GCE

Geology

Advanced GCE **A2 7884**

Advanced Subsidiary GCE **AS 3884**

Report on the Units

June 2007

3884/7884/MS/R/07

Oxford Cambridge and RSA Examinations

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REPORT ON THE UNITS

Chief Examiner's Report

General Comments

All the papers performed well giving a good range of marks. However there are still areas where candidates could improve marks just by careful reading of the wording on the exam paper.

The initial sentence in many questions contains valuable information for candidates that will help them give correct answers. There is a tendency for candidates to ignore this sentence and then give answers that are impossible. Where the stem states that all the rocks are igneous and candidates give the answer as metamorphic it is very clear that ignoring the information in the stem question costs the candidates marks.

There remains an issue of a lack of explanation when the question asks for this, so that candidates are *describing* without giving *reasons*. This excludes candidates from getting full marks for a question that requires an explanation. Concentrating on command words and knowing what they mean are key exam techniques. AS requires a set of basic terms and limited detail while A2 requires a far wider range of terms and detailed responses that need to show understanding and often explanations rather than just descriptions. Problems with a lack of detail at A2 are most noticeable for the petrology paper, that builds on the AS basics of 2832, the Rock Cycle unit, and is also synoptic on other units.

In addition, some candidates need to pay far more care and attention to the quality of their written communication, both for short answer questions and the continuous prose required for the extended answer question. Poor handwriting and spelling continue to be issues for some and candidates should be encouraged to learn the correct spelling of key geological words and terms.

The quality of diagrams produced continues to show improvement, but many candidates still lost marks due to inaccuracies and no or poor labelling.

There are a number of made up words that are appearing regularly. Some like *pentaloid* to describe echinoids are very clever others like *defracted* in reference to waves instead of either reflected or refracted are similar and candidates write them every year. *Artisan* wells is an interesting spelling mistake while beds were *dipped* instead of tilted is so common that it begins to feel correct. There is so much terminology specific to geology exams it seems a real pity to try to increase it!

2831: Global Tectonics and Geological Structures (Written Examination)

General Comments

Candidates were able to answer the whole paper with time not being an issue. There were a number of opportunities in this paper for students to calculate or plot data and as a rule candidates did well. The strongest questions were those on Global Tectonics and the weakest on the structural sections, in particular the block diagram. The extended prose on the core of the Earth produced a range of answers with relatively few candidates gaining full marks. Marks ranged from 5 to 59 out of the maximum 60 marks and there was a wide range of marks on each of the four questions.

All questions were answered correctly by some candidates and there were no part questions that caused major problems.

Comments on Individual Questions

1 Candidates found this question on the effects of earthquakes fairly hard overall, however some aspects were answered well by all.

(a) **(i)** Most candidates answered well on the location of the hospital although there was some confusion amongst candidates about the properties of weathered and unweathered granite. Weathered granite is unlikely to be suitable for strong foundations.

(ii) Good answers, though slightly dependant on the candidates getting the right position for the hospital in the first place! 'Away from coastline' was often stated without being precise enough about the effect of tsunamis or saying that it wouldn't suffer from the effects of coastal erosion.

(iii) More candidates recognised the least suitable place to locate the hospital as either close to the slope or on the reclaimed land.

(b) **(i)** The best answers were usually by those candidates who structured their answer carefully, referring to social factors, then economic factors. Some candidates ignored the word “prediction” in the question and just wrote generally about social and economic effects of an actual earthquake.

(ii) Most candidates found it easier to describe than to name the method. Vagaries included things like 'shock absorbers', 'sway with the building'; many thought that the rubber / base isolators allowed the building to move with the quake rather than separating the building from the moving ground. There were some excellent answers with candidates even including diagrams showing cross bracing and dampers.

Teaching Tip

Students should be familiar with the main methods of reducing the impact of earthquakes on built structures. The table below shows some of the current methods.

Name of method	Description of method
Base isolation	This works by separating the building from the moving ground. *Teflon* pads, large rollers and springs can be used.
Cross-bracing	Diagonal steel structures that criss-cross the building. The aim is to stop the building twisting (torsion) during a earthquake.
Passive damping	It involves using a variety of techniques to absorb shaking energy within a building.
Design	Ensuring that there are no large unsupported ground floor spaces.

(c) **(i)** Most students recognised the conservative plate margin, but a few called it *transform* or *passive* which are not the terms in the specification for use in this context.

(ii) Most candidates gained 2 marks; any dropped marks were usually due to extending the Hayward fault to the SE.

(iii) Most candidates gained one mark with some reference to seismic gap theory even if they did not state this specifically. Few candidates could adequately explain the theory.

(iv) Candidates generally understood earthquake prediction though some answers were too vague and did not refer to an increase or change in the amount of gas, giving just the idea of 'radon gas released'. Other points not credited included: animal behaviour, unless reference was made to abnormal or unusual; water level changes, without a reference to groundwater or wells. The main failure was to identify the idea of change *prior* to an earthquake so allowing a prediction to be made.

2 Candidates tended to do well in this question being strong on plate margins and able to plot the graph.

(a) **(i)** Quite a few candidates missed out the arrows - perhaps they did not see the question, but candidates generally gained the 2 marks.

(ii) Most students knew about the ocean trench although some wrote subduction zone.

(iii) Most candidates knew that the diagram was of a destructive plate margin.

(iv) Many students knew an appropriate example although a few vaguely referred to the “ring of fire” or to a specific volcano rather than the whole area.

(b) **(i)** Most candidates gained a mark for explanation by writing about friction, but only the more able were clear enough in their description of the earthquake foci being along the top edge of the subducted plate. The term Benioff zone is not a description.

(ii) Gaining both marks for the explanation of gravity was a rare occurrence with many candidates gaining one mark for description, but few had a good enough explanation of why the gravity varies.

(c) **(i)** Most students used appropriate scales though some lost marks by missing out the zero on the scale, or had an inaccurate best fit line which did not go through the origin. Most candidates gained the two marks for plotting sufficient points accurately. The majority of candidates scored 3/4 marks on the graph.

(ii) Candidates especial difficulty with getting the order of magnitude correct. Many students lost marks because of poor working. Answers of 5000 cm/year gave amazingly rapid movement while others at 0.005 cm/year were very slow!

Teaching Tip

Candidates should expect this type of question and be aware of general spreading rates which in one direction could vary between 1 and 10 cm a year. Then if their calculations are greater or smaller than this range they should check the calculations and especially the position of the decimal point. Getting a realistic answer is the key issue. Using calculators can be a problem as it is easy to mistake zeros. Working manually is more likely to give an accurate answer.

$\frac{\text{distance}}{\text{time}}$	$\frac{25\text{ km}}{0.5\text{ Ma}}$	$\frac{2\,500\,000}{500\,000}$	$\frac{25}{5}$	5 cm / year

(c) **(iii)** If candidates were correct in 2cii then they tended to gain credit

(iii) whilst many others had ecf (error carried forwards).

(iv) Many candidates were sidetracked into discussing the idea of magnetic reversals rather than explaining why the anomalies were symmetrical. Relatively few candidates mentioned the equal rate of spreading which adds new material to the ocean floor equally on both sides of the ridge at the same time.

Teaching Tip

Using pencils on an OHP is a visual method to show how new crust forms. Placing several pencils with all the pencil tips pointing up to represent one reversal, then more pencils with the tips pointing down pushed in the middle, shows the way that the next reversal forms. This can be repeated for as many reversals as needed to fix the concept. For a more active class use students alternating facing the front then the back of the classroom, and as they are pushed into the centre they remember the sideways movement!

Candidates did better on this structural question than for many years and many answered well. Most candidates could describe the fold, work out the geological history and mix and match the terms with the description. Detailed understanding is still a weak area though. Students should expect structural questions as maps, sections and block diagrams.

3 **(a)** **(i)** Most candidates knew that the fold was a synform but detail and use of technical terms was often lacking and some described the fault. Candidates should be able to describe at least three features of every fold –

- type of fold
- dip of limbs to show whether it is symmetrical or asymmetrical
- direction of the axial plane trace
- form of the fold as closed, open or tight
- shape as rounded or angular.

(ii) Most candidates could draw the fold axis and the best candidates had the axial plane trace displaced and labelled correctly.

(iii) Surprisingly few candidates could work out the dip direction (the main difficulty) or the angle of dip on the perspective view of the diagram. Candidates do need to be able to measure the dip of beds from a cross section or block diagram using a protractor.

(iv) Most candidates knew where the unconformity was especially as a label pointing to the conglomerate rather than the plane of unconformity was accepted. Ideally though, candidates should point to the line that forms the plane of unconformity.

(b) Candidates were generally very impressive at working out the relative ages.

(c) The majority of candidates were able to match the technical terms.

(d) **(i)** Almost all candidates correctly drew the cross section of an antiform as a simple upfold. However in order to ensure that the fold is also an anticline the age of the beds must be labelled with the oldest beds exposed in the centre of the fold. A few candidates used desiccation cracks or graded bedding to indicate way up as an alternative way of indicating the age relationship.

(ii) The monocline was quite well known by many although a significant number had no real idea and some were confused with faults. A monocline needs to have a steep limb separating two areas of horizontal or low dip beds. Both elements are essential for two marks.

Teaching Tip
Cards with all the fold names printed on and cut up diagrams of each fold types and separate fold descriptions make a quick and simple revision or starter activity. Students then put each diagram and description on the card in the correct places.

4 Responses were mixed with relatively few candidates gaining full marks. In general candidates were clear on evidence for the physical state of the Earth's core and in particular the use of seismology. Candidates were less clear about the various sources of evidence for the composition of the core, often being very vague.

Good answers included:

- reference to iron or metallic meteorites
- refraction / slowing down of P-waves at the Gutenberg boundary
- good discussion of the density of the core being heavy compared to the whole Earth in order to balance the lighter crust and upper mantle
- reference to iron in the core creating the magnetic field
- clear reference to inner or outer core when discussing state or composition
- P-waves speeding up in the inner core as it is solid.

