GCE MARKING SCHEME

GEOLOGY
AS/Advanced

SUMMER 2013

INTRODUCTION

The marking schemes which follow were those used by WJEC for the Summer 2013 examination in GCE GEOLOGY. They were finalised after detailed discussion at examiners' conferences by all the examiners involved in the assessment. The conferences were held shortly after the papers were taken so that reference could be made to the full range of candidates' responses, with photocopied scripts forming the basis of discussion. The aim of the conferences was to ensure that the marking schemes were interpreted and applied in the same way by all examiners.

It is hoped that this information will be of assistance to centres but it is recognised at the same time that, without the benefit of participation in the examiners' conferences, teachers may have different views on certain matters of detail or interpretation.

WJEC regrets that it cannot enter into any discussion or correspondence about these marking schemes.

GCE Geology – GL1

Summer 2013

Q.1 (a) (i) Ordovician **[1]**

(ii) Evolved/appeared in (late) Cambrian (1)

Achieved maximum diversity in (early) Ordovician (1)

Extinct in early Devonian (1) **[3]**

(iii) Trilobites evolved earlier / Graptolites later (1)

Trilobites showed greater diversity / Graptolites not as diverse (1)

Trilobites decline more rapid initially, then gradual / Graptolites gradual decline (1)

Trilobites extinct later – Permian / Graptolites extinct first-Devonian (1)

2 max **[2]**

(iv) Evolved rapidly (1) through many short lived stages (1)

Facies free – not restricted to a single environment (1)

Very abundant / common (1)

Easy to identify (1)

Widespread / worldwide distribution (1)

Description of evolution pattern theca/stipes (1)

Hard parts suitable for preservation (1)

2 max **[2]**

(b) (i) Pygidium – accept thorax **[1]**

(ii) Pyrite / Iron Pyrite **[1]**

(iii) Petrification/Petrifaction/Pyritisation (1) **R** – **reserved mark**

Original hard parts dissolved away (1)

Replaced by minerals (1) precipitated from solution (1)

Credit reference to formation of mould then cast

R + 2 max **[3]**

(iv) Death assemblage (1) Not as Life Assemblage, statement is false (1) **R**

Reference to process-transport / moved / washed / eroded (1) **R**

Fossils are incomplete/broken (1)

Fossils sorted / all similar size (1)

Only one fossil group is present (1)

All fossils same age/size not a range from juveniles to adult (1)

Fragments aligned (1)

2**R** + 1 max **[3]**

Total 16 marks

Q.2 (a) (i) Gneiss **[1]**

(ii) The folds strike north–south (1)

The fold limbs have roughly equal angles of dip (1)

Asymmetrical synclines and anticlines (limbs of equal length) (1) **[3]**

(b) (i) Reverse fault/Thrust Fault (1)

Hanging wall upthrown / footwall downthrown (1)

Compression/crustal shortening (1)

Fault plane dips less than 45° / low angle = thrust (1)

Metamorphic rocks (older) now on top of/overly younger sedimentary rocks (1)

3 max **[3]**

(ii) Fault breccia (1) angular, poorly sorted rock (1)

Fault line drag (1) beds bent upwards/downwards next to fault as it moves (1)

Marker beds (1) characteristic colour / mineral / fossil content to estimate throw (1)

Slickensides (1) grooves / scratches on fault plane indicates direction of movement (1)

Change in rock type – regional metamorphic rock overlies sedimentary (1) and explanation (1)

Presence of a spring (1) Fault scarp (1) Gully / Trench (1) and elaboration (1)

Find the outcrop of the dyke / marker bed to the west (1)

2 max **[2]**

(c) Unconformity (1) **R**

Shale and rocks below are folded (1)

Conglomerate horizontal / sub-horizontal / unconformable (1)

Erosion surface / cross cutting surface (1)

R + 2 max **[3]**

(d) False – Gneiss is the oldest NOT the youngest (1)

Gneiss is a foliated regional metamorphic rock – other rocks not metamorphosed (1)

Gneiss has been thrust over onto younger rocks (1)

Gneiss fault boundary – can't tell / don't know – may be older (1)

True – Dolerite is the youngest (1) Younger than the rocks it cuts through (1)

It is discordant cutting through all the sedimentary rocks (1)

4 max **[4]**

Total 16 marks

Q.3 (a) (i) Ocean ridge symbol drawn within the age band 0-5 Ma (1)

Ocean trench symbol drawn offshore and parallel to / along the coastline of west coast of South America (1) **[2]**

(ii) Symmetrical pattern / Repeated pattern (1)

Increases in age to the west and the east / A to B gets younger and B to C gets older (1)

Credit reference to ages (1)

2 max **[2]**

(b) (i) 700 km in 30 million years = 70000000/30000000 (1)

2.33 cm per year (1) (accept 2.2 to 2.5) **[2]**

(ii) Spreading rate changed at 30 Ma (1)

