AS/A Level GCE

GCE Geology

OCR Advanced Subsidiary GCE in Geology H087

OCR Advanced GCE in Geology H487

specification

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Contents

1 About these Qualifications

This booklet contains OCR's Advanced Subsidiary GCE and Advanced GCE specifications in Geology for teaching from September 2008.

The OCR AS GCE and Advanced GCE Geology specifications afford candidates the opportunity to study geological processes that operate at and below the Earth's surface, the evidence of past life and the uses made of geological materials.

The AS GCE Unit F791 and Unit F792 cover the processes and products that form our planet and its rocks.

The Advanced GCE builds on the AS GCE.

The A2 Unit F794 covers major uses of geological resources, addressing environmental, technological, safety and economic issues in addition to geological concepts.

A2 Unit F795 explores the history of life on Earth and introduces palaeontology, a new area of study at this level. Major vertebrate and invertebrate fossil groups are studied, and the interaction between life and the physical environment are explored.

Geology is a practical science, and both AS Unit F793 and A2 Unit F796 develop practical and investigative skills necessary for the proper study of the subject. There is no substitute for studying in the field, but opportunity is given to complete the practical skills required by these specifications within the laboratory and/or classroom.

1.1 The Three-Unit AS

The Advanced Subsidiary GCE is both a 'stand-alone' qualification and also the first half of the corresponding Advanced GCE. The AS GCE is assessed at a standard appropriate for candidates who have completed the first year of study (both in terms of teaching time and content) of the corresponding two-year Advanced GCE course, ie between GCSE and Advanced GCE.

From September 2008 the AS GCE is made up of **three** mandatory units, of which **two** are externally assessed and **one** is internally assessed and will include the assessment of practical skills. These units form 50% of the corresponding six-unit Advanced GCE.

1.2 The Six-Unit Advanced GCE

From September 2008 the Advanced GCE is made up of **three** mandatory units at AS and **three** further mandatory units at A2.

Two of the AS and **two** of the A2 units are externally assessed.

The third AS unit and the third A2 unit are internally assessed and will include the assessment of practical skills.

1.3 Qualification Titles and Levels

These qualifications are shown on a certificate as:

OCR Advanced Subsidiary GCE in Geology.

OCR Advanced GCE in Geology.

1.4 Aims

The aims of these specifications are to encourage candidates to:

- develop their interest in, and enthusiasm for geology, including developing an interest in further study and careers in geology;
- develop essential knowledge and understanding of different areas of geology and how they relate to each other;
- appreciate how society makes decisions about scientific issues and how the sciences contribute to the success of the economy and society;
- develop and demonstrate a deeper appreciation of the skills, knowledge and understanding of How Science Works;
- appreciate geodiversity, the finite nature of the Earth's resources and the need for geoconservation.

1.5 Prior Learning/Attainment

These specifications have been developed for students who wish to continue with or to begin a study of geology at Level 3 in the National Qualifications Framework (NQF). The specification demands no prior knowledge of geology but students who have completed a course in GCSE Geology and/or who have studied GCSE Science and GCSE Additional Science, or the separate sciences at GCSE, will be well prepared to start the course; achievement at a minimum of grade C in the GCSE sciences should be seen as the normal requisite for entry to AS Geology. However, students who have successfully taken other Level 2 qualifications in Science or Applied Science are also likely to have acquired sufficient knowledge and understanding to begin the course. Other students without formal qualifications may have acquired sufficient knowledge and understanding to enable progression onto the course.

Recommended prior learning for the A2 course is successful performance at Advanced Subsidiary Geology.

2 Summary of Content

2.1 AS Units

Unit F791: *Global Tectonics*

Module 1: Earth structure

Module 2: Earthquakes

Module 3: Continental drift, sea floor spreading and plate tectonics

Module 4: Geological structures

Unit F792: *Rocks – Processes and Products*

Module 1: The rock cycle

Module 2: Igneous processes and products

Module 3: Sedimentary processes and products

Module 4: Metamorphic processes and products

Unit F793: *Practical Skills in Geology 1*

Centre-based or fieldwork task

Evaluative task

2.2 A2 Units

Unit F794: *Environmental Geology*

Module 1: Water supply

Module 2: Energy resources

Module 3: Metallic mineral deposits

Module 4: Engineering geology

Unit F795: *Evolution of Life, Earth and Climate*

Module 1: Formation of fossils

Module 2: Morphology of fossils and adaptation of organisms to live in different environments

Module 3: Fossil evidence of the evolution of organisms and mass extinctions

Module 4: Dating methods, correlation methods and interpretation of geological maps

Module 5: Changing climate

Unit F796: *Practical Skills in Geology 2*

Centre-based or fieldwork task

Evaluative task

3 Unit Content

3.1 AS Unit F791: *Global Tectonics*

AS Unit F791: *Global Tectonics*

This unit provides students with a knowledge and understanding of the Earth, its structure and its place within the solar system, including earthquakes, their effects, the issues around predicting earthquakes and the evidence for plate tectonics. The material covered in this unit forms the basis for understanding the tectonic environments in which rocks are formed and geological structures develop.

The unit consists of **four** teaching modules:

- Module 1: Earth structure
- Module 2: Earthquakes
- Module 3: Continental drift, sea floor spreading and plate tectonics
- Module 4: Geological structures

How Science Works

1) Use theories, models and ideas to develop and modify scientific explanations:
   - origin of the solar system, continental drift, sea floor spreading and plate tectonics.
2) Use knowledge and understanding to pose scientific questions, define scientific problems, present scientific arguments and scientific ideas:
   - continental drift, sea floor spreading and plate tectonics.
3) Use appropriate methodology, including ICT, to answer scientific questions and solve scientific problems:
   - continental drift, sea floor spreading and plate tectonics.
4) Scientific knowledge in its social context:
   - appreciate the tentative nature of scientific knowledge of the structure of the Earth;
   - appreciate the role of the scientific community in validating new knowledge and ensuring integrity: new ideas on mantle convection, magnetism.

Links

F792 AS Unit 2: *Origin of igneous and metamorphic rocks*

Module 1: Earth structure	
Context and exemplification	**Assessable learning outcomes**
1.1.1 An overview of planetary geology and ideas for the origin of the solar system	Candidates should be able to: (a) describe the overall structure of the solar system including gas giants and terrestrial planets with a dense inner core, and current theories of its origin and age; (b) describe the geology of the Earth's moon, Mars, Venus and the asteroid belt using knowledge from space exploration; (c) describe the different types of meteorites as iron, stony and carbonaceous chondrites; (d) describe the evidence for impact craters caused by asteroids and meteorites colliding with the Earth and other bodies in the solar system; (e) describe how volcanic activity has been identified on Io – a moon of Jupiter, Mars and Venus; (f) explain how the age of the Earth and other planets can be determined by radiometric dating methods.
1.1.2 Build up a cross-section knowledge of the internal structure of the Earth	Candidates should be able to: (a) state the depths of the main layers of the Earth: inner core, outer core, mantle, asthenosphere, continental crust and oceanic crust; (b) describe how the thickness of the crust varies under continents and oceans; (c) state the depth of the discontinuities: Lehmann, Gutenberg and Moho; (d) describe the nature of these discontinuities and the changes that occur at them; (e) describe the probable composition of each of the layers of the Earth: inner core, outer core, mantle, asthenosphere, continental crust and oceanic crust.
1.1.3 Understand the asthenosphere and lithosphere and their role in plate tectonics	Candidates should be able to: (a) describe and explain the nature of the asthenosphere as a rheid, plastic layer with 1–5% partial melting. Describe how this layer can be identified using P and S waves and its role in plate tectonics;

	(b) describe the lithosphere as a rigid, brittle layer made of part of the crust and upper mantle, which is divided into plates.
1.1.4 Understand how the internal structure of the Earth can be inferred using direct evidence	Candidates should be able to: (a) explain how evidence from rocks seen in deep mines up to 5km below the surface or deep boreholes up to 13km below the surface can be used as evidence for the composition of the crust; (b) explain how rocks brought to the surface by volcanic activity – in kimberlite pipes as mantle xenoliths – provide evidence of mantle rocks; (c) explain how ophiolites and rocks exposed by erosion provide evidence for the structure and composition of oceanic crust.
1.1.5 Understand how the internal structure of the Earth can be inferred using indirect evidence	Candidates should be able to: (a) explain how the variation in P and S wave velocities can be used to identify layers within the Earth; (b) explain how the properties of P and S waves result in shadow zones, which can be used to determine the state and depth of the inner and outer core of the Earth; (c) explain how the density of the whole Earth and the rocks at the surface can be used to infer the density of the core and mantle rocks; (d) explain how stony and iron nickel meteorites from within the solar system can be used to infer the composition of the mantle and core.
1.1.6 Know about the Earth's magnetic field	Candidates should be able to: (a) describe and explain the probable origin of the Earth's magnetic field; (b) describe palaeomagnetism in rocks and magnetic reversals; (c) describe and explain the variation of magnetic inclination with latitude.

Practical skills are assessed using OCR set tasks. The practical work suggested below may be carried out as part of skill development. Centres are not required to carry out all of these experiments.

- Use scale models or graphs of planets in the solar system to illustrate the difference in scale of the two groups of planets.
- Use models to show the scale of different Earth layers.
- Use a light source and beaker of water to illustrate refraction of seismic waves by the liquid outer core to form shadow zones.
- Partial melting can be illustrated by the melting of chocolate in chocolate chip cookies.

- DIY “potty putty” made from sodium tetraborate (borax) and PVA glue as an analogue for the plastic asthenosphere.
- Use a bar magnet, iron filings and plotting compasses as an analogy of the Earth’s magnetic field.

Module 2: Earthquakes	
Context and exemplification	**Assessable learning outcomes**
1.2.1 Understand characteristics of seismic waves (P, S and surface) generated by earthquakes	Candidates should be able to: (a) describe the characteristics of P waves and explain how their path through the Earth produces the P wave shadow zone; (b) describe the characteristics of S waves and explain how their path through the Earth produces the S wave shadow zone; (c) describe the characteristics of surface (L) waves and explain how these surface waves may cause damage.
1.2.2 Know the terms used to describe and define earthquake activity	Candidates should be able to: (a) describe the earthquake focus and state the range of possible depths within the shallow, medium and deep categories; (b) describe the earthquake epicentre and explain how this can be determined and plotted using distance from seismometers or by isoseismal lines.
1.2.3 Know about the use of the Richter and Mercalli scales	Candidates should be able to: (a) define the *Mercalli scale* and explain how it is used to create intensity maps of earthquake effects; (b) describe the relationship between intensity and both consolidated and unconsolidated rocks; (c) plot and interpret isoseismal lines using intensity data; (d) define the *Richter scale* and explain how it is used to measure the magnitude of an earthquake.
1.2.4 Understand why earthquakes occur when stored stress is released and how they are detected and measured	Candidates should be able to: (a) explain how earthquakes occur when stress stored in rocks is released; (b) describe how earthquakes are detected using a seismometer; (c) interpret and analyse seismograms to show distance from epicentre and magnitude; use time/distance graphs to find the epicentre of an earthquake; use seismograms to demonstrate shadow zones.
1.2.5 Appreciate the social and economic effects of	Candidates should be able to: (a) describe the effects of earthquakes: the type

earthquake activity	of ground movement, damage to structures, liquefaction, landslips, tsunamis and aftershocks; describe the social and economic effects of earthquake activity on humans and the built environment.
1.2.6 Know about methods of earthquake prediction and their social consequences; know about measures designed to reduce the impact of the effects of earthquakes	Candidates should be able to: (a) describe and explain possible methods of earthquake prediction: seismic gap theory, detailed measurements of gases, changes in stress in rocks, changes in water levels in wells, changes in ground levels, magnetism and animal behaviour; (b) describe and explain the social consequences of attempted earthquake prediction; (c) describe measures designed to reduce the impact of the effects of earthquakes: building construction codes to ensure strong foundations and reinforced structures, buildings with flexible structural supports, ground isolation systems using teflon or rubber pads or rollers; earthquake proofing mains gas, electricity and water supplies.

Practical skills are assessed using OCR set tasks. The practical work suggested below may be carried out as part of skill development. Centres are not required to carry out all of these experiments.

- Use SlinkiesTM to demonstrate P, S and L wave motion.
- Plot data to calculate earthquake isoseismals and earthquake epicentres.
- Simulate liquefaction by vibrating sand.
- Carry out research on the effects of individual earthquakes.
- Simulate base isolation systems.
- Use web-based software such as ‘virtual earthquake’ to calculate magnitude and epicentre.