Weak answers often included:

- reference to 'meteorites', or 'stony-irons' being like the core
- magnetism being due to the core without reference to iron
- reference to 'the core' without distinguishing inner / outer
- not knowing the detail of the composition of inner and outer core.

Many students picked up good marks for describing the evidence for the physical state of the core. Candidates were less good at gaining marks for describing the evidence for the composition of the core.

2832: The Rock Cycle - Processes and Products (Written Examination)

General Comments

Overall, candidates performed well on this paper. Marks ranged from 5 to 59 out of the maximum 60 marks and there was a wide range of marks on each of the four questions. Maximum marks were awarded on all of the questions There was no evidence that the paper could not be completed in the time allowed.

Comments on Individual Questions

Question 1

Most candidates gained their highest mark on this question. Just over 3% scored maximum marks. The diagram and tables were successfully interpreted and completed with no common errors. The quality of answers to part (c) had a tendency to vary by centre.

1 (a) (i) Although most went on to interpret the rock cycle diagram capably, a very large proportion found offering a definition of the term to be really quite challenging.

Parts **(ii)** and **(iii)** allowed them to show that they could interpret a diagram, but in this part of the question it was equally clear that when asked to put into words what the rock cycle is, very many were unable to do so.

(ii) Generally answered with great efficiency. If there was any confusion it tended to be writing igneous and metamorphic in the wrong boxes.

(iii) Not quite so capably done. Oddly Y, representing lithification, was sometimes placed at a depth lower than a correctly labelled sedimentary box.

(iv) Many candidates were aware of intrusive igneous rocks but some found it difficult to describe the processes involved. Some stated that intrusive igneous rocks were intruded. Although a different part of speech, this type of answer uses the same wording as the question and so does not provide any additional description.

(v) Successfully answered. A mark was sometimes lost by stating ‘extrusive rocks and pyroclasts’, or ‘extrusive rocks and lava’. Extrusive is a term including both lavas and pyroclasts. Extrusive rocks and gas would have been worth full marks.

(b) Correctly completed tables were widespread. Quite a few candidates had one or two letters in the wrong place. A number of candidates did not follow the instruction to use all the letters.

(c) **(i)** Candidates at some centres were unable to name the geological column. The mark scheme sets out a range of acceptable alternatives. Some had no idea and did not offer a response.

(ii) Candidates from most centres shaded the correct time unit. Some shaded the bottom unit instead of the top one in column K. Others had learnt all the names of the units and filled them in on the table. An impressive display, but one that may have cost them valuable time later.

(iii) Possible responses were to leave this blank, to make up some names, to get the right names the wrong way round or to get era and period in the correct order. All variations were seen with the correct one being most frequent.

Teaching Tip

Distinguishing between the broad groups of igneous, sedimentary and metamorphic rocks can be done using a series of cards, each one describing a relevant characteristic. The descriptions used in question 1(b) would make a good start. They could be supplemented by cards describing distinctive minerals for each group, cards with drawings of textures, which can be found in past 2832 papers and photographs of thin sections. The cards can then be sorted so that all the igneous, sedimentary and metamorphic ones are in the right groups. When they are sorted they can be mounted and used as a display that can be seen for as long as you choose.

Question 2

This question again resulted in the full range of marks being awarded, although it was found to be rather more challenging than question 1. Candidates did not perform as consistently well across all the parts of this question as they did in question1.

2 **(a)** **(i)** A large proportion of candidates ably matched the parent and metamorphic rocks. There was a significant minority of what appeared to be random answers with all possible combinations of pairings apart from the right one.

(ii) Knowledge of oolith formation varied by centre as much as by candidate with details sometimes being quite vague. Important factors such as the rolling of a fragment or pellet in carbonate mud were often not mentioned and the diagram did not appear to have stimulated thinking about the concentric layers.

(iii) Some candidates did not refer to an environment or mistakenly described aeolian dunes in deserts because they had misinterpreted the thin section drawing. The idea of oscillating currents was not as widely known as one might have expected.

(iv) There was some confusion between symmetrical and asymmetrical ripple marks. A number of drawings looked rather more like folds than any kind of ripple mark. The best drawings showed the symmetrical shape with the ripple marks having pointed crests and rounded troughs and angles of the sides at less than 35^{o}. A scale was needed for full marks.

(b) **(i)** Freeze-thaw weathering was well known and clearly described by a big majority of candidates, large numbers of whom knew that water expands by 9% on freezing.

(ii) The correct answer *angular* was by far the most frequent response.

(iii) Some candidates who had not read the question properly imagined a coastal cliff and offered *marine transport*. Most knew that the fragments were transported by gravity.

(iv) The chemical weathering process was less well described than the mechanical one in part (i)

(V) Several candidates thought that it might be hydrolysis. A few described atmospheric pollution and had general ideas about 'acid rain eating away at rocks'. Of those who described carbonation, some were very thorough with information on carbonic acid and formulae describing the reactions, whilst others just knew that it involved limestone reacting with acidic water.

(c) Many capable descriptions that referred to the relevant facts. Some had awkward descriptions, which referred to the incorporation of 'dead bodies' into the limestone rather than fragments of organic origin. The unfortunate bodies were then affected by a certain amount of 'squashing' and 'crushing' rather than the more precise burial and compaction. These candidates had some ideas but were unable to express them adequately or use the correct technical terms.

Teaching Tip

Make your own symmetrical ripple marks
Partly fill a rectangular tank with water and add a small amount of clean washed sand. Spread the sand out over the bottom of the tank. Lift one end of the tank gently up and down for about half a minute– not too vigorously or the water will spill out. This creates waves that move backwards and forwards across the tank, rather like waves moving in and out across tidal sand flats. The sand will develop ripple marks that have the same slope angle on either side of the crests – they are symmetrical. They will have pointed crests and rounded troughs.

Question 3

Less well prepared candidates found it easier to gain at least some marks on this question on igneous processes than they did in question 2. There were good answers to all the questions although only a minority gained full marks for b(iii) and c(i)

3 (a) (i) There were few difficulties here, although some candidates got the terms hypabyssal and plutonic the wrong way round.

(ii) The sill was usually correctly identified, although labelling was not always clear. Some lines were drawn near to the sill but not touching it, or in some cases cutting across it and ending in the country rock on the other side. It is necessary for candidates to draw lines that touch, and end at, the feature they are being asked to label. A few wrongly labelled a dyke as a sill.

(b) (i) Most candidates used the correct grain size terms and many others used the scale bar to give an accurate size in mm. There were some who used non-scientific terms like ‘big’ or ‘large’ which do not have a precise meaning in terms of size and so were not credited.

(ii) Vesicles are not ‘air holes’ although a surprising number of responses described them in this way, despite them being labelled as ‘gas holes’ on the diagram. Some candidates wrote about gas bubbles in the magma but did not go on to refer to the fine grained groundmass indicating rapid cooling.

(iii) This three mark question turned out to be a two mark question for most candidates. They forgot to refer to rates of cooling and crystal size at intermediate depths, even though the diagram at the beginning of question 3 had drawn their attention to the three depth categories. A few candidates explained that crystals would be coarse grained at depth due to slow cooling and then said it was ‘vice versa’ for crystals at shallow depth. ‘Vice versa’ is not an explanation. Candidates need to explain fully to gain full marks. Some linked crystal size to rates of cooling but did not make the link to depth. This was an essential part of the answer.

(c) (i) A high proportion gained one mark by knowing that Indonesia is located at a destructive plate boundary. This only went part of the way towards answering the question and a much smaller number referred to partial melting of the subducted plate and subsequent rise of the magma. Some candidates said that the plate boundary was constructive, or just mentioned a plate boundary, but the volcanic products described in the table are consistent only with a destructive plate boundary.

(ii) Not all candidates knew how to calculate a percentage. Some calculated the percentage of deaths rather than the percentage of eruptions and a few others did not show their working. Overall though, this was very well answered.

(iii) Only a few candidates did not link the cold summer of 1816 to the eruption of Tambora the year before. Some referred to ash fall as being responsible for global cooling. It was however, ash in the atmosphere that was responsible, not the ash fall. Several candidates referred to the concept of global dimming.

Teaching Tip

Volcanic Hazards
To appreciate the social and economic effects, the danger to life and property and the impact on climate change of volcanic activity, students can carry out some research that can be used to create a display, or as material for a presentation, possibly including a set of Power Point slides. There is a wide range of resources on the Internet as well as in books and articles. Here are some potential sources to start off:

www.cet.edu/ete/modules/volcanoes/vclimate.html
www.earthobservatory.nasa.gov/Study/Volcano/
www.earthbulletin.amnh.org/D/3/1/index.html
'Volcanoes: Special Report' in The Geographical Magazine, March 2007
'Super Eruptions. Global Effects And Future Threats' London 2005: the Geological Society

Question 4

This question was well answered by many candidates with 10% of candidates gaining full marks. Written communication was usually clear. Candidates appeared not to have run out of time and almost all followed instructions by using diagrams. The essay discriminated between candidates' responses quite effectively and a wide range of quality was seen.

Compaction and cementation were usually given equal coverage in most of the answers and except at the lower end of the range there was little tendency for candidates to confuse them. The concept of porosity was widely used although the spaces between grains could be 'poors' rather than 'pores'. In some answers it was not made clear that it was the mass of overlying sediment that may cause compaction and it was merely reported that there was deposition in layers. In itself this did not describe the process of compaction and there needed to be some reference to the mass of, or pressure exerted by these overlying layers.

Diagrams were often clear and illustrated the closer packing of grains and the expulsion of fluids very effectively. Some diagrams were over elaborate or did not illustrate compaction well because they were at the wrong scale, for example diagrams showing several layers of sediment without showing that the grains in the bottom layer had moved closer together.

Candidates often knew about cementing minerals being carried in solution, but most were not able to say what these minerals might be. Reductions in permeability were referred to and explained in the context of the precipitation of mineral cement.

A significant number of candidates were able to exemplify their descriptions by saying that compaction was a particular feature of clays and that cementation was well illustrated by quartz sandstones. Many pointed out that both compaction and cementation are diagenetic processes but there was sometimes confusion between diagenesis and lithification.
The essays were generally clearly written with significant number of candidates able to use the concepts of porosity and permeability well in structuring their answers.