Faster 30-42 Ma (6.5 cm per year), Slower 0-30 Ma (2.33 cm per year) (1) **[2]**

(iii) Radiometric / Radioactive / Radioisotope dating (1)

Named method Rb/Sr, K/Ar, Ur/Pb (1)

Reference to decay of unstable radioactive isotopes / parent-daughter / half-life (1)

Used on igneous rocks / basalts (1)

2 max **[2]**

(c) Subduction (or description) (1) of oceanic / mafic crust / lithosphere / plate (1)

Partial melting (1) **R**

Of mantle wedge / subducted plate (1)

Contamination / assimilation of xenoliths / continental material (1)

Credit reference to release of water from subducting slab to initiate partial melting (1)

R + 2 max **[3]**

Total 13 marks

Q.4 (a) (i) 2 or 3 sets of joints (1)

Horizontal joints (1) Vertical joints (1)

Joints intersect at right angles / grid pattern (1)

Unevenly spaced, credit reference to spacing measurements (1)

2 max **[2]**

(ii) Cooling and contraction (1)

Pressure release / dilatation / unloading (1) 1 max **[1]**

(iii) Freeze-thaw activity or frost shattering (1)

Water enters joints, freezes and expands by 9% in volume (1)

Internal stresses set up within the rock (1)

Process repeated many times – rock weakened and breaks apart (1) **R**

Credit reference to insolation / exfoliation / pressure release and explanation

R + 2 max **[3]**

(b) (i) Quartz **[1]**

(ii) Size – in the range 1 to 10mm (1)

Shape – angular / subangular / sub-rounded (1)

Sorting – moderately sorted / poorly sorted (1) – no credit for well sorted **[3]**

(iii) Hydrolysis of feldspar / mica to form clay / reference to chemical weathering (1)

Quartz harder than feldspar and mica (1)

Quartz has no cleavage but feldspar / mica have cleavage (1)

Quartz is unreactive and is the only mineral that remains (1)

Credit examples – feldspar-kaolinite / china clay, biotite mica / chlorite (1)

Clay minerals – lighter, washed away / blown away / removed (1)

2 max **[2]**

(iv) False – unlikely to be Aeolian because:

Too coarse (1) expect arenaceous 0.5-1.0mm (1) pitted / frosted (1)

Too angular (1) expect well rounded, spherical, millet seed shaped (1)

Too poorly sorted – wind can only move a very narrow range of particle sizes (1)

Short transport – still angular / poorly sorted / fluvial / alluvial (1)

– no credit for marine or glacial

3 max **[3]**

Total 15 marks

WJEC
May 2013

1212/01
AS GEOLOGY GL2a

Notes:

- This scheme shows the minimum acceptable answer(s) for each mark point. It cannot give every possible alternative so that an equivalent phrasing/drawing should be accepted; use your professional judgement, but if in doubt, seek guidance from the e-mail address gl2a@wjec.co.uk (**quoting your name and centre number**).
- Marking needs to take into account the quality of communication used. The nature of this paper means that continuous prose is not compulsory – answers given in note/diagram form are just as acceptable. Correct spelling of geological terms is desirable; use your professional judgement as to how close the candidate is!

- A forward slash, /, indicates an alternative response; brackets, ( ), indicate a more complete response but is not awarded further credit.

- **Always mark in red ink and ensure that every page has some ink on it to show that you have read it, even if no marks have been awarded.**
- **Do not correct students' work.**
- **Instructions for marking "ticked boxes" are given where appropriate within this mark scheme.**
- **Put a tick close to the key word, phrase or drawing which gains one mark.**
- **Please include annotation shown in scheme to confirm which marks have been awarded (e.g. C for crystalline, Sc for scale etc.) on questions 1(a), 2(a)(i) and 6. See marked example.**
- **Write the total for each part-question in the margin close to the brackets showing the available mark.**
- **Do not exceed the total for each part-question and do not re-distribute marks between sections.**
- **Write the question total in the box at the end of each question and transfer this to the front cover.**
- **Insert the total for the paper on the front cover.**

A marked example is available for download from the WJEC secure website

David Evans
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GL2a (1212/01) Specimens 2013

