Coursework

4.3.1 Summary

Coursework will represent 25% of the total assessment and will relate to the subject content of Sc2, Sc3 and Sc4.

All OCR National Curriculum science and separate sciences syllabuses will use a common scheme for the assessment of coursework. This scheme will form a 'common element' across all of the National Curriculum science syllabuses of the GCSE Examining Groups.

Throughout the course candidates should be presented with frequent opportunities to undertake practical work, and the common scheme of assessment is designed to award credit for performance under four headings:

Skill Area P - Planning Experimental Procedures

Skill Area O - Obtaining Evidence

Skill Area A - Analysing Evidence and Drawing Conclusions

Skill Area E - Evaluating Evidence

The Key Stage 4 Sc1 Programme of Study, the GCSE Grade Descriptors and, to a more limited extent, the Key Stage 3 level descriptors form the basis of the mark descriptions.

4.3.2 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 a phrase such as 'where appropriate' and therefore may not apply to a particular activity.

Descriptions are provided for 2, 4, 6 and 8 marks in Skill Areas P, O and A, and for 2, 4 and 6 marks in Skill Area E (see 4.3.9 for details). The performance needed to gain 6 marks in Skill Area E is commensurate with that required for 8 marks in the other Skill Areas.

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

The mark descriptions 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** (i.e. 3, 5 and 7) where performance exceeds one description but only partially satisfies the next.

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

The **professional judgement** of the teacher in making these decisions is important.

4.3.3 Arrival at the Final Mark Submitted

Centres are required to award each candidate a mark for each of the four Skill Areas. These marks should reflect a candidate's **best performance** during the course.

However, to satisfy the QCA Criteria for Science, the following requirements **must** also be met:

- There must be at least one Skill Area mark obtained from work in the context of **each** of Sc2, Sc3 **and** Sc4.

- At least one of the Skill Area marks must have been obtained from a **whole investigation** carried out by the candidate i.e a piece of work which covers all four Skill Areas. This can represent work in one of Sc2, Sc3 or Sc4.

The minimum evidence must be **three** pieces of work.

Centres should be careful to avoid situations where, in order to meet these requirements, a candidate's best mark in a Skill Area cannot be counted towards the total mark submitted. For example, a candidate's best Skill Area marks may be 8, 8, 8, 6 but with no contributing mark from, say, Sc3. In this case a mark, possibly lower, from Sc3 work for one Skill Area would be needed.

4.3.4 Recording Marks

Coursework Assessment Forms will be provided for Centres to record marks submitted at the end of the course. A copy of the Coursework Assessment Form is provided as Appendix H.
For each candidate the written reports of all work represented in the final total mark must be available for moderation if required.

4.3.5 Authentication

Practical and investigative work which is assessed for Sc1 should, wherever possible, be carried out under supervision. However it is accepted that more extended investigations may involve candidates undertaking some coursework outside their school or college. Where this is the case, the Centre must require that sufficient supervised work takes place to allow the teachers concerned to authenticate each candidate's work with confidence. OCR requires teachers involved in the assessment of Sc1 to sign the marksheet at the end of the course, to verify that the marks submitted for moderation accurately reflect candidates' own work.

4.3.6 Moderation

All coursework is marked by the teacher and internally standardised by the Centre. Marks are then submitted to OCR and moderation takes place in accordance with OCR procedures.

The purpose of external moderation is to ensure that the standard for award of marks in coursework is the same for each Centre, and that

each teacher has applied the standards appropriately across the range of candidates within the Centre.

External moderation will be by postal sample selected by the Moderator.

The sample will represent performance across the whole ability range from the Centre and will include work assessed by each teacher involved in the assessment. It is the responsibility of the Centre to carry out effective internal standardisation; that is to ensure that similar standards are applied by each teacher involved in the assessment. The Moderator will require a written statement describing how effective internal standardisation has been carried out within a Centre.

4.3.7 Minimum coursework requirements

If a candidate submits no work for the coursework component, then the candidate should be indicated as being absent from that component on the coursework mark sheets submitted to OCR. If a candidate completes any work at all for the coursework component then the work should be assessed according to the criteria and marking instructions and the appropriate mark awarded, which may be 0 (zero).

4.3.8 Special Arrangements

For candidates who are unable to complete the full assessment of coursework, or whose performance may be adversely affected through no fault of their own, teachers should consult OCR's procedures which can be found in the Handbook for Centres. Applications for special arrangements in such cases should be made as early as possible during the course.

4.3.9 Mark Descriptions

Skill Area P: Planning Experimental Procedures

Programme of Study Requirements

Candidates should be taught:

- to use scientific knowledge and understanding, drawing on secondary sources where appropriate, to turn ideas suggested to them, and their own ideas, into a form that can be investigated;
- to carry out preliminary work where this helps to clarify what they have to do;
- to make predictions where it is appropriate to do so;
- to consider the key factors in contexts involving a number of factors;
- to plan how to vary or control key variables;
- to consider the number and range of observations or measurements to be made;
- to recognise contexts, for example fieldwork, where variables cannot readily be controlled and to make judgements about the amount of evidence needed in these contexts;
- to select apparatus, equipment and techniques, taking account of safety requirements.

The mark descriptions are arranged to be hierarchical.

All the work is assessed in the context of the syllabus.

Candidates:			Increasing demand of activity
2 marks	P.2a	plan a simple, safe procedure	↓
4 marks	P.4a	plan a fair test or a practical procedure, making a prediction where appropriate	↓
	P.4b	select appropriate equipment	
6 marks	P.6a	use scientific knowledge and understanding to plan a procedure, to identify key factors to vary, control or take into account, and to make a prediction where appropriate	↓
	P.6b	decide on a suitable number and range of observations or measurements to be made	
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 where appropriate	↓
	P.8b	use, where appropriate, relevant information from secondary sources or preliminary work	

Skill Area O: Obtaining evidence

Programme of Study Requirements

Candidates should be taught:

- to use a range of apparatus and equipment safely and with skill;
- to make observations and measurements to a degree of precision appropriate to the context;
- to make sufficient relevant observations and measurements for reliable evidence;
- to consider uncertainties in measurements and observations;
- to repeat measurements and observations where appropriate;
- to record evidence clearly and appropriately as they carry out the work.

The mark descriptions are designed to be hierarchical.

All the work is assessed in the context of the syllabus.

Candidates:			Increasing demand of activity
2 marks	O.2a	use simple equipment safely to make some observations or measurements	↓
4 marks	O.4a	make appropriate observations or measurements which are adequate for the activity	↓
	O.4b	record the observations or measurements	
6 marks	O.6a	make sufficient systematic and accurate observations or measurements and repeat them when appropriate	↓
	O.6b	record clearly and accurately the observations or measurements	
8 marks	O.8a	use equipment with precision and skill to obtain and record reliable evidence which involves an appropriate number and range of observations or measurements	↓

Skill Area A: Analysing evidence and drawing conclusions

Programme of Study Requirements

Candidates should be taught:

- to present qualitative and quantitative data clearly;
- to present data as graphs, using lines of best fit where appropriate;
- to identify patterns or trends in results;
- to use graphs to identify relationships between variables;
- to present numerical results to an appropriate degree of accuracy;
- to check that conclusions drawn are consistent with the evidence;
- to explain how results support or undermine the original predictions when one has been made;
- to try to explain conclusions in the light of their knowledge and understanding of science.

The mark descriptions are arranged to be hierarchical.

All the work is assessed in the context of the syllabus.

Candidates:			Increasing demand of activity
2 marks	A.2a	explain simply what has been found out	↓
4 marks	A.4a	present findings in the form of simple diagrams, charts or graphs	
	A.4b	identify trends and patterns in observations or measurements	
6 marks	A.6a	construct and use appropriate diagrams, charts, graphs (with lines of best fit), or use numerical methods, to process evidence for a conclusion	
	A.6b	draw a conclusion consistent with their evidence and relate this to scientific knowledge and understanding	
8 marks	A.8a	use detailed scientific knowledge and understanding to explain a valid conclusion drawn from processed evidence	
	A.8b	explain how results support or undermine the original prediction when one has been made	

Skill Area E: Evaluating evidence

Programme of Study Requirements

Candidates should be taught:

- to consider whether the evidence is sufficient to enable firm conclusions to be drawn;
- to consider reasons for anomalous results and to reject such results where appropriate;
- to consider the reliability of results in terms of the uncertainty of measurements and observations;
- to propose improvements to the methods that have been used;
- to propose further investigation to test their conclusions;

The mark descriptions are arranged to be hierarchical.

All the work is assessed in the context of the syllabus.

Candidates:			Increasing demand of activity
2 marks	E.2a	make a relevant comment about the procedure used or the evidence obtained	↓
4 marks	E.4a	comment on the accuracy of the observations or measurements, recognising any anomalous results	↓
	E.4b	comment on the suitability of the procedure and, where appropriate, suggest changes to improve the reliability of the evidence	
6 marks	E.6a	comment on the reliability of the evidence, accounting for any anomalous results, or explain whether the evidence is sufficient to support a firm conclusion	↓
	E.6b	propose improvements, or further work, to provide additional evidence for the conclusion, or to extend the enquiry	

4.4 Spelling, Punctuation and Grammar

In line with the Mandatory Code of Practice, 5% of the marks on the coursework component will be allocated to the assessment of Spelling, Punctuation and Grammar (see Appendix B).

4.5 Differentiation

Differentiation in the assessment of this syllabus is achieved in two ways. Written papers are set at two tiers, and the syllabus content is differentiated to reduce the amount of material to be covered, and assessed, for the Foundation Tier. For coursework, there is a single set of criteria for all abilities and so differentiation is by task and by outcome.

4.6 Awarding of Grades

The question papers will have a total weighting of 75% and the coursework a weighting of 25%.

A candidate's mark for each of the papers will be combined with the coursework mark in the appropriate weighting to give the candidate's total mark for the syllabus. The candidate's grade will be determined by this total mark. Candidates failing to achieve the minimum mark for a grade GG in the Foundation Tier or a grade DD in the Higher Tier will be ungraded.

5 SYLLABUS CONTENT

5.1 Introduction

The detailed syllabus content is displayed on pages **20 to 74** and consists of Teaching Blocks for each of Sc2, Sc3 and Sc4. The format used has been designed to provide a 'teacher-friendly' approach to the course.

The first column provides Programme of Study statements from the National Curriculum for Science (1995). The reference numbers refer to (in order) the Attainment Target, the Section and the specific statement of the Key Stage 4 Programme of Study. For example 3.2a refers to the Sc3 statement 2a: *"how oil deposits are formed"*. The second column displays the assessable Learning Outcomes to address the National Curriculum statements, which teachers can use in developing their own Schemes of Work.

A small amount of the supporting Key Stage 3 content has been included in the syllabus for coherence. This is referenced KS3.

The narrow column headed **H** gives guidance on Learning Outcomes more appropriate for students working at Higher levels. Questions addressing the Learning Outcomes aligned with this **H** will **only** appear on the Higher Tier papers, and hence are targeting content which is appropriate to candidates likely to achieve Grades A*A*, AA and BB.

*The use of italic type in the syllabus content indicates those parts of the Teaching Blocks which do not form part of the **Single Award syllabus.***

5.2 Titles of Teaching Blocks

Sc2	Sc3	Sc4
Introducing Biological Principles	Introducing Chemistry	Electric Circuits
Digestion	Metals and the Reactivity Series	Energy Transfer
Respiration	Periodic Table & Atomic Structure	Forces
Breathing		Wave Properties
Photosynthesis	Geological Changes	Using Waves
Circulation and Transport	Rates of reaction	Radioactivity
Communication and Control	Structure, Bonding & the Mole	The Earth and Universe
Energy Flow & Cycling of Elements	Oil	Using Electricity
Inheritance and Evolution	Earth Cycles	Electromagnetism
Living Things in their Environment	Equilibria and Industrial Processes	

5.3 Generalised Requirements for KS4

The following requirements form a substantive part of the National Curriculum. The over-arching philosophy pervading the syllabus ensures that all of these statements are addressed whenever relevant, and the assessment reflects this.

The table below gives some specific examples of Teaching Blocks where each of these generalised requirements is particularly relevant. Other examples will arise in other Teaching Blocks.

Teachers will be able to link these references, and the associated Learning Outcomes, into their own individual Schemes of Work.

