Oxford Cambridge and RSA Examinations

OCR AS GCE in Geology (3884)

OCR Advanced GCE in Geology (7884)

Approved Specifications – Revised Edition

First Advanced Subsidiary GCE certification was 2001 QAN (3884) 100/0609/6
First Advanced GCE certification was 2002 QAN (7884) 100/0437/3

Foreword to Revised Edition

This Revised Edition has been produced to consolidate earlier revisions to these specifications and any changes contained within have previously been detailed in notices to centres**. There is no change to the structure or teaching content of the specification and most differences are cosmetic**. Sidelining will be used to indicate any significant changes.

The main changes are:

Re-sits of Units - The restrictions on re-sitting units have been removed, enabling candidates to re-take units more than once (see page 20 for details).

Foreword (continued)

This booklet contains OCR's Advanced Subsidiary GCE (AS) and Advanced GCE (A level) Geology specifications for teaching from September 2004.

The AS GCE is assessed at a standard appropriate for candidates who have completed the first year of study of a two year Advanced GCE course, i.e. between GCSE and Advanced GCE. It forms the first half of the Advanced GCE course in terms of teaching time and content. When combined with the second half of the Advanced GCE course, known as 'A2', the AS forms 50% of the assessment of the total Advanced GCE. However, the AS can be taken as a 'stand-alone' qualification. A2 is weighted at 50% of the total assessment of the Advanced GCE.

In these specifications the term **module** is used to describe specific teaching and learning requirements. The term **unit** describes a unit of assessment.

Each teaching and learning module is assessed by its associated unit of assessment.

These specifications meet the requirements of the Common Criteria (Qualifications and Curriculum Authority, 1999), the GCE AS and Advanced Level Qualification-Specific Criteria (QCA, 1999) and the relevant Subject Criteria (QCA, 1999).

These specifications are part of a suite of linked specifications in the sciences. All have similar structures and schemes of assessment. The suite comprises:

Biology	**3881 & 7881**
Chemistry	**3882 & 7882**
Physics	**3883 & 7883**
Geology	**3884 & 7884**
Science	**3885 & 7885**

Contents

Specification Summary

Outline

The OCR AS GCE and Advanced GCE **Geology** specifications are designed to offer candidates the opportunity to study a range of geological processes which operate at and below the Earth's surface. The AS GCE covers three main areas of geology and is ideal for a one year course for any candidate. AS GCE is suitable for candidates looking for a broad base in science, and also supports subjects such as geography. There are no QCA Subject Criteria for Geology, but the ideas incorporated extend GCSE balanced science. The Advanced GCE develops some of the ideas from the AS, particularly petrology, with the addition of specimen identification work and also palaeontology, a completely new area of study at this level.

No previous knowledge of geology is required.

The specifications enable candidates to study:

- rocks, minerals and fossils as basic evidence of geological study;
- events past and present at the surface of the Earth;
- the processes which have created the present pattern of continents and oceans;
- the formation of economic deposits of metals and energy resources.

Specification Content

The content is chosen to provide a wide and coherent study of geology. In addition, the specifications allow candidates to develop skills to understand the processes that operate at or near the Earth’s surface.

Scheme of Assessment

The AS GCE forms 50% of the assessment weighting of the full Advanced GCE. AS GCE is assessed at a standard between GCSE and Advanced GCE and can be taken as a stand-alone qualification or as the first half of the full Advanced GCE course.

Assessment is by means of **3 Units of Assessment** for AS GCE and **6 Units of Assessment** for Advanced GCE:

AS GCE	Candidates take Units 2831, 2832 and 2833.
Advanced GCE	Candidates take Units 2831, 2832, 2833, 2834, 2835 and 2836.

Units of Assessment

Unit	Level	Unit Title	Duration	Mode of Assessment	Weighting	
					AS	Advanced GCE
2831	AS	Global Tectonics and Geological Structures	1 hour	Written examination	30%	15%
2832	AS	The Rock Cycle – Processes and Products	1 hour	Written examination	30%	15%
2833	AS	Economic and Environmental Geology / Laboratory and Field Skills 1	-	-	-	-
/01		Economic and Environmental Geology	45 mins	Written examination	20%	10%
/02		Laboratory and Field Skills 1	-	Coursework	20%	10%
2834	A2	Palaeontology	1 hour 30 mins	Written examination	-	15%
2835	A2	Petrology	1 hour 30 mins	Written examination	-	15%
2836	A2	Geological Skills / Laboratory and Field Skills 2	-	-	-	-
/01		Geological Skills	1 hour 15 mins	Written examination	-	10%
/02		Laboratory and Field Skills 2	-	Coursework	-	10%

Units 2833 and 2836 each consist of two equally-weighted components. Both components must be taken in each of these units.

Question Paper Requirements

The question papers for all units of assessment have a common format. They contain both structured questions and questions which require more extended answers. All questions on these papers are compulsory. Quality of written communication is assessed within those parts of the questions which require more extended answers.

The question papers for Units 2835 and 2836, component 01 contain questions covering synoptic assessment. Unit 2836, component 01 is a synoptic paper requiring candidates to draw together their knowledge of Module 2831: Global Tectonics and Geological Structures, Module 2832: The Rock Cycle - Processes and Products, Module 2833, component 01: Economic and Environmental Geology, Module 2834: Palaeontology and Module 2835: Petrology.

Laboratory and Field Skills Requirements

For both AS GCE and Advanced GCE, candidates are assessed on four laboratory and field skills. One mark per skill must be submitted for each candidate, for AS (Unit 2833, components 02) and for A2 (Unit 2836, component 02). Work is marked by the teacher, internally standardised in the Centre, and externally moderated by OCR. There is synoptic assessment in Unit 2836, component 02.

1 Introduction

These OCR specifications lead to qualifications at AS GCE and Advanced GCE in **Geology**. Candidates take three Units of Assessment for AS GCE and a further three for A2. AS and A2 combined constitute the full Advanced GCE specification. There is coursework in both AS and A2.

These specifications have been developed for candidates who wish to continue with a science after GCSE but who wish to study a new science at this level perhaps in combination with chemistry, physics or biology at Advanced GCE or with a variety of other subjects such as geography. Some candidates may wish to take geology for only one year as an AS subject to complement or broaden other subjects. It is expected that many others will enjoy the practical approach and will continue for a further year to Advanced GCE.

Broad aims

These AS GCE and Advanced GCE specifications in Geology are designed to encourage students to

- develop essential knowledge and understanding of the concepts of geology, including an understanding of the link between theory and practical work, using information technology where appropriate;
- sustain and develop their enjoyment of, and interest in, geology.

In addition, this Advanced GCE specification in Geology encourages candidates to bring together knowledge of ways in which different areas of Geology relate to each other.

Environmental situations are of particular concern to the general public and these Geology specifications provide candidates with opportunities to apply the science they learn to a range of environmental phenomena and issues. Social, economic, environmental, ethical and technological aspects of geology are integrated into modules throughout these specifications. It is expected that references to these aspects of geology will be incorporated into the delivery of these specifications. Global tectonics includes the social and economic effects of earthquakes, the modules on the rock cycle cover the social and economic effects of volcanoes, and economic geology similarly expects candidates to consider social and economic effects of a number of processes and activities.

More details of the specification aims are shown in Section 2.

Broad objectives

Geology crosses traditional subject boundaries and forms part of more than one of the separate science disciplines. These specifications are designed to cover a wide range of geological topics, incorporating up-to-date information. The AS GCE specification introduces candidates to events past and present at the surface of the Earth and the processes which create the present pattern of continents and oceans and the formation of economic deposits of metals and energy resources. The study of earthquakes, volcanoes and plate margins, together with the rock cycle and its processes, follow on from work in the

National Curriculum: Science. The use of geological theories to interpret geological events in the world today is included.

The A2 half of the Advanced GCE specification extends the work on rocks to include practical identification of a range of rocks and minerals. It requires a higher level of understanding of the complex igneous, sedimentary and metamorphic processes which form the rocks and minerals. The practical theme continues with a module on palaeontology which requires the recognition of fossils from drawings and photographs. The evolution and morphology of fossil groups requires that fossils are used to interpret conditions in the geological past (palaeoenvironments) and as one of the methods of dating. The identification of rocks, minerals and fossils in the field and laboratory demonstrates a range of practical skills.

The coursework can be assessed entirely by fieldwork, which could be local visits to quarries or other exposures, or could be a residential field trip. Centres are free to choose any area to carry out fieldwork, whether in the British Isles or abroad. It is advisable that fieldwork is offered to all candidates. The Code for Geological Field Work, published by the Geologists Association, should be adhered to. Fieldwork is likely to make candidates aware of some of the environmental issues involved in quarrying or mining.

The coursework components, in Units 2833 and 2836, are based on assessment of fieldwork and/or laboratory skills. Assessment of coursework can be carried out in the laboratory as simulations or practical activities.

Experience of the laboratory and fieldwork is important in any geology course and is recognised in these specifications by the inclusion of coursework components, in both AS and A2, based on assessment of laboratory and/or fieldwork skills.

In the A2 half of the Advanced GCE course, candidates are able to demonstrate that they can bring together and synthesise knowledge, principles and concepts from different areas of geology.

More details of the specification objectives are shown in Section 3.

Progression

These Geology specifications are intended to facilitate broadening of candidates' programmes of study. Two principal candidate audiences are envisaged for AS GCE and Advanced GCE Geology. For one audience, learning geology will form part of their education, as members of the general, lay public. These candidates are unlikely to carry the study of geology on into their adult lives. The AS GCE Geology specification has been designed to meet the needs of such candidates. The second audience consists of those who are likely to make more direct use of geology in their lives. For example, those whose jobs, although not primarily in geology, will involve some contact with geology, or candidates preparing to progress into further or higher education to follow courses in geology, or related subjects. Study of AS GCE or AS or Advanced GCE Geology should also be seen as making a contribution towards life-long learning.

Recommended prior learning

The AS GCE specification builds from grade C in GCSE Science: Single Award, or equivalent. However, it is accepted that a proportion of candidates will enter the AS GCE specification from routes other than the National Curriculum in Science, for example as adult learners. For this reason, the specification demands no specific prior knowledge of geology.

Laboratory/field skills build directly from GCSE. The skills cover the same areas as Sc1 of GCSE, and, for assessment, the mark descriptors are formulated in the same way as the GCSE mark descriptors.

Recommended prior learning for the A2 course would be a successful performance in AS Geology.

There are no QCA Subject Criteria for Geology.

1.1 Certification Title

These specifications will be shown on a certificate as

- OCR Advanced Subsidiary GCE in Geology.
- OCR Advanced GCE in Geology.

1.2 Language

These specifications and associated assessment materials are in English only.

1.3 Overlap with other qualifications

Links with other AS GCE and Advanced GCE specifications

Geology sits within the Sciences and these specifications provide limited overlap with other Advanced GCE specifications, particularly Science and Geography.

Examples of overlap include

Biology

- Module 2834: Palaeontology: Evolution and Extinction (section 5.4.3)

Chemistry

- Module 2831: The lithosphere and plate tectonics
- Module 2835: Petrology: Phase diagrams

Geography

- Module 2831: The lithosphere and plate tectonics, earthquakes
- Module 2832: Volcanoes, weathering and the rock cycle
- Module 2833, component 01: Many environmental issues are discussed within the content of this module, especially those related to metal mining, quarrying, water supply, waste disposal and energy resources.

Physics

- Module 2834: Radiometric dating

Science

- Module 2831: The lithosphere and plate tectonics.
- Module 2833: Many environmental issues are discussed within the content of this module, especially those related to metal mining, quarrying, water supply, waste disposal and energy resources.

1.4 Exclusions

Candidates who enter for this AS GCE specification may **not** also enter for any other AS specification with the certification title Geology in the same examination series.

Candidates who enter for this Advanced GCE specification may **not** also enter for any other Advanced GCE specification with the certification title Geology in the same examination series.

Every specification is assigned to a national classification code indicating the subject area to which it belongs.

Centres should be aware that candidates who enter for more than one GCE qualification with the same classification code will have only one grade (the highest) counted for the purpose of the School and College Performance Tables.

The classification code for this specification is 1770.

1.5 Code of Practice requirements

These specifications will comply in all respects with the 2004 revised Code of Practice.