granite

Specimen A

oolitic limestone

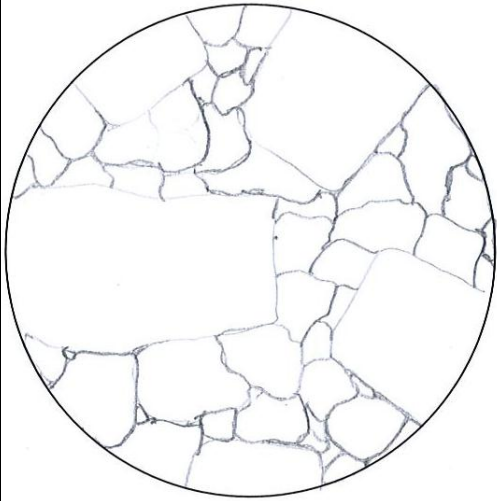
Specimen C

barite

Specimen H

Q	Marks	Expected Answer	Acceptable Answer	Do Not Accept
1a	(1) **C** (1) **P** (1) **Sh** (1) **Sc**	• Crystalline ie. No pores or floating grains • Porphyritic ie obviously larger crystals surrounded by smaller • Shape ie well shaped phenocrysts • Either phenocrysts **(1- 3 cm) or** groundmass **(2-7 mm)** to the correct scale See examples attached	• If drawn equigranular accept mix of well and poorly shaped	• Any pores or floating grains • An equigranular rock • Any mark that is generated only by labels
b(i)	(1) (1)	• **Large** igneous body/ **large** intrusion • Metamorphic aureole • Discordant or equivalent • Coarse or **a value between 2-7 mm**	• Offshoot of a dyke • Non sheet-like • a groundmass size greater than 2mm e.g "they are > 4mm"	• igneous intrusion • ref to phenocryst size • phenocrysts or porphyritic • crystalline • anhedral/subhedral
b(ii)	(1)	• Evaluation False (no credit) but only continue marking if evaluation is false • reference to one or more of quartz, orthoclase feldspar and biotite mica	• mainly light colour/leucocratic/ silicic • not mafic/not dark • absence of one or more of augite/pyroxene/olivine in specimen A	• Any response if evaluation is true • Plagioclase feldspar or feldspar • Do not credit a list of minerals if more than one is incorrect • "gabbro is dark/mafic" unless accompanied by correct statement for specimen A
c	(3)	• It formed by cooling slowly • It formed by cooling at two different rates • It formed by cooling beneath the Earth's surface		If more than 3 boxes are ticked, deduct 1 mark for each box which is wrongly chosen to a minimum of 0
	Total 10			

Examples for Q1(a)

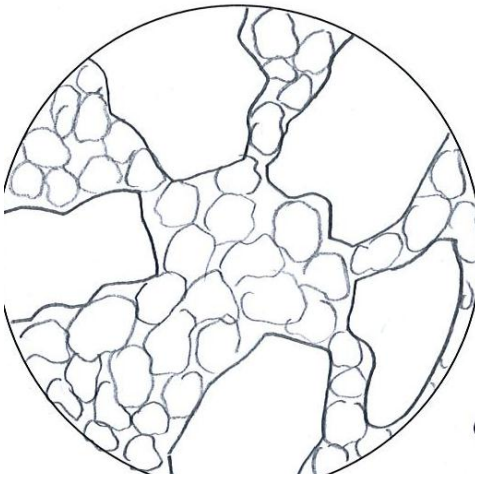


Crystalline (1) Porphyritic (1)

Shapes correct (well shaped phenocrysts) (1)

Scale was correct on the original (1)

Total 4



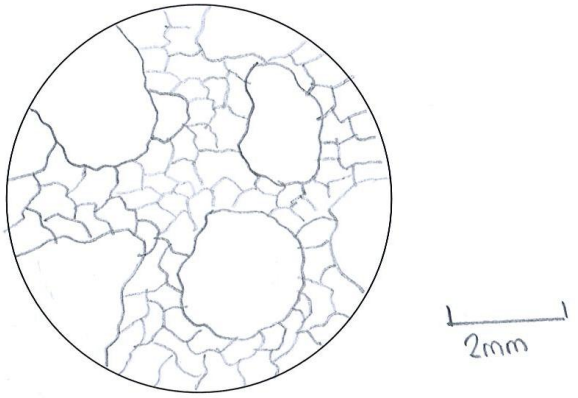
Crystalline (0) (look like floating grains)

Porphyritic (1)

Shapes of phenocrysts ok (just) (1)

Scale was correct on original (1)

Total 3



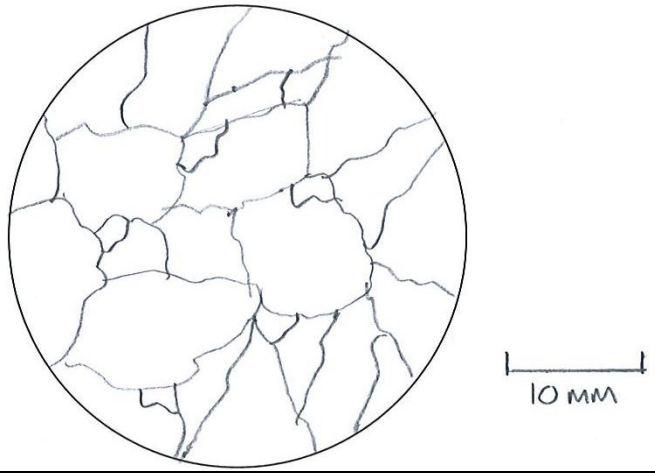
Crystalline (1)