1 Systematic enquiry

	Sc2	Sc3	Sc4
a. use practical tasks and investigations to acquire scientific knowledge, understanding and skills	Sc1 Course work	Sc1 Course work	Sc1 Course work
b. use and bring together information from a range of secondary sources	Block 9	Block 8	Block 3
c. work quantitatively	Block 8	Block 6	Block 3
d. judge when to use IT to collect, handle and investigate scientific information	Block 7	Block 5	Block 6

2 Application of Science

a. consider ways in which science is applied and used, and to evaluate the benefits and drawbacks of scientific and technological developments for individuals, communities and environments	Block 10	Block 8	Block 2
b. use scientific knowledge and understanding to evaluate the effects of some applications of science on health and the quality of life	Block 8	Block 7	Block 5
c. relate scientific knowledge and understanding to the care of living things and of the environment	Block 10	Block 2	Block 9
d. consider competing priorities and the decisions that have to be made about energy requirements, taking into account relevant social, economic and	Block 8	Block 1	Block 9

e. consider the power and limitations of science in addressing industrial, social and environmental issues and some of the ethical dilemmas involved	Block 9	Block 2	Block 5

3 The nature of scientific ideas

a. develop their understanding of how scientific ideas are accepted and rejected on the basis of empirical evidence, and how scientific controversies can arise from different ways of interpreting such evidence	Block 9	Block 8	Block 7
b. consider ways in which scientific ideas may be affected by the social and historical contexts in which they develop, and how these contexts may affect whether or not the ideas are accepted	Block 9	Block 3	Block 7

4 Communication

a. use a wide range of scientific and technical vocabulary and conventions, and to use diagrams, graphs, tables and charts to communicate information and to develop an argument	Block 3	Block 3	Block 3
b. use SI units	Sc1 Course work	Block 6	Block 3
c. present scientific information in symbolic or mathematical form	Block 8	Block 1	Block 3

5 Health and safety

a. take responsibility for recognising hazards in a range of materials, activities and environments, including the unfamiliar	Block 7	Block 3	Block 8
b. use information sources in order to assess the risk of the unfamiliar	Block 10	Block 3	Block 6
c. manage their working environment and justify the action taken to control risks	Sc1 Course work	Sc1 Course work	Sc1 Course work

Sc2 Teaching Block 1: *Introducing Biological Principles*

Candidates should be taught: (National Curriculum Reference)	**Learning Outcomes**	**H**
the life processes common to plants and animals. (2.1a)	Be able to describe in simple terms the life processes of movement, reproduction, sensitivity, growth, respiration, excretion, nutrition.	
that plant and animal cells have some similarities in structure. (2.1c)	Know the positions and functions of the nucleus, cytoplasm, cell membrane and mitochondria in plant and animal cells, and the cell wall, chloroplasts and vacuole in plant cells. Understand that cells are organised into tissues, tissues into organs, and organs into organ systems.	
	Understand that substances can be classified as • inorganic - minerals and water • organic - carbohydrates (sugar, starch, cellulose, glycogen) - fats and oils - amino acids and proteins - nucleic acid (DNA).	
Movement of substances in and out of cells *how substances enter and leave cells through the cell membrane by diffusion, osmosis and active transport. (2.1d)*	*Know that water is the major component in plant and animal cells.* *Know that plant cells possess a large vacuole (filled with cell sap) and a cell wall but that animal cells have neither of these structures.* *Understand that the cell membrane is partially permeable.* *Understand that diffusion is the passive movement of particles down a concentration gradient and is a consequence of the random motion of the particles.* *Understand that compounds with small molecules, eg oxygen, carbon dioxide and water, diffuse across the cell membrane down a concentration gradient.* *Understand that larger particles, such as sugar molecules, might diffuse through membranes more slowly.* *Understand that osmosis is a special case of diffusion.* *Understand that osmosis is the process in which water molecules diffuse from a high water concentration to a lower water concentration through a partially permeable membrane.* *Understand that some substances can be moved into or out of living cells against a concentration gradient by active transport.*	**H** **H** **H** **H** **H**

	Know that respiration provides energy for active transport.	**H**
Enzymes *[Teachers should be aware that enzymes are covered in Sc3 - reference should be made to 3.3p and 3.3q].*	*Know that chemical reactions in cells are catalysed by enzymes.* *Know that enzymes are proteins.*	

Sc2 Teaching Block 2: *Digestion*

Candidates should be taught: (National Curriculum Reference)	**Learning Outcomes**	**H**
that organ systems are adapted for their roles in life processes. (2.1b)	Know that the digestive system is a muscular tube in which food is moved by peristalsis (simple understanding of circular and longitudinal muscles), stored, digested, absorbed and egested.	
the structure of the human digestive system. (2.2a)	Be able to name and locate the main parts of the human digestive system to include mouth, oesophagus, stomach, small and large intestines and the associated organs (liver and pancreas).	
the processes involved in digestion, including the role of enzymes, stomach acid and bile. (2.2b)	Understand that large food molecules are digested to form small soluble molecules by enzymes, i.e • starch to maltose by amylase in the mouth and small intestine • proteins to amino acids by proteases in the stomach and small intestine • fats to fatty acids and glycerol by lipase in the small intestine. Understand the role of stomach acid in sterilising food and adjusting pH for enzyme activity. Understand the role of bile in emulsifying fats. Understand that the small intestine is folded into villi in order to enhance absorption. Be able to carry out and know the results of tests for • starch (iodine solution) • protein (biuret) • simple sugars (Benedict's solution) • fats (alcohol emulsion, grease spot).	**H**

Sc2 Teaching Block 3: *Respiration*

Candidates should be taught: (National Curriculum Reference)	**Learning Outcomes**	**H**
to summarise aerobic respiration in a word equation. (KS3)	*Understand that breathing and gas exchange allow oxygen to reach cells for aerobic respiration.*	
that aerobic respiration involves the reaction in cells between oxygen and food used as a fuel. (KS3)	*Understand that for aerobic respiration to take place glucose and oxygen are needed.* *Know the equation:* *glucose + oxygen → carbon dioxide + water + energy.* *Know the symbol equation for aerobic respiration:* $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ + energy.	H
that respiration may be either aerobic or anaerobic depending on the availability of oxygen. (2.2f)	*Know the difference between aerobic and anaerobic respiration.* *Know that the energy needed for all life processes (in plants and in animals) is provided by respiration and that the rate of oxygen consumption is an estimate of metabolic rate.* *Understand the differences and similarities between burning and respiration.* *Understand that different foods contain different amounts of energy.*	
that an "oxygen debt" may occur in muscles during vigorous exercise. (2.2g)	*Understand that energy intakes should match energy requirements to avoid loss or gain in body mass.* *Know the word equation for anaerobic respiration in our body cells and some bacteria:* *glucose → lactic acid + energy* *Understand that anaerobic respiration releases much less energy than does aerobic respiration.*	H
[Teachers should be aware that the use of enzymes in the brewing, baking and dairy industries is covered in Sc3. Reference should be made to 3.3p and 3.3q].	*Know that lactic acid in the body causes muscle fatigue.* *Know the word equation for the production of ethanol by fermentation:* *glucose → carbon dioxide + ethanol + energy.* *Know that anaerobic respiration in yeast is used in breadmaking and brewing.* *Understand that during fermentation aerobic respiration takes place first until all of the available oxygen has been used up and then anaerobic respiration takes place.* *Understand that anaerobic respiration takes place when there is insufficient oxygen to support aerobic respiration and leads to an 'oxygen debt'.*	H H H

Sc2 Teaching Block 4: *Breathing*

Candidates should be taught: (National Curriculum Reference)	**Learning Outcomes**	**H**
the structure of the thorax. (2. 2d)	*Be able to locate and name the parts of the human breathing system to include ribs, external intercostal muscles, lungs, diaphragm, bronchi, bronchioles and alveoli.* *Understand how the structures of these parts are related to their functions.*	**H**
how breathing, including ventilation of the lungs, takes place. (2.2e)	*Understand how movements of the rib cage and the diaphragm change the volume in the thorax, so altering the pressure, causing air to move in/out of the thorax.* *Know the composition (as an approximate percentage by volume) of gases in inhaled and exhaled air.* *Understand that high concentrations of carbon dioxide or lactic acid in the blood reaching the brain act as stimuli causing the rate of breathing to increase.*	**H**
how lung structure enables gas exchange to take place. (KS3) *how smoking affects lung structure and gas exchange. (KS3)* *the defence mechanisms of the body; mucus membranes of the respiratory tract. (2.2q [part])*	*Understand how lung structure allows gas exchange to take place because of* • *enormous surface area* • *moist surfaces* • *thin-walled air sacs* • *rich supply of blood capillaries.* *Understand how the mucus-secreting cells and the cilia help to keep the lungs clean.* *Be able to explain how this process, which can help to defend the body against infection, is affected by smoking.* *Know that smoking reduces the surface area for gas exchange by destroying alveoli.* *Know the link between smoking and respiratory diseases eg bronchitis, lung cancer.*	

Sc2 Teaching Block 5: *Photosynthesis*

Candidates should be taught: (National Curriculum Reference)	**Learning Outcomes**	**H**
the reactants in, and the products of, photosynthesis. (2.3a)	*Understand that chlorophyll absorbs light in photosynthesis.* *Understand the role of stomata in gas exchange.* *Understand how leaves are adapted for photosynthesis.* *Know the word equation for photosynthesis:* $\text{carbon dioxide + water} \xrightarrow[\text{chlorophyll}]{\text{light}} \text{glucose + oxygen}$ *Know the symbol equation for photosynthesis:* $6CO_2 + 6H_2O \xrightarrow[\text{chlorophyll}]{\text{light}} C_6H_{12}O_6 + 6O_2$ *Understand how different colours of light can affect the rate of photosynthesis.*	**H** **H**
that the rate of photosynthesis may be limited by light intensity, carbon dioxide concentration or temperature. (2.3b)	*Understand that changes in light intensity, temperature or carbon dioxide concentration can affect the rate of photosynthesis.* *Understand that light intensity, temperature or carbon dioxide concentration can act as limiting factors.*	**H**
how the products of photosynthesis are utilised by the plant. (2.3c)	*Understand that the glucose which is made by plants is* • *converted into storage materials eg starch* • *used for respiration* • *converted into cellulose for support* • *converted into protein* • *converted into sucrose.* *Understand that growth takes place at root and shoot tips, developing buds, flowers and fruits, and in storage organs such as potato tubers, swollen roots and onion bulbs.* *Understand that sugars must reach these regions to supply energy and materials for growth.* *Know that phloem tissue is living and conducts sugars up and down stems to growing and storage tissues.* *Know that phloem tissue in leaves, stems and roots forms a continuous system.* *Know that plant cells can use the oxygen from photosynthesis for their respiration.*	

Sc2 Teaching Block 6: *Circulation and Transport*

Candidates should be taught: (National Curriculum Reference)	**Learning Outcomes**	**H**
Blood and Circulation	*Be able to name and locate the parts of the heart to include the valves, left and right atria and ventricles.*	
	Understand how valves prevent the backflow of blood.	
	Understand what is meant by the double circulatory system.	**H**
	Know how diet, exercise and stress can affect the circulatory system.	
	Know that arteries carry blood at high pressure away from the heart.	
	Know that capillaries leak tissue fluid.	
the structure of the human circulatory system including the composition and functions of blood. (2.2c)	*Know that veins return blood at lower pressure to the heart.*	
	Understand how the structure of the blood vessels (arteries, capillaries and veins) is related to their function.	**H**
	Know that : • blood consists of plasma, red blood cells, platelets and white blood cells • plasma carries dissolved food substances, urea, carbon dioxide and hormones • red blood cells carry oxygen • platelets help in the clotting of blood.	
	Understand how the structure of red blood cells is adapted to their function (haemoglobin, surface area, no nucleus).	**H**
the defence mechanisms of the body, including the role of the skin and blood. (2.2q [part])	Know that • the skin and the formation of blood clots act as barriers against infection • tears contain a substance that destroys microbes • stomach acid kills microbes in food • white cells protect against infection either by engulfing microbes or by producing antibodies • white cells are not confined to the blood system.	

Water uptake and Transpiration	*Understand the role of root hairs in water uptake.*	
	Understand that water enters root cells by osmosis.	**H**
how plants take up water and transpire. (2.3f)	*Know the structure of a leaf (external and internal parts including cuticle, epidermis, palisade and spongy layers, stomata, arrangement of main and smaller veins, xylem and phloem).*	
the importance of water in the support of plant tissue. (2.3g)	*Understand that the waxy cuticle reduces water loss from leaves.* *Know that stomata are commonly on the undersurface where there is less air movement and less solar radiation to cause water loss.*	
that substances required for growth and reproduction are transported within plants. (2.3h)	*Understand that transpiration is the evaporation of water from inside leaves and that it is slower when stomata close.* *Understand that transpiration rate is increased by* • *light* • *increase in temperature* • *increase in air movement* • *decrease in humidity.*	
	Know that stomata can open or close in response to external conditions by changing the shape of their guard cells.	**H**
	Know that xylem is in the vascular bundles of plant stems, and that these extend into leaves and roots.	**H**
	Understand how the structure of plant cells and turgor pressure contribute to support in plant tissue.	
	Know that transpiration causes water to be pulled up xylem vessels.	
	Know that water and dissolved minerals are transported up xylem vessels which are dead cells with no cytoplasm.	
Mineral requirements of plants	*Know that nitrogen, phosphorus and potassium are the major elements required by plants in addition to carbon, hydrogen and oxygen.*	
	Know that other elements, eg magnesium, are needed in smaller amounts for healthy plant growth.	
the importance to healthy plant growth of the uptake and utilisation of mineral salts. (2.3d)	*Know that* • *nitrogen is used to make amino acids, proteins and DNA*	**H**
	• *phosphorus is used to make DNA and cell membranes*	**H**
	• *magnesium is needed to make chlorophyll.*	
	Understand that mineral deficiencies result in poor plant growth.	
	Understand that crop production(yield) is limited by lack of any one essential mineral.	**H**
	Understand how monoculture requires the application of fertilisers (organic or inorganic) to produce maximum yields.	**H**

Sc2 Teaching Block 7: *Communication and Control*

Candidates should be taught: (National Curriculum Reference)	**Learning Outcomes**	**H**
the pathway taken by impulses in response to a variety of stimuli, including touch, taste, smell, light, sound and balance. (2.2h) how the reflex arc, which involves a nerve impulse carried via neurones and across synapses, makes possible rapid response to a stimulus. (2.2i)	Know that sense organs detect stimuli • ear - sound and 'balance' • eye - light • nose - chemicals - taste and smell • tongue - chemicals - bitter, salt, sour and sweet taste • skin - touch, pressure and temperature change Know that receptors detect a variety of stimuli such as light, sound, pressure, temperature and chemicals. Know that a receptor transduces energy from a stimulus to form a nerve impulse. Be able to describe, in simple terms, the structure of sensory and motor neurones. Be able to relate the structure of neurones to their functions. Be able to describe the pathway of cells for a simple nervous response, i.e. stimulus → receptor → neurones → effector → response Be able to describe reflex actions as an automatic means of rapidly co-ordinating body activity by nervous control. Understand that nerve impulses travel across junctions (synapses) via chemical means.	H H
the structure of the eye and how it functions in response to light. (2.2j)	Be able to name and locate the parts of the human eye to include cornea, iris, pupil, lens, fovea, retina, optic nerve, ciliary muscles and blind spot. Understand the function of the iris, pupil and retina in controlling the amount of light entering the eye. Understand that rods function in dim light, and cones detect colour and details. Be able to describe how the cornea and the lens produce a focused image on the retina.	H
the way in which hormonal control occurs including the effects of *insulin and* sex hormones. (2.2k)	Know that hormones are chemical messengers carried in blood plasma. Know that hormones affect target cells *Know that insulin is produced by the pancreas and controls blood sugar levels.* Know that oestrogen and progesterone are female sex hormones and that testosterone is the male sex hormone. Know that these hormones are produced by the ovaries and testes, and that they control physical changes during adolescence.	