Module 3: Continental drift, sea floor spreading and plate tectonics

Context and exemplification	**Assessable learning outcomes**
1.3.1 Know about the main features of the oceans and continents	Candidates should be able to: (a) describe the characteristic features of: the continental slope, ocean basins with abyssal plains, seamount, mid-ocean ridges and deep-ocean trenches; (b) describe the characteristic features of: major rift systems, continental shields, fold mountains and continental shelf.
1.3.2 Know about the evidence for the drift of continents	Candidates should be able to: (a) describe the evidence for the movement of continents over time using the fit of Africa and South America as part of Gondwanaland: (i) jigsaw fit of the edges of continental shelves for a geographical fit;

	(ii) the distribution of specific rock types of the same age; (iii) the distribution of fold mountain chains; (iv) the distribution of fossils; (v) the distribution of glacial striations and tillites; (vi) palaeomagnetic evidence using polar wandering curves for the movement of continents.
1.3.3 Know about the evidence for sea floor spreading	Candidates should be able to: (a) describe the evidence for the process of sea floor spreading; (i) the distribution of mid-ocean ridges (MOR) and the depth of the ocean floor; (ii) high heat flow and volcanic activity at the MOR; (iii) gravity anomaly at the MOR and the pattern of magnetic anomalies; (iv) transform faults and the pattern of earthquakes; (v) the age pattern and homogenous structure of the ocean crust and the age and distribution of sediment in deep ocean basins; (vi) direct satellite measurements of the width of the oceans; (b) calculate the rate of sea floor spreading from different data sources.
1.3.4 Know about the pattern of earthquake activity around the world	(a) describe and explain the pattern of Earth's seismicity and aseismicity; (b) describe the distribution of shallow earthquakes in relation to: mid-ocean ridges, transform faults, major rift systems, deep-ocean trenches, fold mountains and subduction zones; (c) describe the distribution of deep and intermediate earthquakes in relation to fold mountains and subduction zones; (d) explain the aseismicity of continental shields and ocean basins.
1.3.5 Understand that plate tectonics provides a model of how the outer part of the Earth operates	Candidates should be able to: (a) describe and explain the relationships between continental drift, sea-floor spreading and plate tectonics.

1.3.6 Understand the nature and distribution of oceanic and continental tectonic plates	Candidates should be able to: (a) describe how plate margins are defined by seismic activity; describe the nature of plates; (b) locate and name the major oceanic and continental plates on maps; (c) describe the similarities and differences between oceanic and continental plates in terms of thickness, density and average composition.
1.3.7 Know about the evidence for plates and plate boundaries and the theory of plate tectonics	Candidates should be able to: (a) describe divergent plate margins and the evidence for the plate boundary: mid-oceanic ridges, submarine volcanic activity, mafic magma, high heat flow, smokers, shallow focus earthquakes, transform faults; (b) describe convergent plate margins involving oceanic plates and the evidence for the plate margin: deep-ocean trenches, earthquake foci along the inclined plane of a Benioff zone, heat flow anomalies, volcanic island arc and intermediate volcanic activity; (c) describe convergent plate margins involving continental and oceanic plates and the evidence for the plate margin: deep-ocean trenches, earthquake foci along the inclined plane of a Benioff zone, heat flow anomalies, fold mountains, silicic and intermediate volcanic activity and batholiths; (d) describe convergent plate margins involving only continental plates and the evidence for the plate boundary: shallow and intermediate focus earthquakes, batholiths, metamorphism and folded and faulted sediments in fold mountains; (e) describe conservative plate margins where plates slide past each other and the evidence for the plate margin: shallow focus earthquakes and faulting.
1.3.8 Understand possible mechanisms for the movement of plates	Candidates should be able to: (a) explain how volcanic activity at ocean ridges may ‘push’ plates apart. Describe how gravity and differences in density may ‘pull’ plates apart; (b) describe the evidence for mantle convection; (c) explain how the balance between formation of oceanic crust and its subduction affects the distribution of plate boundaries.

1.3.9 Understand the evidence for hotspots from mantle plumes within plates and in relation to plate movement	Candidates should be able to: (a) define the terms *hotspots* and *mantle plumes*; (b) describe evidence for hotspots and mantle plumes using heat flow and seismic tomography; (c) describe and explain how chains of hotspots and seamounts develop; explain the age of oceanic islands in terms of their movement over a hotspot and how they can be used to calculate the rate of sea floor spreading.

Practical skills are assessed using OCR set tasks. The practical work suggested below may be carried out as part of skill development. Centres are not required to carry out all of these experiments.

- Devise and plan an activity to produce convection cells using water, a heat source and potassium permanganate. Observe and record rates of convection.
- Plot the distribution of earthquakes to demonstrate plate margins.
- Research specific plate boundaries to identify the type of plate margin.
- Use computer simulations or paper models to reconstruct the continents before continental drift occurred.

Module 4: Geological structures

Context and exemplification	**Assessable learning outcomes**
1.4.1 Understand dip and strike in rocks	Candidates should be able to: (a) define and be able to explain: *beds and bedding planes*, *dip*, *apparent dip and strike*; (b) measure dip and strike.
1.4.2 Understand how rocks are deformed by stress and undergo strain	Candidates should be able to: (a) define and describe *stress* and *strain* and how they affect rocks; explain how stress and strain vary due to temperature, confining pressure and time; (b) define *tension*, *compression* and *shear forces* and describe competent and incompetent rocks; explain how tension, compression and shear forces produce geological structures; (c) describe how the deformation of fossils and ooliths can be used to measure strain.
1.4.3 Recognise and identify geological structures	Candidates should be able to: (a) recognise and explain the origin of an angular unconformity; (b) explain the origin and characteristics of tectonic joints: tension and cross joints, cooling joints in igneous rocks, unloading joints in batholiths.

1.4.4 Recognise and know about faults and the features associated with them	Candidates should be able to: (a) define and recognise fault characteristics: fault plane, throw, fault dip, hanging wall, footwall, upthrow and downthrow; (b) describe and recognise: dip-slip faults (normal and reverse), graben (rift), horst and thrusts, strike-slip faults and transform faults; explain their formation and how they can be recognised in the field, on maps and in cross-sections; (c) describe and recognise: slickensides and fault breccia; explain their formation.
1.4.5 Recognise and know about folds and the outcrop patterns associated with them	Candidates should be able to: (a) define and recognise fold characteristics: fold limbs, hinge, crest, trough, axial plane, axial plane trace, plunge, antiform and synform; (b) describe and recognise symmetrical and asymmetrical anticlines, synclines, overfolds, recumbent folds, nappes, isoclinal folds, domes and basins; explain their formation and how they can be recognised in the field, on maps and in cross-sections; (c) describe and explain the formation of slaty cleavage in incompetent rocks by compressive forces and its relationship to folds.
1.4.6 Understand how cross-cutting structures can be used on maps and cross-sections	Candidates should be able to: (a) deduce the age relationships of geological structures using cross-cutting features of beds, faults, folds and unconformities to date them relative to each other; (b) interpret the types of faults and folds from outcrop patterns and determine upthrow and downthrow of faults using the relationships between faults, folds and beds.

Practical skills are assessed using OCR set tasks. The practical work suggested below may be carried out as part of skill development. Centres are not required to carry out all of these experiments.

- Use modelling clay and dough to make models of stress and strain, dipping beds, joints and folds.
- Use photos, sketches and maps to interpret folds and faults.
- Illustrate cleavage using match sticks or spaghetti with compressive stress applied to show the rotation of particles at right angles to the maximum stress
- Plot rose diagrams to illustrate joint patterns.

3.2 AS Unit F792: *Rocks – Processes and Products*

AS Unit F792: *Rocks – Processes and Products*

The aims of this unit are to provide candidates with a broad knowledge and understanding of the rock cycle and the processes that produce igneous, sedimentary and metamorphic rocks. Material covered in this unit forms the basis for understanding the environments in which the rocks are formed and the plate tectonic settings.

This unit consists of **four** teaching modules:

- Module 1: The rock cycle
- Module 2: Igneous processes and products
- Module 3: Sedimentary processes and products
- Module 4: Metamorphic processes and products

How Science Works

1) Use theories, models and ideas to develop and modify scientific explanations:
   - rock cycles and evidence for environments of deposition of sedimentary rocks.
2) Use appropriate methodology, including ICT, to answer scientific questions and solve scientific problems:
   - research on how to predict volcanic activity.
3) Applications, implications and ethical considerations: consider ethical issues in the treatment of humans, other organisms and the environment:
   - volcanic hazard analysis and prediction of eruptions.
4) Scientific knowledge in its social context:
   - appreciate the tentative nature of scientific knowledge: volcanic hazard analysis and prediction of eruptions.

Links

F792 AS Unit F791: *Earthquakes and Plate Tectonics*

Module 1: The rock cycle

Context and exemplification	Assessable learning outcomes
2.1.1 Understand the rock cycle and the processes which operate within it	Candidates should be able to: (a) describe the rock cycle; (b) define processes operating at the surface: weathering, erosion, transport, deposition and extrusion; (c) define processes operating below the surface: burial, diagenesis, recrystallisation, metamorphism, partial melting, magma accumulation, crystallisation, intrusion and uplift.
2.1.2 Understand the broad classification of rocks and the major rock-forming minerals	Candidates should be able to: (a) describe the classification of rocks into igneous, sedimentary and metamorphic classes using their relationship to temperatures and pressures in the rock cycle; (b) describe the characteristics of the major rock-forming minerals used to classify the rock groups (*mineral identification in examination questions will use a data table of mineral characteristics*).
2.1.3 Know and understand the geological column	(a) describe the division of the geological column into eras and systems using dating principles.

Practical skills are assessed using OCR set tasks. The practical work suggested below may be carried out as part of skill development. Centres are not required to carry out all of these experiments.

- Use strips of paper / till rolls to appreciate extent of geological time.
- Use flow charts and hand specimens to distinguish broad classes of rocks.
- Use hand specimens and photographs to aid identification of igneous, sedimentary and metamorphic rocks.

Module 2: Igneous processes and products

The aims of this module are to provide candidates with knowledge and understanding of igneous processes, the identification and classification of igneous rocks and the relationship of igneous rocks to pressures and temperatures in the rock cycle.

Context and exemplification	Assessable learning outcomes
2.2.1 Classify igneous rocks as silicic, intermediate, mafic and ultramafic	Candidates should be able to: (a) describe and classify silicic, intermediate, mafic and ultramafic rocks using their mineral composition (quartz, feldspars, mafic minerals), crystal grain size and silica percentage.

2.2.2

Understand how crystal grain size is related to rates and depths of cooling

Candidates should be able to:

(a) recognise and measure crystal grain sizes (coarse-grained >5 mm diameter; medium-grained 1-5 mm diameter; fine-grained <1 mm diameter) using observation of samples, photographs and thin section diagrams;

(b) explain how crystal grain size provides evidence for depth of formation and rate of cooling of volcanic, hypabyssal and plutonic igneous rocks.

2.2.3

Understand the formation of igneous textures within rocks

Candidates should be able to:

(a) describe, recognise and compare equigranular, glassy, vesicular, amygdaloidal, flow banding and porphyritic igneous textures using observation of samples, photographs and thin section diagrams;

(b) explain how the textures are formed and what evidence they provide about the formation and cooling histories of igneous rocks.

2.2.4

Know the characteristics and understand the origin of silicic, intermediate, mafic and ultramafic igneous rocks

Candidates should be able to:

(a) describe and identify: granite, granodiorite, rhyolite, pumice, obsidian, pegmatite; diorite, andesite; gabbro, dolerite, basalt and peridotite; by observation of crystal grain size, mineral composition, texture, colour and silica percentage using observation of samples, photographs and thin section diagrams;

(b) explain how their characteristics provide evidence for their origins.

2.2.5

Understand the generation of magmas at plate margins and hotspots

Candidates should be able to:

(a) explain the source of mafic magma at divergent plate margins and hotspots by partial melting of the mantle;

(b) explain the source of silicic and intermediate magma at convergent plate margins to form volcanoes and batholiths.

2.2.6

Understand the differentiation of magmas

Candidates should be able to:

(a) describe the sequence of reactions that occur in Bowen's reaction series controlling the formation of minerals as magma cools and crystallises;

(b) describe the processes of magmatic differentiation: fractional crystallisation, gravity settling and filter pressing;

	(c) explain how differentiation forms ultramafic, mafic, intermediate and silicic rock groups from a single parent magma; (d) explain the results of magmatic differentiation in the formation of major layered intrusions; (e) explain the results of magmatic differentiation in magma chambers below volcanoes and the effect on lava composition.
2.2.7 Understand the intrusion of concordant and discordant bodies as both major and minor intrusions	Candidates should be able to: (a) describe the processes of intrusion and distinguish between major and minor, concordant and discordant intrusions; (b) recognise and describe the characteristics of sills, transgressive sills, dykes and batholiths; (c) define the terms *contact*, *country rock* and *xenolith*; describe and explain how xenoliths form; (d) explain the processes involved in the formation of intrusions: partial melting, stoping, assimilation and magma mixing.
2.2.8 Distinguish between intrusive and extrusive igneous rocks	Candidates should be able to: (a) define the terms *chilled margin*, *baked margin* and *metamorphic aureole*; (b) explain how and where chilled and baked margins and metamorphic aureoles form; (c) describe and explain the differences between sills and lava flows by reference to crystal grain size, baked and chilled margins, xenoliths, vesicles and amygdales, alignment of phenocrysts and weathering; (d) distinguish between major intrusions, minor intrusions and extrusive rocks.
2.2.9 Understand the characteristics and distribution of volcanic products	Candidates should be able to: (a) describe the products of volcanoes: gases, pyroclasts (pumice, tuffs and agglomerates), pyroclastic flows (ignimbrites), lavas of mafic, intermediate and silicic composition; (b) describe and explain the distribution of volcanic products around volcanoes due to energy of blast, grain size of pyroclasts, velocity and direction of winds, gradient and magma viscosity; (c) define the term *isopachyte*, plot and interpret isopachyte maps of pyroclastic deposits.