2 Specification Aims

The aims of these AS GCE and Advanced GCE specifications are to create and sustain interest in, and enjoyment of, geology, as well as provide a body of knowledge appropriate both for those candidates not studying geology beyond this stage and for those continuing further studies in subjects for which geology is relevant. The specifications aim to encourage candidates to:

- develop essential knowledge and understanding of the concepts of geology, and the skills needed for the use of these in new and changing situations;
- develop abilities to perform laboratory and field work with accurate skills of observation and the ability to record and interpret observations, having due regard for safety;
- be aware of how advances in information technology and instrumentation are used in geology;
- appreciate the contributions of geology to society and the responsible use of scientific knowledge and evidence;
- sustain and develop their enjoyment of, and interest in, geology.

In addition, the Advanced GCE specification aims to encourage candidates to:

- show knowledge and understanding of facts, principles and concepts from different areas of geology and to make and use connections between them.

2.1 Spiritual, Moral, Ethical, Social and Cultural Issues

These specifications provide an opportunity for candidates to appreciate the following aspects of the natural world:

- a sense of awe and wonder at the scale and impact of natural processes and phenomena (for example, see Module 2831: Global Tectonics and Geological Structures); the evolution of invertebrate groups over time and the dating of events (for example, see Module 2834: Palaeontology);
- the ethical and moral implications of mining and the extraction of oil, coal and metals; weighing up the damage to the environment versus the benefit to society (for example, see Module 2833, component 01: Environmental and Economic Geology); the advantages and disadvantages of earthquake and volcanic hazard prediction (for example, see Module 2831 Global Tectonics and Geological Structures);
- cultural issues, driven by society, such as mining, quarrying and waste pollution (for example, see Module 2831, component 01: Environmental and Economic Geology).

2.2 Environmental Education

Aspects of environmental education covered by these specifications include:

- use of remote sensing for geophysical surveys (Module 2833, component 01: Environmental and Economic Geology);
- geochemical analysis (Module 2833, component 01: Environmental and Economic Geology);
- risk assessments in volcanic and earthquake areas (Module 2831: Global Tectonics and Geological Structures; Module 2832: The Rock Cycle - Processes and Products);
- mapping techniques at and below the earth's surface (Module 2831: Global Tectonics and Geological Structures);
- reserves of economically valuable materials (Module 2833, component 01: Environmental and Economic Geology);
- weathering and the effect of ground movements over time;
- large scale and long term movements of the earth's crust giving rise to earthquakes and volcanoes (Module 2831: Global Tectonics and Geological Structures; Module 2832: The Rock Cycle - Processes and Products);
- recognition of the importance of geological conservation and care for the environment.

2.3 European Dimension

There have been contributions to the understanding of geology by European geologists. The work of Alfred Wegener, which appears in the specifications and the work of many others, could be drawn upon during teaching. There are also other aspects, not mentioned in the specifications, which could be developed during the course. For example:

- geological mapping and research is frequently multi-national as structures and geological features extend across Europe;
- good examples of volcanic and earthquake activity occur in Europe (see Modules 2831 and 2832);
- oil distribution in the North Sea (see Module 2833, component 01: Environmental and Economic Geology).

2.4 Health and Safety Issues

Aspects of Health and Safety issues feature in these specifications and enable candidates to appreciate the following:

- a safe and plentiful supply of potable water; pollution as a result of waste disposal (see Module 2833, component 01: Environmental and Economic Geology).

2.5 Economic and Industrial Understanding

These specifications promote understanding of the following industrial activities in Module 2833, component 01: Environmental and Economic Geology:

- mineral exploration;
- coal, oil and gas, geothermal power;
- water supply;
- the supply and distribution of bulk materials such as roadstone;
- quarries as sites for waste disposal.

2.6 Avoidance of Bias

OCR has taken great care in the preparation of these specifications and assessment materials to avoid bias of any kind.

3 Assessment Objectives

Knowledge, understanding and skills are closely linked. These specifications require that candidates demonstrate the following assessment objectives in the context of the content and skills prescribed. Assessment Objectives AO1-AO3 are the same for AS GCE and Advanced GCE; AO4 applies only to the A2 part of the Advanced GCE course.

- Assessment objectives A01-A03 are tested using the context of the content and skills within each teaching module.
- Assessment objective A04 is tested using contexts which bring together content and skills from different teaching modules.

AO1 Knowledge with Understanding

Candidates should be able to:

- recognise, recall and show understanding of specific geological facts, terminology, principles, relationships, concepts and practical techniques;
- draw on existing knowledge to show understanding of the ethical, social, economic, environmental and technological implications and applications of geology;
- select, organise and present relevant information clearly and logically, using appropriate vocabulary where appropriate.

AO2 Application of Knowledge and Understanding, Analysis, Synthesis and Evaluation

Candidates should be able to:

- describe, explain and interpret phenomena and effects in terms of geological principles and concepts, presenting ideas clearly and logically, using specialist vocabulary where appropriate;
- interpret and translate, from one form into another, data presented as continuous prose or in tables, diagrams, drawings, maps and graphs;
- apply scientific principles and concepts in solving problems in unfamiliar situations including those which relate to the ethical, social, economic, and technological implications and applications of geology;
- assess the validity of geological information, experiments, inferences and statements.

AO3 Laboratory and Field Skills

Candidates should be able to:

- devise and plan laboratory or field activities, selecting appropriate techniques;
- demonstrate safe and skilful practical techniques;
- make observations and measurements with appropriate precision and record these methodically;
- interpret, explain, evaluate and communicate the results of their laboratory or field activities clearly and logically using geological knowledge and understanding and using appropriate specialist vocabulary.

AO4 Synthesis of Knowledge, Understanding and Skills

In addition, for A2, candidates should be able to:

- bring together principles and concepts from different areas of geology and apply them in a particular context, expressing ideas clearly and logically and using appropriate specialist vocabulary;
- use geological skills in contexts which bring together different areas of the subject.

The assessment objectives in these specifications are weighted as follows:

	AS GCE	A2	Advanced GCE
AO1	48%	25%	36.5%
AO2	32%	25%	28.5%
AO3	20%	10%	15%
AO4	0%	40%	20%

3.1 Specification Grid

The relationship between the assessment objectives and the units of assessment is shown in the specification grid below.

Unit	Level	Percentage of Advanced GCE				Total
		AO1	AO2	AO3	AO4	
2831	AS	9	6	0	0	15
2832	AS	9	6	0	0	15
2833	AS	-	-	-	-	-
/01		6	4	0	0	10
/02		0	0	10	0	10
2834	A2	7	8	0	0	15
2835	A2	5.5	4.5	0	5	15
2836	A2	-	-	-	-	-
/01		0	0	0	10	10
/02		04	0	5	5	10
Total		36.5	28.5	15	20	100

3.2 Quality of Written Communication

The requirement for all AS GCE and Advanced GCE specifications to assess candidates' quality of written communication is met through all four assessment objectives. Questions which provide an assessment of quality of written communication are included in all question papers and in the assessment of laboratory and/or field skills in Units 2833, component 2 and 2836, component 2.

4 Scheme of Assessment

Candidates take three units of assessment, including a coursework component, for AS GCE, followed by a further three units of assessment, including a coursework component, at A2 if they are seeking an Advanced GCE award.

Unit	Level	Unit Title	Duration	Mode of Assessment	Weighting	
					AS	Advanced GCE
2831	AS	Global Tectonics and Geological Structures	1 hour	Written examination	30%	15%
2832	AS	The Rock Cycle – Processes and Products	1 hour	Written examination	30%	15%
2833	AS	Economic and Environmental Geology / Laboratory and Field Skills 1	-	-	-	-
/01		Economic and Environmental Geology	45 mins	Written examination	20%	10%
/02		Laboratory and Field Skills 1	-	Coursework	20%	10%
2834	A2	Palaeontology	1 hour 30 mins	Written examination	-	15%
2835	A2	Petrology	1 hour 30 mins	Written examination	-	15%
2836	A2	Geological Skills / Laboratory and Field Skills 2	-	-	-	-
/01		Geological Skills	1 hour 15 mins	Written examination	-	10%
/02		Laboratory and Field Skills 2	-	Coursework	-	10%

Units 2833 and 2836 each consist of two components. Both components must be taken in each of these units.

If a candidate retakes one of these units within 12 months, they have the opportunity to carry forward the mark for the coursework component.

All candidates for units 2833 and 2836 should be entered under the relevant unit code with one of the following option codes:

Entry Option	Components to be taken	
A	01	Written examination
	02	Coursework
B	01	Written examination
	82	Coursework mark carried forward

Rules of Combination

Candidates must take the following combination of units:

AS GCE — Units 2831, 2832 and 2833

Advanced GCE — Units 2831, 2832, 2833, 2834,2835 and 2836

Unit Availability

There are two unit sessions each year – one in January and one in June.

The availability of units is shown below.

Unit	Unit Title	Jan 2005	June 2005
2831	Global Tectonics and Geological Structures	✓	✓
2832	The Rock Cycle - Processes and Products	✓	✓
2833	Economic and Environmental Geology / Laboratory and Field Skills 1		✓
2834	Palaeontology	✓	✓
2835	Petrology		✓
2836	Geological Skills / Laboratory and Field Skills 2		✓

The availability shown for 2005 will be the same for subsequent years.

Sequence of Units

The normal sequence in which the units could be taken is Units 2831, 2832 and 2833 in the first year of a course of study, leading to an AS GCE award, then Units 2834, 2835 and 2836 in the second year, together leading to the Advanced GCE award. However, units may be taken in other sequences.

Alternatively, candidates may take all units at the end of their AS GCE or Advanced GCE course in a 'linear' fashion, if desired.

Synoptic Assessment

Synoptic assessment involves the explicit drawing together of knowledge, understanding and skills learned in different parts of the Advanced GCE course. Assessment Objective AO4 relates specifically to synoptic assessment. It accounts for 20% of the total Advanced GCE marks and is assessed only in A2 Units 2835 and 2836.

Synoptic assessment:

- requires candidates to make and use connections between different areas of geology, for example, by applying knowledge of a number of areas to a particular situation or context;
- provides opportunities for candidates to use ideas and skills which permeate geology, for example, the identification and analysis of rocks and minerals and the concept of plate tectonics.

In the examination papers for Units 2835 and Unit 2836, component 01, questions are set requiring candidates to demonstrate these abilities.

During laboratory and field skills work, synoptic assessment

- allows candidates to apply knowledge and understanding of principles and concepts of geology in planning work and in the analysis and evaluation of data.

The laboratory and field skills work assessed in Unit 2836, component 02 includes an element of synoptic assessment. Therefore all practical work assessed in Unit 2836, component 02 should draw on the range of experience that the candidate will have acquired during the AS course. It is particularly important that an exercise used to evaluate planning skills should involve an element of research which goes beyond the repetition of an experiment that simply reflects the use of ideas or techniques met within the module currently being studied. Likewise an assessment involving the analysis and evaluation of evidence must require a candidate to use knowledge and understanding acquired from different modules. During the process of moderation, evidence will be sought that such breadth has been achieved.

For Advanced GCE, Units 2835 and 2836 should normally be taken at the end of the course, but this is no longer a requirement.

Certification

Candidates may enter for:

- AS GCE certification;
- AS GCE certification, bank the result, and complete the A2 assessment at a later date;
- Advanced GCE certification.
- Candidates must enter for the appropriate AS and A2 units to qualify for the full Advanced GCE award.
- Individual unit results, prior to certification of the qualification, have a shelf life limited only by that of the qualification.

Re-sits of Units

The restrictions on re-sitting units have been removed, enabling candidates to re-take units more than once. Upon making an entry for certification, the best attempt will be counted towards the final award. This change applies to all candidates, including those who have already been entered for any units or full qualifications.

Re-sits of AS GCE and Advanced GCE

Candidates may still enter for the full qualification an unlimited number of times.

4.2 Question Papers

4.1.1 AS GCE

Unit 2831 - Global Tectonics and Geological Structures (1 hour) (60 marks)
Unit 2832 - The Rock Cycle - Processes and Products (1 hour) (60 marks)
Unit 2833, component 01 - Economic and Environmental Geology (45 mins) (45 marks)

The question papers for Units 2831, 2832 and 2833, component 01 have a common format. Each question paper comprises both structured questions and questions requiring more extended answers.