	Understand the roles of oestrogen and progesterone in the control of the menstrual cycle	**H**
some medical uses of hormones including the control and promotion of fertility *and the treatment of diabetes.* (2.2l)	Know that hormones can be used to control and promote fertility. *Know that insulin can be used by diabetes sufferers to control blood-sugar levels.* *Understand that insulin promotes removal of glucose from the bloodstream, and the conversion of glucose into glycogen in the liver.*	**H** **H**
the importance of maintaining a constant internal environment. (2.2m)	Understand that the body systems work together to provide optimum conditions for the cells to function efficiently. Be able to locate and name the main systems which maintain a constant internal environment, namely blood glucose (pancreas and liver), water content (kidneys) and temperature (skin). Understand that for cells to function effectively, the tissue fluid environment which surrounds them must be kept fairly constant.	 **H**
how waste products of the body functions are removed by the lungs and kidneys. (2.2n) how the kidneys regulate the water content of the body (2.2o) how humans maintain a constant body temperature. (2.2p)	Understand how alveoli and blood capillaries in the lungs enable elimination of carbon dioxide and water to occur. Know that waste products eg urea, excess water and excess salt are removed from the blood by the kidneys. Know that water enters the body in food and is produced in respiration. Understand that gain and loss of water must balance. Understand that kidneys filter blood at high pressure and then re-absorb water (and other substances) to meet the body's needs. Understand that a hormone from the brain (ADH) promotes water reabsorbtion to prevent dehydration. Be able to name and locate the structures of the skin involved in maintaining a constant body temperature. Be able to explain, in simple terms, how humans control body temperature by • vasoconstriction and vasodilation and the effect on blood flow • shivering • sweating • muscle/liver activity.	 **H** **H**

	Know that cells in the brain detect the core temperature of the body and control these response mechanisms. Understand how clothing aids temperature control.	H
the effects of solvents, alcohol, tobacco and other drugs on body functions. (2.2r)	Know that the correct use of drugs under medical supervision can have beneficial effects. Know the effects that depressants, stimulants and analgesics can have on the central nervous system. Know that drugs and organic solvents may affect behaviour and may cause damage to the brain, liver and kidneys. Know that body reactions are affected by alcohol and other drugs. Know that some drugs are harmful and habit-forming. *Know that tobacco smoke inhibits the action of cilia.* Know that there are chemicals in tobacco smoke which may cause heart disease, lung cancer and other diseases.	
the hormonal control of plant growth and development, including commercial applications. (2.3e)	*Know that plant shoots grow towards the stimulus of light and that plant roots grow toward the stimulus of gravity.* *Be able to explain how these responses benefit plants.* *Be able to explain that shoots are positively phototropic and that roots are positively geotropic.* H *Understand that an uneven stimulus eg gravity or unidirectional light, promotes uneven growth in shoots and roots and leads to 'bending' growth movements.* H *Know that plants produce chemicals that regulate cell growth and development.* H *Understand that auxins are plant growth substances which promote faster growth on the shaded side of a shoot tip.* *Understand that shoot tips produce substances that inhibit side shoot growth and that the removal of the tip removes the inhibition eg hedge clipping promotes bushier hedges.* H *Know that 'rooting powder' promotes root growth in shoot cuttings.* *Know that growth substances can be applied to unpollinated flowers to produce 'seedless' fruits eg grapes and citrus fruit.* *Understand that broad leaved weeds in a lawn can be controlled by applying a selective weedkiller containing a synthetic growth substance.*	

Sc2 Teaching Block 8: *Energy Flow and Cycling of Elements*		
Candidates should be taught: (National Curriculum Reference)	**Learning Outcomes**	**H**
Food Chains and Pyramids	*Understand that a community consists of populations of different species interacting with each other in an ecosystem.* *Know that energy enters ecosystems as light.* *Understand that green plants are producers of organic matter.* *Know that animals are consumers because they rely on plants and other animals for food.* *Understand the use of the terms herbivore, carnivore and omnivore.*	
how food chains can be described quantitatively using pyramids of numbers and pyramids of biomass. (2.5c)	*Understand that some organic compounds contain energy which is transferred along food chains.* *Be able to interpret diagrams of food chains and webs.*	**H**
how energy is transferred through an ecosystem. (2.5d)	*Understand that most of the energy obtained by an organism is lost to the environment as heat.* *Understand the use of the term 'trophic level'.* *Understand how to construct a pyramid of numbers from data about a food chain.* *Be able to interpret pyramids of numbers with respect to the size of organisms eg pyramids involving parasites or a single producer.* *Understand how to construct a pyramid of biomass from data about a food chain.* *Understand why a biomass pyramid decreases in width along a food chain.*	**H**

Cycling of Elements	*Know that carbohydrates contain carbon, hydrogen and oxygen, and that proteins contain carbon, hydrogen, oxygen and nitrogen.*	
	Understand that elements such as carbon, hydrogen, oxygen and nitrogen are recycled in ecosystems.	
	Know that decomposition is important in the recycling of elements.	
	Understand that the following are involved in the carbon cycle:	
	• *soil bacteria and fungi are decomposers and that they release carbon dioxide into the air, minerals into the soil and energy to their surroundings* • *energy in some decomposing material becomes trapped as fossil fuels such as coal, gas and oil* • *carbon dioxide is used in photosynthesis by green plants to produce organic compounds* • *plants and animals release carbon dioxide into the air as a product of respiration* • *when fossil fuels are burned carbon dioxide Is released* • *burning all organic compounds, including wood, paper and animal tissues releases carbon dioxide into the air.*	
the role of microbes and other organisms in the decomposition of organic materials and in the cycling of carbon and nitrogen. (2.5e)	*Understand that the following are involved in the nitrogen cycle*	**H**
	• *decay bacteria (decomposers) convert proteins and urea into ammonia*	**H**
	• *that nitrifying bacteria add nitrates to the soil by converting ammonia into nitrates*	**H**
	• *that nitrogen-fixing bacteria convert atmospheric nitrogen into amino acids and protein*	**H**
	• *that some nitrogen-fixing bacteria live freely in soil whilst others are present in the root nodules of leguminous plants.*	**H**
	Understand how leguminous plants can be important in crop rotation as part of organic farming practice.	**H**
	Know that lightning adds nitrates to the soil.	**H**
	Know that plant roots absorb nitrates from the soil to form amino acids and proteins.	**H**
	Know that plant remains can be ploughed back into soil to decay and improve nitrate levels.	

Food production	*Understand why only some energy passes from one trophic level to the next.*	**H**
	Understand why food chains rarely include more than four trophic levels.	**H**
how food production can be managed to improve the efficiency of energy transfer. (2.5f)	*Know that an area of land can produce more plant food and therefore feed more people than if the area is used for producing meat.*	**H**
	Understand that crop yield increases with closer planting but is then limited owing to competition.	
	Understand that weeds, insect pests and fungal diseases reduce crop yields and that they can be controlled by using pesticides or by non-chemical methods (including biological control).	**H**
[Teachers should be aware that fertilisers are covered in Sc3 Teaching Block 9 - ref 3.2q].	*Understand that some areas of land eg moorland and hillsides, are unsuitable for plant crops but are useful for some production eg sheep and deer.*	**H**
	Understand that animals reared intensively eg chickens and pigs, are fed on cereals and therefore indirectly require 'land'.	**H**

Sc2 Teaching Block 9: *Inheritance and Evolution*

Candidates should be taught: (National Curriculum Reference)	**Learning Outcomes**	**H**
the human reproductive system including fertilisation. (KS3)	Be able to name, locate and describe the functions of the testes, sperm tubes, penis, urethra, scrotum, ovaries, oviducts, uterus, cervix and vagina. Be able to describe the fertilisation of the egg by the sperm in an oviduct to form a zygote.	
that the nucleus contains the chromosomes that carry the genes. (2.1e)	Understand how identical and non-identical twins are formed. Know that the nucleus of each body cell of a species has a characteristic number of chromosomes eg 23 pairs in humans.	
that the gene is a section of DNA (2.4g)	*Know that a chromosome includes a long molecule of DNA divided up into sections called genes which may be copied and carried on to the next generation.* *Be able to describe genes as chemical instructions controlling the way cells develop and function.* *Know that each gene acts as a code for the production of a particular protein in the cytoplasm of a cell.*	**H** **H**
the basic principles of genetic engineering. (2.4h [part only])	Understand that foreign genes can be inserted into the DNA of microorganisms to make useful proteins, eg insulin.	**H**
how cells divide by mitosis so that growth takes place, and by meiosis to produce gametes. (2.1f)	Understand the importance of the exact copying of chromosomes before cell division. Understand the principles of DNA replication **[Full names of bases are not required]** Understand how mitosis produces identical cells. Know that cells divide by mitosis to increase the number of cells when an organism grows. Understand the importance of halving the chromosome number in the formation of gametes. Understand how meiosis produces gametes with half the number of chromosomes.	**H** **H** **H** **H** **H** **H**
that sexual reproduction is a source of genetic variation whilst asexual reproduction produces clones. (2.4b)	Know that there are variations between individuals and that some of this variation is inherited. Be able to describe examples of continuous and discontinuous variation. Know that sexual reproduction involves gamete formation and fertilisation.	

	Understand how the random combination of chromosomes in meiosis creates genetic variation amongst the gametes **[Crossing over is not required].** Understand that random fusion of gametes gives rise to variation in offspring. Know that some plants reproduce asexually eg by bulbs, stem tubers and runners. Understand that in asexual reproduction mitosis produces identical offspring (clones).	**H**
the basic principles of cloning. (2.4h [part only])	Know how plants can be propagated by cuttings of shoots to produce clones. Understand the principles of micropropagation for the commercial production of plants and the economic and biological advantages.	 **H**
that mutation is a source of genetic variation and has a number of causes. (2.4c)	Know that chromosomes are not always copied exactly and that this leads to mutations. Know that ionising radiation and some chemicals may increase the probability of random gene mutation. Know the cause of Down's syndrome in humans.	
that some diseases can be inherited. (2.4f)	Know that some diseases including sickle cell anaemia, cystic fibrosis, muscular dystrophy and haemophilia are genetic in origin and can be inherited.	
how variation may arise from both genetic and environmental causes. (2.4a)	Know that some human characteristics including birthweight, height, skin colour, hair colour and hair type are largely genetically determined but can be modified by the environment. Know that environmental conditions can modify the appearance of plants.	
how gender is determined in humans. (2.4d)	Understand how the inheritance of X and Y chromosomes results in male and female offspring.	
the mechanism of monohybrid inheritance where there are dominant and recessive alleles. (2.4e)	Be able to explain monohybrid crosses including reference to the terms gene, allele, dominant, recessive, phenotype, genotype, homozygous, heterozygous, parental, F1 and F2 generations. Be able to demonstrate the expected outcome of a monohybrid cross using a checkerboard diagram, appreciating that these diagrams indicate probabilities only. Understand how 3:1 and 1:1 phenotypic ratios are produced in the offspring of a cross. Understand sex-linked inheritance, eg red-green colour deficiency.	**H** **H** **H** **H**

the basic principles of selective breeding. (2.4h [part only])	Know examples of selective breeding in animals and plants eg dogs for appearance and behaviour, and plants for yield, flavour and disease resistance. Understand that selective breeding involves selecting the parents with desirable traits, crossing them, selecting from their offspring and repeating the process over several generations.	**H**
how variation and selection may lead to evolution or extinction. (2.4j)	Understand the principles of natural selection	**H**
	Understand how natural selection can lead to particular alleles becoming more common or less common.	**H**
	Understand Darwin's four observations leading to the theory of evolution.	**H**
	• all organisms potentially over reproduce	**H**
	• population numbers tend to remain fairly constant over long periods of time	**H**
	• organisms demonstrate variation	**H**
	• some of the variations are inherited	**H**
	Understand that natural selection occurs within species, to include the peppered moth, and that over many generations this may lead to evolution.	**H**
	Understand that failure to adapt to a changing environment may result in extinction.	**H**
	Understand that organisms have adapted to new environments over long periods of time.	**H**
the fossil record as evidence for evolution. (2.4i)	Know how organisms may have become fossilised. Know that fossils provide evidence for evolution and that the fossil record is incomplete.	