2.2.10 Understand the characteristics of volcanoes	Candidates should be able to: (a) describe and explain quiet eruptions of submarine, fissure and shield volcanoes where magma viscosity and gas content are low; (b) describe and explain explosive eruptions of strato-volcanoes where magma viscosity and gas content are high; (c) describe and explain the shape and structure of volcanoes in terms of viscosity, rate of extrusion, gas content and frequency of eruption; (d) describe and explain caldera formation; (e) describe and explain geyser formation.
2.2.11 Appreciate the social and economic effects of volcanic activity	Candidates should be able to: (a) describe methods for the prediction of volcanic activity: historic pattern of activity, changes in ground level, changes in gas composition and volume and precursor earthquake tremors; (b) describe and evaluate the methods of risk analysis by plotting the extent and path of lava flows, blast damage, ash falls, pyroclastic flows and lahars; describe how these are used to create hazard maps and contingency plans; (c) describe the benefits and the danger to life and property of different types of volcanic activity; (d) explain how volcanic activity can cause climate change.

Practical skills are assessed using OCR set tasks. The practical work suggested below may be carried out as part of skill development. Centres are not required to carry out all of these experiments.

- Investigate crystal size and rate of cooling using salol and microscope slides at different temperatures.
- Use a lava lamp to simulate rising magma.
- Simulate lava flows of different viscosities using jelly, sand and water mixtures, treacle or wallpaper paste.
- Simulate partial melting using chocolate chip cookies.
- Use liquids of different densities to show differentiation.
- Use hand specimens and photographs for recognition of rock types and texture.

Module 3: Sedimentary processes and products

The aims of this module are to provide candidates with knowledge and understanding of the identification and classification of sedimentary rocks and the relationship of sedimentary rocks to pressures and temperatures in the rock cycle and the processes of weathering, erosion, transport, deposition, burial and diagenesis that operate within it. Candidates should gain knowledge and understanding of the relationship between sedimentary rocks and environments.

Context and exemplification	Assessable learning outcomes
2.3.1 Understand weathering processes producing soluble products and insoluble residues by chemical, mechanical and biological means	Candidates should be able to: (a) define weathering and describe and explain the processes and products of hydrolysis, carbonation, exfoliation, frost shattering, pressure release, root action and burrowing.
2.3.2 Understand the influence of gravity, wind, ice, the sea and rivers in the formation of sediment	Candidates should be able to: (a) describe how abrasion, attrition and length of transport affect sediment; (b) describe how sediments may be transported by solution, suspension, saltation and traction; (c) analyse and describe the variables of grain composition, grain size, grain shape, roundness and degree of sorting using both qualitative and quantitative methods. Evaluate how methods of transport are related to sediment characteristics; (d) describe and explain the characteristics of sediments transported by gravity, wind, ice, rivers and the sea.
2.3.3 Classify sedimentary rocks	Candidates should be able to: (a) describe and classify mechanically formed, chemically formed and biologically formed sedimentary rocks using grain size, grain shape, mineral composition and fossil content, using observation of samples, photographs and thin section diagrams.
2.3.4 Describe and identify clastic and non-clastic sedimentary rocks using observations of their characteristic features	Candidates should be able to: (a) describe and identify the clastic rocks: breccia, conglomerate, sandstones (orthoquartzite, arkose, greywacke, desert sandstones), mudstone, clay and shale using observation of samples, photographs and thin section diagrams; (b) describe and identify the non-clastic rocks: limestones (oolitic, fossiliferous, chalk) using evidence from grain size, colour grain, mineral composition and fossil content as appropriate, using observation of samples, photographs and thin section diagrams.

2.3.5 Understand the characteristic features, environments of formation and uses of sedimentary structures	Candidates should be able to: (a) describe the characteristic features of the primary sedimentary structures: cross bedding, ripple marks, graded bedding, desiccation cracks, flute casts, salt pseudomorphs and imbricate structure using observation of samples and photographs; (b) explain the processes of formation of these sedimentary structures; (c) explain the evidence for the environments in which they form and their uses as way-up, palaeo-current and palaeo-environmental indicators; (d) plot and interpret rose diagrams showing palaeo-current information.
2.3.6 Understand processes of diagenesis	Candidates should be able to: (a) describe and explain the diagenetic process of compaction of plant material to form coals, and mud to form shale and mudstone; (b) describe and explain the diagenetic process of cementation to form cemented sandstones and limestones; (c) evaluate the effects of diagenesis on rock characteristics.
2.3.7 Understand the characteristic products and processes of sedimentation and be able to use the evidence from rocks, fossils and sedimentary structures to interpret a range of sedimentary environments	Candidates should be able to: (a) describe the deposition in glacial environments of boulder clay (till), varves, fluvio-glacial sands and gravels and explain the processes that formed them; explain how to identify an ancient glacial deposit using the evidence from rocks, fossils and sedimentary structures; (b) describe the deposition in fluvial environments of alluvial fan breccias, arkoses and conglomerates, channel sandstones, flood plain clays and silts and explain the processes that formed them; explain how to identify an ancient fluvial deposit using the evidence from rocks, fossils and sedimentary structures; (c) describe the deposition in hot desert environments of conglomerates in wadis, desert sandstones in dunes and evaporites in playa lakes and explain the processes that formed them; explain how to identify an ancient desert deposit using the evidence from rocks, fossils and sedimentary structures; (d) describe the deposition in deltaic environments of delta top (topsets) to form

coal, seat earth and channel sandstones, sandstones of the delta slope (foresets) and shales to form offshore deposition (bottomsets); explain deltaic deposition in cyclothems; explain how to identify an ancient deltaic deposit using the evidence from rocks, graphic log sequences, fossils and sedimentary structures;

(e) describe the deposition of clastic material in sediment-rich shallow seas to form conglomerates, sandstones and mudstones; explain how to identify an ancient shallow clastic sea or beach deposit using the evidence from rocks, graphic log sequences, fossils and sedimentary structures;

(f) describe the deposition of limestones in clear, non-clastic, shallow marine environments; explain how invertebrate skeletons form bioclastic, reef limestones and chalk and how chemical processes form oolitic and micritic limestones. Explain how to identify an ancient carbonate deposit using the evidence from rocks, fossils and sedimentary structures;

(g) describe the deposition in shallow marine and barred basin environments of evaporites (gypsum, anhydrite, halite and potassium salts) and explain the processes that formed them; explain how to identify an ancient evaporite deposit using the evidence from rocks, fossils, sedimentary structures and cyclic sequences;

(h) describe the deposition in deep marine basin environments to form turbidites, greywackes and shales, and calcareous and siliceous oozes from microfossils and explain the processes that formed them; explain how to identify an ancient deep sea deposit using the evidence from rocks, fossils and sedimentary structures;

(i) plot and interpret graphic logs for these sedimentary environments.

Practical skills are assessed using OCR set tasks. The practical work suggested below may be carried out as part of skill development. Centres are not required to carry out all of these experiments.

- Carry out weathering experiments using nails and test tubes (oxidation), and wetting and freezing rock samples (frost shattering).
- Use a tennis ball to demonstrate traction, saltation and suspension.
- Use a fish tank and sediment to produce turbidity currents.
- Investigate changes in grain shape using rock fragments or sugar cubes shaken in a tube.
- Make graded bedding in a jar containing water and poorly sorted sediment mixture.
- Making cross bedding using sand and sugar.

- Making desiccation cracks by evaporation of clay slurry.
- Grain size analysis of sands by sieving.
- Making asymmetrical ripples in a circular tank of sand and water and symmetrical ripples in a rectangular tank.
- Using hand specimens and photographs for recognition of rock types, textures and sedimentary structures.

Module 4: Metamorphic processes and products

The aims of this module are to provide candidates with knowledge and understanding of the identification and classification of metamorphic rocks, the relationship of metamorphic rocks to pressures and temperatures in the rock cycle and the processes of metamorphism that operate within it.

Context and exemplification	**Assessable learning outcomes**
2.4.1 Understand the relationship between metamorphism and different temperatures and pressures	Candidates should be able to: (a) explain how varying combinations of temperature and pressure in the Earth produce contact, regional and burial metamorphism.
2.4.2 Describe, identify and explain the origin of metamorphic rocks using observations of their characteristic features	Candidates should be able to: (a) describe and identify the metamorphic rocks: slate, schist, gneiss, quartzite (metaquartzite), marble, spotted rock, using observations of mineral content, orientation, textures and foliation, by observation of samples, photographs and thin section diagrams; (b) explain the origin of these metamorphic rocks and describe the relationship of parent rock composition to the mineralogy of the resultant metamorphic rock.
2.4.3 Understand the formation of metamorphic textures within rocks	Candidates should be able to: (a) describe, recognise and compare: slaty cleavage, schistosity, gneissose banding, porphyroblastic and granoblastic textures, using observation of samples, photographs and thin section diagrams; (b) explain how the textures are formed.
2.4.4 Understand contact metamorphism	Candidates should be able to: (a) describe contact metamorphism by heat from an igneous intrusion to form different grades of unfoliated rocks: low grade – spotted rock, medium grade – andalusite slate and high grade – hornfels, and explain their relationship to temperature within a metamorphic aureole; (b) describe and explain the factors controlling the width of contact metamorphic aureoles: volume, composition and temperature of magma; composition of country rock; dip of contact;

	(c) describe the thermal gradient and the distribution of the index minerals biotite, andalusite and sillimanite within a metamorphic aureole; (d) describe the Al_2SiO_5 polymorphs and explain their relationships to temperature and pressure conditions in contact metamorphism; (e) describe and explain the formation of metaquartzite and marble.
2.4.5 Understand regional metamorphism	Candidates should be able to: (a) explain regional metamorphism at convergent plate margins as paired metamorphic belts at subduction zones and broad orogenic belts at continental-continental plate margins; (b) define the terms *metamorphic grade*, *metamorphic zone*, *index mineral* and *isograd*; plot and interpret isograds; (c) describe the grades of regional metamorphic rocks: low grade – slate, medium grade – schist; high grade – gneiss, and explain their relationships to temperature and pressure conditions; (d) describe regional metamorphic zones (Barrovian) and index minerals: chlorite, biotite, garnet, kyanite and sillimanite; (e) describe the Al_2SiO_5 polymorphs and their relationship to temperature and pressure conditions in regional metamorphism.

Practical skills are assessed using OCR set tasks. The practical work suggested below may be carried out as part of skill development. Centres are not required to carry out all of these experiments.

- Use dry spaghetti and rulers to demonstrate alignment of crystals in relation to stress.
- Measure and record temperatures of sand around a buried container of hot water to model the size of a metamorphic aureole.
- Use hand specimens and photographs for recognition of rock types and texture.

3.3 AS Unit F793: *Practical Skills in Geology 1*

AS Unit F793: *Practical Skills in Geology 1*

This unit develops practical and investigative skills within contexts encountered during AS Geology.

Candidates are required to carry out **two** task types:

OCR provided Centre-based task or Centre-devised Fieldwork task	[20 marks]
Evaluative task	[20 marks]

The OCR provided **Centre-based Task** is practically based and candidates carry out this task under controlled conditions in the laboratory/classroom. Alternatively, centres may elect to devise their own **Fieldwork Task**.

Centres intending to devise their own Fieldwork Task must ensure that it matches the requirements of the Centre-based Task. A sample Fieldwork Task and mark scheme is on the OCR website. The proposed Fieldwork Task and its mark scheme must be submitted to OCR for approval at least 6 weeks before being presented to candidates. If centres wish to provide candidates with more than one opportunity to carry out a Fieldwork Task then they will need to submit separate task proposal forms for each task that they devise.

The same skills are assessed whether candidates carry out one of the OCR set Centre-based Tasks based on geological maps, photographs and data **or** undertake a centre-devised Fieldwork Task. Both types involve measurement, observation and recording of data, ie both qualitative and quantitative techniques.

The **Evaluative Task** is provided by OCR in a context that extends geological skills. Candidates are required to evaluate results based on field or practical data. All data and resources required will be supplied with in the Evaluative Task. There is no additional practical work.

Initially, a choice of **three** Centre-based Tasks and **three** Evaluative Tasks are offered. Tasks are refreshed or replaced each year and additional tasks may be made available.

Tasks, mark schemes and guidance for teachers and technicians are downloaded from the OCR Interchange site.

All assessed tasks are carried out under direct teacher supervision.

Each practical skills unit is teacher assessed using a mark scheme provided by OCR via the Interchange website and externally moderated by OCR. One mark will be required for each task type with an overall mark out of **40** being submitted to OCR.

Candidates may attempt more than one task from either task type with the best mark for each type being used to make up the overall mark. A candidate is only permitted one attempt at each task.

Although practical tasks can be used throughout the year, entry for the AS and the A2 practical skills units is available only in the June series of each year.

How Science Works

5a Carry out experimental and investigative activities, including appropriate risk management, in a range of contexts

5b Analyse and interpret data to provide evidence, recognising correlations and causal relationships

5c Evaluate methodology, evidence and data, and resolve conflicting evidence.

Context and exemplification	Assessable learning outcomes
Centre-based or **Fieldwork Task** A single mark out of 20 will be required.	Candidates should be able to: (a) (i) demonstrate skilful and safe practical techniques using suitable qualitative methods; (ii) demonstrate skilful and safe practical techniques using suitable quantitative methods; (b) make and record valid observations; organise results suitably; (c) make and record accurate measurements to an appropriate precision.
Evaluative Task A single mark out of 20 will be required.	Candidates should be able to: (a) analyse the data and assess the reliability and accuracy of an experimental or field based task or research based task; (b) interpret the data to form conclusions, and to make deductions from the processed evidence; (c) evaluate the methodology, identify significant weaknesses and select simple improvements to experimental or field-based procedures and measurements; (d) evaluate the results, identify any anomalies or inaccuracies and recognise and explain the trends in data.