- The distribution of marks in Units 2831 and 2832 is approximately 50 marks for the structured questions and 10 marks for extended answers.
- The distribution of marks in Unit 2833, component 01 is approximately 38 marks for the structured parts and 7 marks for the extended answers.

All questions on these examination papers are compulsory. Quality of written communication is assessed within those parts of the questions requiring more extended answers.

4.1.2 A2

Unit 2834 - Palaeontology (1 hour 30 minutes) (90 marks)
Unit 2835 - Petrology (1 hour 30 minutes) (90 marks)

The question papers for Units 2834 and 2835 have the same format as the question papers for Units 2831 and 2832. They contain questions comprising both structured parts and parts which require more extended answers. Questions for Unit 2835 include an element of synoptic assessment.

- The distribution of marks is approximately 65 marks for the structured parts and 25 marks for extended answers.

All questions on these papers are compulsory. Quality of written communication is assessed within those parts of the questions requiring more extended answers.

Unit 2836, component 01 - Geological Skills (1 hour 15 minutes) (60 marks)

The question paper for Unit 2836, component 01 contains questions covering synoptic assessment. The subject matter in Module 2836, component 01: Geological Skills is synoptic in nature and synoptic assessment will relate content in this module to knowledge and understanding acquired elsewhere in the course. The questions are based on geological maps, photomicrographs and drawings of rocks, minerals or fossils and photographs of geological features.

The question paper for Unit 2836, component 01 comprises both structured questions and questions which require more extended answers.

- The distribution of marks is approximately 45 marks for the structured parts and 15 marks for extended answers.

All questions on this paper are compulsory. The quality of written communication is assessed within those parts of the questions that require more extended answers.

Thus, synoptic assessment in the question papers comprises

- 30 marks from the question paper for Unit 2835, and
- 60 marks from the question paper for Unit 2836, component 01.

4.2 Coursework

C3.1, C3.2, C3.3; N3.1, N3.2, N3.3; IT3.1, IT3.2, IT3.3;

WO3.1, WO3.2, WO3.3; LP3.1, LP3.2, LP3.3; PS3.1, PS3.2, PS3.3;

Unit 2833, component 02 - Laboratory and Field Skills 1 (60 Marks)
Unit 2836, component 02 - Laboratory and Field Skills 2 (60 Marks)

Assessment of candidates' Laboratory and Field Skills work is made by the teacher (as coursework) and moderated externally by OCR. The coursework may be assessed through fieldwork **or** laboratory work **or** a mixture of the two. This provides Centres with a flexible method of assessment which can be adapted to suit individual needs. Entries are made for Unit 2833 (in AS) or 2836 (in A2). In each of these units candidates must take two components - a written paper (component 01) which assesses a part-module of content and the above assessments of Laboratory and Field Skills (component 02). Both written paper and skills assessment components **must** be taken in the same examination session.

In Unit 2833, component 02, marks contribute towards Assessment Objective AO3, Laboratory and Field Skills.

In Unit 2836, component 02, marks contribute equally to Assessment Objectives AO3 and AO4, Synthesis of Knowledge, Understanding and Skills. Assessment of AO4, which is synoptic assessment, is made because:

- candidates are required to use geological knowledge and understanding from other modules of the specification in planning their Laboratory and Field Skills work, and in analysing evidence and drawing conclusions;
- in the assessment of all four laboratory/field skills in Unit 2836, component 02, taken at the end of their course of study, candidates are expected to draw on their experience of such work throughout the course, and in particular on the outcome of the assessment of these skills in Unit 2833, component 02.

The Skills

The laboratory and field skills to be assessed are:

Skill P Planning

Candidates should:

- identify and define the nature of a question or problem using available information and knowledge of geology;
- retrieve and evaluate information from multiple sources (including computer databases where appropriate) and deciding the measurements and observations likely to generate useful and reliable results;
- choose effective and safe procedures, selecting appropriate apparatus and materials, and consider ethical implications and environmental and safety aspects of the proposed procedures.

Skill I Implementing

Candidates should:

- use apparatus and materials in an appropriate and safe way;
- carry out work in a methodical and organised way with due regard for safety and with appropriate consideration for the well-being of living organisms and the environment;
- make and record detailed observations in a suitable way, and make measurements to an appropriate degree of precision, using IT where appropriate.

Skill A Analysing Evidence and Drawing Conclusions

Candidates should:

- present geological information and ideas in appropriate ways, including tabulation, line graphs, histograms, continuous prose, annotated drawings and diagrams, using geological nomenclature and terminology;
- recognise and comment on trends and patterns in a set of data or information, identify sources of error or limitations of measurements, and show an understanding of the concept of statistical significance where appropriate;
- draw valid conclusions by applying scientific knowledge and understanding.

Skill E Evaluating Evidence and Procedures.

Candidates should:

assess the reliability and precision of laboratory/field data and the conclusions drawn from it;

evaluate the techniques used in the laboratory/field activity, recognising their limitations.

In each of AS and A2, the time required for internal assessment is normally expected to be between five and ten hours in total, the majority of which should be supervised laboratory/field time.

Assessment of candidates' experimental and investigative work is made by the teacher (as coursework) and moderated externally by OCR.

Skills **P** and **A** are each marked out of 8 and Skills **I** and **E** are each marked out of 7. One mark per skill must be submitted for each candidate for AS (Unit 2833, component 02) and for A2 (Unit 2836, component 02). Hence, a mark out of 30 is initially calculated for each component. These marks are then doubled so that the final mark submitted for each component is out of 60.

In AS GCE and in A2 the skills may be assessed in the context of separate practical exercises, although more than one skill may be assessed in any one exercise. The skills may also be assessed all together in the context of a single 'whole investigation' in which the task is set by the teacher, or using individual investigations in which each candidate pursues his or her own choice of assignment.

The skills may be assessed at any time during the course using suitable practical activities, based on laboratory or field work, related to or part of the content of the teaching course. The context(s) for the assessment of the coursework for Unit 2833, component 02 should be drawn from the content of AS Modules 2831: Global Tectonics and Geological Structures, Module 2832: The Rock Cycle - Processes and Products and Module 2833, component 01: Economic and Environmental Geology. The context(s) for the assessment of the coursework for Unit 2836, component 02 should be drawn from the content of Module 2834: Palaeontology, Module 2835: Petrology and Module 2836, component 01: Geological Skills, in which the level of demand of the related geological knowledge and understanding is higher.

A similar set of mark descriptors is used for both AS and A2 (see Appendix C). These descriptors have been written to provide clear continuity from the assessment of Sc1 in GCSE Science. The difference in standard of AS and A2 is a product of the level of demand of the related scientific knowledge and understanding, together with the complexity and level of demand of the tasks set. Also, the mark descriptors for Skills **P** and **A** at A2 include synoptic elements.

Notes for Guidance on Coursework assessment and submission are given in Appendix B. Mark descriptors for the assessment of laboratory/field skills are fully detailed in Appendix C.

Further guidance can be found in the Geology Coursework Handbook, which contains copies of all relevant forms.

4.2.1 Laboratory and Field Work at AS and A2

The assessment descriptors given in Appendix C are used for the assessment of coursework for both AS and A2. The criteria used for the assessment at AS and A2 are defined in the same terms but the two levels are distinguished by the complexity of the task set. In A2, candidates are required to apply knowledge, understanding and skills from the AS and A2 parts of the specification in planning laboratory/field work and in the analysis of results to reach conclusions.

At AS, laboratory/field work should either be qualitative or require quantitative processing in a context that is familiar to students.

- **Planning** exercises focus on observations and techniques based on knowledge and understanding from a limited part of the AS specification.
- **Implementing** involves the manipulation of simple apparatus and the application of easily recognised safety procedures.
- **Analysing and concluding** involve simple data handling, reaching conclusions based on a limited part of the AS specification.
- **Evaluation** expects the recognition of the main sources of error and direct methods for improving laboratory and field procedures.

At A2 assessments require a greater level of sophistication and higher level of skill.

- **Planning** exercises require research to provide a satisfactory solution to a problem which can be addressed in more than one way. The underlying knowledge, understanding and skills are likely to be drawn from several different parts of the AS and A2 specifications.
- **Implementing** involves detailed observations and measurements obtained safely and the careful use of apparatus to give reliable results.
- **Analysing and concluding** involves sophisticated data handling and the synthesis of several strands of evidence. In developing conclusions, candidates will have the opportunity to demonstrate their skills in drawing together principles and concepts from different parts of the AS and A2 specifications.
- **Evaluation** requires recognition of practical limitations and other sources of error as well as an understanding of the methods that may be used to limit their effect. The evaluation is likely to draw together principles and concepts from different parts of the specification.

Details of experiments suitable for AS and for A2 for the internal assessment of Laboratory and Field Skills are provided in a support booklet for teachers. This also provides guidance for applying the criteria to specific activities. Exemplar Summary Grids for AS and A2 give an outline of the exercises included (see Appendix B).

4.2.2 Assessment and Moderation

All coursework is marked by the teacher and internally standardised by the Centre. Marks are then submitted to OCR by a specified date, after which postal moderation takes place in accordance with OCR procedures. The purpose of moderation is to ensure that the standard for the 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.

Coursework submissions should be clearly annotated by the Centre to support the marks awarded to the candidates.

The sample of work which is submitted to the Moderator for moderation must show how the marks have been awarded in relation to the marking criteria.

4.2.3 Minimum Coursework Requirements

If a candidate submits no work for a 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 mark descriptors and marking instructions and the appropriate mark awarded, which may be 0 (zero).

4.2.4 Authentication of Coursework

As with all coursework, the teacher must be able to verify that the work submitted for assessment is the candidate's own. Sufficient work must be carried out under direct supervision to allow the teacher to authenticate the coursework marks with confidence.

4.3 Special Arrangements for Coursework

For candidates who are unable to complete the full assessment or whose performance may be adversely affected through no fault of their own, teachers should consult the *Inter-Board Regulations and Guidance Booklet for Special Arrangements and Special Consideration*. In such cases advice should be sought from OCR as early as possible during the course. Applications for special consideration in coursework components should be accompanied by Coursework Assessment Forms giving the breakdown of marks for each skill.

4.4 Differentiation

In the question papers, differentiation is achieved by setting questions which are designed to assess candidates at their appropriate levels of ability and which are intended to allow all candidates to demonstrate what they know, understand and can do.

In coursework, differentiation is by task and by outcome. Candidates undertake assignments which enable them to display positive achievement.

4.5 Awarding of Grades

The AS has a weighting of 50% when used in an Advanced GCE award. An Advanced GCE award is based on the certification of the weighted AS (50%) and A2 (50%) marks.

Both AS GCE and Advanced GCE qualifications are awarded on the scale A to E, or U (unclassified).

4.6 Grade Descriptors

The following grade descriptions indicate the level of attainment characteristic of the given grade at Advanced GCE. They give a general indication of the required learning outcomes at each specified grade. The descriptions should be interpreted in relation to the content outlined in the specification; they are not designed to define that content. The grade awarded will depend in practice upon the extent to which the candidate has met the assessment objectives overall. Shortcomings in some aspects of the examination may be balanced by better performances in others.

Grade A

Candidates recall and consistently use geological knowledge, facts, principles and concepts from the whole specification with few significant omissions and show good understanding of the principles and concepts they use. They select geological knowledge relevant to most situations and present their ideas clearly and logically, making use of appropriate geological terminology, particularly when referring to specific technical terms and in expressing more general concepts and ideas.

Candidates carry out accurately a range of calculations in a logical manner with little guidance and, where appropriate, support their solutions by logical explanation. They demonstrate good understanding of principles and apply them in familiar and new contexts. They show insight into problems and suggest a number of possible solutions using techniques, arguments or knowledge and understanding from more than one area of the specification and other areas of experience. Most responses are correct, relevant and logical. In particular, longer questions are answered to an appropriate depth, communicating ideas effectively with coherent and detailed explanations.

In laboratory/field activities, candidates independently formulate a clear and accurate plan. They use a range of techniques safely and skilfully, making and recording observations with appropriate precision. They interpret and describe the trends and patterns shown by data presented in tabular or graphical form, indicating, where appropriate, anomalies and inconsistencies. They provide coherent, logical and comprehensive explanations using appropriate geological knowledge and terminology. They comment critically on data, evaluate it and use it to support or reject various hypotheses.