Teaching Tip

To demonstrate that compaction and cementation can lithify sand grains, producing ‘sandstone’ can be done practically

Materials needed: syringe with the nozzle cut off and the inside smeared with Vaseline; sand grains (damp); plaster of Paris powder.

Put some of the damp sand grains into the syringe. Block the open end (e.g. with your finger) and press hard on the plunger (compaction). Carefully push the compacted sand out onto a sheet of paper and describe what has happened.

Next use a mix of five parts damp sand and one part plaster of Paris powder. (The plaster of Paris will form a cement). Compact and push out as before. Allow it to dry.

Which of the two samples appears to have been lithified? Describe what happened to this sample.

2833/01 Economic and Environmental Geology

General Comments

For the second year running there appeared to be an improvement in the performance of most candidates. This may be a reflection of the particular topics examined in this session or the fact that candidates are being better prepared for the examination. There was a wide range of marks from 2 to 45 out of a maximum of 45.

Question 1 on water supply was answered very well. Question 2 on the conditions of formation of oil, gas and coal and oil accumulation and extraction produced variable responses. The quality of answers to question 3 on coal, waste disposal and the extended question on hydrothermal mineral deposits was variable and produced a wide spread of marks.

Comments on Individual Questions

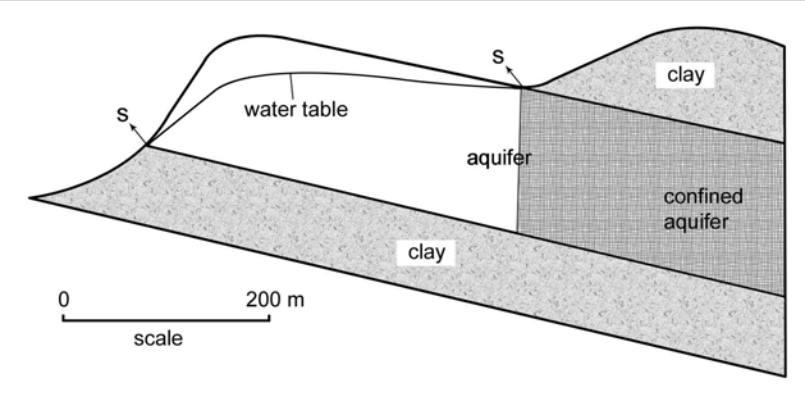
Question 1

This question was well done by the majority of candidates showing that water is a topic that is well known.

(a) The majority of candidates attained both marks for stating two properties that could make a rock a good aquifer. The most common correct answers were the requirements of high porosity and high permeability. Incorrect spelling of the words *permeability* and *porosity* continues to be an issue for some candidates. One or two candidates repeated the same answer twice (e.g. high permeability and good interconnections between the pores) to achieve 1 mark only. A small number of candidates confused *permeable* and *impermeable* and erroneously stated that the rock would need to be impermeable. Others discussed the rocks above and below the aquifer, rather than the requirements for the aquifer itself.

(b) Most candidates attained at least 1 mark for this question. The correct position of a spring was best known. At least half the candidates correctly shaded the confined area of the aquifer, but careless shading lost some candidates marks. The correct position of the water table was least well known. Many candidates extended it into the confined area of the aquifer and others extended it into the clay layers above and below the aquifer.

Teaching Tip



(c) (i) (ii) (iii)

Responses to this question asking for a description and explanation of what would happen to the groundwater if a well is dug into a confined aquifer were variable. Many candidates correctly stated for two marks that the water would rise up or flow out onto the surface because it was under hydrostatic pressure. However, some candidates erroneously thought high pressure is caused by the surrounding rocks and others incorrectly stated the water level would fall. Vague and ambiguous answers such as “the well will fill with water” were not credited as any well dug below the water table will fill with water to the level of the water table – candidates had to convey the idea of the water rising upwards.

A significant number of candidates were not aware that this type of well is called an *artesian* well.

This part question asking for one problem that may occur when water is extracted from the well over a period of time was well known with the vast majority of candidates attaining the mark. The most common correct answer cited was that the level of the water table would fall or a cone of depression would form. Unfortunately, a few candidates penalised themselves with vague answers suggesting that the whole aquifer would dry out.

(d) Many candidates struggled to give correct definitions of the terms *hydrostatic pressure* and *hydraulic gradient* even though they are listed in the specification. Although most candidates recognised that hydrostatic pressure is water pressure, many were unable give the correct definition that it is at a point in a body of water caused by the weight of the overlying column of water. A common misconception was that it is caused by pressure from the surrounding rocks. As there was only one mark available for the definition of hydraulic gradient, answers such as *it is the slope of the water table* were credited, but only a handful of candidates gave the detailed definition that it is *the difference in hydrostatic pressure/hydraulic head between two points divided by the distance between them.*

(e) Most candidates gained the mark for stating one advantage of groundwater supply over surface water supply from rivers and reservoirs. The most common correct answers were that rocks act as a natural filter purifying the water or that there is no loss of water through evaporation. However, some candidates gave vague answers such as it is *less likely to be polluted* and these were not credited unless they gave a specific reason. It should be noted that aquifers are vulnerable to pollution and once polluted, the pollutants have a long residence time and are virtually impossible to remove.

2 Question 2 produced variable responses and, while there were some very good answers, there were also a number of very poor answers, particularly to the part questions about North Sea oil and gas and primary oil recovery. The quality of responses appeared to be centre-dependent.

(a) Although there have been past examination questions on the conditions required for the formation of oil, gas and coal, this was the first time they had been combined as a table in one question. Only a few candidates managed to gain the full 4 marks. Some candidates did not appear to appreciate the meaning of the term *sedimentary environment* and incorrectly gave *climatic (tropical)* or *vegetation (rainforest)* zones as their answer. Many candidates were not clear as to the type of organic matter that is required to produce oil and imprecise answers such as sea creatures are not sufficient. Most candidates were able to correctly state that coal formation requires anaerobic conditions, but fewer were aware of rapid rates of sedimentation in deltaic environments.

Teaching Tip

The correct answer to the question is given below:

	oil	**coal**
sedimentary environment	deep marine	**deltaic / delta top / swamp / marsh / bog / floodplain**
type of organic matter	**plankton / micro-organisms / sapropel**	terrestrial vegetation
oxygen conditions	anoxic sea bed conditions	**low oxygen / reducing / anoxic / anaerobic / stagnant**
rate of sedimentation	slow	**fast / rapid**

Presenting information in tables can be a useful way of summarising and comparing information. Tables are a common feature of examination papers and candidates must be able to confidently translate information from continuous prose into table form and vice versa.

(b) (i) (ii)

The question asking for the name of the main source rock for oil in the northern basin of the North Sea was very poorly answered. Very few gave the correct answer *Kimmeridge Clay*.

Only the strongest candidates were able to explain why only gas is found in the southern basin of the North Sea. Very few candidates were aware that the gas in the southern basin of the North Sea originates from a different source rock (the Carboniferous Coal Measures) to the oil and gas in the northern basin of the North Sea. Unfortunately, a number of candidates appear to have misread the question and attempted to discuss why there is no coal in the southern basin of the North Sea.

(c) (i) (ii) (iii) (iv)

It was disappointing that so many candidates were unable to show where oil might accumulate on diagram 1 by shading horizontally in the top of the limestone unit at the crest of the anticline. Common errors were not shading the oil horizontally or only shading the source rock.

Teaching tip

The issue of candidates not realising that the layer of oil must be horizontal was highlighted in last year's report and it appears that some candidates still suffer from this misconception. A simple experiment can be carried out to demonstrate this - Quarter fill a beaker with water and then pour a thin layer of cooking oil (preferably coloured with food colouring) on top. This will demonstrate that oil is less dense than water. Then tilt the beaker at an angle to show that the layer of oil remains horizontal.

The vast majority of candidates attained both marks for explaining why oil might be found in the area shaded. Some candidates lost marks because they did not use technical terms in their explanations. Another common misconception is that oil rises upwards because it is less dense than rock, rather than water.

This part question asking why oil would be unlikely to be found in the geological situation shown on diagram 2 was less well done. Many candidates recognised that the presence of the fault could result in leakage of oil but, unfortunately, some suggested it would leak downwards rather than upwards, clearly not appreciating the effect of the oil's low density. Although many candidates also realised the igneous intrusion would be a problem, a significant number suggested the problem would be a lack of permeability, rather than the issue of high temperatures denaturing and destroying the oil. Few used the term metamorphism to explain the altered rock around the igneous intrusion and that any oil present would be destroyed by metamorphism.

Responses to this part question asking how primary oil recovery could take place from the area shown on diagram 1 were variable. Many candidates produced good answers describing how a production well would be drilled into the reservoir rock and the oil come to the surface under pressure for the full two marks. However, others appeared to have no idea of what primary recovery entails and waffled or let themselves down with poor English and a lack of technical terminology. A number of candidates mistakenly wrote about secondary recovery techniques.

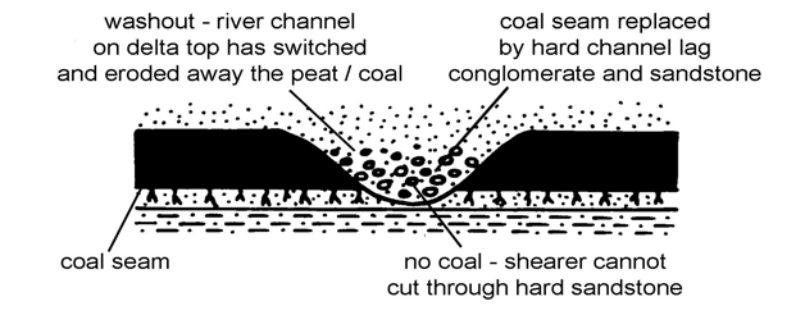
3 The quality of answers to question 3 on coal, waste disposal, and the extended question on hydrothermal mineral veins was variable. The question discriminated well between strong and weak candidates. The first part of the question on coal was the least well done on the paper. The answers to the section on waste disposal were good and clearly this is well known by candidates. While there were some excellent answers to the extended question on hydrothermal mineral deposits, others seemed to have no knowledge of this part of the specification or wrote about any type of mineral deposit they could think of.