Further advice and guidance on the use and marking of the tasks can be found in the *Practical Skills Handbook*.

3.4 A2 Unit F794: *Environmental Geology*

AS Unit F794: *Environmental Geology*

This unit provides candidates with a knowledge and understanding of the applications of geology to water supply, energy resources, metallic mineral deposits, engineering geology and construction materials. It also covers the main environmental, technological, safety and economic issues related to these areas of geology.

This unit consists of **four** teaching modules:

- Module 1: Water supply
- Module 2: Energy resources
- Module 3: Metallic mineral deposits
- Module 4: Engineering geology

How Science Works

This unit incorporates many aspects of *How Science Works*.

1) Use knowledge and understanding to pose scientific questions, define scientific problems, present scientific arguments and scientific ideas: all aspects of this unit.

2) Use appropriate methodology, including ICT, to answer scientific questions and solve scientific problems: exploration for oil, natural gas and metallic minerals; calculating oil, natural gas, coal and metal reserves.

3) Obtaining, analysing and evaluating data:
   - analyse and interpret data to provide evidence, recognising correlations and causal relationships: exploration for oil, natural gas and metallic minerals.

4) Applications, implications and ethical considerations:
   - consider applications and implications of science and appreciate their associated benefits and risks: extraction of water, energy, metallic and industrial mineral resources; engineering geology – dam and reservoir construction; road construction; tunnelling; coastal defences; waste disposal including nuclear waste;
   - consider ethical issues in the treatment of humans, other organisms and the environment: environmental aspects of resource geology – extraction of water, energy, metallic and industrial mineral resources; environmental aspects of engineering geology – dam and reservoir construction; road construction; tunnelling; coastal defences; waste disposal including nuclear waste.

5) Scientific knowledge in its social context:

- appreciate the ways in which society uses science to inform decision-making: extraction of water, energy and mineral resources; social aspects of geology in engineering – dam and reservoir construction; road construction; tunnelling; coastal defences; waste disposal including nuclear waste.

Links

The unit requires specific knowledge and skills acquired from studying both Unit F791: *Global Tectonics*, particularly Module 4 *Geological structures*, and most aspects of Unit F792: *Rocks – Processes and Products*.

Module 1: Water supply	
Context and exemplification	**Assessable learning outcomes**
4.1.1 Understand the terms used to describe how water is stored and can move through rocks	Candidates should be able to: (d) define the term *porosity* and calculate % porosity; define the term *permeability* and calculate permeability as a rate of flow; describe and explain the factors that affect porosity and permeability; (e) define the terms *groundwater* and *water table* and recognise the position of the water table; (f) define the terms *hydrostatic pressure* and *hydraulic gradient* and calculate the hydraulic gradient.
4.1.2 Understand the geological conditions necessary for aquifers, artesian basins and water supply from wells and boreholes	Candidates should be able to: (a) define the terms *aquifer*, *aquiclude* and *recharge zone*; recognise and explain the difference between an unconfined and a confined aquifer; describe and explain the conditions required for a perched aquifer; (b) recognise and describe an artesian basin as a type of confined aquifer and explain the conditions necessary for the formation of an artesian well; (c) describe and explain the terms *draw down* and *cone of depression* in relation to water supply from wells and boreholes; (d) describe the problems of water extraction from aquifers and artesian basins leading to a lowering of the water table, subsidence and saltwater encroachment; (e) describe and explain the issues of groundwater quality and residence time of pollutants.

4.1.3 Understand the geological conditions leading to the formation of springs	Candidates should be able to: (a) describe and explain the geological conditions leading to the formation of springs where the water table intersects the topographic surface at the junction of permeable and impermeable rocks; (b) recognise and explain how springs form as a result of lithology, faults and unconformities.
4.1.4 Know about water supply from 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	Candidates should be able to: (a) describe and explain the advantages and disadvantages of surface water supply from rivers and reservoirs; (b) describe and explain the advantages and disadvantages of underground water supply from aquifers and artesian basins; (c) describe and explain how water supply is renewable as part of the water cycle and is sustainable provided the rate of extraction does not exceed the rate of recharge; (d) outline initiatives in the development of underground storage facilities for water in rocks.

Practical skills are assessed using OCR set tasks. The practical work suggested below may be carried out as part of skill development. Centres are not required to carry out all of these experiments.

- Carry out porosity experiments – finding the porosity of rocks by finding their dry and wet mass; using marbles in a beaker to model porosity.
- Carry out permeability experiments – attaching tubes to rocks with silicone sealant and timing rate of flow of water into rocks; using sediment with different degrees of sorting in filter paper to model permeability.
- Model hydrostatic pressure and hydraulic head – use a large plastic tube or measuring cylinder with holes drilled up one side, fill with water and measure how far jets of water come out.
- Model a confined aquifer and artesian conditions – use a U tube with bung at one end filled with water; when bung is removed the water level on that side will rise up.

Module 2: Energy resources

Context and exemplification	Assessable learning outcomes
4.2.1 Understand the origin of oil and natural gas and migration from source rock to reservoir rock Understand how oil accumulates in a trap structure under a cap rock	Candidates should be able to: (a) describe a source rock, reservoir rock and cap rock; describe the environment of deposition and explain the process of maturation to form oil and natural gas in the source rock; describe the process of migration from source rock to reservoir rock under a cap rock and explain the factors that control migration; (b) explain the term *trap*; recognise and describe different trap structures: anticline, fault, salt dome, unconformity, lithological; describe and explain how oil and natural gas may be destroyed or lost from trap structures.
4.2.2 Know how geophysical exploration techniques and exploration drilling are used to find hydrocarbons	Candidates should be able to: (a) describe and explain the geophysical exploration techniques of seismic reflection and gravity surveys; (b) describe how exploration drilling and downhole logging (porosity, gamma ray, resistivity) are used to find hydrocarbons.
4.2.3 Know about reserves of oil and natural gas Understand the methods of primary and secondary recovery of oil and natural gas from suitable reservoirs	Candidates should be able to: (a) calculate reserves of oil and natural gas when provided with suitable data and explain the difficulties in accurately determining reserves; (b) describe and explain how production wells are established and oil and natural gas are extracted by primary recovery; (c) describe and explain the main methods of secondary recovery by injection of water, steam or carbon dioxide and the use of detergents and bacteriological techniques; (d) outline recent initiatives in exploitation of unconventional petroleum from oil shale and the possible future exploitation of gas hydrates.
4.2.4 Understand the environmental, safety and technological problems of oil and natural gas extraction and pipeline transportation	Candidates should be able to: (a) describe the main environmental and safety problems of oil and natural gas extraction and pipeline transportation; (b) describe the technological problems of oil and natural gas extraction including those that prevent 100% recovery; (c) outline recent initiatives in the development of underground storage facilities for natural gas in rocks.

4.2.5 Know about the occurrence of oil and natural gas in and around the British Isles Understand that oil and natural gas are examples of non-renewable energy resources	Candidates should be able to: (a) locate the main areas where oil and natural gas are found in and around the British Isles; (b) describe and explain why both oil and natural gas are present in the northern basin of the North Sea from Kimmeridge Clay source rocks but only natural gas is present in the southern basin from Coal Measures source rocks; (c) explain why oil and natural gas are examples of non-renewable energy resources; (d) debate the future sustainability of British oil and natural gas production.
4.2.6 Know the origin of peat and coal Understand the development of rank and the properties of lignite, bituminous coal and anthracite	Candidates should be able to: (a) describe and explain the climatic and environmental conditions required for the formation of peat and coal as part of deltaic sequences; (b) describe and explain the diagenetic processes of compaction and coalification to produce peat and coal; (c) define the terms *rank* and *coal series*; describe the physical and chemical properties of lignite, bituminous coal and anthracite.
4.2.7 Know about reserves of coal and methods of extracting economic deposits of coal by opencast and underground mining Understand the geological factors that affect safety and can make coal mining uneconomic	Candidates should be able to: (a) calculate reserves of coal when provided with suitable data and explain the difficulties in accurately determining reserves; (b) describe the geological considerations and method of opencast coal mining from quarries; (c) describe long-wall retreat mining as the main method of underground coal mining used in the British Isles; (d) describe and explain the geological factors that can make underground coal mining difficult and uneconomic; (e) discuss the advantages and disadvantages of opencast and underground coal mining including an outline of economic and safety issues.
4.2.8 Know the broad structure and distribution of coalfields in the British Isles Understand the environmental consequences of coal mining operations Understand that coal is an example of a non-renewable energy resource	Candidates should be able to: (a) locate the main areas where coal is found in and around the British Isles; explain the difference between an exposed and a concealed coalfield; describe the broad structures of the South Wales and Yorkshire coalfields;

	(b) discuss the environmental consequences of the legacy of coal mining in the British Isles and describe methods of land restoration; (c) explain why coal is an example of a non-renewable energy resource; (d) discuss the future sustainability of British coal production from opencast and underground sources.
4.2.9 Know about geothermal energy extraction Understand that geothermal energy is an example of a renewable energy resource	Candidates should be able to: (a) describe and explain the main methods of geothermal energy extraction from: volcanic sources; geothermal aquifers in sedimentary basins; and the potential for geothermal energy extraction from hot dry rock sources such as granite; (b) calculate the geothermal gradient and explain the source of heat for geothermal energy; (c) explain why geothermal energy is an example of a renewable energy resource; (d) describe and explain the advantages and disadvantages of geothermal energy extraction.

Practical skills are assessed using OCR set tasks. The practical work suggested below may be carried out as part of skill development. Centres are not required to carry out all of these experiments.

- Model oil in a trap using a beaker of water with coloured cooking oil on top and tilting beaker to show layer of oil is always horizontal.
- Model an oil trap and gusher – use an inverted funnel with bung in the end held by a clamp in a beaker full of water: add oil by squirting under water with pipette and add gas by introducing methane or blowing air under water: remove bung and see what happens. Note that this requires use of safety glasses.
- Carry out a computer simulation of oil and natural gas exploration programme.
- Study hand specimens of types of coal to show the physical properties of lignite, bituminous coal and anthracite.

Module 3: Metallic mineral deposits

Context and exemplification	**Assessable learning outcomes**
4.3.1 Show an understanding of concentration factors to produce economic deposits from low crustal abundances of metallic minerals Know about mineral reserves	(*mineral identification in examination questions will use a data table of mineral characteristics*); Candidates should be able to: (a) define the terms *resource*, *reserves*, *ore*, *ore mineral*, *gangue mineral*, *average crustal abundance*, *cut off grade* and *concentration factor*; (b) calculate concentration factors and mineral reserves when provided with suitable data and explain the difficulties in accurately determining reserves;

	(c) discuss the influence of world supply and demand and stockpiling of strategic metals on metallic mineral reserves.
4.3.2 Understand the concentration of magnetite by gravity-settling in igneous intrusions	Candidates should be able to: (a) describe and explain the process of gravity-settling and the properties of magnetite that allow it to be concentrated at the base of mafic and ultramafic igneous intrusions.
4.3.3 Understand how hydrothermal mineral veins of cassiterite, galena and sphalerite are formed in association with igneous intrusions	Candidates should be able to: (a) define the term *hydrothermal fluid* and explain the source of hydrothermal fluids; (b) describe and explain how veins of cassiterite, galena and sphalerite are formed by hydrothermal processes associated with silicic igneous intrusions; (c) describe and explain the distribution and zonation of hydrothermal mineral veins in and around igneous intrusions.
4.3.4 Understand how residual deposits of bauxite are formed	Candidates should be able to: (a) describe and explain how residual deposits of bauxite form as the insoluble product of extreme chemical weathering of impure limestone and granite; (b) describe and explain the factors that control the rate of chemical weathering and the formation of residual deposits.
4.3.5 Understand the secondary enrichment of chalcopyrite in copper deposits	Candidates should be able to: (a) describe how secondary enrichment processes can increase the grade of otherwise uneconomic copper deposits; (b) describe and explain the process of secondary enrichment of chalcopyrite as a result of chemical weathering and changes in chemistry above and below the water table.
4.3.6 Understand how deposits of uranium ore are formed in sandstones	Candidates should be able to: (a) describe and explain how deposits of uranium ore are formed in sandstones as a result of solution, transport in groundwater and reprecipitation at or above the water table.
4.3.7 Understand the formation of placer deposits of cassiterite, gold and diamonds in rivers and beaches	Candidates should be able to: (a) describe and explain the weathering, erosion, transport and depositional processes involved in placer formation and the properties of cassiterite, gold and diamonds that allow them to be concentrated in placer deposits;

	(b) recognise and explain how placer deposits form: at meander bends; in plunge pools and potholes; upstream of projections; downstream of confluences; and on beaches; (c) describe the advantages and disadvantages of mining placer deposits at the surface compared to mining underground deposits.
4.3.8 Know how geophysical exploration techniques are used to find metals	Candidates should be able to: (a) describe and explain how magnetic, gravity and electrical resistivity surveys are used to find metallic mineral deposits.
4.3.9 Know how geochemical exploration methods are used to find metals	Candidates should be able to: (a) define the term *geochemical anomaly*; describe and explain how soil and stream sediment geochemical surveys are used to find metallic mineral deposits.
4.3.10 Know the environmental consequences of opencast and underground metal mining operations Understand that metal mining is an example of unsustainable resource exploitation	Candidates should be able to: (a) describe and explain the environmental consequences of opencast metal mining operations; (b) describe and explain the environmental consequences of underground metal mining operations; (c) describe the environmental consequences of heap-leaching and other mineral processing operations; (d) discuss the long-term environmental consequences of the legacy of metal mining in the British Isles; (e) explain why metal mining is an example of unsustainable resource exploitation on a global scale.
4.3.11 Understand the application of geochemistry to environmental problems	Candidates should be able to: (a) describe and explain the source of radon gas from the breakdown of radioactive elements in granite and other rocks and appreciate the hazard it poses; (b) describe how heavy metal contamination of soils can be recognised.