Porphyritic (1)

Phenocrysts not well shaped enough (0)

Scale incorrect (0)

Total 2



Crystalline (1)

Porphyritic (0)

Shapes (0)

Size (within range of the crystals in the rock) (1)

Total 2

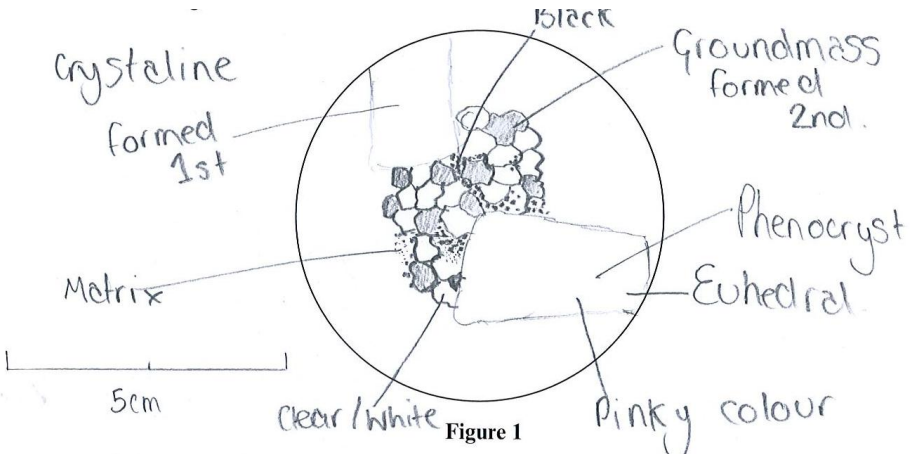


Figure 1

Crystalline (1)

Phenocrysts (1)

Shape of phenocrysts (1)

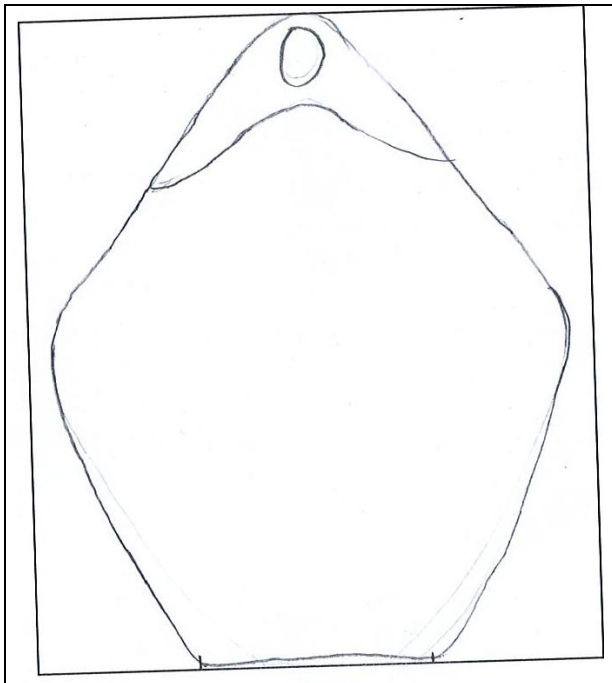
Scale (1)

N.B. The diagram does not have to fill the entire circle

N.B There is no credit for labels. Do not credit any features whch are generated by labels. Mark only what is drawn

Q	Marks	Expected Answer	Acceptable Answer	Do Not Accept
2a(i)	(1) **Sc** (1) **Sh** (1) **B** (1) **F**	• Drawn to correct scale (it should fill box vertically) • Correct ratio of "height" to width (ie it looks correct rather than too fat or too elongate) and relatively accurate shape (see examples attached) (be relatively generous for shape) • Shows top edge of brachial valve • Shows the foramen	• Allow a minimum "height" of 7.5 cm and maximum of 10 cm (which will be just longer than the box)	
a(ii)	(1)	• 2 valves of unequal size		If more than 1box is ticked, deduct 1 mark for each box which is wrongly chosen to a minimum of 0
b	(1)	• Brachiopod		
	Total 6			

Examples for Q2(a)(i)