Sc2 Teaching Block 10: *Living Things in their Environment*		
Candidates should be taught: (National Curriculum Reference)	**Learning Outcomes**	**H**
how keys can be used to identify animals and plants. (KS3)	Be able to use a key to identify major plant and animal groups. Be able to construct a workable dichotomous key based on observable features of a group of several different plants or animals.	
how the distribution and relative abundance of organisms in a habitat can be explained in terms of adaptation, competition and predation. (2.5a)	Understand how environmental factors affect the distribution of plants or algae. Understand how predators are adapted to catch prey and how prey animals are adapted to avoid predators. Understand how plants compete for light and water and how they deter herbivores by toxins, stings and spines etc. Understand how the features of a polar bear adapt it to life in a very cold climate and how the features of a camel adapt it to life in an arid climate.	 **H**
how the impact of human activity on the environment is related to population size, economic factors and industrial requirements. (2.5b)	Be able to discuss the consequences of the introduction of a new species into an ecosystem, to include grey squirrels in Britain and rabbits in Australia. Understand how humans bring about rapid environmental changes to include acid rain, the greenhouse effect, depletion of tropical rainforests, and the possible consequences for other organisms. Be able to discuss the advantages and disadvantages of using pesticides.	**H** **H**

Sc3 Teaching Block 1: *Introducing Chemistry*

Candidates should be taught: (National Curriculum Reference)	**Learning Outcomes**	**H**
Symbols and Equations Throughout all Sc3 Teaching Blocks candidates should be taught ... to represent chemical reactions by word equations. (3.2r) to represent reactions, including electrolytic reactions, by balanced equations using chemical symbols. (3.2s)	Be able to represent chemical reactions by word equations that show all reactants and products. Be able to represent simple reactions, where appropriate, by balanced chemical equations using symbols. Be able to represent chemical reactions, including electrolytic reactions where appropriate, with balanced chemical and ionic equations using chemical symbols.	 H
Acids that pH is a measure of the acidity of a solution. (KS3)	Understand how solutions can be classified as acidic, neutral or basic by using indicators. Be able to use and interpret the pH scale.	
the reactions of acids with metals and bases, including carbonates, to form salts. (KS3)	Know that acids are a group of compounds that have characteristic properties, to include • effect on indicators • reaction with carbonates • reaction with metals such as magnesium and zinc • reaction with bases to form salts and water only. Understand the tests for hydrogen and carbon dioxide.	
Mixtures about methods, including filtration, distillation and chromatography, that can be used to separate mixtures into their constituents. (KS3)	Understand that common mixtures including air and seawater contain constituents which are not combined. Be able to describe the processes of filtration, distillation, chromatography and crystallisation. Know how to separate mixtures and understand that the method chosen will depend on the different physical properties of the substances in the mixture.	
that crude oil is a mixture of substances, most of which are hydrocarbons, which can be separated by fractional distillation. (3.2b)	Know that crude oil is a mixture of substances, most of which are hydrocarbons. Know that these hydrocarbons have different boiling points and contain different numbers of carbon and hydrogen atoms. Know that fractional distillation can be used to separate the components of crude oil.	

Combustion the use as fuels of some of the products from crude oil distillation.(3.2c)	Know that energy is transferred when hydrocarbons burn. Know that most of the fractions from crude oil can be used as fuels for different purposes, or as raw materials for other purposes.	
the products of burning hydrocarbons. (3.2d)	Know that the products from the complete combustion of hydrocarbons are carbon dioxide and water. Know that the products from the incomplete combustion of hydrocarbons include carbon monoxide. Understand the relation between burning fossil fuels, including incomplete combustion, atmospheric pollution and the possible effect on global warming.	
Particles to recognise differences between solids, liquids and gases in terms of properties. (KS3) *that solids, liquids and gases are all composed of particles. (3.1a)*	Understand and be able to use the particle model to explain the properties of solids, liquids and gases (to include density, compressibility, ease of flow, maintenance of shape and volume) and change of state (to include the energy transfer involved).	
that elements consist of atoms and that all atoms of the same element contain the same number of protons. (KS3)	Know that elements consist of atoms and that all atoms of the same element contain the same number of protons.	
Reactions *that new substances are formed when atoms combine. (3.1g)*	Know that compounds have properties different from the elements from which they are made. Know that compounds contain more than one kind of atom joined together.	
that changes of temperature often accompany reactions. (3.3u)	Understand that chemical reactions may be accompanied by an energy change which, in solution, may be detected as a temperature change.	
that reactions can be exothermic or endothermic. (3.3v)	Understand the terms exothermic and endothermic.	

Sc3 Teaching Block 2: *Metals and the Reactivity Series*

Candidates should be taught: (National Curriculum Reference)	**Learning Outcomes**	**H**
Metals *the reactions of metals with oxygen, water and acids. (KS3)* *how a reactivity series can be determined by considering displacement reactions. (KS3)*	*Know the characteristic reactions of metals with* • *oxygen to form oxides* • *water to form hydrogen and oxides/hydroxides* • *acids to form hydrogen and salts.* *Be able to use evidence from competition/displacement reactions to set up a reactivity series.* *Be able to compare the reactivity of metals, hydrogen and carbon using competition reactions for oxygen.* *Be able to predict reactions using a reactivity series.*	
Extraction of metals *that metal ores are found in the Earth. (3.2j)*	*Know that metal ores are rocks containing minerals (metal compounds), or (more rarely) metals in economic amounts for the extraction of the metal.* *Be able to give examples to show that economic, social and environmental issues may be involved when minerals are mined.*	
that the way in which a particular metal is extracted from its ores is related to its reactivity.(3.2k)	*Understand that extracting a metal usually involves a chemical reaction by which the metal is separated from the other elements in the mineral.* *Know the two common methods of extraction of metals from their ores: chemical reduction (usually by carbon or carbon monoxide) or electrolysis.* *Be able to suggest possible methods of extraction of a metal from its ore given the position in the reactivity series.*	
an example of how a less reactive metal can be extracted by reduction with carbon or carbon monoxide. (3.2m) *an example of how a reactive metal can be extracted by electrolysis.(3.2l)* *an example of how a metal can be purified by electrolysis. (3.2n)*	*Be able to outline the chemical processes involved in the extraction of iron .* *Be able to describe the main reactions in a blast furnace.* *Be able to describe and explain the extraction of aluminium including the use of cryolite.* *Be able to describe and explain the purification of copper by electrolysis.*	

Properties of metals *similarities between transition metals. (3.3j [part])* *some uses of transition metals. (3.3k)*	*Know the characteristic physical and chemical properties of the typical transition metals based on a study of iron, nickel and copper (elements only).* *Be able to relate the uses of typical transition metals to their properties. Recall of specific knowledge of important uses will be limited to iron, nickel and copper.*	

Sc3 Teaching Block 3: *Periodic Table and Atomic Structure*		
Candidates should be taught: (National Curriculum Reference)	**Learning Outcomes**	**H**
that the Periodic Table shows all elements arranged in order of ascending atomic number. (3.3a)	Know that elements can be divided into metals and non-metals. Know the typical features which distinguish metals from non-metals. Understand that many elements, such as the alkali metals and the halogens, can be grouped into families based on chemical and physical properties. Understand the importance of atomic mass in the development of the Periodic Table. Know that the Periodic Table shows all of the elements arranged in increasing atomic number. Know that the vertical columns of elements are called groups and that the horizontal rows of elements are called periods.	
that elements in the same group of the Periodic Table have similar properties. (3.3c)	Know that elements in the same vertical group have similar properties.	
the properties and reactions of the alkali metals. (3.3f)	Know that the elements in Group I are called the alkali metals. Know the characteristic physical properties, to include low density, appearance when freshly cut and the trends in hardness and melting point. Recognise some of the hazards involved in the use of the alkali metals and be able to suggest the action which should be taken to minimise the hazard. Know the reactions of the alkali metals with water. Be able to predict further properties of the alkali metals based on the knowledge above.	**H**
the properties, reactions and uses of simple compounds of the alkali metals. (3.3g)	Know the general appearance, stability and solubility in water of alkali metal compounds. Know the common uses of sodium chloride, sodium carbonate, sodium hydrogencarbonate and sodium hydroxide to include soap, bleaches and the chlor-alkali industry.	
the properties, reactions and uses of the halogens. (3.3h)	Know that the elements in Group VII, the halogens, are all non-metals and that there are trends in colour, state, melting point and boiling point. Know that the halogens react with metals to form salts and be able to recall the trend in reactivity. Know that a more reactive halogen will displace a less reactive one from its compounds.	**H**

	Know about the uses of chlorine, to include its use as a bleach, in purifying drinking water, in swimming pools and in insecticides. Recognise some of the hazards involved in the use of the halogens and be able to suggest the action which should be taken to minimise the hazard. Be able to predict properties of the other halogens based on the knowledge above.	**H**
the properties, reactions and uses of simple compounds of the halogens. (3.3i)	Know the appearance, solubility in water, and reaction with aqueous silver nitrate of the halides (exemplified by sodium chloride, bromide and iodide). Know that hydrogen chloride is a colourless gas with a simple molecular structure that dissolves in water to form hydrochloric acid. Know that hydrogen halides are colourless gases that dissolve easily in water to form strongly acidic solutions.	
the properties and uses of the noble gases. (3.3e)	Know that the Group 0 elements, the noble gases, are all colourless and very unreactive but do show trends in density and boiling point. Know about their uses in balloons, gas discharge tubes, lasers and where an inert atmosphere is required.	
that there is a gradual change in the properties of the elements from the top to the bottom of a group. (3.3d)	Know that within each group of elements there is a gradual change in properties of the elements with increasing atomic number. Understand this trend in terms of a comparison of the properties of elements in Groups I, VII and 0.	**H**
the characteristic properties of the transition metal compounds. (3.3j [part])	*Know the position of the transition metals in the Periodic Table.* *Know that transition metals form a range of brightly coloured compounds and that the colour is due to the transition metal ion they contain.* *Know that transition metals often have more than one simple ion (eg Fe^{2+} and Fe^{3+}) and that these may have different colours.*	**H**
that atoms consist of nuclei and electrons. (3.1b)	Know that atoms consist of a central nucleus composed of protons and neutrons, surrounded by electrons.	
the charges and relative masses of protons, neutrons and electrons. (3.1c)	*Know the charge and relative mass of a proton, a neutron and an electron.*	

about mass number, atomic number and isotopes. (3.1d)	*Know that all atoms of a particular element have the same number of protons in their nuclei which is the same as the atomic number of the element.* *Know that in a neutral atom the number of electrons is the same as the number of protons.* *Understand why isotopes of an element have the same atomic number but differing atomic mass numbers.*	
about a model of the way electrons are arranged in atoms. (3.1e) the connection between the arrangement of outer electrons and the position of an element in the Periodic Table. (3.3b)	Understand how electrons are arranged in shells around the nucleus. Be able to represent the electronic structures of elements 1 to 20. Understand the connection between the arrangement of the outer electrons of an element and its position on the Periodic Table.	**H** **H**

Sc3 Teaching Block 4: *Geological Changes*		
Candidates should be taught: (National Curriculum Reference)	**Learning Outcomes**	**H**
how rocks are weathered by expansion and contraction, and by the freezing of water. (KS3) *that the rock cycle involves sedimentary, metamorphic and igneous processes that take place over different timescales. (KS3)*	*Know the two main ways (exfoliation and freeze-thaw weathering) in which rocks undergo physical weathering.* *Be able to place geological changes in the context of the rock cycle as a whole.* *Be able to describe the structure of the Earth using the terms, core, mantle, crust and atmosphere.*	
that a variety of useful substances can be made from rocks and minerals. (3.2o)	*Know that the Earth's crust, seas and atmosphere are the source of all raw materials from which all manufactured materials are ultimately derived.* *Be able to consider, evaluate and discuss environmental issues from the exploitation of mineral resources.*	
how igneous rocks are formed by the cooling of magma. (3.2x [part only])	*Know that igneous rocks are formed by the cooling and solidifying of hot molten material called magma.* *Recognise the interlocking crystal texture of an igneous rock formed by cooling of magma to give a mixture of different minerals, and that the size of the crystals is related to the rate of cooling.* *Recognise granite as a typical intrusive igneous rock formed from a high viscosity magma that has cooled slowly at depth to give large crystals of mainly light coloured minerals.* *Recognise basalt as a typical extrusive igneous rock formed from a low viscosity magma that has cooled more rapidly at or near the surface to give small crystals of mainly dark coloured minerals.*	**H** **H**

how sedimentary rocks are formed by the deposition and consolidation of sediments. *(3.2x [part only])*	*Know that most sedimentary rocks are formed by the deposition under gravity of eroded rocks which are then buried deeply where they undergo consolidation into new rock helped by cementation and from percolating solutions.* *Understand the role of wind and water in the sorting and shaping of these fragments.* *Know that other sedimentary rocks, such as limestone and salt deposits, are formed by physical, chemical and/or biological processes which result in the formation of sediments by precipitation or crystallisation from water.* *Recognise the texture of most sedimentary rocks as fragments bound together by cementing material.* *Understand how the size, shape, arrangements and composition of the fragments (including any fossils) and cementing materials in the rock gives evidence for the environment of deposition.* *Recognise typical examples of fragmentary sedimentary rocks such as conglomerate, sandstone and shale, and typical examples of limestone (including chalk).*	**H** **H**
how metamorphic rocks are formed by the action of heat and pressure on existing rocks. (3.2x[part only])	*Know that metamorphic rocks are formed when pre-existing rocks are subjected to high temperatures or pressures.* *Know that the composition of the pre-existing rock affects the nature of the metamorphic rock derived from it.* *Recognise typical examples of metamorphic rocks such as slate, marble, schist and gneiss.* *Interpret folding and faulting in rocks in terms of the magnitude and direction of the forces involved.*	**H** **H**