Practical skills are assessed using OCR set tasks. The practical work suggested below may be carried out as part of skill development. Centres are not required to carry out all of these experiments.

- Study hand specimens of ore minerals to indicate suitable properties for gravity-settling (magnetite) or placer deposition (cassiterite). Find the density of ore minerals.
- Investigate gravity-settling using minerals of different densities and a measuring cylinder filled with liquid wallpaper paste.
- Plot and interpret rose diagrams of mineral vein information.
- Carry out a computer simulation of a metals exploration programme.

Module 4: Engineering geology

Context and exemplification	**Assessable learning outcomes**
4.4.1 Know the characteristics of suitable materials for building and construction Understand the environmental implications of their exploitation	Candidates should be able to: (a) describe and explain the characteristics of suitable materials for building stone, roadstone, brick clay, aggregate, and the manufacture of cement and concrete; state the uses for these materials; (b) describe the extraction of industrial rocks and minerals by quarrying and dredging techniques; (c) discuss the environmental implications of their exploitation including the location and development of super-quarries and dredging offshore for marine aggregates.
4.4.2 Understand the geological factors affecting the construction of dams and reservoirs Know ground improvement methods which can be used to prevent leakage from reservoirs Appreciate the environmental consequences of dam and reservoir construction	Candidates should be able to: (a) describe and explain the geological factors affecting the construction of dams and reservoirs: rock type and strength; foundations; attitude of strata; geological structures; availability of construction materials; (b) describe and explain methods that can be used to prevent leakage from reservoirs: grouting; clay/plastic lining; cut-off curtain; (c) appreciate the environmental and social consequences of dam and reservoir construction including failure and collapse of dams due to poor siting, design or construction and their use for hydroelectric power generation; (d) describe and explain how dam and reservoir construction can lead to an increase in seismic activity.
4.4.3 Understand the geological factors that cause landslips and slumping hazards	Candidates should be able to: (a) describe and explain the geological factors that cause landslips and slumping hazards: rock type; dip; presence of geological structures;

	(b) explain how heavy rainfall can increase the likelihood of landslips and slumping hazards; (c) explain how human activity can increase the likelihood of landslips and slumping hazards.
4.4.4 Understand the geological factors affecting the construction of road cuttings, embankments and tunnels through both hard rock and unconsolidated material Know ground improvement methods that can be used to stabilise rocks and prevent flooding of tunnels	Candidates should be able to: (a) describe and explain the geological factors affecting the construction of road cuttings and embankments: slope stability; foundations; construction methods; (b) describe and explain methods that can be used to stabilise slopes and rocks: slope modification; retaining walls; gabions; rock bolts; rock drains; wire netting; shotcrete; vegetation; (c) describe and explain the geological factors affecting the construction of tunnels through both hard rock and unconsolidated material: rock type and strength; attitude of strata; geological structures; groundwater; (d) describe and explain methods which can be used to prevent collapse and flooding of tunnels: lining; rock bolts; grouting; rock drains.
4.4.5 Understand the geological factors affecting the construction of coastal defences Know methods that can be used to prevent coastal erosion and flooding	Candidates should be able to: (a) describe and explain the geological factors affecting the location and construction of coastal defences: rock type; attitude of strata; geological structures; construction considerations and materials; (b) describe and explain methods that can be used to prevent coastal erosion and flooding: sea walls and banks; flood barriers and barrages; rock buttresses and revetments; groynes; slope stabilisation; beach nourishment; (c) discuss the environmental implications of constructing coastal defences.
4.4.6 Understand the geological factors affecting the disposal of waste in landfill sites and appreciate the environmental consequences of landfill waste disposal Understand the technological, environmental and safety problems of underground storage of nuclear waste	Candidates should be able to: (a) describe and explain the geological factors affecting the disposal of waste in landfill sites: rock type; attitude of strata; geological structures; groundwater; (b) describe and explain the short-term and long-term environmental consequences of disposal of waste in landfill sites; (c) define the term *leachate* and describe and explain methods that can be used to prevent leakage of toxic leachates from landfill sites: grouting; clay/geomembrane lining; drainage and collection;

(d) describe and explain the technological and short-term and long-term environmental and safety problems of underground storage of nuclear waste in rocks.

Practical skills are assessed using OCR set tasks. The practical work suggested below may be carried out as part of skill development. Centres are not required to carry out all of these experiments.

- Test rocks for roadstone – experiments to find hardness, impact strength, porosity/permeability, resistance to abrasion, resistance to freeze-thaw action, resistance to chemical corrosion.

3.5 A2 Unit F795: *Evolution of Life, Earth and Climate*

A2 Unit F795: *Evolution of Life, Earth and Climate*

This unit provides candidates with a knowledge and understanding of the evolution of fossils and climate.

This unit consists of **five** teaching modules:

- Module 1: Formation of fossils
- Module 2: Morphology of fossils and adaptation of organisms to live in different environments
- Module 3: Fossil evidence of the evolution of organisms and mass extinctions
- Module 4: Dating methods, correlation and interpretation of geological maps
- Module 5: Changing climate

How Science Works

This component incorporates many aspects of *How Science Works*. In particular it deals in depth with:

1) Use theories, models and ideas to develop and modify scientific explanations:
   - mass extinctions, cycles and evidence for climate change, evolution.

2) Use knowledge and understanding to pose scientific questions, define scientific problems, present scientific arguments and scientific ideas:
   - mass extinctions, cycles and evidence for climate change.

3) Use appropriate methodology, including ICT, to answer scientific questions and solve scientific problems:
   - mass extinctions, cycles and evidence for climate change.

4) Obtaining, analysing and evaluation data:
   - analyse and interpret data to provide evidence, recognising correlations and causal relationships: correlations, dating and zone fossils;
   - evaluate methodology, evidence and data, and resolve conflicting evidence: fossil assemblages to interpret palaeoenvironments, mass extinction and dating.

Links

AS Unit F792 *Origin of sedimentary rocks* Module 2: Structural geology

Module 1: Formation of fossils

Context and exemplification	Assessable learning outcomes
5.1.1 Understand the different types of preservation of hard skeletal tissues	Candidates should be able to: (a) describe how replacement of body fossils occurs and how fossils are altered from less stable aragonite to stable calcite; (b) explain how silicification occurs, where wood or other organic materials are replaced by silica; (c) explain how pyritisation occurs as a result of anaerobic bacterial action on the deep sea floor; (d) explain how carbonisation of plant and graptolite fossils occurs as a result of loss of volatiles, due to increased pressure and temperature; (e) describe how internal and external moulds and casts are formed.
5.1.2 Understand exceptional preservation of fossils	Candidates should be able to: (a) explain how rapid burial, lack of oxygen, lack of scavengers, rapid deposition of fine sediment and early diagenesis affect the level of detail in the fossil record; (b) explain why the fossil record is incomplete; (c) describe how amber was formed from tree resin that trapped small organisms (especially insects) and then hardened; (d) describe how tar pits trapped organisms; (e) describe the preservation of a varied assemblage of organisms in the Burgess Shale; (f) describe the preservation in the Solenhofen Limestone.
5.1.3 Know about trace fossils and understand their use in interpreting palaeoenvironments	Candidates should be able to: (a) define *trace fossils* as a record of the activity and/or behaviour of an organism; (b) describe how tracks (footprints) are formed and how trails are formed as impressions of whole animals at rest or travelling; explain how dinosaur footprints are used to interpret the size and locomotion of dinosaurs;

	(c) explain how burrows (soft substrate) and borings (hard substrate) are structures for dwelling, protection or feeding; (d) explain that a low energy environment is required to preserve tracks and trails and that burrows can be formed in variable energy environments.
5.1.4 Understand the use of fossil assemblages in interpreting palaeoenvironments	Candidates should be able to: (a) define the terms: *fossil life assemblages*, *fossil death assemblages* and *derived fossils*; (b) explain how fossil assemblages can be used to interpret palaeoenvironments; (c) describe the methods used and difficulties encountered in inferring the mode of life of extinct fossil groups: trilobites, graptolites, ammonoids, dinosaurs.

Practical skills are assessed using OCR set tasks. The practical work suggested below may be carried out as part of skill development. Centres are not required to carry out all of these experiments.

- Use the internet to research the different types of exceptional preservation.
- Use sea shells and plaster of Paris to make internal and external moulds. Refill the plaster of Paris moulds with another substance (eg jelly or plasticine) to make a cast.
- Use a tray filled with wet sand; move objects across the surface and study their impressions. Notice the difference in shapes when the objects are moving at different speeds, or at rest. Add more water and finer sand to compare the effect of softer substrates. Use a digital camera to record data for analysis.
- Study assemblages of fossils to investigate palaeoenvironments.

Module 2: Morphology of fossils and adaptation of organisms to live in different environments

Context and exemplification	Assessable learning outcomes
5.2.1 Know the morphology of trilobites and understand the adaptations for different environments	Candidates should be able to: (a) describe the trilobite exoskeleton: cephalon, thorax, pygidium, glabella, compound eyes, facial suture, free cheek, fixed cheek, spines, pleura, nature and position of the legs and gills, and explain the inferred functions of these features; (b) describe and explain adaptations for a nektonic life style, including eyes on stalks, small size, separated pleura and spines; (c) describe and explain adaptations for a planktonic lifestyle including inflated glabella, small eyes or no eyes, few pleural segments and small size; (d) describe and explain adaptations for a benthonic life style including ability to enrol, many thoracic segments and legs, 360^o vision;

	(e) describe and explain adaptations for an infaunal life style including, a large cephalic fringe, cephalic pits, extended genal spines and no eyes.
5.2.2 Know the morphology of tabulate, rugose and scleractinian corals; understand that fossil corals may indicate a tropical, marine, reef environment	Candidates should be able to: (a) describe coral morphology; septa, tabulae, dissepiments, columella, calice and corallite within the corallum; describe solitary and compound forms; (b) compare the morphological similarities and differences between tabulate, rugose and scleractinian corals; (c) describe and explain the conditions that modern corals need for good growth; explain how modern corals have a symbiotic relationship with photosynthetic algae and that the conditions for growth were probably similar in the past; (d) describe the modern distribution of coral reefs and explain how coral reefs are formed.
5.2.3 Know the morphology of brachiopods	Candidates should be able to: (a) describe brachiopod morphology: symmetry, shape, pedicle and brachial valves, ornament, pedicle, foramen, adductor and diductor muscle scars, umbo, commisure, lophophore support system, pedicle and shape of hinge line, and where appropriate explain the functions of these features; (b) explain how brachiopods feed as filter feeders using the lophophore; (c) describe how ancient brachiopods lived in shallow, muddy or carbonate seas.
5.2.4 Know the morphological differences between regular and irregular echinoids that reflect their respective modes of life	Candidates should be able to: (a) describe echinoid morphology: shape of test, symmetry, ambulacra, interambulacra, spines, tubercles, pore pairs for tube feet, position of periproct / anus, position of peristome / mouth, apical system, madreporite, labrum, fasciole, plastron, anterior groove and explain the functions of these features; (b) describe an epifaunal (scavenger) mode of life for the regular echinoids; (c) describe an infaunal (burrowing) mode of life for the irregular echinoids; (d) compare the morphological similarities and differences between regular and irregular echinoids and explain how they reflect their respective modes of life.

5.2.5 Know the morphology of bivalves and understand how their adaptations for different environments	Candidates should be able to: (a) describe bivalve morphology: symmetry, left and right valves, shell shape and gape, umbone, ornament, dentition, pallial line and sinus, adductor muscle scars and explain the functions of these features; (b) describe and explain adaptations for cemented forms on hard substrate with thick shells to withstand a high energy environment; (c) describe and explain adaptations for non-cemented, free-lying forms so they do not easily sink into soft substrate; (d) describe and explain adaptations for byssally attached forms with rounded and elongate shells designed to withstand high energy on rocky shores; (e) describe and explain adaptations for nektonic (swimming) forms with corrugated, thin shells; (f) describe and explain adaptations for infaunal shallow and deep burrowers and compare these adaptations. (g) compare the morphological similarities and differences between brachiopods and bivalves.
5.2.6 Recognise minor fossil groups and the environments in which they live	Candidates should be able to: (a) describe and recognise gastropods using the shape of the coiled shell, spire, and body chamber; describe the mode of life of gastropods in high and low energy shallow seas; (b) describe and recognise belemnites using the shape of guard and phragmacone; describe the mode of life and preservation of belemnites in marine conditions; (c) describe and recognise crinoid morphology: calyx, brachia, stem and ossicles; explain how crinoids may be disarticulated after death and form bioclastic limestone; describe the mode of life of ancient crinoids in shallow carbonate seas.
5.2.7 Know about the main microfossil groups and understand their use in stratigraphy	Candidates should be able to: (a) describe the composition of ostracods, foraminifera, conodonts and radiolaria and the environments in which they lived; (b) state that most fossil spores and pollen are derived from vascular land plants; (c) outline the main uses of microfossils in stratigraphy.