(a) Very few candidates attained all three marks for naming and describing one method of underground coal mining. The quality of responses varied between centres. Regrettably, some candidates misread the question and wrote about opencast mining. Others named room and pillar or longwall mining correctly and then wrote about the other type of mining. Many others used no technical terminology whatsoever and wrote vague descriptions such as *holes are dug underground and miners hack the coal out and bring it to the surface*, which did not score any marks. The most common misconceptions about room and pillar mining were that the pillars are made of rock or artificial props rather than coal; the roof is allowed to collapse after mining; and that it is safer than longwall mining. It should be noted that longwall mining is the main mining method employed in modern underground coal mines. Many seemed far more familiar with 18th Century coal mining methods! Candidates that did describe longwall mining mainly concentrated on describing how a shearer travels back and forth along the coal face cutting coal that falls onto a conveyor belt. Only the strongest candidates were aware that the roof is supported by mobile hydraulic supports; or that the mining usually takes place backwards retreating towards the shaft; or that the mined out area is allowed to collapse deliberately (and safely!).

(b) (i)

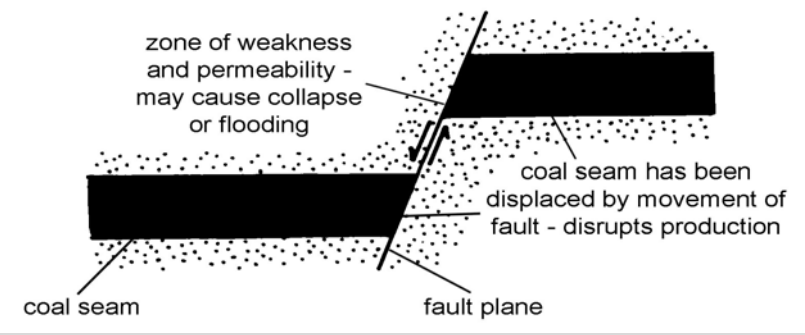
(ii) This part question asking candidates to draw a labelled diagram to illustrate how a washout can cause problems for underground mining was not done very well. It was clear that a significant number of candidates had no idea that a washout results from channel switching on the ancient delta top. In desperation, many drew a picture (rather than labelled diagram) of a mine being flooded and the coal (and miners) being washed away! Inaccurate or poor labelling of diagrams to illustrate how washouts and faults can cause problems.

Teaching tip



This part question asking candidates to draw a labelled diagram to illustrate how a fault can cause problems for underground mining was done better than the question on washouts. However, a number of candidates still let themselves down with poor quality, scruffy drawings and little or no labelling.

Teaching tip



(c) Most candidates gained one mark for correctly describing one advantage of opencast coal mining compared to underground coal mining. However, some candidates penalised themselves by not following the command word *describe* and merely stated it would be cheaper, or safer, or would cause less pollution.

(d) (i) (ii) (iii)

The majority of candidates were able to explain correctly why there were concerns that toxic fluids may leak from the landfill into the groundwater supply. It was particularly pleasing that most candidates attributed the problem to the sandstone's permeability, with only a small minority incorrectly attributing it to porosity.

The calculation was also done correctly by the majority of candidates. Responses to this part question asking what could be done to the abandoned quarry prior to its being used for waste disposal were generally good with the most common correct answers being to make the quarry floor impermeable by grouting or using a clay or plastic lining. However, some candidates did not include sufficient detail to achieve the second mark. Furthermore, a small number of candidates seemed to think grouting and lining are the same thing.

(e) There were some excellent, well written answers to the extended question on the formation of hydrothermal mineral veins which achieved the maximum 7 marks with ease. However, a significant number of candidates did not write anything. Some candidates wrote about igneous intrusions in general with no reference to mineral deposits. Some struggled to recall the correct ore minerals and others failed to include correct descriptions of the chemical processes taking place. Only the strongest candidates gave a good definition of what a hydrothermal fluid is and explained its origin as *the residual water, volatiles and incompatible metals left over from crystallisation of silicate minerals in acid igneous intrusions*. Some potentially good answers were spoilt by confusion with pegmatites – a number of candidates suggested hydrothermal mineral veins are formed by magma exploiting cracks and joints. Some failed to explain that precipitation of ore minerals occurs as a result of cooling of the hydrothermal fluid or that ore minerals precipitate from the fluid in order of solubility. Diagrams could have been used to greater effect by many candidates, particularly to show the relationship of the mineral veins to the igneous intrusion and to show the zonation of ore minerals away from the intrusion.

2834: Palaeontology (Written Examination)

General Comments

Overall, the paper was of appropriate difficulty for the A2 candidates. Marks ranged from 11 to 84 out of the maximum 90 marks and there was a wide range of marks on each of the questions. Recall of complex morphology and classification was much improved and the application of ideas applied to new situations was also good.

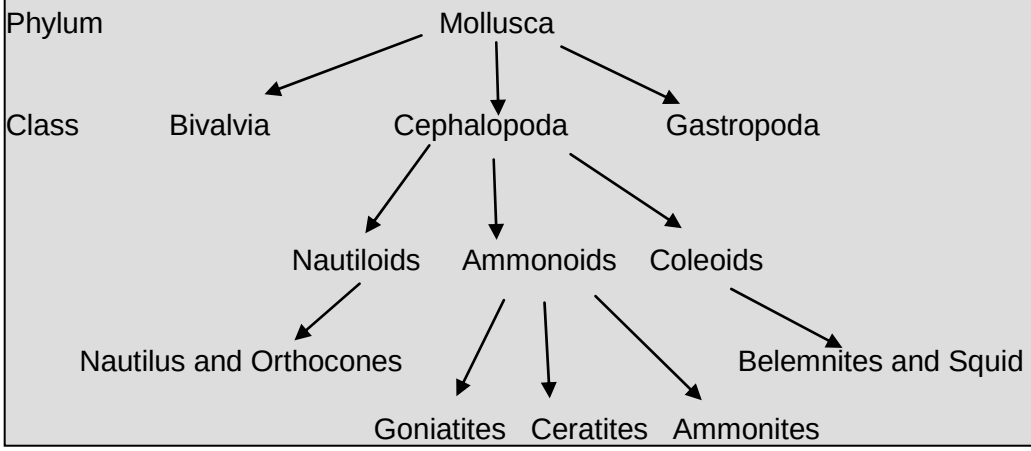
As usual, the quality of the diagrams produced by the candidates was variable, and both good practice and poor practice was often centre specific. Some diagrams were still unlabelled or unclear. The diagrams of bivalves in the extended answer question were generally very good, and probably a reflection of a previous short answer exam question.

Comments on Individual Questions
Question 1

(1) (a) (i) Most candidates recognised all the fossil groups and knew the phylum for trilobites. Many were less sure of the phylum for ammonites and belemnites and very few were able to differentiate between the groups of brachiopoda. Some thought fossil A was a bivalve, a coral or an echinoderm.

Teaching Tip

Teach the inter-relationships as a simple branch diagram, especially for mollusca. A simple example is given below.



(ii) The recall of trilobite morphology was good, although some used more complicated terminology which is not on the specification. Labelling the protoconch provided candidates with the biggest problem with many mistaking this for the umbilicus. Some simply labelled the brachial valve as shell.

(iii) Modes of life were generally well known though the belemnite caused some uncertainty. Some candidates thought the terms could only be used once, therefore missing the point that the environments were similar for B and C. Some used all of the terms several times, with no understanding of their meanings, so giving contradictory answers. A minority of candidates used completely different terms not given in the question.

(b) **(i)** The most obvious answer that the brachiopod has a tough shell and may have lived in an environment without sufficient energy to break it up was common. A detailed understanding of the functional morphology was displayed by those who knew that the shells would remain closed when the muscles decayed.

(ii) For C, the belemnite, candidates guessed that it was a burrower which may explain its alignment, misunderstanding its mode of life completely. A minority explained this alignment by discussing low grade metamorphism and pressure. The most common misconception was that the belemnites lived as a colony and all died at the same time.

(iii) There was a tendency to the simplistic, stating that trilobites had three parts and were delicate. These answers also had to invoke high energy conditions. Many candidates successfully used ecdysis to explain the number of fragmented fossils and there were intelligent realisations that the exoskeleton relied on living tissue to hold it together.

Question 2

2 **(a)** **(i)** This question was well answered with most candidates recognising irregular echinoids and / or *Micraster*. Incorrect guesses named the group as echinodermata which was not helpful as this information was already in the question and therefore gained no marks.

(ii) Most candidates recognised the two morphological features and could label them successfully. Very few candidates mislabelled the incorrect fossil.

(iii) Very few candidates achieved full marks on this section. The position of the labrum was known reasonably well although some thought that its function was to scoop sediment into the mouth and others thought that it had tube feet attached. The plastron proved more of a problem and was often mistaken for the sub-anal fasciole.

(b) **(i)** The description and explanation were rarely fulfilled to a high level. Most were able to record differences in the echinoid morphology but were hazy on the reasons for it, often plumping for generalisations such as *more evolved*. A surprising number compared the wrong two echinoids or described differences that were not on the diagrams.

(ii) Most candidates were able to put these examples in order but many of the answers were reversed.

(c) **(i)** Most candidates were able to select two differences between regular and irregular echinoids although candidates should avoid answers that could be classed as repetition e.g. *heart-shaped* and *bilateral symmetry*.

(ii) Candidates were usually able to name the mode of life of the regular echinoid. Some failed to expand on this merely re-stating a definition of the term. Many made correct associations of tube feet and locomotion but did not describe the mode of life. Some worryingly described these creatures as being attached to debris and planktonic.

Question 3

3 **(a)** Most candidates recognised the three fossils, the most common error being to see N as a vagrant bivalve flapping its way across the seafloor or fossil O as a belemnite, coprolite, tree trunk or coral. There were many excellent answers displaying good morphological knowledge and often including mechanisms of preservation. The environment caused slightly more of a problem as the broken graptolite was assumed to have encountered higher energy. There were frequent contradictions showing that the term littoral was not well known.