Grade C

Candidates recall and show a sound use of geological knowledge, facts, principles and concepts from many parts of the specification and show understanding of some fundamental principles and concepts. They frequently select scientific knowledge relevant to a particular situation or context and present their ideas clearly and logically, making use of appropriate geological terminology.

Candidates show knowledge of fundamental principles and are often able to apply these in new contexts. They bring together information from more than one area of the specification. Many responses are correct, relevant and logical.

In laboratory/field activities, candidates formulate a plan which may need some modification. They use a range of techniques safely, making and recording observations and measurements which are adequate for the task. They interpret and explain laboratory/field results relating these to geological knowledge and understanding and, with help, evaluate their results. They comment on data and use selected data to support a particular hypothesis.

Grade E

Candidates recall and use geological knowledge, facts, principles and concepts from some parts of the specification and demonstrate some understanding of fundamental principles and concepts. Candidates select discrete items of knowledge in response to structured questions and use basic geological terminology. This may be displayed consistently across the questions set or may vary between quite good and poor on different questions.

Candidates select appropriate facts and principles to solve problems concerning familiar material. Where problems are concerned with unfamiliar material, answers relate to the appropriate subject area even if difficulties are experienced in applying the facts and principles involved.

They make connections between some ideas encountered in different parts of the specification. Their answers show some logic and coherence although they include irrelevant material. They use correctly a limited range of geological terminology.

In laboratory/field activities, candidates formulate some elements of a practical approach when provided with guidance. They carry out practical procedures in a reasonably skilful manner, recognising the risks in procedures and obtaining some appropriate results. They interpret broad trends shown by data presented in tabular or graphical form. They select appropriate facts and principles to produce limited but relevant explanations and make superficial conclusions from data. They may need assistance to relate these to geological knowledge and understanding.

5 Specification Content

The specifications are set out in the form of teaching modules.

Throughout this section the symbol  is used in the margin to highlight where Key Skills development opportunities are signposted. For more information on Keys Skills coverage please refer to Appendix A.

Each teaching and learning module is assessed by its associated unit of assessment.

AS GCE

AS candidates complete the following modules:

Module 2831: Global Tectonics and Geological Structures

Module 2832: The Rock Cycle – Processes and Products

Module 2833: Economic and Environmental Geology / Laboratory and Field Skills 1

Advanced GCE

Advanced GCE candidates complete the AS modules above and the following A2 modules:

Module 2834: Palaeontology

Module 2835: Petrology

Module 2836: Geological Skills / Laboratory and Field Skills 2

5.1 Module 2831: Global Tectonics and Geological Structures

C3.1b, C3.2, C3.3; N3.1; IT3.1, IT3.2, IT3.3;	**LP3.1, LP3.2, LP3.3.**

In addition to the aims of the scheme this module is intended to act as a foundation module for all of the geology modules. It provides a broad treatment of the structure of the earth, earthquakes, global tectonics and geological structures. The ideas from this module underpin many of the concepts used in the later modules.

5.1.1 The Structure of the Earth

Learning Outcomes

Candidates should be able to:

(a) state the depths and composition of the Earth's inner core, outer core, mantle, continental crust and oceanic crust. Describe and explain the physical states and composition of the Earth's inner core, outer core, mantle, continental crust and oceanic crust.

(b) describe the nature of the (rheid) plastic asthenosphere and (rigid) brittle lithosphere.

(c) state the depth and describe the nature of discontinuities between the layers in the Earth: inner core, outer core, mantle, continental crust and oceanic crust.

(d) explain how the internal structure of the Earth can be inferred from direct observations of rocks seen in deep mines and rocks now at the surface which have been brought up in volcanic vents and as ophiolites.

(e) explain how the internal structure of the Earth can be inferred from indirect observations using seismic wave velocities and shadow zones, whole Earth and rock density data and meteorites from within the solar system.

5.1.2 Earthquakes

Learning Outcomes

Candidates should be able to:

(a) describe the characteristics of seismic waves (P, S and L) generated by earthquakes and the paths of body and surface waves.

(b) define the terms: foci, epicentres, isoseismal lines and how they are determined or plotted.

(c) explain why earthquakes occur when stored stress is released and how earthquakes are detected and measured using seismographs and seismograms.

(d) explain the nature and use of the Richter and Mercalli Scales.

(e) appreciate the social and economic effects of earthquake activity - the type of ground movement, damage to structures, liquefaction, landslips, tsunamis and aftershocks.

(f) describe methods of earthquake prediction; seismic gap theory, detailed measurements of gases, stress in rocks, water levels, ground levels, magnetism and animal behaviour. Understand the social consequences of earthquake prediction. Describe measures designed to reduce the impact of the effects of earthquakes.

(g) describe and explain the Earth's seismicity and aseismicity: the origin, depth and distribution of earthquakes in relation to major features of the Earth's surface; mid-ocean ridges, major rift systems, deep-sea trenches, fold mountain ranges, transform faults, continental shields and ocean basins.

5.1.3 Global Tectonics

Learning Outcomes

Candidates should be able to:

(a) explain the evidence for the movement of continents over time using rocks, fossils and major geological structures.

(b) describe the evidence of age, type and distribution of rocks, fossils and major geological structures for a geological fit of past continents and of the edges of continental shelves for a geographical fit. Explain the palaeoclimatic and palaeomagnetic evidence for the movement of continents.

(c) describe and explain palaeomagnetism and reversals in the Earth's magnetic field and the variation of inclination with latitude.

(d) describe the characteristic features of continental shelf, continental slope, ocean basins (abyssal plain), seamount, mid-ocean ridges, major rift systems, deep-sea trenches, fold mountain ranges and continental shields (craton).

(e) explain the concept of sea floor spreading and be able to calculate the rate of spreading from different data sources.

(f) describe the evidence for the process of sea floor spreading using the depth of the ocean floor, the distribution of mid-ocean ridges, the age of oceanic crust, the pattern of volcanic islands and hotspots, the depth and distribution of earthquakes, transform faults, heat flow and gravity anomalies, the age, formation and distribution of ocean sediments and patterns of magnetic anomalies.

(g) describe about the nature and distribution of continental and oceanic tectonic plates. Understand the concept of plate tectonics.

(h) describe and explain the characteristics and distribution of constructive, destructive and conservative plate margins and their relationship to vulcanicity, seismicity, gravity, heat flow, rock type, mid-ocean ridges, fold mountains and trenches.

(i) know about possible mechanisms for the movement of plates and the balance between formation of oceanic crust at mid-ocean ridges and its subduction in deep-ocean trenches.

(j) describe the evidence for hotspots from mantle plumes within plates and in relation to plate movement.

5.1.4 Geological Structures

Learning Outcomes

Candidates should be able to:

(a) define and be able to explain: dip and strike, apparent dip, beds and bedding planes, inliers and outliers. Be able to measure dips and strike.

(b) recognise and explain the origin of an angular unconformity.

(c) explain the origin and nature of tectonic joints, cooling joints, unloading joints.

(d) describe the formation of slaty cleavage by compressive forces and its relation to folds.

(e) describe stress and strain in rocks, and their variation due to temperature, pressure and time. Understand the effects of tension, compression and shear forces causing deformation of competent and incompetent rocks and the deformation of fossils and ooliths.

(f) define and recognise: fault plane, throw, fault dip, hanging wall, footwall.

(g) describe and recognise: dip-slip faults (normal and reverse), graben (rift) and horst, step faults, strike-slip faults (tear [wrench] faults and transform faults) and thrusts and explain their formation.

(h) describe and recognise: slickensides and fault breccia and mylonite and explain their formation.

(i) define and recognise: fold limbs, hinge, crest, trough, axial plane, axial plane trace, plunge, antiform, synform.

(j) describe and recognise the formation of symmetrical and asymmetrical anticlines, synclines plunging folds, monoclines, overfolds, isoclinal folds, recumbent folds, nappes, domes, basins and explain their formation.

(k) recognise the age relationships between structures on simplified geological maps, cross-sections and photographs.

(l) describe the age relationships of beds using cross-cutting features: beds, faults, folds, unconformities and igneous features.

5.2 Module 2832: The Rock Cycle - Processes and Products

C3.1b, C3.2, C3.3; N3.1, N3.2, N3.3; IT3.1, IT3.2, IT3.3.

LP3.1, LP3.2, LP3.3.

This module provides a broad treatment of the rock cycle and the processes that produce sedimentary, igneous and metamorphic rocks. It uses knowledge and understanding from National Curriculum Science and content and skills developed in Module 2831: Global Tectonics and Geological Structures.

5.2.1 The Rock Cycle

Learning Outcomes

Candidates should be able to:

(a) describe the rock cycle and define the processes which operate within it:

(i) at the surface - weathering, erosion, transport ,deposition and extrusion;

(ii) below the surface - burial, diagenesis, recrystallisation, metamorphism, partial melting, magma accumulation, crystallisation, intrusion and uplift.

(b) describe the broad classification of rocks into igneous, sedimentary and metamorphic classes and their relationship to temperatures and pressures in the rock cycle.

(c) distinguish between the broad groups of igneous, sedimentary and metamorphic rocks using characteristic features including mineral composition and textures as seen in simplified drawings / photographs taken from thin sections (microscope work is not expected).

(d) describe the division of the geological column into eras and systems.

5.2.2 Sedimentary Processes and Products

Learning Outcomes

Candidates should be able to:

(a) describe and explain the weathering processes producing soluble products and insoluble residues by chemical (hydrolysis, hydration, oxidation, carbonation), mechanical (exfoliation and frost shattering) and biological processes.

(b) explain the influence of gravity, wind, ice, the sea and rivers on the parameters of grain size, shape, roundness and degree of sorting and methods of transport (solution, suspension, saltation and traction).

(c) describe the deposition in hot desert environments of wadi conglomerates, dune sandstones and evaporites in playa lakes.

(d) describe the deposition in deltaic environments of delta top (topsets) to form coal, sandstones of the delta slope (foresets) and shales to form offshore deposition (bottomsets). Understand deltaic deposition in cyclothems.

(e) describe the deposition of clastic material formed in sediment-rich shallow seas, to form conglomerates, sandstones and mudstones.

(f) describe the deposition of limestones formed in shallow seas to form oolitic and bioclastic limestones.

(g) describe the characteristic features of the primary sedimentary structures: cross bedding, ripple marks, graded bedding, desiccation cracks. Describe the environments in which they form and the processes of formation. Describe the uses of these sedimentary structures as way up and palaeo-environmental indicators.

(h) define lithification. Describe and explain the diagenetic processes of compaction and cementation.

5.2.3 Igneous Processes and Products

Learning Outcomes

Candidates should be able to:

(a) describe the intrusion of concordant and discordant bodies as both major and minor intrusions. Recognise and describe the characteristics of sills, dykes, transgressive sills and batholiths.

(b) explain the origin and nature of chilled and baked margins and metamorphic aureoles.

(c) distinguish between intrusive and extrusive igneous rocks. Explain the differences between rocks formed by these methods - sill and lava flow.

(d) describe how crystal grain size is related to rates of cooling of volcanic, hypabyssal and plutonic igneous rocks. Know how vesicular and porphyritic textures are formed.

(e) describe volcanic processes - basic magma at constructive margins and hotspots, intermediate and acid magma at destructive plate margins. Explain why volcanoes form at plate margins.

(f) describe the products of volcanoes: gases, pyroclasts and lavas of basic, intermediate and acid composition. Explain the distribution of volcanic products around volcanoes.

(g) describe the characteristics of: submarine; fissure, shield and strato-volcanoes and explain the type of volcanic activity at each. Know about caldera formation, pyroclastic flows and geysers.

(h) appreciate the social and economic effects of volcanic activity and the danger to life and property of different types of volcanic activity including climatic change. Describe the advantages which volcanic activity can bring. Describe methods for the prediction of volcanic activity: historic pattern of activity, changes in ground level, changes in gas composition and precursor earthquake tremors. Describe the methods of risk analysis: extent and path of lava flows, blast damage, ash falls, pyroclastic flows and lahars using hazard maps.

5.2.4 Metamorphic Processes and Products

Learning Outcomes

Candidates should be able to:

(a) explain thermal (contact), regional and burial metamorphism in relation to varying temperatures and pressures.