Practical skills

- Use the internet to research the different types of fossil group (eg morphology, mode of life, evolution, etc)
- Use modern shells and masses directed at a fixed point to assess relative damage to shells of different thicknesses or with different types of ornament. Relative strength can be determined using quantitative methods.
- Study and draw real fossils in the laboratory.
- Make model bivalves and brachiopods to explain how they opened and closed their valves.
- Make rose diagrams of fossil orientation.

Module 3: Fossil evidence of the evolution of organisms and mass extinctions	
Context and exemplification	**Assessable learning outcomes**
5.3.1 Know the meaning of evolution	Candidates should be able to: (a) explain the Darwinian theory of evolution; state that adaptations are a result of evolution.
5.3.2 Know the morphology of graptoloids (graptolites) and the morphological changes that show the evolution of graptolites in the Lower Palaeozoic	Candidates should be able to: (a) describe graptolite morphology: stipe, sicula, thecae, rhabdosome and nema; (b) describe the changes in morphology as graptolites evolved through the Lower Palaeozoic: (i) describe the change in the number of stipes in the rhabdosome; (ii) describe the change in the attitude of the stipes (pendent, horizontal, reclined, scandent); (iii) describe the changes in the shapes of the thecae (simple, hooked, sigmoidal); (iv) describe the change in the shape of the rhabdosome (uniserial, biserial); (c) deduce the probable mode of life of graptolites as planktonic colonial filter feeders within the water column.
5.3.3 Know the morphology of nautiloids and ammonoids and the morphological changes and evolution of nautiloids and ammonoids in the Palaeozoic and Mesozoic	Candidates should be able to: (a) describe nautiloid and ammonoid morphology: shell shape, form of coiling, ornament, aperture, body chamber, suture lines, saddles and lobes, siphuncle, septal necks, septa, keel, sulcus, umbilicus and where appropriate explain the inferred functions of these features; (b) describe the changes in morphology as nautiloids and ammonoids evolved through the Palaeozoic and Mesozoic: (i) describe the changes in suture lines from simple orthoceratitic to goniatitic (Carboniferous), ceratitic (Triassic) to complex ammonitic (Jurassic and Cretaceous);

	(ii) describe the changes in the position of the siphuncle and the septal necks between nautiloids and ammonoids; (iii) describe the changes in shape of the shell from involute to evolute and increases in ornamentation; (c) explain that heteromorphs are either evolutionary changes or adaptations to different environments; (d) deduce the probable mode of life of ammonoids as nektonic.
5.3.4 Know about the evolution of amphibians from fish	Candidates should be able to: (a) describe the similarities between coelacanths and lungfish and the early amphibians in the Devonian using skull morphology, fin bones, limb bones, teeth, body shape, tail fin and scales; (b) explain how early amphibians were adapted to terrestrial life in the Carboniferous.
5.3.5 Know about the evolution of dinosaurs	Candidates should be able to: (a) explain the advantages of amniotic eggs for life on land; (b) describe how dinosaurs evolved into the Saurischia (saurapoda, therapoda) and Ornithischia; (c) describe the characteristics of saurischian dinosaurs: arrangement of hip bones, grasping hand, asymmetrical fingers, long mobile neck; (d) explain how *Diplodocus* (sauropod herbivore) and *Tyrannosaurus* (therapod carnivore) are adapted to different modes of life; (e) describe the characteristics of ornithischian dinosaurs: arrangement of hip bones, armoured, horned and duck billed; (f) explain how *Iguanodon* was adapted to its mode of life on land: horny beak, teeth, hinged upper jaw, defensive spike, hand adaptation, quadrupedal and bipedal stance; (g) describe how the birds evolved from therapod dinosaurs; (h) describe the similarities of *Archaeopteryx* to both dinosaurs and birds.
5.3.6 Know about the major mass extinction events	Candidates should be able to: (a) define the term *mass extinction* and state that there have been a number of mass extinction events over geological time;

	(b) describe and explain the possible reasons for the mass extinction at the Permo – Triassic boundary; explain how the evidence for major volcanic activity (Siberian Traps) can be used to account for this mass extinction; (c) describe and explain the possible reasons for the mass extinction at the Cretaceous – Tertiary boundary; explain how the evidence for a major asteroid impact and volcanic activity (Deccan Traps) can be used to account for this mass extinction; (d) state the fossil groups that became extinct at these boundaries.

Practical skills are assessed using OCR set tasks. The practical work suggested below may be carried out as part of skill development. Centres are not required to carry out all of these experiments.

- Use the internet to research the different types of fossil group (eg dinosaurs and evolution, etc). Carry out an investigation to compare the relative strengths of differently folded paper or thin card. Apply masses and measure distortion. This simulates the types of sutures in cephalopods.

Module 4: Dating methods, correlation methods and interpretation of geological maps

Context and exemplification	Assessable learning outcomes
5.4.1 Know about radiometric dating	Candidates should be able to: (a) explain how radiometric dating is used to establish an absolute timescale; (b) describe and explain the limitations of radiometric dating based on the scarcity of appropriate radioactive minerals; (c) describe and explain the problems of obtaining accurate radiometric dates, particularly with respect to sedimentary and metamorphic rocks; (d) describe potassium-argon and rubidium-strontium methods of radiometric dating and explain how they are used to date different rocks of varied ages; (e) plot and interpret half-life curves for these methods.
5.4.2 Know about relative dating	Candidates should be able to: (a) describe and explain the use of superposition, original horizontality, way-up criteria, cross-cutting relationships, included fragments, unconformities and fossils to date rocks at the surface and in boreholes; (b) describe and explain the problems of using relative dating when derived fossils and erosion may give contradictory evidence;

	(c) explain how both relative and radiometric dating are used to create the geological timescale.
5.4.3 Use dating evidence to interpret geological maps	Candidates should be able to: (a) recognise the age relationships between structures on simplified geological maps, cross-sections and photographs using both relative and absolute dates, correlation and zone fossils; (b) describe the age relationships of beds using cross-cutting features: beds, faults, folds, unconformities and igneous features to interpret map and cross-section geological histories.
5.4.4 Know and understand the geological column	Candidates should be able to: (a) outline early attempts made to estimate the Earth's absolute age: salts in the ocean, rates of sedimentation, rate of cooling; (b) describe the division of the geological column into eras and systems using both relative and absolute dating methods.
5.4.5 Know how rocks can be correlated	Candidates should be able to: (a) describe and apply biostratigraphic correlation using first appearance, stratigraphic range, extinction and fossil assemblages; explain the problems of derived fossils or scarcity of fossils; (b) describe and apply lithostratigraphic correlation using sequences of beds, thickness and composition; explain the problems of lateral variation and diachronous rocks; (c) describe and apply chronostratigraphic correlation using tuffs and varves.
5.4.6 Know the main appearances and extinctions of key fossil groups and their use as zone fossils	Candidates should be able to: (a) describe and explain the use of the first appearance and extinction of the main invertebrate fossil groups to establish a relative timescale for the Phanerozoic into eras and systems; (b) state the stratigraphic ranges of trilobites, graptolites, tabulate, rugose and scleractinian corals, goniatites, ceratites and ammonites, regular and irregular echinoids, long hinged and short hinged brachiopods; (c) describe and explain the factors that make a good zone fossil; outline the advantages and disadvantages of using graptolites, ammonoids and microfossils as zone fossils.

Practical skills are assessed using OCR set tasks. The practical work suggested below may be carried out as part of skill development. Centres are not required to carry out all of these experiments.

- Use the internet to research the main extinction events.
- Use geological maps, photographs and cross-sections to write a geological history.

Module 5: Changing climate

Context and exemplification	Assessable learning outcomes
5.5.1 Know that climate has changed over geological time	Candidates should be able to: (a) define the term climate; describe changing climate in terms of icehouse – greenhouse cycles throughout geological time and explain the possible link to mass extinction events; (b) describe how Milankovitch cycles may explain patterns of sedimentation, particularly in the Jurassic; (c) describe the use of oxygen (^{18}O and ^{16}O) isotopes to determine water temperature; (d) describe the use of carbon (^{13}C and ^{12}C) isotopes in identifying geological changes.
5.5.2 Know that there have been major changes in sea level over geological time	Candidates should be able to: (a) interpret Vail sea level curves showing changes over geological time in comparison with modern sea level; (b) explain how both isostatic and eustatic sea level changes take place; (c) explain the relationship between sea level and climate change and the possible link to mass extinction events.
5.5.3 Know about the evidence for palaeoclimatic changes	Candidates should be able to: (a) describe and explain the fossil evidence for palaeoclimatic changes: corals and plants; (b) describe and explain the lithological evidence for palaeoclimatic changes: coal, desert sandstone, evaporites, boulder clay (tillite) and reef limestone; (c) describe the evidence for the northward movement of the British Isles throughout geological time.

Practical skills are assessed using OCR set tasks. The practical work suggested below may be carried out as part of skill development. Centres are not required to carry out all of these experiments.

- Use the internet to research the main changes in climate events. Analyse data to investigate changes throughout geological time.

3.6 A2 Unit F796: *Practical Skills in Geology 2*

A2 Unit F796: *Practical Skills in Geology 2*

This unit develops practical and investigative skills within contexts encountered during A2 Geology.

Candidates are required to carry out **two** task types:

OCR provided Centre-based task or Centre-devised Fieldwork task	[20 marks]
Evaluative task	[20 marks]

The OCR provided **Centre-based Task** is practically based and candidates carry out this task under controlled conditions in the laboratory/classroom. Alternatively, centres may elect to devise their own **Fieldwork Task**.

Centres intending to devise their own Fieldwork Task must ensure that it matches the requirements of the Centre-based Task. A sample Fieldwork Task and mark scheme is on the OCR website. The proposed Fieldwork Task and its mark scheme must be submitted to OCR for approval at least 6 weeks before being presented to candidates. If centres wish to provide candidates with more than one opportunity to carry out a Fieldwork Task then they will need to submit separate task proposal forms for each task that they devise.

The same skills are assessed whether candidates carry out one of the OCR set Centre-based Tasks based on geological maps, photographs and data **or** undertake a centre-devised Fieldwork Task. Both types involve measurement, observation and recording of data, ie both qualitative and quantitative techniques.

The **Evaluative Task** is provided by OCR in a context that extends geological skills. Candidates are required to evaluate results based on field or practical data. All data and resources required will be supplied with in the Evaluative Task. There is no additional practical work.

Initially, a choice of **three** Centre-based Tasks and **three** Evaluative Tasks are offered. Tasks are refreshed or replaced each year and additional tasks may be made available.

Tasks, mark schemes and guidance for teachers and technicians are downloaded from the OCR Interchange site.

All assessed tasks are carried out under direct teacher supervision.

Each practical skills unit is teacher assessed using a mark scheme provided by OCR via the Interchange website and externally moderated by OCR. One mark will be required for each task type with an overall mark out of **40** being submitted to OCR.

Candidates may attempt more than one task from either task type with the best mark for each type being used to make up the overall mark. A candidate is only permitted one attempt at each task.

Although practical tasks can be used throughout the year, entry for the AS and the A2 practical skills units is available only in the June series of each year.

How Science Works

5a Carry out experimental and investigative activities, including appropriate risk management, in a range of contexts

5b Analyse and interpret data to provide evidence, recognising correlations and causal relationships

5c Evaluate methodology, evidence and data, and resolve conflicting evidence.

Context and exemplification	Assessable learning outcomes
Centre-based or **Fieldwork Task** A single mark out of 20 will be required	Candidates should be able to: (a) (i) demonstrate skilful and safe practical techniques using suitable qualitative methods; (ii) demonstrate skilful and safe practical techniques using suitable quantitative methods; (b) make and record valid observations; organise results suitably; (c) make and record accurate measurements to an appropriate precision.
Evaluative Task A single mark out of 20 will be required.	Candidates should be able to: (a) analyse the data and assess the reliability and accuracy of an experimental or field based task or research based task; (b) interpret the data to form conclusions, and to make deductions from the processed evidence; (c) evaluate the methodology, identify significant weaknesses and select simple improvements to experimental or field-based procedures and measurements; (d) evaluate the results, identify any anomalies or inaccuracies and recognise and explain the trends in data.

Further advice and guidance on the use and marking of the tasks can be found in the Practical Skills Handbook.

4 Schemes of Assessment

4.1 AS GCE Scheme of Assessment

AS GCE Geology (H087)	
AS Unit F791: *Global Tectonics*	
30% of the total AS GCE marks 1 h written paper 60 marks	Candidates answer **all** questions.
AS Unit F792: *Rocks – Processes and Products*	
50% of the total AS GCE marks 1 h 45 min written paper 100 marks	Candidates answer **all** questions.
AS Unit F793: Practical Skills in Geology	
20% of the total AS GCE marks Coursework 40 marks	Candidates complete **two** tasks set by OCR. Tasks are marked by the centre using a mark scheme written by OCR and are moderated by OCR.