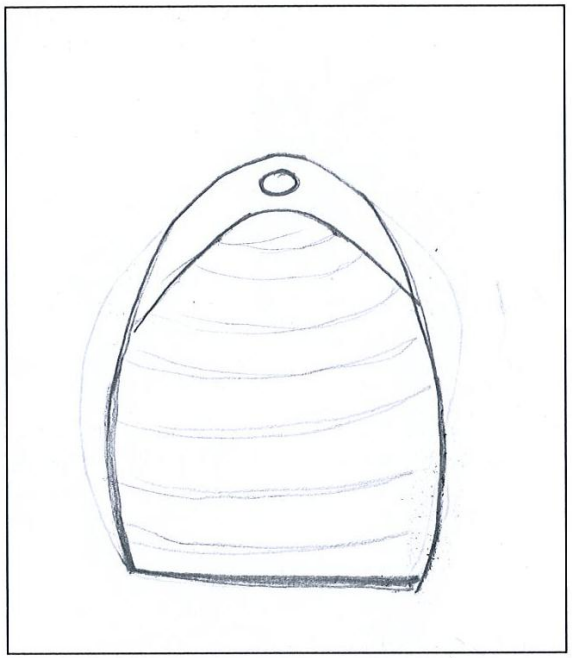
Scale correct (fills box vertically) (1)

Ratio and shape correct (1)

Top edge of brachial valve shown (1)

Foramen shown (1)

Total 4



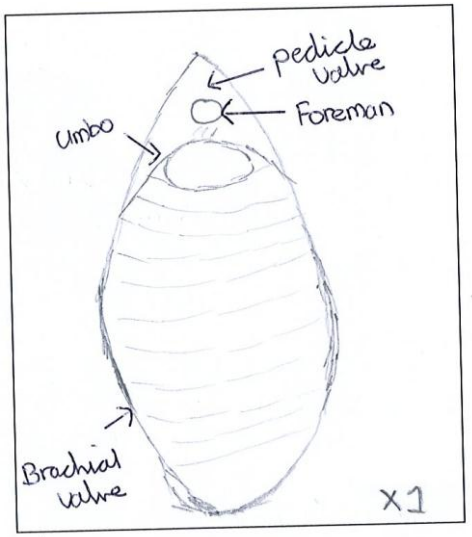
Scale incorrect (0)

Ratio and shape (shape not good enough) (0)

Top edge of brachial valve shown (1)

Foramen shown (1)

Total 2



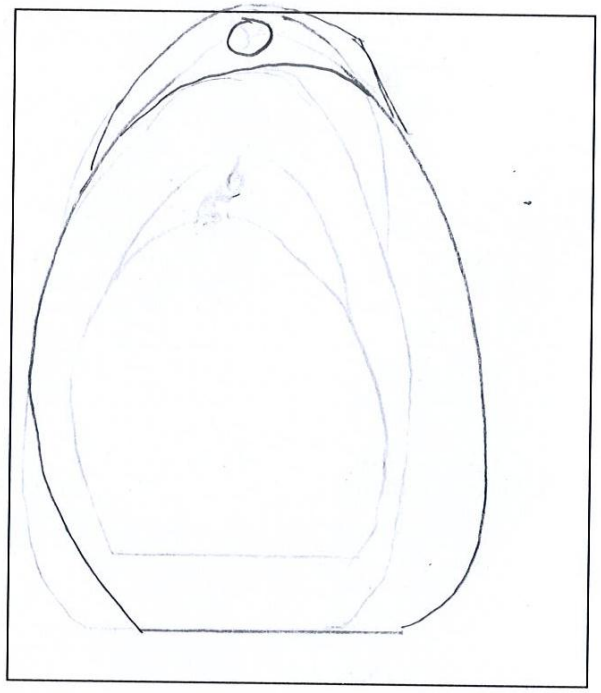
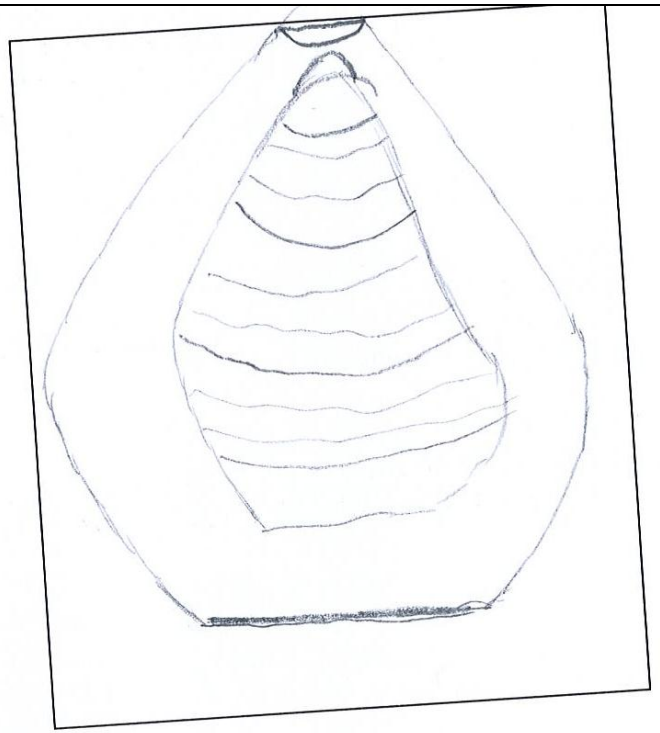
Scale correct (fills box enough vertically: ignore x1 in the box) (1)