Sc3 Teaching Block 5: *Rates of Reaction*

Candidates should be taught: (National Curriculum Reference)	**Learning Outcomes**	**H**
that there is a great variation in the rates at which different reactions take place. (3.3l)	Recall simple examples of chemical reactions that proceed at a variety of rates, such as rusting, metals with acids, and explosions.	
how the rates of reaction can be altered by varying temperature or concentration, or by changing the surface area of a solid reactant, or by adding a catalyst. (3.3m)	Understand how the progress of a reaction is followed by the rate of formation of product or by rate of disappearance of reactant. Know how the rate of a reaction depends on the temperature, the concentration of reactants in solution, and on the size of solid particles. Know that manganese(IV) oxide acts as a catalyst in the decomposition of hydrogen peroxide. Be able to recall the test for oxygen. Be able to plot and interpret graphs involving rates of formation of products or consumption of reactants. Know that a catalyst affects the rate, but is not used up. Know that different reactions need different catalysts. *Be able to recall the uses of transition metals as catalysts including iron in the Haber process.*	
that reactions can occur when particles collide. (3.3n)	Understand that changing the concentration, temperature and size of solid pieces affects the rate of particle collision, and can affect the rate of reaction.	
that increasing frequency of collisions increases rates. (3.3o [part])	Understand that solid catalysts bring reactants together in a particular way eg on their surface.	**H**
rates can be increased by increasing energy of collision between particles. (3.3o [part])	Understand that for reactions to occur some particles need to have enough energy to break bonds.	**H**
	Know that more particles have this energy as the temperature is increased **[Activation energy is not required].**	**H**

the use of enzymes in the baking, brewing and dairy industries. (3.3q)	*Know that enzymes are catalysts produced by living things.* *Know that a specific enzyme is required for a particular reaction eg in apple browning.* *Be able to describe the use of enzymes in* • *baking* • *brewing - including the word equation for fermentation* • *the dairy industry with reference to cheese and yoghurt making.*	
how rates of enzyme-catalysed reactions vary with temperature. (3.3p)	*Know how enzyme activity varies with temperature.* *Know everyday practical applications in food preservation to include freezing, refrigeration and cooking.*	

Sc3 Teaching Block 6: *Structure, Bonding and the Mole*

Candidates should be taught: (National Curriculum Reference)	**Learning Outcomes**	**H**
the physical properties of some substances with giant structures and some with simple molecular structures. (3.1m)	*Be able to use the terms giant structure and molecular structure.*	
	Understand that substances with giant structures have high melting points and boiling points.	
	Understand that substances with molecular structures have low melting points and boiling points.	
	Understand that a solid with a giant structure is based on a closely packed lattice of particles with strong forces between them.	**H**
	Understand that there are three types of strong forces between particles: metallic, covalent and ionic.	**H**
	Understand that a substance with a molecular structure is based on particles with relatively weak forces between them.	**H**
that chemical bonding can be explained in terms of the transfer or sharing of electrons (3.1h)	*Know that the forces which hold atoms together in giant structures and molecules are called chemical bonds.*	
	Understand that chemical bonds result from the balance of electrical forces between charged particles of which atoms are made.	
	Understand how cations are formed by loss of electrons from the outer electron shells in Groups I and II.	
how ions are formed when atoms gain or lose electrons. (3.1i)	*Understand how anions are formed to complete the outer electron shells of elements in Groups VI and VII.*	
	Be aware that the chemical properties of the elements depend on the number of electrons in their outer shells.	
	Be able to explain the similarity of the reactions of elements in the same group in terms of the number of electrons in the outer shell of the atoms.	
that the reactions of elements depend on the arrangement of electrons in their atoms (3.1f)	*Understand how elements in Groups I and II react with elements in Groups VI and VII to form ionic compounds.*	

	Be able to explain the formation of an ionic compound such as NaCl by electron transfer.	
that ionic lattices are held together by attraction between oppositely charged ions. (3.1j)	*Understand the structural model for ionic compounds as a giant structure of oppositely charged ions which results in the typical properties of a giant structure.* *Know that the structure is held together by strong forces.*	**H**
that covalent bonds are formed when atoms share electrons. (3.1k) *that substances with covalent bonds may form simple molecular structures or giant structures. (3.1l)*	*Understand how elements such as hydrogen, carbon, nitrogen, oxygen, sulphur and the halogens form molecules by the sharing of electrons.* *Know that covalent and ionic bonds are both strong.* *Understand that forces between simple molecules are relatively weak and account for the low melting and boiling temperatures of these substances.* *Understand that the physical properties of substances with giant covalent structures are due to strong bonds throughout the structure.*	**H** **H** **H** **H**
to use chemical equations to predict reacting quantities. (3.2t)	*Be able to calculate the formula mass of a substance, given atomic masses.* *Be able to calculate reacting quantities from equations .* *Understand that in practice 100% yield may not be obtained.*	 **H** **H**
to determine the formulae of simple compounds from reacting masses. (3.2u)	*Understand that the formula of a compound has to be determined by experiment.* *Know the definition of the mole.* *Understand how the formula of a simple compound, such as magnesium oxide, may be found experimentally by determining reacting masses and calculating mole ratios.*	**H** **H** **H**

that the making and breaking of chemical bonds in chemical reactions involves energy transfers. (3.3w)	Be able to represent exothermic and endothermic reactions by energy level diagrams.	
	Know that a particular energy value can be associated with a particular bond.	H
	Understand that bond breaking is an endothermic process and that bond making is exothermic process.	H
	Be able to calculate the energy transfer in a reaction by a consideration of bonds made and broken.	H

Sc3 Teaching Block 7: *Oil*

Candidates should be taught: (National Curriculum Reference)	**Learning Outcomes**	**H**
how oil deposits are formed. (3.2a)	Understand the sequence of events necessary for the formation of oil (organic source material, deposition in an oxygen-free environment, burial in sediments at sufficient depth to give the right temperature [90 °C - 120 °C] to convert into oil, migration to permeable reservoir rocks, formation of oil traps).	
that there are different groups of hydrocarbons. (3.2e)	Know that hydrocarbons may be classified into groups which include the alkanes, and the alkenes. Be able to recognise alkanes and alkenes given their chemical formulae, or from displayed formulae, and be able to explain differences in their reactions in terms of the differences in their structures.	
that alkanes are saturated hydrocarbons, and alkenes are unsaturated hydrocarbons containing one double covalent bond between carbon atoms. (3.2f)	Know how to distinguish alkenes (as unsaturated hydrocarbons) from alkanes (as saturated hydrocarbons) using addition reactions with aqueous bromine. Understand that the characteristic properties of unsaturated hydrocarbons result from the presence of carbon-carbon double covalent bonds.	**H** **H**
that hydrocarbon molecules can be cracked to form smaller molecules, including alkenes. (3.2g)	Know how larger hydrocarbon molecules may be cracked by the use of a hot catalyst to yield smaller hydrocarbon molecules and hydrogen. Know that the cracking of hydrocarbon molecules yields alkenes. Be able to interpret cracking reactions in terms of simple graphical (displayed) formulae.	 **H** **H**
that addition polymers can be made from alkenes formed during cracking. (3.2h)	Know that small alkene monomer molecules can react with themselves under suitable conditions to produce long chain addition polymer molecules. Be able to interpret polymerisation reactions in terms of simple graphical (displayed) formulae.	**H** **H**
some uses of addition polymers. (3.2i)	Know that the uses of different polymers are related to their structure and properties. Understand that the variety of possible small alkene monomer molecules leads to a variety of different polymers with differing properties.	 **H**

Sc3 Teaching Block 8: *Earth Cycles*

Candidates should be taught: (National Curriculum Reference)	**Learning Outcomes**	**H**
how the sequence of, and the evidence for, these processes [..the formation of igneous, sedimentary and metamorphic rocks.....] is obtained from the rock record. (3.2y)	*Use knowledge and understanding of the processes in the rock cycle to interpret examples from the rock record by deducing details and sequence of the events.* *Understand how patterns from the rock record and the Earth's surface features provide evidence for continental drift, sea-floor spreading and hence for the theory of plate tectonics.*	
how plate tectonic processes are involved in the formation, deformation and recycling of rocks. (3.2z)	*Understand how plate tectonic processes are involved in the formation, deformation and recycling of rocks.* *Use scientific knowledge and understanding to evaluate and discuss environmental and social issues arising from earthquakes.*	**H**
how the atmosphere and oceans evolved to their present composition. (3.2v)	*Know that the present atmosphere consists of approximately four fifths nitrogen and one fifth oxygen with traces of other gases including the noble gases and carbon dioxide.* *Understand the major roles played in the development of the atmosphere to its present composition by volcanic activity, the evolution of photosynthesising organisms on land and in the sea and the weathering of rocks containing iron compounds.* *Understand that the composition of the oceans depends on the balance between input of dissolved salts in river water from the weathering of rocks, and the removal of dissolved salts by processes that include shell-formation by marine organisms, chemical reactions to form sea-floor sediments, and crystallisation to form salt deposits.*	**H**
how the carbon cycle helps to maintain atmospheric composition. (3.2w) *[Teachers should be aware that the carbon cycle also forms part of Sc2 Teaching Block 8. Ref to 2.5c]*	*Understand that the amount of carbon dioxide in the atmosphere depends on the rates at which carbon dioxide is* • *removed by processes such as photosynthesis* • *added by processes such as combustion and respiration.* *Be able to explain that an increase in the burning of fossil fuels may lead to a steady increase in the amount of carbon dioxide in the atmosphere.*	

	Be able to explain why the continued burning of fossil fuels may increase global warming. *Be able to explain how the amount of carbon dioxide in the atmosphere depends on a balance between carbon dioxide removed and carbon dioxide added.*	**H**

Sc3 Teaching Block 9: *Equilibria and Industrial Processes*

Candidates should be taught: (National Curriculum Reference)	**Learning Outcomes**	**H**
that some reactions are reversible. (3.3r)	*Know that some reactions are significantly reversible and may reach an equilibrium.* *Know that the reaction between hydrogen and nitrogen to form ammonia is a reversible reaction and is the basis of the Haber process.* *Be able to use the equilibrium notation.*	 **H**
how the yield of products from reversible reactions depends on the conditions. (3.3s)	*Understand in simple qualitative terms how removing the product or increasing the pressure affects the position of equilibrium.* ***[Le Chatelier's Principle is not required, and the effect of temperature will not be assessed].***	**H**
that some manufacturing processes are based on reversible reactions. (3.3t)	*Be able to interpret data about manufacturing processes based on reversible reactions and the need for maximum economic yield of product.* *Understand the role of catalysts in manufacturing processes including those based on reversible reactions.*	**H** **H**
how nitrogen can be converted into ammonia in industry. (3.2p)	*Understand how nitrogen from air and hydrogen from the cracking of oil are obtained and used in the manufacture of ammonia.* *Understand that industrial manufacturing processes often involve a compromise between several factors.*	 **H**
how nitrogenous fertilisers are manufactured and their effects on plant growth and the environment. (3.2q)	*Know the use of ammonia to produce nitric acid and ammonium salts, and the uses of these in the making of fertilisers.* *Understand that nitrogenous fertilisers are used to promote plant growth and the environmental problems associated with their use eg water pollution.* *Understand that nitrogenous fertilisers can cause eutrophication.*	

Sc4 Teaching Block 1: *Electric Circuits*

Candidates should be taught: (National Curriculum Reference)	**Learning Outcomes**	**H**
how to measure current in series and parallel circuits. (4.1a)	Be able to position an ammeter in a circuit to measure a current. Understand that the current is the same in all parts of a series circuit. Understand that, in a parallel circuit, the current into a junction equals the current out of the junction. Know the electrical symbols for a cell, power supply, filament lamp, switch, LDR, fixed and variable resistor, LED, motor, heater, ammeter and voltmeter. Be able to draw and interpret simple circuit diagrams for series and parallel circuits containing no more than three parallel branches.	
that energy is transferred from batteries and other sources to other components in electrical circuits. (4.1b) that resistors are heated when charge flows through them. (4.1c)	Understand that energy is transferred to make things happen in a complete electrical circuit. Be able to identify solar cells, batteries, cells and generators as electrical sources, and lamps, resistors, bells, motors, LEDs and buzzers as parts of an electrical circuit where electrical energy is dissipated. Know that resistors are heated when electric current flows through them.	
the qualitative effect of changing resistance on the current in a circuit. (4.1d)	Describe and explain the effect of a variable resistor in controlling the brightness of a lamp and the speed of a motor.	
how to make simple measurements of voltage. (4.1e)	Be able to position a voltmeter in a circuit to measure a voltage. Know that the voltage is the same across components in parallel.	
the quantitative relationship between resistance, voltage and current. (4.1f)	Be able to measure resistance using a voltmeter and an ammeter. Know and be able to use V = I x R	

how current varies with voltage in a range of devices, including resistors, filament bulbs, diodes, light-dependent resistors (LDRs) and thermistors. (4.1g)	Know how current varies with voltage in a metal wire at constant temperature, a filament lamp and a silicon diode.	
	Know how the resistance of an LDR varies with light level.	**H**
	Know how the resistance of a thermistor (ntc only) varies with temperature.	**H**

Sc4 Teaching Block 2: *Energy Transfer*		
Candidates should be taught: (National Curriculum Reference)	**Learning Outcomes**	**H**
that differences in temperature can lead to transfer of energy. (4.5a) that insulation can reduce transfer of energy from hotter to colder objects, and how insulation is used in domestic contexts. (4.5d)	Know that a change in temperature may be caused by energy transfer. Know that energy can be transferred by conduction and convection. Understand that domestic insulation reduces energy transfer by conduction and convection.	
how energy is transferred by the movement of particles in conduction, convection and evaporation. (4.5b)	Understand that convection currents involve a movement of fluid due to differences in density. Be able to use a particle model to describe energy transfer by conduction. Understand the role of free electrons in conduction in metals. Know that objects containing a liquid can transfer energy by evaporation. Be able to use a particle model to describe energy transfer by evaporation.	**H**
how energy is transferred by radiation. (4.5c)	Know that all everyday objects radiate energy. Understand that radiated energy is in the form of electromagnetic waves. Understand that the power radiated depends on the temperature. Be able to describe how the emission and absorption of radiated energy depends on the nature of the surface. Understand how the transfer of radiated energy can be maximised or minimised.	**H**

the meaning of energy efficiency and the need for economical use of energy resources. (4.5e)	Understand the meaning of energy efficiency in the context of heating buildings and the measurement and performance of machines. Be able to use: energy efficiency = $\frac{\text{useful energy output}}{\text{total energy input}}$ Be able to use data on energy efficiency measures to evaluate cost-effectiveness of different approaches. Appreciate how LDRs and thermistors can be used with electrical circuits to monitor light levels and temperature in a building. Understand the effect on energy resources of the efficient use of those resources, considering pollution and running costs.	