4.2 Advanced GCE Scheme of Assessment

Advanced GCE Geology (H487)	
AS units as above, Unit F791 being 15% of the total Advanced GCE marks, Unit F792 being 25% of the Advanced GCE marks, and Unit F793 being 10% of the Advanced GCE marks.	
A2 Unit F794: *Environmental Geology*	
15% of the total Advanced GCE marks 1 h written paper 60 marks	Candidates answer **all** questions. This unit is synoptic.
A2 Unit F795: *Evolution of Life, Earth and Climate*	
25% of the total Advanced GCE marks 1 h 45 min written paper 100 marks	Candidates answer **all** questions. This unit is synoptic.
A2 Unit F796: Practical Skills in Geology 2	
10% of the total Advanced GCE marks Coursework 40 marks	Candidates complete two tasks set by OCR. Tasks are marked by the centre using a mark scheme written by OCR.

4.3 Unit Order

The normal order in which the unit assessments could be taken is AS Units F791, F792 and F793 in the first year of study, leading to an AS GCE award, then A2 Units F794, F795 and F796 leading to the Advanced GCE award.

Alternatively, candidates may take a valid combination of unit assessments at the end of their AS GCE or Advanced GCE course in a ‘linear’ fashion.

4.4 Unit Options (at AS/A2)

There are no optional units in the AS GCE specification; for AS GCE Geology candidates must take AS Units F791, F792 and F793.

There are no optional units in the Advanced GCE specification; for Advanced GCE Geology candidates take AS Units F791, F792 and F793, *and* A2 Units F794, F795 and F796.

4.5 Synoptic Assessment (A Level GCE)

Synoptic assessment tests the candidates’ understanding of the connections between different elements of the subject.

Synoptic assessment involves the explicit drawing together of knowledge, understanding and skills learned in different parts of the Advanced GCE course. The emphasis of synoptic assessment is to encourage the development of the understanding of the subject as a discipline. All A2 units, whether internally or externally assessed, contain synoptic assessment.

Synoptic assessment requires candidates to make and use connections within and between different areas of Geology geology at AS and A2, for example, by:

- applying knowledge and understanding of more than one area to a particular situation or context; and
- using knowledge and understanding of principles and concepts in planning experimental and investigative work and in the analysis and evaluation of data
- bringing together scientific knowledge and understanding from different areas of the subject and applying them.

All A2 units, F794, F795 and F796, contain some synoptic assessment.

4.6 Assessment Availability

There are two examination series each year, in January and June.

The availability of units is shown below.

Level	Unit	January 2009	June 2009	January 2010	June 2010	January 2011	June 2011
AS	F791	✓	✓	✓	✓	✓	✓
AS	F792		✓	✓	✓	✓	✓
AS	F793		✓		✓		✓
A2	F794			✓	✓	✓	✓
A2	F795				✓	✓	✓
A2	F796				✓		✓

The availability shown for 2011 will apply for subsequent years

4.7 Assessment Objectives

Candidates are expected to demonstrate the following in the context of the content described.

AO1 Knowledge and Understanding

- recognise, recall and show understanding of scientific knowledge;
- select, organise and communicate relevant information in a variety of forms.

AO2 Application of Knowledge and Understanding

- analyse and evaluate scientific knowledge and processes;
- apply scientific knowledge and processes to unfamiliar situations including those related to issues;
- assess the validity, reliability and credibility of scientific information.

AO3 How Science Works

- demonstrate and describe ethical, safe and skilful practical techniques and processes, selecting appropriate qualitative and quantitative methods;
- Make, record and communicate reliable and valid observations and measurements with appropriate precision and accuracy;
- Analyse, interpret, explain and evaluate the methodology, results and impact of their own and others' experimental and investigative activities in a variety of ways.

AO weightings in AS GCE

Unit	% of AS GCE			Total
	AO1	AO2	AO3	
AS Unit F791: *Global Tectonics*	14	14	2	30%
AS Unit F792: *Rocks – Processes and Products*	21	24	5	50%
AS Unit F793: *Practical Skills in Geology 1*	3	2	15	20%
	38%	40%	22%	100%

AO weightings in Advanced GCE

Unit	% of Advanced GCE			Total
	AO1	AO2	AO3	
AS Unit F791: *Global Tectonics*	7	7	1	15%
AS Unit F792: *Rocks – Processes and Products*	10.5	12	2.5	25%
AS Unit F793: *Practical Skills in Geology 1*	1.5	1	7.5	10%
A2 Unit F794: *Environmental Geology*	5	9	1	15%
A2 Unit F795: *Evolution of Life, Earth and Climate*	9	13.5	2.5	25%
A2 Unit F796: *Practical Skills in Geology 2*	1	1.5	7.5	10%
	34%	44%	22%	100%

4.8 Quality of Written Communication

Quality of Written Communication is assessed in all units and credit may be restricted if communication is unclear.

Candidates will:

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

This specification provides opportunities to assess the quality of written communication by:

- the use of extended writing tasks in all assessment units;
- expecting candidates to use specialist vocabulary throughout;
- the use of a variety of question types and wordings to encourage a variety of forms and styles of responses.

5 Technical Information

5.1 Making Unit Entries

Please note that centres must be registered with OCR in order to make any entries, including estimated entries. It is recommended that centres apply to OCR to become a registered centre well in advance of making their first entries. Centres must have made an entry for a unit in order for OCR to supply the appropriate forms or moderator details for coursework.

It is essential that unit entry codes are quoted in all correspondence with OCR. See Sections 4.1 and 4.2 for these unit entry codes.

5.2 Making Qualification Entries

Candidates must enter for qualification certification separately from unit assessment(s). If a certification entry is **not** made, no overall grade can be awarded.

Candidates may enter for:

- AS GCE certification (entry code H087).
- Advanced GCE certification (entry code H487).

A candidate who has completed all the units required for the qualification may enter for certification either in the same examination series (within a specified period after publication of results) or in a later series.

AS GCE certification is available from June 2009.
Advanced GCE certification is available from June 2010.

5.3 Grading

All GCE units are awarded a–e. The Advanced Subsidiary GCE is awarded on the scale A–E with access to an A*. To be awarded an A*, candidates will need to achieve a grade A on their full A level qualification and an A* on the aggregate of their A2 units. Grades are reported on certificates. Results for candidates who fail to achieve the minimum grade (E or e) will be recorded as unclassified (U or u) and this is **not** certificated.

A Uniform Mark Scale (UMS) enables comparison of candidates' performance across units and across series and enables candidates' scores to be put on a common scale for aggregation purposes. The three-unit AS GCE has a total of 300 *uniform* marks and the six-unit Advanced GCE has a total of 600 *uniform* marks.

OCR converts the candidate's raw mark for each unit to a *uniform* mark. The maximum *uniform* mark for any unit depends on that unit's weighting in the specification. In these Geology specifications the six units of the Advanced GCE specification have *uniform* mark weightings of 15%/25%/10%/15%/25%/10% (and the three units of the AS GCE specification have *uniform* mark weightings of 30%/50%/20%). The *uniform* mark totals are 90/150/60/90/150/60 respectively. Each unit's *raw* mark grade boundary equates to the *uniform* mark boundary at the same grade. Intermediate marks are converted on a pro-rata basis.

Uniform marks correspond to *unit* grades as follows:

(Advanced GCE) Unit Weighting	Maximum Unit Uniform Mark	Unit Grade					
		a	b	c	d	e	u
25%	150	150–120	119–105	104–90	89–75	74–60	59–0
15%	90	90–72	71–63	62–54	53–45	44–36	35–0
10%	60	60–48	47–42	41–36	35–30	29–24	23–0

OCR adds together the unit *uniform* marks and compares these to pre-set boundaries (see the table below) to arrive at *qualification* grades.

Qualification	Qualification Grade					
	A	B	C	D	E	U
AS GCE	300–240	239–210	209–180	179–150	149–120	119–0
Advanced GCE	600–480	479–420	419–360	359–300	299–240	239–0

Candidates achieving at least 480 *uniform* marks in their Advanced GCE, ie grade A, and who also gain at least 270 *uniform* marks in their three A2 units will receive an A* grade.

5.4 Result Enquiries and Appeals

Under certain circumstances, a centre may wish to query the grade available to one or more candidates or to submit an appeal against an outcome of such an enquiry. Enquiries about unit results must be made immediately following the series in which the relevant unit was taken.

For procedures relating to enquires on results and appeals, centres should consult the OCR *Administration Guide for General Qualifications* and the document *Enquiries about Results and Appeals – Information and Guidance for Centres* produced by the Joint Council. Copies of the most recent editions of these papers can be obtained from OCR.

5.5 Shelf-life of Units

Individual unit results, prior to certification of the qualification, have a shelf-life limited only by that of the qualification.

5.6 Unit and Qualification Re-sits

There is no restriction on the number of times a candidate may re-sit each unit before entering for certification for an AS GCE or Advanced GCE.

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

5.7 Guided Learning Hours

AS GCE Geology requires **180** guided learning hours in total.
Advanced GCE Geology requires **360** guided learning hours in total.

5.8 Code of Practice/Subject Criteria/Common Criteria Requirements

These specifications comply in all respects with current *GCSE, GCE, GNVQ and AEA Code of Practice* as available on the QCA website, the subject criteria for GCE Geology and *The Statutory Regulation of External Qualifications 2004*.

5.9 Arrangements for Candidates with Particular Requirements

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 *Access Arrangements and Special Consideration Regulations* and *Guidance Relating to Candidates who are Eligible for Adjustments in Examinations* produced by the Joint Council. In such cases advice should be sought from OCR as early as possible during the course.

5.10 Prohibited Qualifications and Classification Code

Candidates who enter for the OCR GCE specifications may not also enter for any other 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 Achievement and Attainment Tables.

The classification code for these specifications is 1770.

5.11 Coursework Administration/Regulations

Supervision and Authentication

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

Submitting marks to OCR

Centres must have made an entry for a unit in order for OCR to supply the appropriate forms or moderator details for coursework. Coursework administration documents are sent to centres on the basis of estimated entries. Marks may be submitted to OCR either via Interchange, on the computer-printed Coursework Mark Sheets (MS1) provided by OCR (sending the top copy to OCR and the second copy to their allocated moderator) or by EDI (centres using EDI are asked to print a copy of their file and sign it before sending to their allocated moderator).

Deadline for the receipt of coursework marks is:
15 May for the June series

The awarding body must require centres to obtain from each candidate a signed declaration that authenticates the coursework they produce as their own. For regulations governing coursework, centres should consult the OCR *Administration Guide for General Qualifications.* Further copies of the coursework administration documents are available on the OCR website (www.ocr.org.uk).

Standardisation and Moderation

All internally assessed coursework is marked by the teacher and internally standardised by the centre. Marks must be submitted to OCR by the agreed 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 internally assessed 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 sample of work that is submitted to the moderator for moderation must show how the marks have been awarded in relation to the marking criteria.

Minimum Coursework Required

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

6 Other Specification Issues

6.1 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 the following.

Biology

A2 Unit F795: *Evolution of Life, Earth and Climate*. Module 3: Fossil evidence of the evolution of organisms and mass extinctions

Chemistry

A2 Unit F795: *Evolution of Life, Earth and Climate.* Module 5: Changing climate.

Geography

AS Unit F791: *Global tectonics*. Module 2: Earthquakes.

AS Unit F792: *Rocks – Processes and Products.* Module 2: Igneous processes and products – volcanoes.

A2 Unit F794: *Environmental Geology.* 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

A2 Unit F795: *Evolution of Life, Earth and Climate*. Module 4: Dating methods, correlation methods and interpretation of geological maps.

Science

A2 Unit F794: *Environmental Geology*. Many environmental issues are discussed within the content of this module, especially those related to water supply, waste disposal and energy resources.

A2 Unit F795: *Evolution of Life, Earth and Climate.* Module 3: Fossil evidence of the evolution of organisms and mass extinctions.

A2 Unit F795: *Evolution of Life, Earth and Climate*. Module 4: Dating methods, correlation methods and interpretation of geological maps.

6.2 Progression from these Qualifications

These Geology specifications are intended to facilitate the 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 second audience consists of those who are likely to make more direct use of geology; 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 and Advanced GCE Geology should also be seen as making a contribution towards life-long learning.

6.3 Key Skills Mapping

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* at Levels 2 and/or 3. However, the extent to which this evidence fulfils the Key Skills criteria at these levels will be totally dependent on the style of teaching and learning adopted for each unit.

The following table indicates where opportunities *may* exist for at least some coverage of the various Key Skills criteria at Levels 2 and/or 3 for each unit.

Unit	C				AoN			IT			WwO			IoLP			PS		
	.1a	.1b	.2	.3	.1	.2	.3	.1	.2	.3	.1	.2	.3	.1	.2	.3	.1	.2	.3
F791	✓	✓						✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
F792	✓	✓						✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
F793				✓	✓	✓	✓	✓	✓	✓									
F794	✓	✓	✓					✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
F795	✓	✓	✓					✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
F796		✓	✓	✓	✓	✓	✓	✓	✓	✓									

6.4 Spiritual, Moral, Ethical, Social, Legislative, Economic and Cultural Issues

These specifications offer opportunities that can contribute to an understanding of these issues in the following topics:

- a sense of awe and wonder at the scale and impact of natural processes and phenomena (for example, see AS Unit F791: *Global Tectonics*); the evolution of invertebrate groups and dinosaurs over time and the dating of events (for example, see A2 Unit F795: *Evolution of Life, Earth and Climate*);

- 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 A2 Unit F794: *Environmental Geology*); the advantages and disadvantages of earthquake and volcanic hazard prediction (for example, see AS Unit F791: *Global Tectonics*);

- cultural issues, driven by society, such as mining, quarrying and waste pollution (for example, see A2 Unit F794: *Environmental Geology*).