(b) Some candidates failed to grasp the distinction between the environment and the type of organism responsible for the coprolite. There were intelligent guesses stating that the energy levels needed to be low to preserve the faeces in the first place.

(c) **(i)** The majority of candidates failed to get full marks on this section. This may reflect the inadequate coverage of the topic in popular texts. Silica from pore waters can replace the original structure (sometimes progressively) or can infill pore spaces within bones, plants or shells (impregnation /petrifaction). Carbonisation was frequently incorrectly described as replacement by carbon or carbon coating of the skeleton.

(ii) Most candidates were able to give a sensible answer relating to the relative instability of aragonite. There were some excellent and detailed descriptions of the mechanisms involved, although these were not asked for. The commonest misconception was to need a chemical reaction, which liberated O_2 or reacted with CO_2 to produce calcite as a product.

Question 4

4 (a) (i) Very few were able to succinctly describe radioactive decay, many describing a half-life instead. A few incorrectly discussed 'rotting' radioactive minerals.

(ii) Most candidates successfully plotted the graph and drew a curve through those points which started at 100% and did not cross the x-axis. It should be emphasised to candidates that plotting points in splodges of biro and then attempting to alter these by crossing them out in more biro will not result in full marks. Careful and clear pencil points in circles or with crosses were generally correct. A few candidates had no idea and drew a curve parallel to the existing one.

(iii) It seemed difficult for candidates to explain that the curve for X is steeper due to its more rapid decay. Some alluded to using fossils directly, the shorter the half life the younger the fossil, the same candidates incorrectly answering later questions.

(iv) Most candidates were able to read these points correctly from their graphs. Error carried forward (ecf) was allowed here.

(v) There were very good answers to this section with some candidates demonstrating an excellent understanding of the geological problems inherent in absolute dating. The potential loss of argon was well represented although candidates were divided as to how this would affect the age ascribed to the rock. It may be as well to emphasise the choice of distinct mechanisms in questions of this nature so that repetition does not lead to loss of marks.

(b) This section was not well answered in general.

(i) Argon was recognised as one of the decay products of ^{40}K. Some bizarre answers included gold. Some stated ^{40}Ca, which is one of the products in the decay chain.

(ii) The half life of ^{40}K was known to only a few candidates and most of those had the incorrect version that has infected the literature and even past exam papers (those answers were allowed but should not be taught). The correct value is 1 260 million years.

(iii) Although there are a number of minerals containing ^{40}K many guessed at quartz. Some suggested that argon would be found in aragonite. Some gave a rock name as the answer to part (iii) and a mineral as the answer to part (iv).

(iv) Most candidates could give the category or name of a rock containing the mineral given in part (iii).

Question 5

5 (a) This question was, in general, well answered although there were many candidates who could have achieved full marks had they obeyed the rubric. Some neglected to discuss all four types, instead giving very detailed accounts of one type of bivalve.

The best answers were on burrowing adaptations with excellent descriptions of the elongation and thinning of the shell, pallial sinus and long siphons. Weaker candidates brought in siphuncles at this point. In common with the other modes of life, the diagrams were often tiny and without morphological labels to illustrate the adaptations. They tended to merely show the mode of life e.g. a bivalve in a burrow. Diagrams have to be large enough to be recognisable.

The nektonic mechanism of *Pecten* was well known, although it was not often shown to be monomyarian and there were divided schools of thought on which way it moved as water was expelled.

Attached forms confirmed the inability of many to distinguish between *bivalve* and *brachiopod*. A common mistake was in referring to a pedicle.

Free-lying forms such as *Gryphea* were poorly described in relation to the other modes of life and were most often omitted from the answers.

There was a general imbalance between the answers given for the four modes of life which probably reflects variable knowledge rather than poor exam technique.

(b) The responses were often poorly written such that the little knowledge available was not clearly set down. Reading the question would have saved much unnecessary discussion of scleractinian corals. *Rugose* was generally assumed to be only a solitary coral and *tabulae* were frequently *tabulates*.

There seemed to be an assumption that either this question would not come up or that the differences represented too much of an intellectual challenge. Many candidates did not need the last page, managing to convey the weight of their understanding in less than 14 lines. Diagrams were again ‘sketchy’ with little labelling and most drew a tabulate coral with a columella despite its rarity in the fossil record.

Corals is seen as a difficult topic but creating a table to show the similarities and differences, serves as an aid to memory and ensures that proper comparisons are made between the groups.

Teaching tip
The table below is a useful summary and with the addition of diagrams makes a quick revision sheet. However it is useful as a starter or plenary cut up as cards that students can match.

	TABULATE	RUGOSE	SCLERACTINIAN
1. Form	compound	compound or solitary	compound or solitary
2. Tabula	present	present	present
3. Septa - vertical partitions	none	major and minor septa in cycles of 4 show bilateral symmetry	in cycles of 6 show radial symmetry
4. Dissepiments	none	present between septa	present between septa
5. Columella	very rare	vertical rod or more complex plates about axis of coral	vertical rod or plate shape may be present
6. Corallum	calcareous, massive or bun shaped or chain of corallites	calcareous solitary with transversely wrinkled or rugose surface, massive, round or polygonal compound corallites	calcareous skeleton, outer wall of minute fibres of aragonite, massive, round or polygonal corallites
7. Calice	few mm across, round, oval, or polygonal shape	cup shaped hollow which polyp sits in	cup shaped hollow which polyp sits in
8. Size	each corallite a few mm, forms mass up to 2 m across	each corallite 4 mm -> 20 cm, forms mass up to 10 m across	each corallite each 3 mm -> 8 cm and forms a mass up to 10 m across
9. Attached	no	yes	yes
10. Age	Ordovician - Permian, common in Silurian	Silurian - Permian, common in Carboniferous	Triassic - recent

There was no evidence that the candidates had run out of time, as many had used extension sheets to complete their answers.

The quality of written communication was generally of a good standard though spelling of technical terms is an issue as usual.

2835: Petrology (Written Examination)

General Comments

The examination paper this session gave a full range of responses, with a large variation amongst centres. There were, though, many excellent scripts utilising technical terms very effectively and clearly demonstrating a clear understanding of the relevant subject matter and concepts. However there was an inconsistent performance across the questions that led to some promising performances being marred by underachievement on some questions. Marks ranged from 5 to 84 out of the maximum 90 marks and there was a wide range of marks on each of the questions.

In this A2 examination it is essential that answers include sufficient detail and not just a general statement. This paper is synoptic on the three AS modules and it was clear that some candidates had not revised the AS material. A number of candidates did well on the short answers but made little or no response to the extended writing questions, especially 5a.

Comments on Individual Questions

1) This question on igneous petrology led to a wide range of marks with no candidate scoring maximum marks. The marks were readily available if the specification had been covered. Knowledge and understanding of Bowens Reaction Series and binary phase diagrams is noticeably improving. The average mark was high on this question.

(a) **(i)** Most candidates recognised the description of obsidian but were less familiar with rhyolite and diorite. A large number incorrectly identified C as granite without recognising the absence of quartz as an essential mineral and the presence of augite.

(ii) There was a large range of responses to describe flow banding and the quality of diagrams was often poor and lacked clear, meaningful labels. A number of candidates confused flow banding with gneissose banding in metamorphic rocks.

(iii) The majority of candidates were able to explain why there were no crystals in Rock B, referring to very rapid cooling and no time for crystals to form. Some weaker candidates failed to refer to rapid cooling which is essential in the formation of a glass.

(iv) The ability to define the term *conchoidal fracture* was very varied and centre specific. Good candidates were able to refer to a curved or shell shaped pattern, and a small number used a diagram to aid their definition which was acceptable. Incorrect responses often referred to *irregular breaks*.

(b) **(i)** The majority of candidates were unable to distinguish between augite and hornblende, only stronger candidates being able to refer to cleavage angles and crystal shapes. This part question was often not attempted.

(ii) The diagnostic properties of plagioclase feldspar were not well known. Many candidates have no perception of the term *diagnostic* and therefore made reference to a white colour, which alone would not allow plagioclase to be identified amongst other white minerals. Reference to twinning was made by the more able candidates, along with hardness.

(c) The knowledge and understanding of Bowens Reaction Series is continuing to improve and there were some good responses to this part question.

(i) The majority of candidates were able to name a minimum of two of the four minerals correctly, top grade candidates often named all four.

(ii) The relationship between Bowens Reaction Series and temperature was less well known, the majority of candidates being able to relate it to temperature in the broad sense with olivine and Ca plagioclase forming at high temperatures and quartz at low. Only the more able candidates scored maximum marks by referring to minerals at specific temperatures and having a clear understanding of reactions.

Teaching Tip:

The easiest way to learn the physical properties of a mineral is to examine the mineral in a practical laboratory session. Candidates should be encouraged to carry out all the physical tests and know the key characteristics that separate one mineral from another. For remembering the details, fact flash cards or loop description cards where a series of questions lead to the correct answer can help.

(d) Binary phase diagrams are no longer proving to be a problem with the majority of candidates who now show a basic understanding of the principles involved.

(i) This part question proved to be the most difficult and a good differentiator. Only the more able referred to the composition of the first formed crystals as being 100% anorthite, while the majority of candidates incorrectly answered 80% anorthite. Other weaker candidates gave the composition of the eutectic.

(ii) and **(iii)** These two parts were well answered by the majority of candidates showing a much clearer understanding of the principles involved.

2 This question was generally not well answered, although a small number of candidates did score maximum marks. Characteristics of minerals continue to be a problem to students and as a consequence this question proved to be difficult. This question also included the synoptic element as economic geology of ores, which was clearly understood at AS but was not answered well at A2 indicating the likelihood that this content had not been revisited as part of a revision programme.

(a) **(i)** The vast majority of candidates were able to describe the crystal shape of the three minerals as cubic.