(b) describe the relation of parent rock type and composition and the environment of metamorphism to the mineralogy of the resulting metamorphic rock:

  (i) mica and clay minerals in slate from shale,

  (ii) mica and garnet in schist from slate,

  (iii) quartz, feldspar and mafic minerals in gneiss from schist,

  (iv) calcite in marble from limestone,

  (v) quartz in quartzite (metaquartzite) from sandstone.

(c) describe thermal metamorphism by heat from an igneous intrusion to form different grades of unfoliated rocks within a metamorphic aureole. Understand the factors controlling the width of contact aureoles and metamorphic grade.

5.3 Module 2833, Component 01: Economic and Environmental Geology

C3.1a, C3.1b, C3.2; N3.1, N3.2, N3.3.

WO3.1, WO3.2, WO3.3; LP3.1, LP3.2, LP3.3.

This module provides a broad treatment of the main issues in economic geology including ethical, social, environmental and technological implications and applications. It covers the processes that govern water supply, energy resources, metal deposits and applied geology. Knowledge and skills from both Modules 2831 and 2832 are necessary.

5.3.1 Water Supply

Learning Outcomes

Candidates should be able to:

(a) define and explain the following terms: porosity, permeability, hydrostatic pressure, hydraulic gradient, aquifers and the water table.

(b) describe and explain the geological conditions leading to the formation of springs as a result of lithology, faults and unconformities.

(c) explain the geological conditions necessary for artesian basins and water supply from wells.

(d) describe water supply in relation to river, reservoir and underground sources. Understand the advantages and disadvantages of surface and underground supply. Understand that water resources are both renewable and sustainable if carefully developed.

5.3.2 Energy Resources

Learning Outcomes

Candidates should be able to:

(a) describe and explain the origin of oil and natural gas and migration from source-rock to reservoir-rock under a cap rock. Define and recognise the trap structures; anticline, fault, salt dome, unconformity and lithological.

(b) describe the methods of primary and secondary recovery of oil and natural gas from suitable reservoirs and the environmental and technological problems of oil and natural gas extraction.

(c) describe the occurrence of oil and natural gas in and around the British Isles and its social and environmental implications. Understand that oil and natural gas are examples of non-renewable energy resources.

(d) describe and explain the origin of coal and coal seams as part of a cyclothem. Describe the development of rank and the physical properties of lignite, bituminous coal and anthracite.

(e) describe the methods of extracting economic deposits of coal by opencast and underground mining. Describe the geological problems that can make coal mining uneconomic.

(f) describe the broad structure and distribution of coalfields in the British Isles. Describe the effects of mining and understand the environmental consequences of mining operations. Understand that coal is an example of a non-renewable energy resource.

(g) describe geothermal energy extraction from volcanic sources around the world and potential 'hot' rock sources in the British Isles. Understand that geothermal energy is an example of a renewable energy resource.

5.3.3 Metal Deposits

Learning Outcomes

Candidates should be able to:

(a) show an understanding of concentration factors to produce economic deposits from low crustal abundances of metallic minerals; calculate concentration factors.

(b) describe the concentration of magnetite by gravity-settling in igneous intrusions.

(c) describe the secondary enrichment of chalcopyrite copper deposits.

(d) describe the hydrothermal processes associated with igneous intrusions forming veins of galena, sphalerite and cassiterite.

(e) describe how residual deposits of bauxite are formed as the insoluble product of chemical weathering.

(f) describe the formation of placer deposits of cassiterite and gold in rivers and beaches and the characteristics of these minerals which make them suitable.

(g) describe the effects of mining and understand the environmental consequences of mining operations. Understand that metal mining is an example of unsustainable resource exploitation.

5.3.4 Applied Geology

Learning Outcomes

Candidates should be able to:

(a) describe the geological factors affecting major construction or engineering projects:

(i) road cuttings and embankments;

(ii) tunnels in both hard rock and unconsolidated material;

(iii) waste disposal in quarries;

(iv) dams and reservoirs

(b) Describe methods which can be used to stabilise rocks for these projects: grouting, gabions, rock drains, rock bolts, retaining wall.

(c) describe the geological factors that cause landslips and slumping hazards.

(d) describe how geophysical exploration techniques are used for finding hydrocarbons, coal and metals: seismic reflection and refraction, gravity surveys, magnetic survey using proton magnetometer, electrical resistivity and down hole logging surveys.

(e) describe how the geochemical exploration methods of soil sampling and stream sampling are used for metal exploration.

5.4 Module 2834: Palaeontology

C3.1a; C3.1b; C3.2; C3.3; N3.1; N3.2; N3.3;

LP3.1, LP3.2, LP3.3.

This A2 module provides an in depth knowledge and understanding of the major invertebrate phyla. It covers the preservation of fossils, invertebrate fossil morphology, evolution and mode of life of specific fossil groups and the dating of rocks. Skills from both Modules 2831 and 2832 are necessary. The module introduces the recognition of fossils from drawings or photographs and the use of morphological terms.

5.4.1 Preservation of Fossils

Learning Outcomes

Candidates should be able to:

(a) explain the exceptional preservation of body fossils in amber, tar and Burgess Shale.

(b) describe and explain the preservation of hard skeletal tissues, replacement, preservation by alteration of aragonite to calcite, pyritisation, carbonisation, silicification, cast and mould preservation.

(c) describe trace fossils (tracks, trails and burrows) and outline their use in interpreting palaeoenvironments.

5.4.2 Morphology

Learning Outcomes

Candidates should be able to describe the morphological features, both internal and external, which allow recognition of the main fossil invertebrate phyla:

(a) arthropods (trilobites only); cephalon, thorax, pygidium, glabella, compound eyes, cheeks, facial suture, genal angle, spines, thoracic segment (pleuron) shape of exoskeleton, nature and position of legs, gills and mouth.

(b) brachiopods (articulates only); symmetry, shape, pedicle and brachial valves, ornament, foramen, cardinal process, adductor and diductor muscle scars, relative length and shape of hinge line, umbone, commissure, lophophore support system (brachidium), pedicle

(c) cnidarians (tabulate, rugose and scleractinic corals only); solitary forms (horn, cylindrical), compound forms (fasiculate, massive), corallum, corallite, septa, tabulae, dissepiments, axial structure / columella, calice.

(d) echinoderms (crinoids and echinoids only); Crinoids; columnals / stem, calyx, tegmen, brachia, pinnules, holdfast. Echinoids; shape of test, symmetry, ambulacra and interambulacra, tubercles and spines, tube feet and pore pairs, periproct / anus, peristome / mouth, apical system / disc, labrum, fasciole, plastron, anterior groove.

(e) graptoloids; shape of thecae, shape of rhabdosome, position and number of stipes, sicula, nema.

(f) molluscs (bivalves, gastropods and cephalopods [nautiloids, ammonoids and belemnoids]). Bivalves; symmetry, shape, left and right valves, ornament, umbones, gape, dentition, ligament, pallial line and sinus, adductor muscle scars, shell thickness, foot and siphons. Gastropods; shape of aperture, body chamber, siphonal canal, outer/inner lip, whorl, columella, suture, ornament, apical angle, form of coiling, apex, spire. Cephalopods; shell shape, form of coiling, ornament, septa, septal necks, siphuncle, suture, saddles and lobes, phragmocone, guard, aperture, body chamber, venter, keel, sulcus, umbilicus.

5.4.3 Evolution and Extinction

Learning Outcomes

Candidates should be able to:

(a) describe the use of the first appearance and extinction of the main invertebrate groups, to establish a relative time-scale for the Phanerozoic (eras and systems, stages and zones): trilobites; graptolites, tabulate, rugose and scleractinic corals, goniatites and ammonites, regular and irregular echinoids, long-hinged (strophic) and short-hinged (non-strophic) brachiopods.

(b) describe the possible reasons for mass extinctions at the Permo-Triassic and Cretaceous-Tertiary boundaries and know the groups that became extinct.

(c) describe and explain the morphological changes and evolution of graptolites in the Lower Palaeozoic.

(d) describe and explain the morphological changes and evolution of nautiloids and ammonoids in the Palaeozoic and Mesozoic.

(e) describe and explain the morphological changes and evolution of *Micraster* in the Cretaceous.

(f) describe and explain the factors which make a good zone fossil. Outline the principles of using graptolites, ammonoids and microfossils as zone fossils.

5.4.4 Palaeoenvironments and Mode of Life

Learning Outcomes

Candidates should be able to:

(a) recognise palaeoenvironments using fossil assemblages:

(i) Coal Measure plants to indicate non-marine deltaic environment.

(ii) corals to indicate tropical, marine, reef environment.

(iii) robust molluscs, brachiopods, echinoderms, corals and trilobites to indicate high-energy continental shelf carbonate environment.

(iv) common trace fossils, more delicate molluscs, brachiopods, echinoderms, corals and trilobites to indicate low-energy continental shelf environment.

(v) pelagic microfossils, graptolites and some trilobites to indicate deeper water environment.

(b) describe the fossil evidence for palaeoclimatic changes during the northward movement of the British Isles in the Phanerozoic.

(c) define the terms : fossil life assemblage, fossil death assemblage, derived fossil.

(d) explain how trilobites show adaptive radiation to: nektonic, pelagic, benthonic and infaunal modes of life.

(e) explain how bivalves show adaptive radiation to: attached, sessile, swimming, freelying, shallow infaunal, deep infaunal and vagrant modes of life.

(f) explain the morphological differences between regular and irregular echinoids which reflect their mode of life.

5.4.5 Dating

Learning Outcomes

Candidates should be able to:

(a) describe the division of the geological column into eras and systems using both relative and absolute dating methods.

(b) explain the uses of radiometric dating to establish an absolute time-scale. and the limitations and problems of radiometric dating.

(c) explain how to apply the Potassium-Argon and Uranium-Lead methods of radiometric dating.

(d) describe the use of superposition, way-up-criteria, cross-cutting relationships, included fragments and fossils to date rocks at the surface and in boreholes.

(e) describe the use of biostratigraphic correlation and the problems of derived fossils.

(f) explain the use of varves in lithostratigraphy and volcanic ash layers as chronostratigraphic markers.

5.5 Module 2835: Petrology

	N3.1; N3.2; N3.3; IT3.1; IT3.3;	**LP3.1, LP3.2, LP3.3.**

This A2 module provides an in depth knowledge and understanding of rock classification and rock forming processes. It uses knowledge, understanding and skills gained in the study of Modules 2831, 2833 Component 01 and 2834 and develops further knowledge of igneous, sedimentary and metamorphic processes introduced in Module 2832.

5.5.1 Igneous Classification and Processes

Learning Outcomes

Candidates should be able to:

(a) classify igneous rocks into acid, intermediate, basic and ultrabasic using mineral composition (quartz, feldspars, mafic minerals), crystal grain size and silica percentage.

(b) describe the physical characteristics and origin of the major igneous rock-forming minerals and the identification of: olivine, augite, hornblende, biotite, muscovite, plagioclase and potash feldspars, quartz.

(c) explain the formation of igneous textures within rocks: equigranular, glassy, vesicular, amygdaloidal, flow banding, porphyritic and poikilitic (ophitic).

(d) identify, describe and explain the origin of acidic and intermediate igneous rocks using observation of mineral composition, texture, colour and silica percentage: granite, granodiorite, a porphyry, rhyolite, pumice, obsidian, tuffs, agglomerates and ignimbrites, diorite, andesite.

(e) identify, describe and explain the origin of basic and ultrabasic igneous rocks using observation of mineral composition, texture, colour and silica percentage: gabbro, dolerite, basalt and peridotite.

(f) describe the crystallisation of magmas and Bowen's reaction series: mafic minerals and the discontinuous reaction series; plagioclases and the continuous reaction series. Understand phase diagrams for the diopside-anorthite and anorthite-albite systems.

(g) explain the differentiation of magmas to form different rock groups: ultrabasic, basic, intermediate and acidic. Describe the processes of differentiation by which a variety of rock types can be produced from a single parent magma.

(h) explain the relationship between igneous activity, magmatic composition, rock types and plate boundaries.

(i) recognise and describe the characteristics of intrusive igneous rock masses: batholiths, bosses, stocks, dykes, ring dykes, cone sheets, sills, transgressive sills and laccoliths. Explain the processes involved in their formation.