6.5 Sustainable Development, Health and Safety Considerations and European Developments

These specifications support these issues, consistent with current EU agreements, in the following topics.

Sustainable development

- A2 Unit F794: *Environmental Geology* addresses the main environmental, technological, safety and economic issues related to water supply, energy resources, and metallic mineral deposits;

- an appreciation of geodiversity and the Earth's finite resources is essential for sustainable development;

- an appreciation of the necessity to conserve sites of geological significance.

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 A2 Unit F794: *Environmental Geology*);

- adherence to the Geologists' Association *Geological Fieldwork Code* when in the field.

European dimension

There have been many contributions to the science 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, that could be developed during the course. For example:

- geological mapping and research is frequently multinational as structures and geological features extend across Europe;

- good examples of earthquake activity (see AS Unit F791: *Global Tectonics*), volcanic activity, (see AS Unit F792: *Rocks – Processes and Products*) and use of geothermal energy (see A2 Unit F794: *Environmental Geology*), occur in Europe;

- oil distribution in the North Sea (see A2 Unit F794: *Environmental Geology*).

6.6 Avoidance of Bias

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

6.7 Language

These specifications and associated assessment materials are in English only.

6.8 Disability Discrimination Act Information Relating to these Specifications

AS/A levels often require assessment of a broad range of competences. This is because they are general qualifications and, as such, prepare candidates for a wide range of occupations and higher level courses.

The revised AS/A level qualification and subject criteria were reviewed to identify whether any of the competences required by the subject presented a potential barrier to any disabled candidates. If this was the case, the situation was reviewed again to ensure that such competences were included only where essential to the subject. The findings of this process were discussed with disability groups and with disabled people.

Reasonable adjustments are made for disabled candidates in order to enable them to access the assessments. For this reason, very few candidates will have a complete barrier to any part of the assessment. Information on reasonable adjustments is found in *Access Arrangements and Special Consideration Regulations and Guidance Relating to Candidates who are Eligible for Adjustments in Examinations* produced by the Joint Council (refer to Section 5.9 of this specification).

Candidates who are still unable to access a significant part of the assessment, even after exploring all possibilities through reasonable adjustments, may still be able to receive an award. They would be given a grade on the parts of the assessment they have taken and there would be an indication on their certificate that not all of the competences have been addressed. This will be kept under review and may be amended in the future.

Practical assistants may be used for manipulating equipment and making observations. Technology may help visually impaired students to take readings and make observations.

Appendix A: Performance Descriptions

Performance descriptions have been created for all GCE subjects. They describe the learning outcomes and levels of attainment likely to be demonstrated by a representative candidate performing at the A/B and E/U boundaries for AS and A2.

In practice most candidates will show uneven profiles across the attainments listed, with strengths in some areas compensating for weaknesses or omissions elsewhere in the award process. Performance descriptions illustrate expectations at the A/B and E/U boundaries of the AS and A2 as a whole; they have not been written at unit level.

Grade A/B and E/U boundaries should be set using professional judgement. The judgement should reflect the quality of candidates' work, informed by the available technical and statistical evidence. Performance descriptions are designed to assist examiners in exercising their professional judgement. They should be interpreted and applied in the context of individual specifications and their associated units. However, performance descriptions are not designed to define the content of specifications and units.

The requirement for all AS and A Level specifications to assess candidates' quality of written communication will be met through one or more of the assessment objectives.

The performance descriptions have been produced by the regulatory authorities in collaboration with the awarding bodies.

AS performance descriptions for geology

	Assessment Objective 1	Assessment Objective 2	Assessment Objective 3
Assessment Objectives	**Knowledge and understanding of science and of How science works** Candidates should be able to: • recognise, recall and show understanding of scientific knowledge; • select, organise and communicate relevant information in a variety of forms.	**Application of knowledge and understanding of science and of How science works** Candidates should be able to: • analyse and evaluate scientific knowledge and processes; • apply scientific knowledge and processes to unfamiliar situations including those related to issues; • assess the validity, reliability and credibility of scientific information.	**How science works** Candidates should be able to: • demonstrate and describe ethical, safe and skilful practical techniques and processes, selecting appropriate qualitative and quantitative methods; • make, record and communicate reliable and valid observations and measurements with appropriate precision and accuracy; • analyse, interpret, explain and evaluate the methodology, results and impact of their own and others' experimental and investigative activities in a variety of ways.
A/B boundary Performance Descriptions	Candidates characteristically: a) demonstrate knowledge of most principles, concepts and facts from the AS specification; b) show understanding of most principles, concepts and facts from the AS specification; c) select relevant information from the AS specification; d) organise and present information clearly in appropriate forms using scientific terminology.	Candidates characteristically: a) apply principles and concepts in familiar and new contexts involving only a few steps in the argument; b) describe significant trends and patterns shown by data presented in tabular or graphical form, interpret phenomena with few errors and present arguments and evaluations clearly; c) explain and interpret phenomena with few errors and present arguments and evaluations clearly; d) carry out structured calculations with few errors.	Candidates characteristically: a) devise and plan experimental and investigative activities, selecting appropriate techniques; b) demonstrate safe and skilful practical techniques; c) make observations and measurements with appropriate precision and record these methodically; d) interpret, explain, evaluate and communicate the results of their own and others experimental and investigative activities, in appropriate contexts.

E/U boundary Performance Descriptions	Candidates characteristically: a) demonstrate knowledge of some principles and facts from the AS specification; b) show understanding of some principles and facts from the AS specification; c) select some relevant information from the AS specification; d) present information using basic terminology from the AS specification.	Candidates characteristically: a) apply a given principle to material presented in familiar or closely related contexts involving only a few steps in the argument; b) describe some trends or patterns shown by data presented in tabular or graphical form; c) provide basic explanations and interpretations of some phenomena, presenting very limited evaluations; d) carry out some steps within calculations.	Candidates characteristically: a) devise and plan some aspects of experimental and investigative activities; b) demonstrate safe practical techniques; c) make observations and measurements, and record them; d) interpret, explain and communicate some aspects of the results of their own and others' experimental and investigative activities, in appropriate contexts.

A2 performance descriptions for geology

	Assessment Objective 1	Assessment Objective 2	Assessment Objective 3
Assessment Objectives	**Knowledge and understanding of science and of How science works** Candidates should be able to: • recognise, recall and show understanding of scientific knowledge; • select, organise and communicate relevant information in a variety of forms.	**Application of knowledge and understanding of science and of How science works** Candidates should be able to: • analyse and evaluate scientific knowledge and processes; • apply scientific knowledge and processes to unfamiliar situations including those related to issues; • assess the validity, reliability and credibility of scientific information.	**How science works** Candidates should be able to: • demonstrate and describe ethical, safe and skilful practical techniques and processes, selecting appropriate qualitative and quantitative methods; • make, record and communicate reliable and valid observations and measurements with appropriate precision and accuracy; • analyse, interpret, explain and evaluate the methodology, results and impact of their own and others' experimental and investigative activities in a variety of ways.
A/B boundary Performance Descriptions	Candidates characteristically: a) demonstrate detailed knowledge of most principles, concepts and facts from the A2 specification; b) show understanding of most principles, concepts and facts from the A2 specification; c) select relevant information from the A2 specification; d) organise and present information clearly in appropriate forms using scientific terminology.	Candidates characteristically: a) apply principles and concepts in familiar and new contexts involving several steps in the argument; b) describe significant trends and patterns shown by complex data presented in tabular or graphical form, interpret phenomena with few errors, and present arguments and evaluations clearly and logically; c) explain and interpret phenomena effectively, presenting arguments and evaluations; d) carry out extended calculations, with little or no guidance; e) select a wide range of facts, principles and concepts from both AS and A2 specifications; f) link together appropriate facts, principles and concepts from different areas of the specification.	Candidates characteristically: a) devise and plan experimental and investigative activities, selecting appropriate techniques; b) demonstrate safe and skilful practical techniques; c) make observations and measurements with appropriate precision and record these methodically; d) interpret, explain, evaluate and communicate the results of their own and others' experimental and investigative activities, in appropriate contexts.

E/U boundary performance descriptions	Candidates characteristically: a) demonstrate knowledge of some principles and facts from the A2 specification b) show understanding of some principles and facts from the A2 specification c) select some relevant information from the A2 specification d) present information using basic terminology from the A2 specification.	Candidates characteristically: a) apply given principles or concepts in familiar and new contexts involving a few steps in the argument b) describe, and provide a limited explanation of, trends or patterns shown by complex data presented in tabular or graphical form c) provide basic explanations and interpretations of some phenomena, presenting very limited arguments and evaluations d) carry out routine calculations, where guidance is given e) select some facts, principles and concepts from both AS and A2 specifications f) put together some facts, principles and concepts from different areas of the specification.	Candidates characteristically: a) devise and plan some aspects of experimental and investigative activities b) demonstrate safe practical techniques c) make observations and measurements and record them d) interpret, explain and communicate some aspects of the results of their own and others experimental and investigative activities, in appropriate contexts.

Appendix B: Mathematical Requirements

In order to be able to develop their skills, knowledge and understanding in Geology, students need to have been taught, and to have acquired competence in, the appropriate areas of mathematics relevant to the subject as indicated below.

1) Arithmetic and numerical computation:

- 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).

2) Handling data:

- use an appropriate number of significant figures;
- find arithmetic means;
- construct and interpret frequency tables and diagrams, bar charts and histograms;
- understand simple probability;
- understand the principles of sampling as applied to scientific data;
- understand the terms mean, median and mode;
- use a scatter diagram to identify a correlation between two variables;
- use a simple statistical test;
- make order of magnitude calculations.

3) Algebra:

- understand and use the symbols: $=$, $<$, $\ll$, $\gg$,$>$, $\propto$, $\sim$;
- substitute numerical values into algebraic equations using appropriate units for physical quantities.

4) Graphs:

- translate information between graphical, numerical and algebraic forms;

- plot two variables from experimental or other data;

- understand that $y = mx + c$ represents a linear relationship;

- determine the slope and intercept of a linear graph;

- calculate rate of change from a graph showing a linear relationship.

5) Geometry and trigonometry:

- visualise and represent 2-D and 3-D forms including two-dimensional representations of 3-D objects;

- calculate areas of triangles, circumferences and areas of circles, surface areas and volumes of rectangular blocks, cylinders and spheres.

Appendix C: 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 local 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 2002 and the Management of Health and Safety at Work Regulations 1999, 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 at www.ase.org.uk/htm/teacher_zone/safety_in_science_education.php.

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.

  Now out of print but sections are available at:
  www.ase.org.uk/htm/teacher_zone/safety_in_science_education.php;

- *Topics in Safety*, 3rd edition, 2001, ASE ISBN 0 86357 316 9;

- *Safeguards in the School Laboratory*, 11th edition, 2006, ASE ISBN 978 0 86357 408 5;

- CLEAPSS® *Hazcards*, 2007 edition and later updates*;

- CLEAPSS® *Laboratory Handbook**;

- *Hazardous Chemicals*, A Manual for Science Education, 1997, SSERC Limited

  ISBN 0 9531776 0 2 (see www.sserc.org.uk/public/hazcd/whats_new.htm).

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 CLEAPSS® (or, in Scotland, SSERC).

*These, and other CLEAPSS® publications, are on the CLEAPSS® Science Publications CD-ROM issued annually to members. Note that CLEAPSS® publications are only available to members. For more information about CLEAPSS® go to www.cleapss.org.uk. In Scotland, SSERC (www.sserc.org.uk) has a similar role to CLEAPSS® and there are some reciprocal arrangements.

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Appendix D: Using OCR Interchange to download Practical Skills tasks

All materials for the assessment of GCE Geology Practical Skills can be obtained from OCR Interchange.

How to use OCR Interchange
OCR Interchange is a secure extranet enabling registered users to administer qualifications on-line. Your Examinations Officer is probably using OCR Interchange to administer qualifications already. If this is not the case, then your centre will need to register.

Your Examinations Officer will be able to:*

- download the relevant documents for you by adding the role of 'Science Coordinator' to their other roles or
- create a new user account for you (adding the Science Coordinator role) so that you can access the GCE Geology pages and download documents when you need them.*

*Note that in order to assign the role of Science Coordinator to others, the Examinations Officer will need to hold the role of Centre Administrator.

The website address for Interchange is:

https://interchange.ocr.org.uk

The teacher who has downloaded these materials is responsible for ensuring that any pages labelled **confidential** are stored securely so that students do not have the opportunity to access them.

It is intended that the circulation of the Practical Tasks is limited to those students who are currently undertaking that task. These materials should be photocopied and issued to students at the start of the task. Numbering the documents may help to keep track of them.

Registering for Interchange

If your Examinations Officer is not already a registered user of Interchange then he/she will need to register before the Geology Tasks can be downloaded.

This is a straightforward process:

- Go to the website – https://interchange.ocr.org.uk
- The first page has a New User section
- Click on Sign Up to access the OCR Interchange Agreement Form 1
- Download this document and fill in your details
- Return form by post to OCR Customer Contact Centre, Westwood Way, Coventry, CV4 8JQ or fax the form back to 024 76 851633
- OCR will then contact the Head of Centre with the details needed for the Examinations Officer to access OCR Interchange.