Sc4 Teaching Block 3: *Forces*		
Candidates should be taught: (National Curriculum Reference)	**Learning Outcomes**	**H**
Forces and materials how extension varies with applied force for a range of materials. (4.2j)	Be able to describe the behaviour of a helical spring, copper wire and a rubber band when subjected to an increasing stretching force. Understand the difference between elastic and inelastic behaviour.	
the quantitative relationship between the force acting normally per unit area on a surface and the pressure on that surface. (KS3) some applications of this relationship. (KS3)	Know and be able to use $\text{pressure} = \frac{\text{force}}{\text{area}}$ Be able to describe **one** situation where a force is applied over a small area to create a large pressure and **one** situation where a force is applied over a large area to reduce the pressure.	
how liquids behave under pressure, including simple everyday applications of hydraulics. (4.2k)	*Know that liquids transmit pressure equally in all directions and understand how this enables force to be multiplied.* *Be able to apply pressure = force / area to simple hydraulic machines to include a car braking system.*	
how the volume of a fixed mass of gas at constant temperature is related to pressure. (4.2l)	*Understand that when the volume of a gas is reduced, its pressure increases.* *Be able to explain this using a molecular model.* *Be able to use:* $pV = \text{constant}$	**H** **H**
the principle of moments and its application to situations involving one pivot. (KS3)	Understand that the turning effect of a force depends on the size of the force and the perpendicular distance from the point of application to the pivot. Be able to use: moment of a force = force x perpendicular distance to pivot Be able to use for a balanced system: sum of clockwise moments = sum of anticlockwise moments	

Forces and Energy *the quantitative relationship between force and work. (4.5f)*	*Know and be able to use:* *work done = force x distance moved in its own direction*	
to calculate power in terms of the rate of working or of transferring energy. (4.5g)	*Be able to use:* *power = work done (or energy transfer) / time taken*	
the quantitative links between kinetic energy, potential energy and work. (4.5h)	*Be able to use:* *change in gravitational potential energy = mass x gravitational field strength x height moved* *Be able to use:* $kinetic\ energy = \frac{1}{2}mv^2$ *Know and be able to use:* *energy transferred = work done*	**H** **H** **H**
Force and motion the quantitative relationship between speed, distance and time. (KS3) how distance, time and speed can be determined and represented graphically. (4.2a)	Know and be able to use: $speed = \frac{distance}{time\ taken}$ Be able to plot and interpret distance-time graphs. Understand how to calculate speed from a distance-time graph. Be able to plot and interpret speed-time graphs. Understand how to calculate distance travelled from a speed-time graph.	
about factors affecting vehicle stopping distances. (4.2b)	*Know how braking distance is affected by the road surface, the mass and speed of the vehicle.* *Be able to describe factors that affect the "thinking distance".* *Understand that stopping distance is the sum of the thinking distance and the braking distance.* *Be able to use the equation:* $energy\ transferred = force \times distance = \frac{1}{2}mv^2$ *to discuss stopping distances*	**H**
the difference between speed and velocity. (4.2c)	*Know that velocity describes the speed and direction of a moving object.* *Be able to calculate velocity from a displacement-time graph.*	

about acceleration as change in velocity per unit time. (4.2d)	*Know and be able to use:* $\text{acceleration} = \frac{\text{change in velocity}}{\text{time taken}}$ *Be able to calculate acceleration from a velocity-time graph.*	
that balanced forces do not alter the velocity of a moving object. (4.2e)	*Be able to describe the relative sizes of the horizontal forces on an object moving in a straight line when it is accelerating, decelerating and moving at constant speed.*	
the quantitative relationship between force, mass and acceleration. (4.2f)	*Know and be able to use:* *force = mass x acceleration* *Be able to apply this relationship to the action of seat-belts and crumple zones.*	**H** **H**
that when two bodies interact, the forces they exert on each other are equal and opposite. (4.2g)	*Know that forces act between objects.* *Understand that when object A pulls or pushes object B then object B pulls or pushes object A with an equal-sized force in the opposite direction.*	
the forces acting on falling objects. (4.2h)	Be able to describe the effects of the Earth's pull and resistive forces due to motion in a fluid. Be able to use: weight = mass x gravitational field strength	
why falling objects reach a terminal velocity. (4.2i)	Understand that the size of the resistive force depends on the speed of the object. Know that the forces acting on an object falling at terminal velocity are balanced.	

Sc4 Teaching Block 4: *Waves Properties*		
Candidates should be taught: (National Curriculum Reference)	**Learning Outcomes**	**H**
that waves transfer energy without transferring matter. (4.3g)	*Understand that the energy of a sound wave can cause objects, including the ear drum to vibrate.* *Understand the effects of absorbing electromagnetic waves: heating, ionisation and damage to cells and tissue.*	
about longitudinal and transverse waves in ropes, springs and water. (4.3c)	*Understand that wave motion involves an oscillation.* *Be able to describe the differences between a transverse and a longitudinal wave and give one example of each.*	
the meaning of frequency, wavelength and amplitude of a wave. (4.3e)	Know the meaning of frequency, wavelength and amplitude. Be able to identify the wavelength and amplitude of a transverse wave. Know the effect on the loudness of a sound when the amplitude is changed. Know the effect on the pitch of a sound when the frequency is changed.	
the quantitative relationship between the speed, frequency and wavelength of a wave. (4.3f)	*Know and be able to use:* *wave speed = frequency x wavelength*	**H**

that waves can be reflected, refracted *and diffracted.* (4.3d)	*Know that echoes are caused by the reflection of sound.*	
	Know how objects can be seen by the reflection of light.	
	Know that light is reflected at equal angles by a mirror (a smooth and shiny surface), but that light is reflected at all angles by a sheet of paper (an uneven surface).	
	Understand how virtual images are produced by the reflection of light by a plane mirror.	
	Know the properties of images in a plane mirror - virtual, same size, as far behind the mirror as the object is in front.	
	Know that refraction involves the change in speed of a wave.	
	Understand how changing the speed of a wave causes a change in wavelength and that this may cause a change in direction.	
	Understand how virtual images are caused by the refraction of light.	
that light *and sound* can be reflected, refracted *and diffracted.* (4.3a)	Know that water waves can be reflected at a plane barrier and that the angle of incidence equals the angle of reflection.	
	Understand how plane waves are reflected at a concave barrier, and circular ripples are reflected at a plane barrier.	**H**
	Know that water waves can be refracted if they are slowed down.	
	Know that water waves can spread out at a narrow gap and that this is know as diffraction.	**H**
	Understand how the amount of spreading depends on the size of the gap compared to the wavelength of the wave.	**H**
	Know that light can be diffracted but needs a very small gap as the wavelength of light is very small.	**H**
	Understand that the diffraction of light is evidence for the wave nature of light.	**H**
	Know that sound can be diffracted.	**H**
	Understand that the amount of diffraction of sound depends on the size of the sound source and the wavelength of the sound.	**H**

Sc4 Teaching Block 5: *Using Waves*

Candidates should be taught: (National Curriculum Reference)	**Learning Outcomes**	**H**
the conditions for total internal reflection and its use in optical fibres. (4.3b)	*Be able to describe what happens to light incident on a perspex/glass - air surface, both above and below the critical angle of incidence.*	
	Be able to describe how light is reflected at the inner face of a right-angled prism.	
	Understand how optical fibres are used in endoscopy.	
	Understand that optical fibres allow the rapid transmission of data using digital signals.	**H**
about sound and ultrasound waves and some medical and other uses of ultrasound. (4.3l)	*Know that ultrasound is a high-frequency longitudinal wave.*	
	Understand how distances can be measured using echo-sounding.	
	Understand that the reflection of ultrasound by body tissue enables organs to be scanned.	
	Be able to describe how ultrasound is used for pre-natal scanning.	
	Be able to describe one non-medical use of ultrasound.	**H**
that longitudinal waves and transverse waves are transmitted through the Earth producing wave records that provide evidence for the Earth's layered structure. (4.3m)	*Know that earthquakes produce wave motions on the surface and inside the Earth which can be detected by instruments (seismometers) located on the Earth's surface.*	**H**
	Know that during earthquakes there are several types of wave produced:	**H**
	• *P-waves (pressure waves) which are longitudinal waves which travel through both solids and liquids*	**H**
	• *S-waves(shake waves) which are transverse waves which travel through solids but not through liquids.*	**H**
	Understand how the differences in behaviour of P-waves and S-waves inside the Earth can be interpreted in terms of a simple mantle/core structure for the inner Earth.	**H**
	Understand that the seismographic record can be used to find the velocities of seismic waves, which give evidence for the structure of the Earth.	**H**

that the electromagnetic spectrum includes radio waves, microwaves, infra-red, visible light, ultra violet waves, X-rays and gamma-rays. (4.3h)	Know that light consists of electromagnetic waves with a range of wavelength and frequency and that they transfer energy. Know that the different types of electromagnetic waves form a continuous spectrum. Be able to list the parts of the spectrum in order of wavelength and frequency (gamma rays; X-rays; ultraviolet; light; infra-red; microwaves; radio waves).	
some uses and dangers of microwaves, infra-red and ultra violet waves in domestic situations. (4.3i)	Know that microwaves cause heating when absorbed by water and causes burns when absorbed by body tissue. Know that infra-red radiation causes heating when absorbed by any object, and its use in radiant heaters. Know that ultra-violet radiation is produced in fluorescent lights. Know that being out in the Sun for too long can cause sunburn from the infra-red radiation and skin cancer from the ultra-violet radiation. Understand that the darker the skin, the more ultra-violet radiation is absorbed by the skin and the less reaches the deeper body tissues to cause these cells to become cancerous.	
some uses of radio waves, microwaves, infra-red and visible light in communications. (4.3j)	Know that information can be transmitted using electromagnetic radiation. Understand that radio waves are readily diffracted and are therefore suitable for broadcasting. Understand how information in narrow beams can be transmitted using microwaves. Be able to describe the use of infra-red radiation in night photography . Be able to describe the transmission of data pulses using light in optical fibres.	H H
some uses of X-rays and gamma-rays in medicine. (4.3k)	Understand that X-rays pass through flesh but are absorbed by bone. Be aware of the safety precautions that should be taken when using X-rays and gamma-rays. Be able to describe the use of gamma-rays as tracers to detect malfunction of organs and as treatment for killing body tissue.	

Sc4 Teaching Block 6: *Radioactivity*		
Candidates should be taught: (National Curriculum Reference)	**Learning Outcomes**	**H**
that radioactivity arises from the breakdown of an unstable nucleus. (4.6a)	Understand how changes to an unstable nucleus result in radioactive emission and may result in the formation of a new element.	
	Understand that a stable nucleus can become unstable by the absorption of neutrons.	**H**
that there is background radioactivity. (4.6b)	Understand that the level of background radiation, from different sources, is higher in some places than in others.	
	Understand how to take background radioactivity into account when performing experiments.	
that there are three main types of radioactive emission with different penetrating powers. (4.6c)	Know the relative penetration of alpha, beta and gamma emissions.	
	Be able to apply this knowledge to explain why different emissions are suited to particular purposes.	
the nature of alpha and beta particles and of gamma radiation. (4.6d)	Be able to describe alpha, beta and gamma in terms of atomic particles and electromagnetic waves.	
the meaning of the term "half-life". (4.6e)	Understand that the activity of a radioactive sample decreases with time.	**H**
	Be able to attribute this decrease in activity to a corresponding decrease in the number of unstable nuclei.	**H**
	Understand half-life as the average time for the number of undecayed nuclei in a sample to halve.	**H**
	Understand that different radioactive materials decay at different rates.	**H**
	Be able to use an activity-time graph to determine the half-life of a material.	**H**
	Be able to describe how the half-life of a material can be measured.	**H**
	Be able to apply an understanding of half-life to explain why different sources are suited to particular purposes.	**H**

the beneficial and harmful effects of radiation on matter and living organisms. (4.6f) *some uses of radioactivity including the radioactive dating of rocks. (4.6g)*	Know that exposure to ionising radiation can be harmful. Understand the precautions that should be taken when handling radioactive materials. Know some effects of radiation on the human body. Understand how the effects of radiation depend on the energy and penetration of the emission as well as the amount of exposure. *Understand how measurements of the amounts of radioactive elements and their decay products in rocks can be used to calculate the age of a rock.*	**H**