(j) explain late-stage igneous processes, involving water-rich fluids, to form pegmatites and hydrothermal veins.

(k) describe the physical characteristics and origin of the hydrothermal vein minerals and the identification of: galena, sphalerite, fluorite, barytes, iron pyrites.

5.5.2 Sedimentary Classification and Processes

Learning Outcomes

Candidates should be able to:

(a) classify mechanically-, chemically - and biologically-formed sedimentary rocks by grain size, shape, mineral composition and fossil content.

(b) describe the physical characteristics and origin of the major sedimentary rock-forming minerals and the identification of: quartz, potash feldspar, muscovite, calcite, gypsum, halite, haematite.

(c) identify, describe and explain the origin of clastic sedimentary rocks using observation of grain size, grain shape, degree of sorting, colour, mineral composition and texture; breccia, conglomerate, sandstones (orthoquartzite, arkose, greywacke, micaceous sandstones, desert sandstones), mudstone, clay and shale.

(d) identify, describe and explain the origin of non-clastic sedimentary rocks using observation of colour, fossil content, mineral composition and texture; ironstone, evaporites (gypsum, halite), limestones (micritic, oolitic, fossiliferous, chalk), coals (lignite, bituminous and anthracite).

(e) identify, describe and explain the origin of sedimentary structures within rocks: sole structures (flute casts, tool marks), salt pseudomorphs, imbricate structure. Explain the origin of cross bedding, graded bedding, ripple marks and desiccation cracks. Understand the uses of these sedimentary structures as way-up, palaeo-current and palaeo-environmental indicators. Describe secondary sedimentary structures: load casts and slumping.

(f) describe the characteristic products of sedimentation in fluvial environments: alluvial fan breccias, arkoses and conglomerates, channel sandstones, flood plain clays and silts and explain the processes which formed them.

(g) describe the characteristic products of sedimentation in glacial environments: boulder clay (till), fluvio-glacial sands and gravels and explain the processes which formed them. Explain how glacial deposits can be used to interpret climatic change.

(h) describe the characteristic products of sedimentation in clear, non-clastic, shallow marine environments to form carbonate deposits and explain the processes which formed them. Describe how invertebrate skeletons form bioclastic and reef limestones and chalk. Describe how oolite and micrite limestones are formed by chemical processes. Explain how reef limestones can be used to interpret climatic change.

(i) describe the characteristic products of sedimentation in shallow marine environments to form evaporites (gypsum, anhydrite, halite and potassium salts) and explain the processes which formed them. Explain how evaporite sequences form in cycles in large barred basins or seas. Explain how evaporite deposits can be used to interpret climatic change.

(j) describe the characteristic products of sedimentation in deep marine basin environments: formation of turbidites of greywackes and shales, and calcareous and siliceous oozes from microfossils and explain the processes which formed them.

(k) Describe the characteristics of suitable materials for building stone, roadstone, brick clay, aggregate and the manufacture of cement. State the uses for these materials. Understand the environmental implications of their exploitation.

(l) explain the interpretation of vertical sequences in terms of lateral facies change (Walther's Law).

(m) describe and use the methods by which sedimentary sequences may be correlated:

(i) lithostratigraphic methods of correlation using tuffs and varves and other suitable rocks at the surface and in boreholes. The problems of correlation, including diachronous beds, lithological variation and lateral change.

(ii) biostratigraphic methods of correlation, at the surface and in boreholes, and the problems including derived fossils.

(iii) chronostratigraphic methods and problems of correlation at the surface and in boreholes.

5.5.3 Metamorphic Classification and Processes

Learning Outcomes

Candidates should be able to:

(a) classify metamorphic rocks using observations of grain size, mineral content and foliation.

(b) describe the physical characteristics and origin of the major metamorphic rock-forming minerals and the identification of: chlorite, biotite, muscovite, garnet.

(c) identify, describe and explain the origin of metamorphic rocks using observation of mineral content, orientation, textures and foliation, including cleavage: slate, schist, gneiss, quartzite (metaquartzite), marble, spotted slate.

(d) explain the formation of metamorphic textures within rocks: slaty cleavage, phyllitic, schistosity, gneissose banding, sugary and granoblastic.

(e) describe the factors controlling metamorphism: temperature, pore pressure, load pressure, compressive stress and time.

(f) describe the chemical reactions which occur during metamorphism: clay minerals to form Al_2SiO_5 polymorphs and the breakdown of muscovite to feldspar; impure limestones to form wollastonite and garnet. Explain the loss of volatiles (CO_2 and H_2O) and the relationship to reversible reactions.

(g) describe the thermal gradient and the distribution of index minerals within a metamorphic aureole (biotite, andalusite, sillimanite). Explain the Al_2SiO_5 polymorphs and their relationship to temperature and pressure in thermal metamorphism.

(h) describe the grades of thermal metamorphic rocks: low-grade - spotted slate, medium grade - andalusite slate and high grade - hornfels and explain their relationship to temperature.

(i) explain regional metamorphism in relation to destructive plate margins: paired metamorphic belts at subduction zones and broad orogenic belts at continental-continental plate margins.

(j) define metamorphic grade and isograds. Describe the grades of regional metamorphic rocks: low grade - slate, phyllite; medium grade - schist; high grade - gneiss and explain their relation to pressure.

(k) describe metamorphic zones (Barrovian) and index minerals: chlorite, biotite, garnet, kyanite and sillimanite. Explain the Al2SiO5 polymorphs and their relationship to temperature and pressure in regional metamorphism.

(l) explain dynamic metamorphism and the process of cataclasis. Describe the formation of mylonite.

5.6 Module 2836, Component 01: Geological Skills

LP3.1; LP3.2; LP3.3

This synoptic component concentrates on description, observational and interpretive geological skills. It requires the use of photographs, photomicrographs, drawings, descriptions, annotated sketches, graphic logs and the interpretation of geological maps, geological cross-sections and geological histories.

Geological maps and cross-sections are used to unify a range of topics from different modules.

The associated question paper uses knowledge, understanding and skills developed in the study of module 2831 (particularly section 5.1.4 on geological structures), from modules 2832 and 2835 (rocks and minerals and their forms and textures), from module 2833 component 01 (the uses of rocks and minerals as well as environmental issues of extraction) and, from module 2834, fossils and dating, particularly in relation to maps.

6 Further Information and Training for Teachers

To support teachers using these specifications, OCR will make the following materials and services available:

- a full programme of In-Service Training (INSET) meetings;
- specimen question papers and mark schemes;
- past question papers and mark schemes after each examination session;
- coursework guidance materials, including a Geology Coursework Handbook;
- written advice on coursework proposals;
- individual feedback to each Centre on the moderation of coursework;
- a Report on the Examination, compiled by senior examining personnel, after each examination session.

If you would like further information about these specifications, please contact OCR.

7 Reading List and Other Resources

Introduction

The resources referred to below may prove useful in delivering AS GCE and Advanced GCE Geology.

The list is not intended to be exhaustive nor does inclusion on the list constitute a recommendation of the suitability of the resource for the specification. The list below contains books (and CD-ROMS) that are available in spring 2004. The possibility exists that more up to date texts which have been prepared for the revised GCE specifications may become available. Teachers will need to use their professional judgement in assessing the suitability of the material contained in this list.

General

Allaby A, *A dictionary of earth science*, Oxford University Press, 2003

Duff D, *Holmes' principles of physical geology,* 4th edition, Chapman and Hall, 1993

Edwards, D & King C, *Geoscience,* Hodder & Stoughton Educational, 1999

Kearey P, *The encyclopedia of the solid earth sciences*, Blackwell Scientific, 1994

Lapidus DF, *Collins dictionary of geology*, Harper, 2003

McLeish, A, *Geological science*, Nelson, 1993

Pellant C and Phillips R, *Rocks, minerals and fossils of the world*, Pan, 1990

Porter SC and Skinner BJ, *The Dynamic Earth: An Introduction To Physical Geography*, Wiley, 2000

Kearey P, *The new Penguin dictionary of geology*, Penguin

Geopix website at www.geopix.org – geological photographs and study guides for AS/A2 Level.

Module 2831: Global Tectonics and Geological Structures

Bolt BA, *Earthquakes*, Freeman, 5th Edition, 2004

Erickson J, *Volcanoes and earthquakes*, Tab Books, 1990

Hamblin WK, *Earth's dynamic systems*, Prentice Hall, 2003

Kearey P & Vine FJ, *Global Tectonics*, Blackwell, Oxford, 1996

Monroe JS and Wicander R, *Physical geology: exploring the earth*, Brooks Cole, 2001

Plummer CC and McGeary D, *Physical Geology*, McGraw Hill, 1996

Press F and Siever R, *Earth*, Freeman, 2004 (inc. CD-ROM)

CD-ROMs

Plummer CC & McGeary D, *Interactive Plate Tectonics*, Wm. C. Brown, Dubuque, 1996

Module 2832: The Rock Cycle – Processes and Products

Blatt H and Ehlers EG, *Petrology Igneous, Sedimentary and Metamorphic*, Freeman, 1982

Francis P, *Volcanoes: a planetary perspective*, Oxford University Press, 1993

Knapp B, *Volcano*, Heinemann, 1990

Scarth A, *Volcanoes*, UCL Press, 1994

Van Rose S, *Volcano*, Dorling Kindersley, 1992

Module 2833, Component 01: Economic and Environmental Geology

Blyth FGH, and de Freitas MH, *A geology for engineers,* Edward Arnold, 2004

McLean, AC, *Geology for civil engineers,* Allen & Unwin, 1985

Montgomery CW, *Environmental geology,* Wm C Brown, 2002

Open University Course Team, *Fossil Fuels (S268 Block 4)*, Open University Press, 2001

Tank RW, *Environmental geology,* Oxford University Press, 1983

Waltham AC, *Foundations of Engineering* Geology, Blackie, 2001

Woodcock N, *Geology and Environment in Britain & Ireland*, UCL Press, London, 1994

Module 2834: Palaeontology

Allen KC et al, *Evolution and the Fossil Record*, Wiley 1991

Black RM, *Elements of palaeontology*, Cambridge University Press, 1989

British Museum (Natural History), *British Caenozoic Fossils*, HMSO, 2001

British Museum (Natural History), *British Mesozoic Fossils*, HMSO, 2001

British Museum (Natural History), *British Palaeozoic Fossils*, HMSO, 2002

Clarkson ENK, *Invertebrate palaeontology and evolution*, Blackwell Science, 1998

Doyle P, *Understanding fossils : an introduction to invertebrate palaeontology*, Wiley,1996

Fortey RA, *Fossils the key to the past*, Natural History Museum, 2002

Module 2835: Petrology

Adams, AE and MacKenzie WS, *Atlas of sedimentary rocks under the microscope*, Longman, 1984

Donaldson CH and. MacKenzie WS, *Atlas of igneous rocks and their textures*, Longman, 1982

Hall A, *Igneous petrology*, Prentice Hall, 1996

Leeder MR, *Sedimentology process and product*, Allen & Unwin, 1982

Mason R, *Petrology of the Metamorphic Rocks*, Kluwer Academic Publishers, 1990

Simpson B, *Rocks and Minerals, Heinemann*

Thorpe RS & Brown GC, *The Field Description of Igneous Rocks*, Wiley, 1991

Tucker ME, *Sedimentary petrology an introduction*, Blackwell Scientific, 2001

Tucker ME, *Sedimentary Rocks in The Field*, Wiley, Chichester, 2003

Appendix A

Key Skills

These specifications provide opportunities for the development of the Key Skills of Communication, Application of Number, Information Technology, Working With Others, Improving Own Learning and Performance and Problem Solving.

Through classwork, coursework and preparation for external assessment, candidates may produce evidence for Key Skills at Level 3. However, the extent to which this evidence fulfils the requirements of the QCA Key Skills specifications at this level will be dependent on the style of teaching and learning adopted for each module. In some cases, the work produced may meet the evidence requirements of the Key Skills specifications at a higher or lower level.

Throughout section 5 the symbol  is used in the margin to highlight where Key Skills development opportunities are signposted. The following abbreviations are used to represent the above Key Skills:

C = Communication

N = Application of Number

IT = Information Technology

WO = Working with Others

LP = Improving Own Learning and Performance

PS = Problem Solving

These abbreviations are taken from the QCA Key Skills specifications for use in programmes starting from September 2000. References in section 5 and Appendix A, for example **IT3.1**, show the Key Skill (IT), the level (3) and subsection (1).