Ratio and shape (too thin) (0)

Top edge of brachial valve shown (1)

Foramen shown (1)

Total 3

		
Scale correct (fills box enough vertically) (1) Ratio and shape correct enough. (Be relatively generous on shape) (1) Top edge of brachial valve shown (1) Foramen shown (1) **Total 4**	Scale incorrect (0) Ratio and shape (shape good enough) (1) Top edge of brachial valve shown (1) Foramen shown (1) **Total 3**	Scale correct (fills box enough vertically) (1) Ratio and shape (shape good enough) (1) Top edge of brachial valve shown (1) Foramen not complete (0) **Total 3**

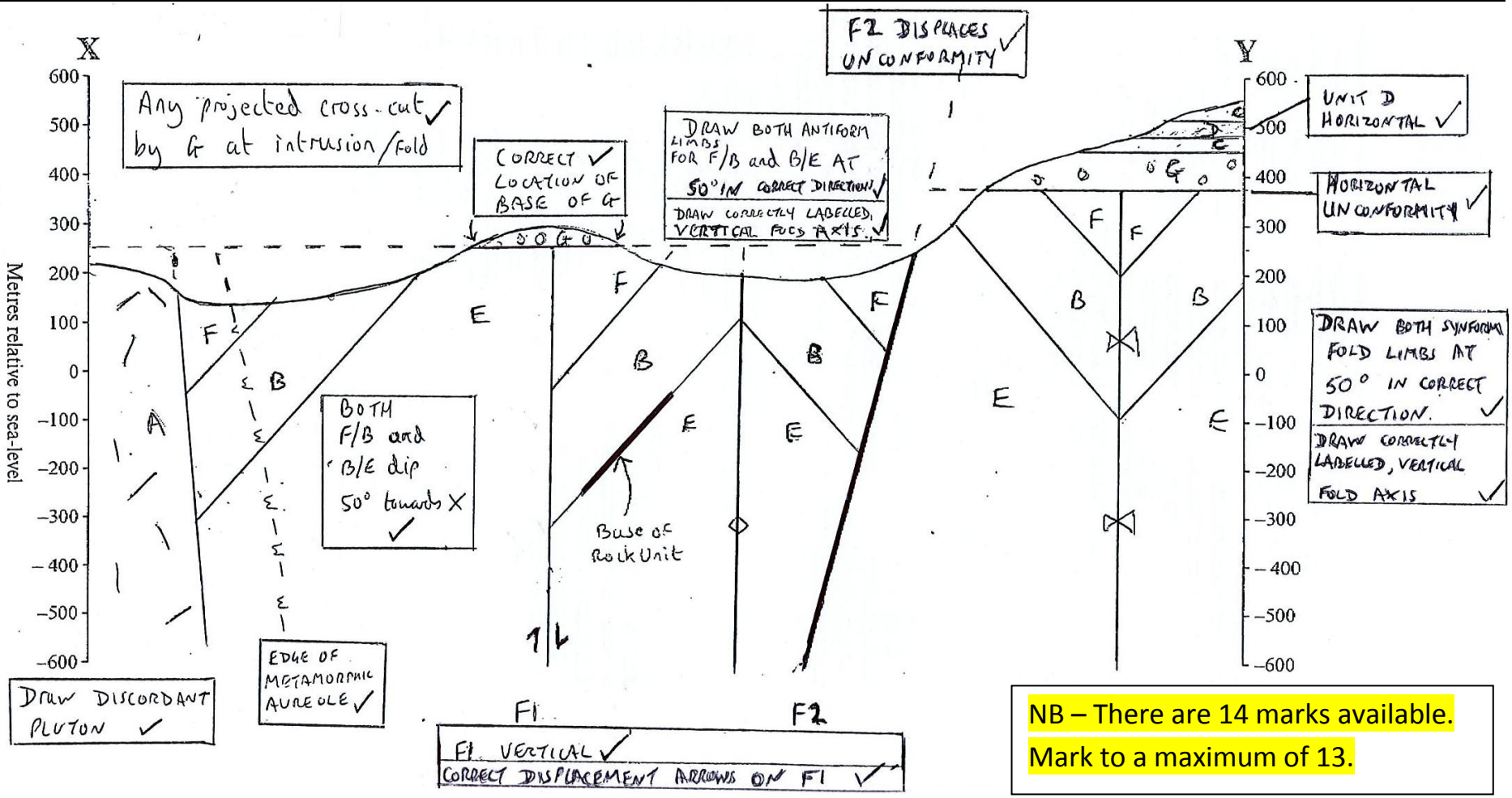
Q	Marks	Expected Answer	Acceptable Answer	Do Not Accept
3a	(1)	• Yes (for crystalline texture Fig 3)		• a stated range where one of the values is outside the acceptable values e.g "1-2 mm" for specimen C e.g "1-2 mm" for Fig 3 • a value involving > or < e.g >2mm for Fig 3
		Mean size of grains/crystals		
	(1)	• Specimen C 1 mm	• 0.5–1.5 mm	
	(1)	• Fig 3 2 mm	• 1.7–2.7 mm	
		Test and result		
	(1)	• Test with acid/ it effervesces or equivalent	• "It reacted with acid" i.e accept a blend of the description of the test and the result in one sentence • Credit the mark for "it fizzed with acid" even if this is appears under the conclusion/composition section	
		Conclusion/composition		
	(1)	• Composed of calcium carbonate/calcite/limestone/ calcareous		
	(1)	Name of rock • Oolitic Limestone	• Limestone/bioclastic or shelly limestone	• Chalk
b	(1) (1)	Accept **two** of the following three points • Contact/thermal/heat/baked • Metamorphism • Due to/by Rock unit D or "an igneous body"	• changed/metamorphosed /recrystallized	• regional metamorphism (although they may refer to regional metamorphism as part of a general intro of how marble forms, and then refer to contact metamorphism specifically later, in which case credit the specific link to contact metamorphism forming this marble) • heat **and** pressure