Sc4 Teaching Block 7: *The Earth and Universe*

Candidates should be taught: (National Curriculum Reference)	**Learning Outcomes**	**H**
the relative positions of the Earth, Moon, Sun, planets and other bodies in the Universe. (4.4a)	Know that the Earth and other planets orbit the Sun. Know that the Moon orbits the Earth and other planets also have satellites. Understand that the orbit time of a planet depends on its distance from the Sun. Know that comets also orbit the Sun.	
that gravitational forces determine the movements of planets, moons, comets and satellites. (4.4b)	Understand that the Moon remains in orbit around the Earth, and the planets orbit the Sun, because of the gravitational attractive forces between them. Understand that the orbit period of an artificial satellite increases with increasing height above the Earth's surface. Be able to describe the variation in gravitational force with distance. Be able to explain the variation in speed of a comet during its orbit around the Sun.	 **H** **H**
how stars evolve over a long time scale. (4.4c)	*Know that our Sun is a star and that stars have a finite life.* *Be able to describe how stars evolve over a long time scale:* • *stars form within clouds of dust and gas in space* • *gravitational forces cause part of a dust cloud to contract and the contraction causes heating* • *a star is formed when the temperature is great enough for hydrogen nuclei to fuse into helium nuclei releasing energy* • *as the fusion of hydrogen nuclei into helium nuclei in the star's core comes to an end, the star expands into a red giant* • *a small star, like our Sun, then contracts, becoming a white dwarf which changes colour and fades as it cools* • *very massive stars may glow brightly again as they undergo further fusion reactions, expanding and contracting several times and forming the nuclei of heavier elements before becoming a supernova* • *an exploding supernova throws its outer layer of dust and gas into space, leaving behind a very dense core called a neutron star* • *second generation stars such as our Sun can form in the cloud of dust and gas from the exploding supernova.*	**H** **H** **H** **H** **H** **H** **H** **H** **H**

about some ideas used to explain the evolution of the Universe into its present state. (4.4d)	*Understand that theories for the origin of the Universe must take into account* • *that light from other galaxies is shifted to the red end of the spectrum* • *that the further away galaxies are, the greater the red shift.* *Understand that one way of explaining this is* • *that other galaxies are moving away from us very quickly* • *that galaxies furthest away from us are moving fastest.* *Understand that the whole Universe is expanding and that it might have started billions of years ago from one place with a huge explosion - the Big Bang.* *Understand that there are possible futures for the Universe depending on the amount of mass in the Universe and the speed at which the galaxies are moving apart.* *Understand how knowledge of the rate of expansion of the Universe enables its age to be estimated.*	**H** **H** **H** **H** **H** **H** **H** **H**

Sc4 Teaching Block 8: *Using Electricity*		
Candidates should be taught: (National Curriculum Reference)	**Learning Outcomes**	**H**
about common electrostatic phenomena in terms of the movement of electrons. (4.1n)	*Understand that when two objects rub together and become charged, electrons are transferred from one object to the other.* *Understand how charging by contact occurs in terms of the movement of electrons.* *Know that there are repulsive forces between objects with similar charges, and attractive forces between objects with opposite charges.* *Understand how charging by induction occurs in terms of the movement of electrons.*	**H**
the dangers and uses of electrostatic charges generated in everyday situations. (4.1o)	*Know some everyday uses of electrostatic charge, such as photocopying and the removal of ash from the waste gases in a coal-burning power station.* *Be able to give everyday examples of where the build-up of static charge should be avoided, such as on the inner surface of a television screen and when refuelling aircraft.*	
the quantitative relationship between steady current, charge and time. (4.1p)	*Understand that current is a flow of charge.* *Know and be able to use the relationship:* *charge = current x time*	**H**
about electric current as the flow of free electrons in metals or of ions during electrolysis. (4.1q)	*Understand that the current in a metal is due to a flow of electrons from negative to positive.* *Understand that a current in a gas or electrolytic solution is due to a flow of both positively and negatively charged particles.*	
that voltage is the energy transferred per unit charge. (4.1h)	*Know that the voltage between two points is the number of joules of energy transferred for each coulomb of charge that passes between the points.*	**H**
the quantitative relationship between power, voltage and current. (4.1i)	*Know and be able to use:* *power = current x voltage*	
the difference between direct current (d.c.) and alternating current (a.c.).(4.1j)	Understand that a direct current is always in the same direction but an alternating current changes direction.	

the functions of the live, neutral and earth wires in the domestic mains supply, and the use of insulation, earthing, fuses and circuit breakers to protect users of electrical equipment. (4.1k)	Know that energy is supplied to houses through the live wire. Know that the neutral wire provides the return path for the electric current. Know that in normal use no current passes in the earth wire. Understand that the live wire has to be insulated from the earth and neutral wires. Understand how fuses and circuit breakers prevent fire due to electrical faults. Understand how the earth wire, together with the fuse or circuit breaker, prevents electrocution. *Understand why double-insulated appliances do not need an earth wire.*	
that electrical heating is used in a variety of ways in domestic contexts. (4.1l)	Understand that energy can be transferred from the electricity supply as convection currents and also as electromagnetic waves, including infra-red and microwaves.	
how measurements of energy transferred are used to calculate the costs of using common domestic appliances. (4.1m)	Be able to use: energy = power x time to calculate energy transfer in joules and kilowatt-hours. Know that a domestic electricity meter measures the energy transfer in kilowatt-hours. Be able to calculate the cost of electrical energy from a knowledge of the power, the time and the unit cost.	

Sc4 Teaching Block 9: *Electromagnetism*		
Candidates should be taught: (National Curriculum Reference)	**Learning Outcomes**	**H**
that a current in a coil produces a magnetic field pattern. (KS3)	Be able to sketch the magnetic field pattern inside and outside a current-carrying coil. Know that a soft iron core increases the magnetic field strength.	
how electromagnets are constructed and used in devices. (KS3)	Know some uses of electromagnets. Be able to describe the sequence of events in the operation of an electric bell and a relay. Be able to describe the construction of an electromagnet. Understand that the strength of an electromagnet depends on the number of turns, the current passing and the core material.	
that like magnetic poles repel and unlike magnetic poles attract. (4.1r)	*Know that magnets attract unmagnetised iron, steel and nickel.* *Understand that attractive and repulsive forces act between pairs of magnets.* *Be able to sketch the magnetic field patterns between two magnetic poles that repel and between two magnetic poles that attract. [Neutral points will not be examined.].*	
that a force is exerted on a current-carrying wire in a magnetic field and the application of this effect in simple electric motors. (4.1s)	*Know that a current-carrying conductor at right angles to a magnetic field experiences a force.* *Understand the effect of reversing the current and the direction of the magnetic field.* *Understand how this effect is used in a simple electric motor.* *Understand the effect of changing the size of the current and the strength of the magnetic field.* **H** *Understand how the forces on a current-carrying coil in a magnetic field produce a turning effect on the coil.* **H** *Describe the use of a split-ring commutator in a simple d.c. motor.* **H**	

that a voltage is induced *when a conductor cuts magnetic field lines* and when the magnetic field through a coil changes (4.1t)	Understand that a voltage is induced in a conductor when it moves across a magnetic field. Understand that a voltage is induced in a conductor when the magnetic field through it changes. Understand how the size of the induced voltage depends on the rate at which the change occurs. Know the effect of reversing the change.	 H H
how simple a.c. generators and *transformers work.* (4.1u)	Understand that an alternating current is generated when a magnet rotates within a coil of wire. *Understand that a changing magnetic field in one coil of wire can induce a voltage in a neighbouring coil.*	
the quantitative relationship between the voltages across the coils in a transformer and the numbers of turns in them. (4.1v)	*Understand that a transformer changes the size of an alternating voltage.* *Describe the construction of a transformer as two coils of wire wound on an iron core.* *Know the difference in action and in construction of a step-up and a step-down transformer.* *Know and be able to use the relationship:* $\frac{V_p}{V_s} = \frac{N_p}{N_s}$ *Be able to use the relationship* $V_p I_p = V_s I_s$	 H H
how electricity is generated and *transmitted.* (4.1w)	Be able to describe the energy flow through a coal-burning power station. Understand the social and environmental issues associated with different methods of generating electricity. Understand that electricity is generated by rotating an electromagnet within coils of wire. *Be able to describe power losses in transmission.* *Understand why power is transmitted at high voltage.* *Understand the use of transformers in power transmission.* *Understand why the use of transformers dictates the use of alternating current.*	

6 GRADE DESCRIPTIONS

Grade descriptions are provided to give a general indication of the standards of achievement likely to have been shown by candidates awarded particular grades. The descriptions should be interpreted in relation to the content specified in the syllabus: they are not designed to define the 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 devise fair tests in contexts which involve only a few factors; record observations and measurements in tables and graphs; offer simple explanations consistent with the evidence obtained.

Candidates use simple apparatus to make measurements appropriate to the task.

Candidates recall a limited range of information, for example, they state the main functions of the organs of the human body and flowering plants; state some uses of materials obtained from oil, suggest 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 obtain information from simple tables, charts and graphs and identify simple patterns in information and observations.

Candidates link cause and effect in simple contexts, make some use of scientific and technical vocabulary and make simple generalisations from information.

Grade C

Candidates use scientific knowledge and understanding to identify key factors to vary and control and where appropriate to make predictions; present data systematically, in graphs where appropriate, and use lines of best fit; draw conclusions consistent with their evidence and explain these using scientific knowledge and understanding.

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.

Candidates recall a range of scientific information from all areas of the syllabus, 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 use scientific knowledge and understanding to make inferences and identify and explain patterns within data; make predictions from patterns within data.

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.

Grade A

Candidates use scientific knowledge and understanding to select an appropriate strategy for a task, identifying the key factors to be considered and making predictions where appropriate; 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; use scientific knowledge and understanding to draw conclusions from their evidence; identify shortcomings in the evidence.

Candidates decide the level of precision needed in measurements and use a range of apparatus with precision and skill; make appropriately precise measurements; make systematic observations in qualitative work; decide which observations are relevant to the task in hand.

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

Candidates use detailed 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 equations; use understanding of bonding to explain the simple properties of a material; use a wide range of relationships between physical quantities to carry out calculations effectively.

Candidates use scientific knowledge and understanding to identify patterns and draw conclusions by combining data of more than one kind or from more than one source.

Candidates draw together and communicate knowledge from more than one area; use routinely scientific or mathematical conventions in support of arguments; use a wide range of scientific and technical vocabulary throughout their work.

7 FURTHER INFORMATION AND TRAINING FOR TEACHERS

In support of this syllabus, OCR will make the following materials and services available to teachers:

- a full service of In-Service Training (INSET) meetings.
- coursework guidance materials.
- a comprehensive set of test papers and mark schemes to support the syllabus content for use in Centres.
- regional syllabus consultants to advise on coursework and other aspects of OCR science syllabuses.
- dedicated subject-specific telephone numbers.
- past question papers and mark schemes after each examination session.
- a Report on the Examination, compiled by Principal Examiners and Moderators, after each Summer examination session.
- individual feedback to each Centre on the moderation of coursework.

REQUIREMENTS RELATED TO ENGLISH, MATHEMATICS AND INFORMATION TECHNOLOGY

1 LANGUAGE AND LITERACY SKILLS

Candidates should be taught to express themselves clearly in both speech and writing and to develop their reading skills. They should be taught to use grammatically correct sentences and to spell and punctuate accurately in order to communicate effectively in written English.

In particular the following skills should be developed during the course: recording and storage of information in various forms; using and understanding information gained from various sources; communication of ideas to others; summarising and organising information in order to communicate adequately; using appropriate language to explain the results of observations in a variety of contexts; using and interpreting scientific nomenclature, symbols and conventions.

2 MATHEMATICAL SKILLS

During the course of study for this syllabus, many opportunities will arise for quantitative work, including appropriate calculations. The mathematical requirements which form part of the syllabus are listed below. Items in the first table may be examined in written papers covering both Tiers. Items in the second table may be examined only in written papers covering the Higher Tier.

Both Tiers
add, subtract, multiply and divide whole numbers
recognise and use expressions in decimal form
make approximations and estimates to obtain reasonable answers
use simple formulae expressed in words
understand and use averages
read, interpret, and draw simple inferences from tables and statistical diagrams
find fractions or percentages of quantities
construct and interpret pie-charts
calculate with fractions, decimals, percentage or ratio
solve simple equations
substitute numbers in simple equations
interpret and use graphs
plot graphs from data provided, given the axes and scales
choose by simple inspection and then draw the best smooth curve through a set of points on a graph

Higher Tier only
recognise and use expressions in standard form
manipulate equations
select appropriate axes and scales for graph plotting
determine the intercept of a linear graph
understand and use inverse proportion

3 INFORMATION TECHNOLOGY

Candidates should be given opportunities, where appropriate, to develop and apply their Information Technology (IT) capability in their study of science.

THE ASSESSMENT OF SPELLING, PUNCTUATION AND GRAMMAR

1 The assessment of spelling, punctuation and grammar is required in the coursework component of the syllabus.

2 The marks will be awarded on the basis of the performance in spelling, punctuation and grammar on the component overall, in accordance with the performance criteria given below.

3 Teachers should first assess each candidate's work against the Sc1 criteria given in the syllabus. The criteria for spelling, punctuation and grammar should then be applied, and marks added according to the range given below. The Coursework Assessment Forms issued by OCR (see Appendix H) will accommodate the marks awarded for spelling, punctuation and grammar.

Application of Criteria	Allocation of Marks
Threshold performance	
Candidates spell, punctuate and use the rules of grammar with reasonable accuracy; they use a limited range of specialist terms appropriately.	1
Intermediate performance	
Candidates spell, punctuate and use the rules of grammar with considerable accuracy; they use a good range of specialist terms with facility.	2
High performance	
Candidates spell, punctuate and use the rules of grammar with almost faultless accuracy, deploying a range of grammatical constructions; they use a wide range of specialist terms adeptly and with precision.	3

EXPLANATION OF TERMS USED IN LEARNING OUTCOMES

All the Learning Outcomes in the content section of the syllabus are expressed in terms of what the candidates **know, understand** or **can do.** This appendix, which is not intended to be exhaustive or prescriptive, provides some guidance about the meanings of these words.