(ii) Only the more able candidates were able to identify all three of the minerals. *Pyrite* was the mineral the majority of candidates identified correctly, only rarely *galena* and *fluorite*. In terms of H it was often identified incorrectly as *garnet*, students being misled by the colour, failing to refer to the hardness.

(b) **(i)** There is still a great deal of confusion between the metamorphic term *porphyroblast* and the igneous term *porphyritic*, and as a consequence responses to this part question were varied. Students should focus on the prefix 'blast' which refers to the growth of material in a solid medium therefore indicating a metamorphic process. A large number of candidates referred to rates of cooling showing a clear confusion between igneous and metamorphic terms. When Mineral H was incorrectly identified as *garnet* its presence as a porphyroblast was accepted along with the correct Mineral K, *pyrite*.

(ii) The inability to transfer content learnt and clearly understood at AS was evident in this part question. Only the more able candidates recognised Mineral J, *galena,* as the ore mineral. A small majority of candidates were able to define the term but only occasional references were made to the presence of an economical metal that can be extracted.

(c) **(i)** The majority of candidates gave L or N correctly as the most appropriate roadstone material but only rarely were able to explain their answer. Uses of igneous rocks for roadstone is part of this module but seems to have been omitted from teaching at some centres.

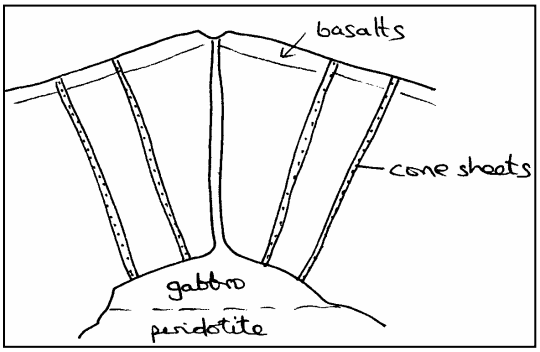
(ii) As a consequence of the above there were very few correct names given for a suitable rock. A larger number of candidates referred to granite, and a significant number failed to use the clue in the stem that they were igneous rocks and gave gritstone as an incorrect answer. Crystal grain size was generally ignored when answering this part question

(iii) This part question was not well answered with too much emphasis on economic geography in the qualities that makes a good aggregate! Candidates scored some marks but a number referred to how cheap the material was, closeness to location and referred to porosity and permeability. The key points wanted were the *high crushing strength* and *ability to resist weathering*.

3 There were some varied responses to this question which focussed on igneous processes and products, with few candidates scoring very high marks.

(a) **(i)** This part question led to surprisingly few candidates achieving maximum marks.
Candidates were often let down by their inability to describe what they could see, i.e. let down by their English rather than their geological knowledge. Many candidates struggled to use the correct terminology of radial dykes, although they could describe the pattern without any attempt to explain its origin. A large number of candidates described either ring dykes or cone sheets, rarely both as the question required. A number incorrectly decided to discuss cross cutting relationships.

(ii) The responses to this part question proved most disappointing. There was again much emphasis on cross-cutting relationships and the succession of events rather than the spatial juxtaposition of the major intrusive / extrusive features.



The quality of diagrams was poor with few candidates able to describe and show the relationships between the rocks given in the question. The peridotite and gabbro would have formed at depth in the magma chamber while the cone sheets would have formed below the volcano that produced the basalt lava flows.

Some candidates described the characteristics of the oceanic crust as shown through an ophiolite suite. A number of candidates did not attempt this part question at all.

Teaching Tip

Windscreen or toughened glass that has had an object hit it at high speed will break with a characteristic pattern of concentric and radial fractures. There are many photos available on the net to show this distinctive pattern which is very similar to that found around volcanoes where the fractures have been filled by magma to form dykes and cone sheets.
(www.eng.ysu.edu/~mtegr/3768/ife/Glass_Fractures.doc)

(b) **(i)** There have been a large number of thin section diagrams on previous papers but the ability to identify the three thin sections was poor. Answers ranged from porphyritic, poikilitic, porphyroblastic, corona structure, zoned crystal, ophitic, pegmatic, vesicular, amygdaloidal. Only a small number of candidates identified P as equicrystalline. Texture Q was only rarely identified as amygdaloidal; common misidentifications were zoned crystal, corona structure and vesicular although credit was given for the latter two. Texture R was the most straightforward but still caused problems, with the terms porphyritic and porphyroblastic still being used inappropriately. Some candidates identified the black crystals in the phenocrysts and thus described the texture as poikilitic and credit was given for this.

(ii) The ability of candidates to measure the maximum length of the largest crystal in rock R was varied, with many candidates unable to use the scale given.

(iii) The more able candidates were able to describe how an amygdaloidal texture formed and referred initially to the formation of a vesicular texture, with gases exsolving and rapid cooling of the magma followed by secondary mineral precipitation in the vesicles by percolating fluids. Error carried forward was allowed here and credit given for identification of the texture as vesicular or corona.

(iv) The majority of candidates were able to describe how the porphyritic texture formed, with reference to two stages of cooling and which crystals formed first. Some weaker candidates incorrectly described the groundmass forming before the phenocrysts. A number of candidates identified the texture as poikilitic and were able to describe how it formed using the appropriate terms *enclosed* and *enclosing*.

4 This question was generally well done although a significant number of candidates showed a limited understanding of the environmental processes associated with fluviatile deposition. Only a small number of candidates scored over 15 of the 20 marks available.

(a) The majority of candidates were able to label that erosion takes place on the outer bend of the meander and deposition on the inside bend.

(b) **(i)** The sedimentary sequence identification led to a variety of responses. More able candidates were able to recognise a fining upward sequence although credit was given for a cyclothem. Incorrect responses included Bouma Sequences, deltas and point bars.

(ii)(iii) Many candidates tended to discuss energy levels rather than describe the specific environments as asked. Responses were often vague and drawn out. The more able candidates referred to flood plains and overbank deposits in (ii) and channel lag, point bars and braided streams in (iii).

(c) The majority of candidates could describe the energy level changes shown by the graphic log; the more able were able to link specific energy levels to specific deposits and thus achieved maximum marks for this part question.

(d) This part question although involving three dimensional interpretation and the testing of higher level skills, produced some pleasing responses. Many candidates showed a clear understanding of the way clay and sand-grade sediments are distributed as a result of lateral and vertical variation.

(e) The vast majority of candidates were able to describe the methods of transport for sands and gravels using the correct terminology, showing knowledge of AS material that had been lacking in earlier questions. Weaker candidates confused saltation with suspension even though a clue was given in (ii) where a fine grain size or equivalent was required.

(f) **(i)** A significant number of candidates were able to name a sedimentary structure typically left by a meandering river although only a minority were able to explain how it forms. Responses were often vague, with cross bedding and ripple marks being confused for this AS content. Specific reference to where the structure formed was often omitted, i.e. point bar and deposition on a slope. There were some good explanations for the formation of imbricate structures. A large number of candidates incorrectly named a typical structure as graded bedding and went on to describe its formation in a submarine canyon as a result of turbidity currents.

(ii) In this part question many candidates were unable to make the connection between preservation and the need for anoxic, no decay conditions for root preservation. The majority of candidates were able to achieve one mark for an explanation of why leaves and stems were not preserved.

Teaching Tip:

Sedimentary environments are topics that can be used for group presentations. Small groups of students are given a specific environment such as glacial or beach. They plan, research and present their findings to their peers in the form of a *Power-point* presentation, including a handout. General group understanding is monitored through an open group discussion at the end of the presentations.

5 There were many excellent answers as these long answer questions give candidates an opportunity to show detailed knowledge, diagrams and explanations. The organisation of the answers needs to be logical and structured in order to obtain the marks for the Quality of Written Communication (QWC)

(a) This question was on the whole the most poorly answered question on the examination paper. Students either knew how to classify sedimentary rocks or did not. The question was heavily structured, but instead of discussing grain shape, size etc. as an aid to classification, far too much emphasis was placed on environments of formation with discussions of sorting and maturity.

Candidates were frequently unable to discriminate between clastic and non-clastic rocks. Common misconceptions were that angular fragments were clastic and rounded were non-clastic, that coarse fragments were clastic and fine fragments non-clastic or that the difference between the two was based on fossil content.

The majority of responses lacked detail, with little reference to rock types and their specifics and characteristics. The classification of sandstones with appropriate detail to define the different types was rarely covered. Appropriate triangular diagrams would have been appropriate here to explain the classification system used.

Only a small number of candidates referred to non-clastic classification in detail. Limestones were superficially covered but only a small number of candidates commented on types of limestone and relationship to fossil content. Few candidates discussed evaporites, coal, ironstones and siliceous oozes all of which are non-clastic sedimentary rock formed by either chemical or biological processes.

There was a large number of possible marks in the mark scheme which would allow candidates to gain full marks. Top candidates scored well but the majority failed to achieve even half marks. The key to answering a question of this type is to use the headings given and plan accordingly before tending to ‘write everything you know about sedimentary rocks’.

(b) There were some excellent responses to this question proving that metamorphism is an accessible topic from the specification. Well prepared candidates could clearly describe the processes and products involved including rock types, textures and new mineral growth. There were some good labelled thin section diagrams showing textural changes in shale that has undergone progressive regional metamorphism showing changes in foliation, along with diagrams showing Barrovian zones and specific mineralogical changes.

The most predictable error was that weaker candidates described the thermal metamorphic products of an argillaceous rock rather than those resulting from regional metamorphism and discussed at length igneous intrusions and metamorphic aureoles.

Some candidates who correctly recognised the sequence of rocks formed, occasionally lost marks when they did not have a sufficiently clear knowledge and understanding of the subject matter to give the detail and technical terms required. Reference to specific temperature and pressure conditions is beneficial along with an understanding of the mineralogical changes that take place

2836: Geological Skills (Written Examination)

General Comments

The Geological Skills examination is synoptic, so requires knowledge of all the other units. Many candidates will not have sat AS units since the previous summer session and their knowledge of topics covered in these units was at times a problem. A good knowledge of structural geology from 2831 is vital for sketches of structures and the geological history of a map. The skills for this paper can be practised, so teaching the skills as a topic is essential preparation for this examination. The skills listed in the specification include graphic logs, geological maps and geological histories. The quality of the sketches from the photograph was very mixed and even the help of a colour photograph did not aid the identification of the features illustrated.