Centres are encouraged to consider the OCR Key Skills scheme to provide certification of Key Skills for their students.

Detailed opportunities for generating Key Skills evidence through this specification are posted on the OCR website, www.ocr.org.uk

Key Skills Coverage

For each module, the following matrix indicates those Key Skills for which opportunities exist for at least some coverage of the relevant Key Skills specification.

Module	Communication	Application of Number	IT	Working with Others	Learning Performance	Problem Solving
	Level 3	Level 3	Level 3	Level 3	Level 3	Level 3
2831	✓	✓	✓		✓	
2832	✓		✓		✓	
2833	✓	✓	✓	✓	✓	✓
2834	✓	✓			✓	
2835	✓	✓	✓		✓	
2836	✓	✓	✓	✓	✓	✓

Appendix B

Notes for Guidance on Coursework Assessment and Submission

This appendix is intended to provide guidance for teachers in assessing laboratory/field skills, but should not exert an undue influence on the methods of teaching or provide a constraint on the practical work undertaken by candidates. It is not expected that all of the practical work undertaken by candidates would be appropriate for assessment.

For examples of suitable tasks for assessing practical skills, and for examples of possible individual studies, teachers should refer to the Geology Coursework Handbook. Copies can be ordered from the OCR Publications Department.

The experimental and investigative skills to be assessed are:

P Planning;

I Implementing;

A Analysing Evidence and Drawing Conclusions;

E Evaluating Evidence and Procedures.

It is expected that candidates will have had opportunities to acquire experience and develop the relevant skills before assessment takes place.

The skills may be assessed at any time during the course using suitable practical activities, based on laboratory or field work, related to or part of the content of the teaching course. The context(s) for the assessment of the coursework for Unit 2833, component 02 should be drawn from the content of AS Modules 2831, 2832 and 2833, component 01. The context(s) for the assessment of the coursework for Unit 2836, component 02 should be drawn from the content of A2 Modules 2834, 2835 and 2836, component 01 in which the level of demand of the related scientific knowledge and understanding is higher.

In AS and in A2 the skills may be assessed in the context of separate practical exercises, although more than one skill may be assessed in any one exercise. They may also be assessed all together in the context of a single 'whole investigation' in which the task is set by the teacher, or using individual investigations in which each candidate pursues his or her own choice of assignment.

Skills **P** and **A** are marked out of 8 and Skills **I** and **E** are marked out of 7. Thus, for each candidate entered for Unit 2833, Component 02, or for Unit 2836, Component 02, Centres are required to award **one** mark for each of Skills **P**, **I**, **A** and **E**. Hence the maximum raw mark available for each component is 30. These marks are then doubled so that the final marks submitted are out of 60.

When a skill has been assessed on more than one occasion the better or best mark for that skill should be submitted. However, Centres are recommended **not** to assess the skills on more than two occasions in each of AS and A2 since this may take up time which might better be devoted to other aspects of the specification. In each of AS and A2 the time required for the internal assessment of experimental and investigative work is normally expected to be between 5 and 10 hours.

All coursework is marked by the teacher and internally standardised by the Centre. Marks are then submitted to OCR by a specified date, after which postal moderation takes place in accordance with OCR procedures. The purpose of moderation is to ensure that the standard for the 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.

The Demand of an Activity

The demand of an activity is an important feature of the assessment. From the bottom to the top of the mark range in a skill area the activity should involve increasing demands of associated scientific knowledge and understanding, manipulation, precision and accuracy and complexity. Also, the mark descriptors for Skills **P** and **A** at A2 include synoptic elements.

In A2, candidates are required to apply knowledge, understanding and skills from the AS and A2 parts of the Advanced GCE specification in planning experimental work and in the evaluation of data (synoptic assessment). Details of the way in which tasks can be differentiated are given in Section 4.2 and further guidance on setting appropriate tasks is given in the Coursework Handbook published separately.

The difference in standard of AS and A2 is a product of the level of demand of the related scientific knowledge and understanding and the complexity and level of demand of the tasks set.

Teachers should appreciate that the choice of an activity that is comparatively undemanding (primarily in terms of the level of the scientific knowledge and understanding that can be linked to the activity, and in the range/complexity of the equipment/techniques used) may prevent access to the highest marks.

Teachers should be aware of this feature of the assessment so that, when considering the award of higher marks, the activity should require a sophisticated approach and/or complex treatment. Higher marks must not be awarded for work that is simplistic or trivial.

One of the factors that determine the demand of an activity is the level of guidance given to candidates. The use of a highly structured worksheet, for example, will reduce the number of decisions and judgements required by the candidate and so will limit the range of marks available.

Marking Candidates' Work

A similar set of mark descriptors is used for both AS and A2 (see Appendix C). The descriptors should be used to make a judgement as to which mark best fits a candidate's performance.

The descriptors have been written to provide clear continuity from the assessment of Sc1 for GCSE. This should ensure an effective continuation of the development of candidates' skills from GCSE to AS GCE and Advanced GCE.

The mark descriptors within a skill area have been written to be hierarchical. Thus, in marking a piece of work, the descriptors for the lowest defined mark level should be considered first and only if there is a good match should the descriptors for the next level up be considered. Therefore, if a teacher is considering awarding a high mark for a piece of work, the work must have demonstrated a good match to all the lower mark descriptors.

For each skill the scheme allows the award of intermediate marks (between the defined mark levels). An intermediate mark may be awarded when the work of a candidate exceeds the requirements of a defined mark level but does not meet the requirements of the next higher defined mark level sufficiently to justify its award. Thus, an intermediate mark could be awarded if the work meets only one of the two descriptors at the higher defined mark level, provides a partial match to both or provides a complete match to one and a partial match to the other.

In Skills P and A, a mark above the highest defined mark level should be awarded for work which meets all the requirements of the descriptors for the highest defined mark level and is judged to be of exceptional merit in terms of originality, depth, flair or the use of novel or innovative methods.

A mark of zero should be awarded where there has been an attempt to address the skill but the work does not meet the requirements of the lowest defined mark level.

The marks awarded should be based on both the final written work and the teacher's knowledge of the work carried out by the candidate. In assigning a mark, attention should be paid to the extent of any guidance needed by, or given to, the candidate.

In defining the various mark descriptors it is recognised that practical tasks vary widely, both in the experimental procedures used, and in the nature of the observations and measurements which may be made by the candidate. The mark descriptors for each defined level are intended to provide guidance to teachers on how to recognise levels of achievement. It is acknowledged that the balance between the statements provided for a particular level of performance will vary with the nature of the activity. Whilst both statements for a particular defined level must be considered in awarding the marks, it is clear that teachers will need to judge for themselves the relative weightings they attach to each of the statements.

Synoptic Assessment

Synoptic assessment involves the explicit drawing together of knowledge, understanding and skills learned in different parts of the Advanced GCE course. Assessment Objective AO4 relates specifically to synoptic assessment and marks from Unit 2836 Component 02 contribute to the assessment of AO4.

During experimental and investigative work, synoptic assessment

- allows candidates to apply knowledge and understanding of principles and concepts from different parts of the specification in planning experimental work and in the analysis and evaluation of data.
- allows candidates to apply skills and techniques learned during the course.

All practical work assessed internally by centres for the A2 unit 2836, component 02 should draw on the range of experience that the candidate has acquired during the AS and A2 courses. It is particularly important that an exercise used to assess planning skills should involve an element of research which goes beyond the repetition of an experiment that simply reflects the use of ideas or techniques met within the module currently being studied. Likewise, an assessment involving analysing evidence and drawing conclusions must require a candidate to use knowledge and understanding acquired outside the confines of a standard experiment recently practised. During the process of moderation, evidence will be sought that such breadth has been achieved.

The assessment descriptors for the skills of Planning (**P**) and Analysing Evidence and Drawing Conclusions (**A**) include statements that relate specifically to synoptic assessment. These are shown in bold and should be applied only when assessing A2 work. Thus, in A2, a candidate will not be able to achieve more than 2 marks in each of Skills **P** and **A** without demonstrating aspects of synoptic assessment. Candidates should also bring to the assessment of Skill **I** (Implementing) their experience of practical and investigative work from throughout the course. In Skill **E** (Evaluating Evidence and Procedures) aspects of Skills **P** and **A** are evaluated. Overall, in A2, approximately 15 of the 30 available marks can thus be identified as contributing to an assessment of AO4 (synoptic assessment).

Quality of Written Communication

Coursework must include an assessment of candidates' quality of written communication. At Level 3 candidates are required to:

- select and use a form of writing that is appropriate to the purpose and complex subject matter;
- organise relevant information clearly and coherently, using specialist vocabulary when appropriate;
- ensure text is legible and spelling, grammar and punctuation are accurate, so the meaning is clear.

The mark descriptors for Skills **P** and **A** have been written to include these aspects and these skills carry an additional mark each in recognition of this.

Annotation of Candidates' Work

Each piece of assessed coursework must be annotated to show how the marks have been awarded in relation to the relevant skills.

The writing of comments on candidates' work can provide a means of dialogue and feedback between teacher and candidate and a means of communication between teachers during internal standardisation of coursework. The main purpose of annotating candidates' coursework should be, however, to provide a means of communication between teacher and the Moderator, showing where marks have been awarded and why. The sample of work which is submitted for moderation **must** show how the marks have been awarded in relation to the marking criteria.

Annotations should be made at appropriate points in the margins of the text. The annotations should indicate both where achievement for a particular skill has been recognised and the mark awarded. It is suggested that the minimum which is necessary is that the 'shorthand' mark descriptors (for example, **P.5a**, **I.3b**) should be written at the point on the script where it is judged that the work has met the descriptors concerned.

For Skill **I** (Implementing) more detail is necessary, and the Moderator will require evidence concerning candidates' use of practical techniques and safe working practice. This evidence could take the form of checklists or written notes.

Health and Safety

In UK law, health and safety is the responsibility of the employer. For most establishments entering candidates for AS and Advanced GCE this is likely to be the education authority or the governing body. Employees, i.e. teachers and lecturers, have a duty to cooperate with their employer on health and safety matters.

Various regulations, but especially the COSHH Regulations 1996 and the Management of Health and Safety at Work Regulations 1992, require that before any activity involving a hazardous procedure or harmful micro-organisms is carried out, or hazardous chemicals are used or made, the employer must provide a risk assessment. A useful summary of the requirements for risk assessment in school or college science can be found in Chapter 4 of *Safety in Science Education* (see below). For members, the CLEAPSS guide, *Managing Risk Assessment in Science* offers detailed advice.

Most education employers have adopted a range of nationally available publications as the basis for their Model Risk Assessments. Those commonly used include:

Safety in Science Education, DfEE, 1996, HMSO, ISBN 0 11 270915 X;

Safeguards in the School Laboratory, 10th edition, 1996, ASE ISBN 0 86357 250 2;

Hazcards, 1995, CLEAPSS School Science Service*;

Laboratory Handbook, 1988-97, CLEAPSS School Science Service*;

Topics in Safety, 2nd edition, 1988, ASE ISBN 0 86357 104 2;

Safety Reprints, 1996 edition, ASE ISBN 0 86357 246 4.

SSERC *Hazardous Chemicals, A Manual for Science Education,* 1997, SSERC ISBN 0 9531776 0 2

* Note that CLEAPSS publications are only available to members or associates.

Where an employer has adopted these or other publications as the basis of their model risk assessments, an individual school or college then has to review them, to see if there is a need to modify or adapt them in some way to suit the particular conditions of the establishment. Such adaptations might include a reduced scale of working, deciding that the fume cupboard provision was inadequate or the skills of the candidates were insufficient to attempt particular activities safely. The significant findings of such risk assessment should then be recorded, for example on schemes of work, published teachers guides, work sheets, etc. There is no specific legal requirement that detailed risk assessment forms should be completed, although a few employers require this.

Where project work or individual investigations, sometimes linked to work-related activities, are included in specifications this may well lead to the use of novel procedures, chemicals or micro-organisms, which are not covered by the employer's model risk assessments. The employer should have given guidance on how to proceed in such cases. Often, for members, it will involve contacting the CLEAPSS School Science Service (or, in Scotland, SSERC).