It must be stressed that the precise meaning of a term depends on the context in which it is set, and consequently it is not possible to provide precise definitions of these words which can be rigidly applied in all circumstances. Nevertheless, it is hoped that this general guidance will be of use in helping to interpret both the syllabus content and the assessment of this content in written papers.

"Know...."

This term is closely linked with factual recall. Candidates are expected to remember the facts, concepts, laws and principles which they have been taught. Also in this category are learning outcomes beginning :

"Recognise that...", "Be able to name...", "Be able to draw...", "Be able to test for...".

The words used on examination papers in connection with the assessment of these Learning Outcomes may include: *"State...", "List...", "Give...", "Name...", "Draw...","Write...", "What..." "How...", "What is meant by..?."*

e.g. ***'What is meant by the term 'producer' ?'***
'Name parts A, B and C on the diagram.'

The GCSE Criteria for Science require that about 20% of the examination will assess factual recall.

"Understand..."

This word is used in two separate, but closely aligned ways.

(a) associated with simple factual recall

'Understand' requires the candidates to recall the relevant part of the defined syllabus and to use this recalled information to amplify, extend or expand this in a wider context. This wider context will normally include situations/materials with which the candidates are familiar.

Parts of questions on examination papers may include words such as *"Explain...", "Complete...", "Why...", "Construct...", "Which..."*

e.g. ***'Explain, in terms of moving particles, why air exerts a pressure in a car tyre.'***
'Explain why some people turn paler as they get colder.'

(b) associated with skills other than simple factual recall.

'Understand' can be used to assess the candidates' abilities in problem solving, interpretation and evaluation, data handling and in communication of scientific ideas, principles, concepts etc.

Words such as *"Work out...", "How would you know that...", "Suggest..."* may be used in examination papers for questions associated with this meaning of the word.

e.g. ***'Suggest two advantages of growing crops which are nitrogen-fixing.'***
'Suggest why concrete has a low tensile strength.'

"Be able to..."

The use of this phrase is often closely connected with the higher order skills of interpretation, evaluation, calculation and communication.

It involves the ability to recall the appropriate material from the content and to apply this knowledge.

Questions assessing these Learning Outcomes may require candidates to demonstrate their ability to interpret, evaluate, calculate, process information.

Questions in this category may include : *"Be able to.....*

...relate...	*...interpret...*	*...carry out...*
...explain...	*...evaluate...*	*...predict...*
...discuss...	*...construct...*	*...suggest...*
...calculate...	*...demonstrate...*	

e.g. **'Use the graph to calculate the acceleration of the cyclist.'**
'Explain why it is important for animal and plant species to be conserved.'

QUANTITATIVE RELATIONSHIPS WHICH WILL NOT BE PROVIDED FOR CANDIDATES IN EXAMINATION PAPERS

All the formula marked "**H**" will only be required for Higher Tier papers.

National Curriculum Reference		
4.1f		the quantitative relationship between resistance, voltage and current $voltage = current \times resistance$
4.1i		*the quantitative relationship between power, voltage and current* $electrical\ power = voltage \times current$
4.1p	**H**	*the quantitative relationship between steady current, charge and time* $charge = current \times time$
4.1v	**H**	*the quantitative relationship between the voltage across the coils in a transformer and the number of turns in them* $\frac{voltage\ across\ coil\ 1}{voltage\ across\ coil\ 2} = \frac{number\ of\ turns\ in\ coil\ 1}{number\ of\ turns\ in\ coil\ 2}$
KS3		the quantitative relationship between the force acting normally per unit area on a surface and the pressure on that surface $pressure = \frac{force}{area}$
4.2a		how distance, time and speed may be determined the quantitative relationship between speed, distance and time $speed = \frac{distance}{time\ taken}$
4.2d		*about acceleration as change in velocity per unit time* $acceleration = \frac{change\ in\ velocity}{time\ taken}$
4.2f	**H**	*the quantitative relationship between force, mass and acceleration* $force = mass \times acceleration$

National Curriculum Reference		
4.3f	**H**	*the quantitative relationship between the speed, frequency and wavelength of a wave* *wave speed = frequency x wavelength*
4.5f		*the quantitative relationship between force and work* *work done = force x distance moved in direction of force*
4.5h	**H**	*the quantitative relationship between kinetic energy, potential energy and work:* *energy transferred = work done*

Science: Syllabus A (Co-ordinated) (1794, 1795)
Science: Syllabus B (Suffolk) (1777, 1778)
Science: Syllabus C (Salters) (1774, 1775)
Science: Biology (1780, 1785, 1790)
Science: Chemistry (1781, 1786, 1791)
Science: Physics (1782, 1787, 1792)

INSTRUCTIONS FOR COMPLETION

Marking and Internal Moderation

1. Teachers must be thoroughly familiar with the appropriate sections of the syllabus and with the general coursework regulations. Full details of submission of marks and subsequent moderation are given in the instruction leaflet: **SCIENCES/CW/Inst.**

2. This form must be used for recording Coursework marks for the following OCR Science syllabuses: Syllabus A (Co-ordinated) **(1794, 1795)**, Syllabus B (Suffolk) **(1777, 1778)**, Syllabus C (Salters) **(1774, 1775)**, Biology **(1780, 1785, 1790)**, Chemistry **(1781, 1786, 1791)**, Physics **(1782, 1787, 1792). A separate form must be used for each syllabus.**

3. A different Coursework Assessment Form should be used for Science Rural **(1758)**.

4. Complete the information at the head of the form. The syllabus title should be given in full e.g. Science: Syllabus C (Salters).

5. List the candidates in an order which will allow ease of transfer of information to a computer-printed mark sheet (Form MS1) or to EDI at a later stage. The candidate number and the teaching group/set should be shown.

6. Candidates' marks in each of the Skill Areas P, O, A and E, must be aggregated in accordance with the QCA Criteria for the subjects which are detailed in Section 4.3 of each syllabus.

7. Carry out internal standardisation to ensure that the total marks awarded to the candidates reflect a single valid and reliable order of merit for the syllabus.

8. Enter the Skill Area marks selected for aggregation in the appropriate spaces, together with the total mark out of 30.

9. Multiply this total mark by 2 to produce a new total mark out of 60.

10. Award marks for spelling, punctuation and grammar (SPAG) in accordance with the table below. Add the SPAG mark to give a final total out of 63.

Maximum mark		60
Maximum SPAG mark		3
Performance lower than threshold performance		0
Threshold performance	Candidates spell, punctuate and use the rules of grammar with reasonable accuracy; they use a limited range of specialist terms appropriately.	1
Intermediate performance	Candidates spell, punctuate and use the rules of grammar with considerable accuracy; they use a good range of specialist terms appropriately.	2
High performance	Candidates spell, punctuate and use the rules of grammar with almost faultless accuracy; deploying a range of grammatical constructions; they use a limited range of specialist terms adeptly and with precision.	3

11. Ensure that all mark transcripts and additions are independently checked.

12. Retain all forms securely. You are advised to keep a copy of this form.

PHYSICAL QUANTITIES AND UNITS

It is expected that candidates will show an understanding of the physical quantities and corresponding SI units listed below and will be able to use them in quantitative work and calculations.

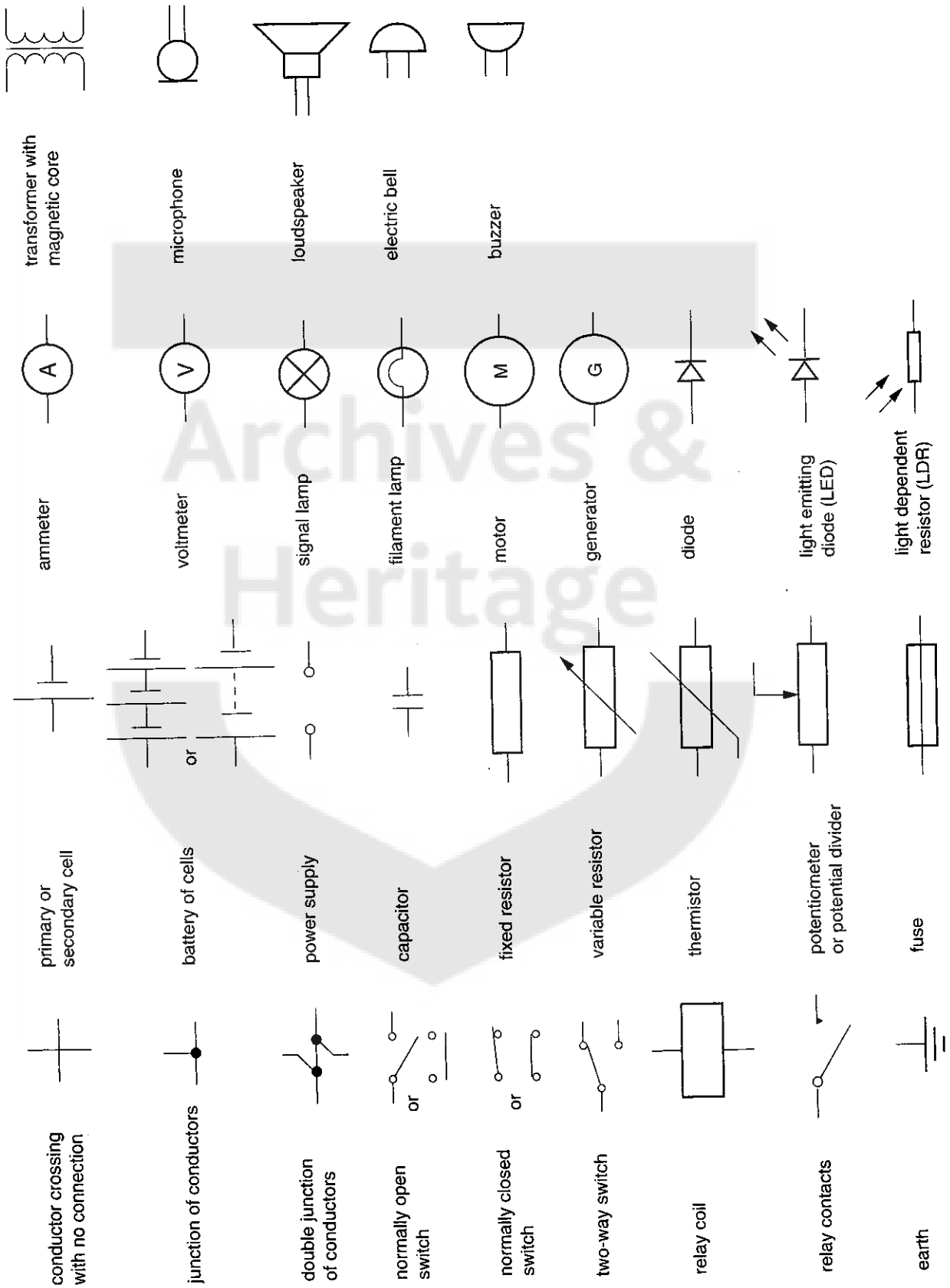
Fundamental physical quantities

Physical quantity	*Unit(s)*
length	metre (m); kilometre (km); centimetre (cm); millimetre (mm)
mass	kilogram (kg); gram (g); milligram (mg)
time	second(s); millisecond (ms)
temperature	degree Celsius (°C); kelvin (K)
current	ampere (A); milliampere (mA)

Derived quantities and units

Physical quantity	*Unit(s)*
area	cm^2; m^2
volume	cm^3; dm^3; m^3; litre (l); millilitre (ml)
density	kg/m^3; g/cm^3
force	newton (N)
pressure	pascal (Pa or N/m^2); N/cm^2
speed	m/s; km/h
acceleration	m/s^2
energy	joule (J); kilojoule (kJ); ocrajoule (MJ)
power	watt (W); kilowatt (kW); ocrawatt (MW)
frequency	hertz (Hz); kilohertz (kHz)
electrical charge	coulomb (C)
potential difference	volt (V)
resistance	ohm (Ω)
gravitational field strength	N/kg
radioactivity	becquerel (Bq)
sound intensity	decibel (dB)

ELECTRICAL AND ELECTRONIC SYMBOLS TO BE USED ON QUESTION PAPER



APPENDIX E

DATA SHEET
The Periodic Table of the Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 0
																	4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulphur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57 *	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	Po Polonium 84	At Astatine 85	Rn Radon 86
Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89 †															

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
232 Th Thorium 90	Pa Protactinium 91	238 U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einstelnium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103

*58-71 Lanthanoid series
†90-103 Actinoid series

Key: a X b — a = relative atomic mass; X = atomic symbol; b = proton (atomic) number

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.)

OCR
RECOGNISING ACHIEVEMENT

APPENDIX H

GCSE SCIENCE SYLLABUSES
1794-5, 1777-8, 1774-5,
1780-2, 1785-7, 1790-2
SUMMARY COURSEWORK ASSESSMENT FORM
GCSE EXAMINATIONS 2000

Read the instructions printed overleaf before completing this form.

CENTRE NUMBER		CENTRE NAME	
SYLLABUS CODE		SYLLABUS TITLE	

Candidate Number	Candidate Name	Teaching Group/Set	**Skill Area P** Planning . . . procedures (max 8)	**Skill Area O** Obtaining evidence (max 8)	**Skill Area A** Analysing evidence . . . (max 8)	**Skill Area E** Evaluating evidence (max 6)	TOTAL (max 30)	TOTAL x 2 (max 60)	SPAG (max 3)	FINAL TOTAL (max 63)