c(i)	(1) (1) (1)	Do not credit the Evaluation but only continue marking if evaluation is correct. **Outcrop pattern** • True because: Concordant or equivalent **Structures** • False because: Pillow structures formed when lava erupts underwater **Rocks at locality I and II** • False because:Metamorphism on lower contact only	• Pillow structures/pillow lavas/pillows • Structures only form under water • Structures only found in lavas • Structures are not found in sills • Metamorphism on one side only or equivalent	• Any reference to concordant
c(ii)	(1)	• Lava Flow		
	Total 12			

Q	Marks	Expected Answer	Acceptable Answer	Do Not Accept
4a	(1) (1)	• Antiform APT trending N-S anywhere within rock unit B between F1 and F2 • Synform APT trending N-S anywhere within Rock Unit F to the east of F2		• Synform axis if it cuts the unconformity
b	(1) (1)	• 375 -250m • 125m		
c	(1) (1)	• F1 is **older** than F2 • F1 older than rock unit G because G lies on top of/cuts F1, but F2 younger than G because F2 displaces/moves G	• F1 does not displace/move G • F1 is older than G but F2 is younger than G • F2 displaces/moves G but F1 does not (need both halves of this statement)	• No mark for box answer if more than one box ticked • G overlies F1 but not F2
d	(1) (1) (1) (1)	• Dyke 100 m wide (1.5 cm) • Dyke strikes approx NE-SW • Dyke disappears beneath outcrop of rock unit G (dyke must appear on both sides of G south of F3) • Dyke is displaced by F3	• Accept 1.3-1.7 cm • Strike between NNE and ENE • Strike between NNE-ENE even if it does not start in the SW corner of the map • Any direction of displacement of dyke by F3	• Dyke running along F3 • Dyke simply stopping at F3

e(i)	(1) (1) (1)	• Did scratch with a steel pin Description/observation Credit description of only the following • Heft in hand or equivalent • Look for/at the crystal habit or equivalent Result • Feels heavy or equivalent • Bladed crystals Candidates who have referred to a test/observation other than density or crystal habit will score **no mark for description of test/observation**, but may score **one mark** for a correct result of that test or observation for barite as follows • Has 2 good cleavages planes at 90° • Can be scratched by a copper coin • Cannot be scratched by a finger nail • Has a white streak • Has a vitreous (or resinous) lustre • Correct colour for the specimen e.g white, yellow white, pink • Does not react with acid	• Tabular crystals N.B A few samples of specimen H did contain calcite as well as barite. If a candidate has noted a positive acid reaction, then credit this up to two marks for the description of test and result but only if they have then named the mineral as calcite in e(ii)	• Has a hardness of 3-3.5 (or any other stated figures alone) • A quoted relative density of 4-5 • A quoted hardness value
e(ii)	(1)	• Barite	• Calcite (but only if positive acid reaction noted in e(i))	
	Total 14			

Q	Marks	Expected Answer	Acceptable Answer	Do Not Accept
5	See below	*Candidates are asked to complete a sketch cross section not to construct, so the mark scheme allows for some variations in dips/positions of beds*	• Approximate dip values for fold limbs (40°-60°)	• Any dip > 5° on unconformity (base B) • Inclined (<80°)APT of folds • Vertical Fault F1 at an angle of less than 80°
	Total 13			



NB – There are 14 marks available.
Mark to a maximum of 13.