When candidates are planning their own practical activities, whether in project work or more routine situations, the teacher or lecturer has a duty to check the plans before practical work starts and to monitor the activity as it proceeds.

Support material

Details of suitable tasks for the internal assessment of Laboratory/Field Skills are provided in a support booklet for teachers, the Geology Coursework Handbook. This gives guidance for applying the criteria to specific activities. Exemplar Summary Grids for AS and A2 give an outline of the exercises included.

AS - Exemplar Summary Grid

The following table summarises the skills that can be assessed for some suggested activities that are suitable for AS.

- **Skill P** Planning
- **Skill I** Implementing
- **Skill A** Analysing Evidence and Drawing Conclusions
- **Skill E** Evaluating Evidence and Procedures

Laboratory / Field Activity	Skill P	Skill I	Skill A	Skill E
An investigation into the geological structures of Fox Bay				
Analysing the causes and the effects of an earthquake.			✓	✓
Investigating the origin of five mystery sediments to determine the environment of deposition by sieving and sediment analysis.		✓	✓	
An investigation into the igneous structures of Arran		✓	✓	
Porosity and permeability experiment	✓			✓
Geophysical survey - a quarry investigation	✓	✓		

A2 - Exemplar Summary Grid

The table below summarises the skills that can be assessed for each of four activities suitable for A2.

- **Skill P** Planning
- **Skill I** Implementing
- **Skill A** Analysing Evidence and Drawing Conclusions
- **Skill E** Evaluating Evidence and Procedures

Laboratory / Field Activity	Skill P	Skill I	Skill A	Skill E
Comparison of fossil assemblages and palaeoenvironments.			✓	✓
Mapping and Graphic logging exercise		✓	✓	
A laboratory investigation into cooling rates and crystal size.	✓			✓
An investigation into the origin of Triassic sediments at Lowchester	✓	✓		

Appendix C

Mark Descriptors for Laboratory / Field Skills

In defining the various mark descriptors, it is recognised that practical tasks vary widely, both in the experimental procedures used and in the nature of the observations and measurements which may be made by the candidate. The mark descriptors within each defined level are intended to provide guidance to teachers on how to recognise levels of achievement. It is acknowledged that the balance between the statements provided for a particular level of performance will vary with the nature of the activity. Whilst both statements for a particular level **must** be considered in awarding the marks, it is clear that teachers will need to judge for themselves the relative weightings they attach to each of the statements.

For examples of suitable tasks for assessing practical skills, and for examples of possible individual studies, teachers should refer to the Geology Coursework Handbook. Copies can be ordered from the OCR Publications Department.

Skill P – Planning		Total 8
Mark	**Descriptor**	**The candidate:**
1	**P.1a**	develops a question or problem in simple terms and plans a fair test or an appropriate practical procedure, making a prediction where relevant.
	P.1b	chooses appropriate equipment.
2		
3	**P.3a**	develops a question or problem using scientific knowledge and understanding **drawn from more than one area of the specification**; identifies the key factors to vary, control or take account of.
	P.3b	decides on a suitable number and range of observations and/or measurements to be made.
4		
5	**P.5a**	uses detailed scientific knowledge and understanding **drawn from more than one module of the specification** and information from preliminary work or a secondary source to plan an appropriate strategy, taking into account the need for safe working and justifying any prediction made;
	P.5b	describes a strategy, including choice of equipment, which takes into account the need to produce precise and reliable evidence; produces a clear account and uses specialist vocabulary appropriately.
6		
7	**P.7a**	retrieves and evaluates information from a variety of sources, and uses it to develop a strategy which is well structured, logical and linked coherently to underlying scientific knowledge and understanding **drawn from different parts of the AS and A2 specification**; uses spelling, punctuation and grammar accurately.
	P.7b	justifies the strategy developed, including the choice of equipment, in terms of the need for precision and reliability.
8		

The statements in bold represent additional requirements when assessing Unit 2836, Component 02; they are not to be used for Unit 2833, Component 02.

Both statements at a defined level must be satisfied in order that the mark for this level is awarded. All descriptors for lower defined levels must be satisfied before a higher mark is awarded. From the bottom to the top of the mark range the activity should involve increasing demands of related scientific knowledge and understanding, manipulation, precision, accuracy and complexity.

Skill I – Implementing		Total 7
Mark	**Descriptor**	**The Candidate:**
1	**I.1a**	demonstrates competence in simple techniques and an awareness of the need for safe working.
	I.1b	makes and records observations and/or measurements which are adequate for the activity.
2		
3	**I.3a**	demonstrates competence in practised techniques and is able to manipulate materials and equipment with precision.
	I.3b	makes systematic and accurate observations and/or measurements which are recorded clearly and accurately.
4		
5	**I.5a**	demonstrates competence and confidence in the use of practical techniques; adopts safe working practices throughout.
		makes observations and/or measurements with precision and skill; records observations and/or measurements in an appropriate format.
6		
7	**I.7a**	demonstrates skilful and proficient use of all techniques and equipment.
	I.7b	makes and records all observations and/or measurements in appropriate detail and to the degree of precision permitted by the techniques or apparatus.

Both statements at a defined level must be satisfied in order that the mark for this level is awarded. All descriptors for lower defined levels must be satisfied before a higher mark is awarded. From the bottom to the top of the mark range the activity should involve increasing demands of related scientific knowledge and understanding, manipulation, precision, accuracy and complexity.

Skill A - Analysing Evidence & Drawing Conclusions		Total 8
Mark	**Descriptor**	**The candidate:**
1	**A.1a**	carries out some simple processing of the evidence collected from experimental work.
	A.1b	identifies trends or patterns in the evidence and draws simple conclusions.
2		
3	**A.3a**	processes and presents evidence gathered from experimental work including, where appropriate, the use of appropriate graphical and/or numerical techniques.
	A.3b	links conclusions drawn from processed evidence with the associated scientific knowledge and understanding **drawn from more than one area of the specification**.
4		
5	**A.5a**	carries out detailed processing of evidence and analysis including, where appropriate, the use of advanced numerical techniques such as statistics, the plotting of intercepts or the calculation of gradients.
	A.5b	draws conclusions which are consistent with the processed evidence and links these with detailed scientific knowledge and understanding **drawn from more than one module of the specification**; produces a clear account which uses specialist vocabulary appropriately.
6		
7	**A.7a**	where appropriate, uses detailed scientific knowledge and understanding **drawn from different parts of the AS and A2 specification** to make deductions from the processed evidence, with due regard to nomenclature, terminology and the use of significant figures (where relevant).
	A.7b	draws conclusions which are well structured, appropriate, comprehensive and concise, and which are coherently linked to underlying scientific knowledge and understanding **drawn from different parts of the AS and A2 specification**; uses spelling, punctuation and grammar accurately.
8		

The statements in bold represent additional requirements when assessing Unit 2836, Component 02; they are not to be used for Unit 2833, Component 02.

Both statements at a defined level must be satisfied in order that the mark for this level is awarded. All descriptors for lower defined levels must be satisfied before a higher mark is awarded. From the bottom to the top of the mark range the activity should involve increasing demands of related scientific knowledge and understanding, manipulation, precision, accuracy and complexity.

Skill E - Evaluating Evidence and Procedures		Total 7
Mark	**Descriptor**	**The candidate:**
1	**E1.a**	makes relevant comments on the suitability of the experimental procedures.
	E1.b	recognises any anomalous results.
2		
3	**E3.a**	recognises how limitations in the experimental procedures and/or strategy may result in sources of error.
	E3.b	comments on the accuracy of the observations and/or measurements, suggesting reasons for any anomalous results.
4		
5	**E5.a**	indicates the significant limitations of the experimental procedures and/or strategy and suggests how they could be improved.
	E5.b	comments on the reliability of the evidence and evaluates the main sources of error.
6		
7	**E7.a**	justifies proposed improvements to the experimental procedures and/or strategy in terms of increasing the reliability of the evidence and minimising significant sources of error.
	E7.b	assesses the significance of the uncertainties in the evidence in terms of their effect on the validity of the final conclusions drawn.

Both statements at a defined level must be satisfied in order that the mark for this level is awarded. All descriptors for lower defined levels must be satisfied before a higher mark is awarded. From the bottom to the top of the mark range the activity should involve increasing demands of related scientific knowledge and understanding, manipulation, precision, accuracy and complexity.

Appendix D

Mathematical Requirements

Arithmetic and Computation

Candidates should be able to:

recognise and use expressions in decimal and standard form;

use ratios, fractions and percentages;

make estimates of the results of calculations (without using a calculator);

use calculators to find and use x^2, $\frac{1}{x}$, $\sqrt{x}$, $\log_{10}x$.

Handling Data

Candidates should be able to:

- use an appropriate number of significant figures;
- find arithmetic means and medians;
- construct and interpret bar charts, pie charts and histograms;
- use a technique for smoothing a set of data;
- understand the use of scatter plots and correlation coefficients to identify a relationship between two variables;
- interpret and use logarithmic scales.

Algebra

Candidates should be able to:

- understand and use the following symbols: <, >, Δ, $\approx$, $\propto$;
- understand use the prefixes: giga (G), mega (M), kilo (k), milli (m), micro (μ), nano (n);
- change the subject of an equation;
- substitute numerical values into algebraic equations using appropriate units for physical quantities.

Graphs

Candidates should be able to:

- translate information between graphical, numerical and algebraic forms;
- plot and interpret graphs of two variables from laboratory/field or other data.

Appendix E

Glossary of Terms used in Question Papers

It is hoped that the glossary will prove helpful to candidates as a guide, although it is not exhaustive. The glossary has been deliberately kept brief not only with respect to the number of terms included but also to the descriptions of their meanings. Candidates should appreciate that the meaning of a term must depend in part on its context. They should also note that the number of marks allocated for any part of a question is a guide to the depth of treatment required for the answer.

(a) *Define (the term[s])*... is intended literally, only a formal statement being required.

(b) *Explain / What is meant by*... normally implies that a definition should be given, together with some relevant comment on the significance or context of the term(s) concerned, especially where two or more terms are included in the question. The amount of supplementary comment intended should be interpreted in the light of the indicated mark value.

(c) *State* ... implies a concise answer with little or no supporting argument.

(d) *List* ... requires a number of points with no elaboration. Where a given number of points is specified, this should not be exceeded.

(e) *Describe* ... requires candidates to state in words (using diagrams where appropriate) the main points of the topic. The amount of description intended should be interpreted in the light of the indicated mark value.

(f) *Discuss* ... requires candidates to give a critical account of the points involved in the topic.

(g) *Deduce / Predict* ... implies that candidates are not expected to produce the required answer by recall but by making a logical connection between other pieces of information. Such information may be wholly given in the question or may depend on answers extracted in an earlier part of the question. Predict also implies a concise answer with no supporting statement required.

(h) *Outline* … implies brevity, i.e. restricting the answer to giving essential detail only.

(i) *Suggest* ... is used in two main contexts. It may either imply that there is no unique answer or that candidates are expected to apply their general knowledge to a 'novel' situation, one that formally may not be 'in the syllabus'.

(j) *Calculate* ... is used when a numerical answer is required. In general, working should be shown.

(k) *Measure* ... implies that the quantity concerned can be directly obtained from a suitable measuring instrument, for example, mass using a balance, or volume using a burette.

(l) *Determine* ... often implies that the quantity concerned cannot be measured directly but is obtained by calculation, substituting measured or known values of other quantities into a standard formula.

(m) *Estimate* ... implies a reasoned order of magnitude statement or calculation of the quantity concerned. Candidates should make such simplifying assumptions as may be necessary about points of principle and about the values of quantities not otherwise included in the question.

(n) *Sketch* ... when applied to graph work, implies that the shape and/or position of the curve need only be qualitatively correct. However, candidates should be aware that, depending on the context, some quantitative aspects may be looked for, for example, passing through the origin, or discontinuity at a particular value. On a sketch graph it is essential that candidates clearly indicate what is being plotted on each axis.

(o) *Sketch* ... when applied to diagrams, implies that a simple, freehand drawing is acceptable. Nevertheless, care should be taken over proportions and the clear exposition of important details.

Special Note

Candidates are expected to quote units wherever necessary and to quote answers to an appropriate number of significant figures. The number of significant figures used in a numerical problem should be used as a guide to candidates.