A major problem seen throughout the paper is the confusion of technical terms between sedimentary, igneous and metamorphic, which given the petrology paper just a week earlier is a surprise. In part this is due to not reading the stem of a question where it may state that it is an igneous rock, yet candidates gave answers using metamorphic terms. Some candidates missed marks by not reading all the information at the top of the page.

There was no evidence that candidates could not complete the paper in the time and there were very few questions left blank.

Comments on Individual Questions

1 This produced a really variable response that was heavily centre based and was the weakest question on the paper. The question is synoptic on 2835 which all candidates will have taken a week before, yet there was confusion regarding the basic terms and rock types. There were many excellent answers where candidates showed a thorough knowledge of the entire topic of turbidites. However others were reduced to guesswork and general statements. A number of candidates were hedging their bets giving a list of answers when asked to identify the features. In this case it is the first answer written on the script that is marked.

(a) **(i)** Candidates answers were remarkably varied; perhaps they misread the question and thought that they were describing the whole 50 m rather than specifically the greywacke. A greywacke is classified as an arenaceous sedimentary rock so that the grain size should be in the sand size category. The composition is varied but the question asked for a description so that two or more specific mineral components such as quartz, clay minerals, feldspar were expected to be given. The correct technical term to describe sorting is *poorly sorted* rather than *bad.*

(ii) The characteristics of shale were not well known with many references to sorting and grain shape which are not appropriate for these fine grained rocks. There was confusion with slates and references to metamorphic rocks. Slatey cleavage was often described instead of thinly bedded or laminated shale and use of metamorphic terms like foliation shows confusion between the rock groups.

(iii) Only the weakest candidates failed to get the mark for the Silurian fossil as a graptolite.

(b) Photograph 1 of a load cast was very well answered by many candidates but the list of incorrect answers to identify the feature was wide – unconformity, ripple marks, washout, slumping, tool marks - and some candidates may only have encountered diagrams of these features. The explanations were often excellent and even included extra detail on the relationship between load casts and flame structures.

(iii) The methods to identify the mineral as quartz or calcite required candidates to give information about both minerals eg calcite reacts with dilute hydrochloric acid but quartz does not. General statements of test for hardness did not gain marks. Many candidates gave accurate and excellent answers giving precise information using a steel nail as a hardness test to scratch calcite but not quartz.

(c) Photograph 2 of a flute cast was generally correctly identified but the explanation illustrated a number of misconceptions. The idea of sediment building up behind an object to form a mound shows no appreciation of the fact that flute casts form on the base of the bed as given in the question. A different misconception centres on the idea that the hollow was created by an object such as a pebble instead of the power of the current scouring out the hollow.

Teaching Tip

Image searches on the internet produce many excellent and varied photographs of sedimentary structures which can be put together as a *Powerpoint* so that many different photographs of the structures can be seen. Students are often excellent at producing these presentations to create a whole class resource.

Flute casts can be created very simply using a tray of sediment / soil and a tap hose to create hollows with the distinctive shape of deep closest to the current and shallowing down current.

(c) **(iii)** The environment in which the rocks were laid down was well known as a deep sea basin with turbidity flows.

2 The geological history of the map - a skill synoptic on 2831 - was well known. However the more recent work on igneous rocks, synoptic on 2835, was less well done.

(a) Many candidates did not read the instructions, so few obtained both marks in the majority of centres. Technical terms are a standard form of words and the terms are listed in the specification, but candidates failed to mention an axis or limbs. A surprising number of candidates ignored the element of the question which asked for directions. Answers could have given the direction of dip of the limbs as NW and SE or the direction of the axial plane trace as NE – SW. Sometimes the direction was given just as NE which could not gain a mark.

(b) The geological history was very well answered in terms of the order of events, with nearly all candidates having this correct. The task of getting all the events in the correct order is a high level skill that has greatly improved over the years. Many answers, however, lacked essential technical detail which lost marks. Typical examples of this are the statement of dolerite intrusion without saying it was a sill or the laying down of the limestone without saying that it was unconformable. There was some confusion with the quartz porphyry as some candidates thought that this was a mineral vein rather than dykes. Even the detail of periods of erosion before the unconformable rocks were laid down was not always described. The quality of communication mark can not be awarded for lists. The word *dipped* has been invented by candidates to describe the tilt of the beds – perhaps it will make it into dictionaries in the future!

(c) Knowledge of the igneous classification table made this question very straight forward for some candidates. Others, however, who thought that quartz porphyry was a vein or who just used the word quartz found it more difficult. Most of the marks could still be obtained in this case. Another common error was to miss the statement that the observations were of *hand specimens* and write about *field relationships*.

(i) The difference asked for was one that could be seen in hand specimen so colour was the most obvious

(ii) Answers for this sometimes just had a phrase eg *grain size* which was not enough as candidates needed to say what the difference was with the granite as coarse crystals and the quartz porphyry as medium.

(iii) This question was disappointing as it showed no improvement from last year when a question on thermal / contact metamorphism also asked about the rock types. This question asked for the name and the description for any two of the three rocks in the aureole. *Spotted rock* answers illustrated the confusion with slate and with very few describing the spots. Knowledge of hornfels was very poor and only the more able candidates scored the mark - referring to granoblastic texture. However many other candidates referred to regional metamorphic rocks such as gneiss and schist.

Teaching Tip

Tables of descriptive terms to use for rocks or structures can help candidates get used to supplying the detail needed. Technical terms checklists where students have to use at least three terms can get them into the habit of systematically using terms.

Folds checklist:	fold name, limb dips and directions, axial plane trace directions, open, closed or tight
Fault checklist	fault type, downthrow, throw amount, fault features
Igneous rock checklist	crystal size, texture, colour, mineral composition
Sedimentary rock checklist	grain size, grain shape, sorting, colour, mineral composition

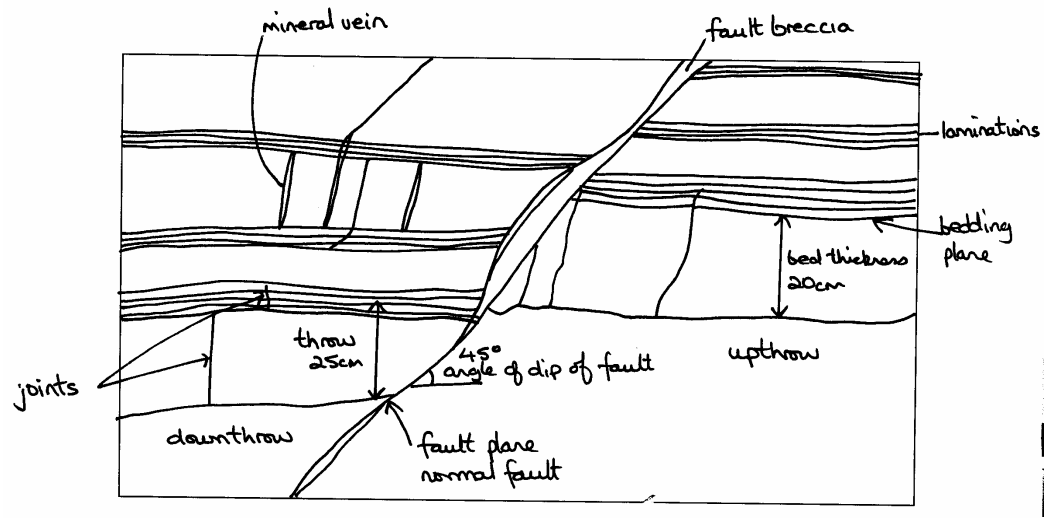
3 As candidates expect a photo they tend not to read the instructions well. In this question the candidates were asked for appropriate measurements and it was not possible to gain full marks without this detail. Suitable measurements were the dip of the fault measured from the horizontal and the throw of the fault measured vertically from the top / bottom of a bed to the top / bottom of the next. There were very few examples of downthrow measured correctly the thickness of a specific bed

This question is synoptic on 2831 structural geology. Very mixed quality for sketches from excellent to weak - some good drawings with almost no relevant labels..

Some of the sketches were lacking in detail with few meaningful labels. Artistic skills and shading are not needed and as on the example below it is not necessary to include all the detail for all beds on the sketch.

Vague use of technical terms such as joints labelled as *cracks* or *fractures* did not gain marks. There were fewer references to weathering this year.

The fault was clearly normal but it was incorrectly identified as reverse, tear, transform and thrust.



Teaching Tip

Using a photograph projected onto a whiteboard is ideal for class work with students finding as many features to label as possible and drawing the main features for the sketch over the photograph. There is a very good range of geological photographs on the internet which allows a lot of skills work to improve this question.

4 This question was synoptic on 2834 and most candidates were prepared for questions on fossils. Some excellent answers to this question. Many candidates will have completed the palaeontology paper just before this one and they are well prepared and informed. High marks were common even from weaker candidates so that this was the highest scoring question on the paper.

(a) The identification of fossils was very good with many gaining full marks. A few candidates ignored the term *scleractinian* and referred to the corals as *tabulate* or *rugose*.

(b) A very mixed response with some candidates having a clear appreciation of how the nektonic ammonites can sink to a shallow sea floor on death to join the attached corals and brachiopods and create this death assemblage. Other candidates were confused between life and death assemblages. Solitary corals live in a wider range of environments than colonial corals which are likely to be restricted to reefs so that marks were not given for a list of environmental conditions for a reef. Perhaps the most surprising omission was that many candidates did not state that all these organisms are marine.

5 This question was synoptic on 2835 and 2833 and was often answered very well. The diagram proved a valuable stimulus and there were some good answers. Many candidates noted the slight angle of dip and made use of this in their answers.

(a) Very limited knowledge of the concept of lithostratigraphy so that answers ranged from relative dating to radiometric dating to biostratigraphy. Even where the method was named, the description of matching the shales in terms of composition or thickness or colour were not given.

(b) **(i)** This question on dams was very well answered. Some candidates however think that the terms *porous* and *permeable* are synonymous.

(ii) This question was very “hit and miss” The diagram should have helped candidates here but some did not seem to have noticed the boreholes.

(c) Many candidates drew the wrong conclusions from these descriptions which illustrated a problem with knowledge of rock classification.

(d) Often answered well but often spelt very badly! Imbricate structure and its relationship to current direction was good but mention of how the pebbles were transported as the bed load by traction was less common. The issue of questions that ask candidates to *explain* rather than *describe* was a problem here.

(e) The majority of candidates answered this question very well with good explanations. However concrete, cement, aggregate, clay, shale, oolite were offered as possible materials for constructing a masonry dam. Perhaps candidates thought that the dam wall was a facing stone hence answers on attractiveness and ease of dressing the stone.

2833/2836: Geology (Coursework)

General Comments

Many very good examples of coursework were seen this year and it is evident that most centres are studying the OCR mark scheme thoroughly and then carefully planning interesting and challenging coursework for their candidates. Interesting work has been produced from a variety of topics.

There was consensus between the moderating team that in general centres are getting more confident in completing all of the necessary paperwork for their coursework submissions. Many of the team had received their packages well before the deadline, and it is very helpful to have a wide range of material to use at the initial moderating meeting.

There were, however, still a few issues. It is important to note that the Centre Authentication Sheet which the teachers responsible for marking the coursework sign, must be sent with the coursework, whilst the sheets signed by the candidates should be retained by the centre in case of future queries. Moderators must follow up this omission, as technically, marks could be held back from being recorded if this important document is not received. Copies of these sheets are usually despatched to centres with other subject specific sheets in the spring or else they can be downloaded from the OCR website.

If contacted by your moderator re missing paperwork please act as soon as possible so that there is no delay in the processing of the centre's results. This also applies to the return of CW/AMEND forms which may be sent out to you for a variety of reasons; from arithmetic error and errors in copying across marks, to invalid order of merits - where the moderator disagrees with the rank order of the candidates within a centre. In all these cases the marks for the whole centre cannot be processed until the signed form is returned.

A new problem this year seemed to be in the quality of the duplicated MS1 sheets. The moderator is sent the middle copy, the top copy is sent direct to OCR and the bottom copy is kept by the centre. In many cases this year these forms were virtually unreadable.

The general pattern is still for most AS work to be laboratory based, with activities such as sieving investigations, lava simulations or porosity and permeability experiments. It should be noted that purely computer based research such as earthquake research, unless very carefully planned to meet all descriptors, can often fall short of many of the descriptors.

Some centres do carry out fieldwork. The best ones worked when the candidates had done a fair bit of geology and could make appropriate linkages between the theory and what they were seeing, which usually means later in the spring term, leaving a lot less time for the teacher to mark it! A few centres did their work very early on, and it was quite obvious that many candidates had not yet fully gained the skills necessary to make the most of field work observations and techniques, often falling short on some of the higher level descriptors.

At A2, most centres carry out fieldwork to a very impressive level. A few "Cooks tours"of far flung locations have a good range of field descriptions but they are often very disjointed with little in terms of analysis and mathematical components for A5a. This can give only superficial coursework, and whilst is excellent for studying geology in the field, a more carefully crafted item for coursework may be needed.

Comments on individual skill descriptors;

Skill P Planning

It was noted that many centres are now truly using this section as a working plan, which is written in advance with preliminary experiments being used and then amended and evaluated for the proper run through. This gives candidates an ideal chance to identify variables and to state what controls should be put in place.

Many good predictions, with reasoning for the choice are being put forward, giving geology coursework a really good scientific feel. Other centres are using hypotheses very well. There is no compulsion to use Null and alternative hypotheses, but if centres wish to this is fine.

A few centres are still giving all their candidates a vague title which is all they then base their plan upon e.g. “I will study the geology of the Lulworth cove area” is a particularly common one, which fails to allow candidates to fully develop P3a which require candidates to “develop a question or problem using scientific knowledge and understanding, identifies the key factors to vary, control or take account of”.

Teaching tip:

Before starting the coursework give candidate an A4 sheet, with a variety of questions to help them through the planning stages of skill P, for example questions could include;

what hypothesis will you be studying?
what reasons can you give for this choice?
what secondary sources will you use to help you research this hypothesis?
what equipment might you need? why do you need it?
do you need a trial run?
how do you plan to carry out this method?
what data will you collect and how many times will you collect it?

A quick look through this A4 “crib sheet” will enable the teacher to check that the candidate is on the right lines. It also helps to alleviate the problem of friends having the same hypothesis. One centre this year had every candidate with exactly the same wording for their hypothesis!

P5a still needs both safety and background detail to be included. Many centres are using preliminary experiments which is fine, as long as they are clearly worked into the plan and not left as a standalone section.

P7a needs evidence of a bibliography or for the candidate to quote sources directly in the text. This information must then be incorporated/and evaluated into the strategy.

P7b still causes problems, but if a preliminary experiment is carried out this becomes much easier to do, as changes to the original plan can be highlighted and reasons for the changes can be justified in terms of increasing the precision and reliability.

Teaching tip:
Get the candidates to use the wording of the mark descriptors e.g. for P7b, they should say how they can make it more reliable and how they can get their results to be more precise.

Skill I Implementing

There is evidence for a lot of very good data/information being collected for coursework, especially true for laboratory and field based exercises. Computer exercises can struggle here.

Many centres are still sending chunky notebooks. Please either tear out or photocopy the relevant pages as this saves on postage and makes it easier for the work to be understood, if only the relevant sheets are included.

Many centres are now including tick sheets to show where candidates are getting marks and more importantly where they are failing to do so. A few moderators were concerned that some centres seemed to be awarding the maximum of 7 across the board when quite clearly there was considerable variety in the quality of the work. In a few cases, teachers seem to have been especially hard, giving only 3/4 for masses of field data which would definitely have been given 7 elsewhere!

Skill A Analysis

This skill is getting a lot better, with many centres planning really good opportunities for candidates to score well. However when there are problems, these are often severe. There were, unfortunately, a few cases where most candidates were given 7/8 and yet the work was barely reaching descriptors A3a and A3b, this resulted in some large downward adjustments for a small number of centres.

Problem descriptors are the same as in previous years; A3a needs graphs of some sort, rose diagrams are acceptable here. Photographs are not sufficient, although if annotated, they can help with A1a, A1b or A3b.

A5a requires some advanced mathematical manipulation. Calculation of averages, modes etc is not sufficient and other statistical tests should be employed such as Chi-squared, Spearman's Rank Correlation or Standard Deviation, which saw quite an upsurge in popularity this year.

Geological maps are also a good way of covering this, although the plotting of just one or two dips and strikes is not really sufficient. If using a photocopy of an OS map, a range of things should be put onto the map which tests the skills of the candidate in applying location rules and marking on appropriate thicknesses of units etc. One dyke, (as was often done at Praa Sands), is not really sufficient. Maps on blank pieces of paper to plot bearings of faults, dykes, sills, thicknesses of sedimentary units etc all work well as the candidate has to employ an accurate mathematical scale.

For A3b through to A7a and b an increasing amount of detail needs to be used. A couple of sentences cannot be awarded level 7, more likely achieving A3b. A5b requires yet more detail in at least one detailed paragraph, as this will allow the candidate to achieve 5/6 marks out of 8 which equates to upper 60-75%, equivalent of a high grade. 8 should be reserved for work of an exceptional quality which exceeds all of the previous descriptors.

Skill E Evaluation

This is usually the weakest skill, with many candidates giving it much less attention than the other skills. Sometimes there are only brief mentions of the suitability of the methods with a few comments about improvements.

If the coursework has “answers”, make sure that the previous skills have been marked and the correct findings have been discussed, so that the candidates are aware of what errors, if any, they have made. This makes it much easier for students to comment upon areas like E5b, (the reliability of their evidence), and E7b (how significant the uncertainties in their evidence were to their final result/findings).

Teaching tip

Another “crib” sheet could be used to focus students’ attention onto the crucial areas of concern;

Which parts of your method worked well, why?
Where any results not what you expected, why?
Which parts of the method did not work and caused limitations?
How did errors creep into your data collection?
How could you improve the method, how could you get more reliable results?
Did your errors make any impact upon the results gained?

This sheet could again be scrutinised so that the areas can be checked for suitability and to make sure that no descriptors are missed out. This would help to structure Skill E work. Lack of structure is the reason why Skill E so often fails to gain as many marks as the high scoring other skills.

Advanced GCE (Subject) (Aggregation Code(s))
June 2007 Assessment Series

Unit Threshold Marks

	Unit	**Maximum Mark**	**a**	**b**	**c**	**d**	**e**	**u**
2831	Raw	60	44	39	34	29	25	0
	UMS	90	72	63	54	45	36	0
2832	Raw	60	47	42	37	32	28	0
	UMS	90	72	63	54	45	36	0
2833	Raw	120	92	81	70	59	49	0
	UMS	120	96	84	72	60	48	0
2834	Raw	90	66	58	50	43	36	0
	UMS	90	72	63	54	45	36	0
2835	Raw	90	55	48	41	34	27	0
	UMS	90	72	63	54	45	36	0
2836	Raw	120	89	79	69	59	50	0
	UMS	120	96	84	72	60	48	0

Specification Aggregation Results

Overall threshold marks in UMS (i.e. after conversion of raw marks to uniform marks)

	Maximum Mark	**A**	**B**	**C**	**D**	**E**	**U**
3884	300	240	210	180	150	120	0
7884	600	480	420	360	300	240	0

The cumulative percentage of candidates awarded each grade was as follows:

	A	**B**	**C**	**D**	**E**	**U**	**Total Number of Candidates**
3884	18.2	38.6	60.2	79.2	91.8	100.0	1169
7884	24.9	49.6	70.7	90.0	97.7	100.0	842

2011 candidates aggregated this series

For a description of how UMS marks are calculated see;
http://www.ocr.org.uk/exam_system/understand_ums.html

Statistics are correct at the time of publication

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