Q	Marks	Expected Answer	Acceptable Answer	Do Not Accept
6	(1) **N** (1) (1) **W** (1) (1) **O**	• Relevant named structure e.g pillow lava, cross bedding or current bedding, load cast, graded bedding • Statements/annotation/drawing of how it shows **way up**. **Up to 2 marks** for **2 points as to how it shows way up** e.g pillows have "rounded tops" and "pinched bottoms", cross bedding is "concave up" and truncated at the top, load cast points down and flame casts point • Explanation of the **origin** of the structure **up to 2 marks** for **2 points** which could be written text or annotation. Points may include... e.g. load casts form in turbidites, sandy sediment is deposited wet on mud, sand sinks into wet mud below forming load cast e.g pillow structures form underwater, rapid cooling forms a skin, magma inflates the skin forming pillow e.g. current bedding forms in aeolian (or fluvial) conditions, unidirectional current, correct arrow for current direction, avalanche of grains down advancing face of a dune	• Diagram with simply the shape drawn and "top" or "bottom" correctly located or "way up" indicated (for 1 mark)	• A fieldwork locality name • Any marks for features not relevant to the photographs, if one of the photograph boxes has been ticked i.e. No marks for any features unrelated to pillow structures if photograph 2 used i.e. No marks for any features unrelated to current/cross bedding if photograph 3 used
	Total 5			

GCE Geology – GL3

Summer 2013

Q.1 (a) (i) 200 m (accept 190 – 210m) **[1]**

(ii) Explosion crater (1)
Hot springs (1)
Dyke (feeder) (1)
Pyroclastic/volcanic breccia in vent (1)
Presence of CO_2 gas (1)
(Max 2 marks) **[2]**

(b) (i) Dissolved in groundwater (1)
Introduced by springs (1)
Denser than water above (1)
Stays in solution by hydrostatic pressure (1)
(Max 2 marks) **[2]**

(ii) Lower waters disturbed and move upwards
Hydrostatic pressure reduced
CO_2 solubility reduced
Gas comes out of solution, erupts explosively on surface
(Holistic) **[2]**

(iii) Denser than air – flows downhill /does not escape harmlessly to atmosphere
Colourless/odourless/silent – not detected by people asleep
Suffocating – removes air preventing breathing
(not poisonous unless qualified)
(Max 2 marks) **[2]**

(c) Evidence
Water leaking – caves/vegetation
Water pathway – pore pressure increase chance of slip failure
Undercutting of upper layer/erosion of lower unit – landslip
Joints on upper layer widening - tension
Dip of beds downslope – unstable
(Holistic - Max 4 marks) **[4]**

Total 13 marks

Q.2 (a) (i) % of pore space (1) between grains (1) and in fractures/cavities (1)
Compared to the volume of solid grains (1)
(Max 2) **[2]**

(ii) Shale pores are not connected (1) therefore less permeable (1)
(not less or smaller) **[2]**

(b) Water – force generates cracks (1) increasing permeability(1)
(Max 2)

Sand – keeps cracks open (1) and has greater porosity (1) allowing higher permeability (1) (Max 2) **[3]**

(c) (i) Holistic involving:
Increase in pore pressure/lubrication
Resulting in reduction in friction
Generating minor local fault movements
"Unlocking" rock – stress release
(Max 3 marks) **[3]**

(ii) Holistic
Describe - Not particularly high
Damage is normally limited to objects falling off shelves if that
No structural damage
Explain - Magnitude-2.3 earthquakes can barely shake the ground enough to be felt
(Max 2 marks) **[2]**

Total 12 marks

Q.3 *(a)* *Outline the social and economic benefits and limitations of attempting to predict earthquakes.*

Benefits:
Promotes awareness of potential dangers
Protection of life and property reduces hazard
Time for disaster planning
- hazard mapping/landuse planning
- evacuation procedures emplacement
- community preparedness
- preparing the emergency services (fire/ambulance/civil defence)
- building codes implementation/enforcement
- contingencies for redevelopment/aid relief

Psychological effects - feeling “safe”

Limitations:
Prediction does not always allow effective warning (Kobe)
Insurance premiums high/house prices fall
Hinders economic development
Current methods are unreliable
LECDs do not have money for prediction or control/favours MEDCs
Psychological effects – feeling “unsafe”
(Max 10 marks, only advantages or disadvantages max 7)

(b) *Using one or more case studies, explain how the destructive effects of earthquakes can be managed and controlled to reduce risk.*

Stress release on faults. Theoretical. Release of "locked" areas of fault by injecting fluids along fault to produce smaller controlled earthquakes or underground explosions.

Denver - waste fluids injected into deep wells in fractured rock triggered minor earthquakes until pumping stopped. Water lubricates fault zone.

Colorado - pumping water from deep wells - reduced water pressure/decreased earthquakes.

Both considered as a possible method of releasing the strain in "locked" parts of San Andreas fault. Very expensive and not proven to be safe or feasible yet.

Credit students who write wholly or partly beyond the specification such as:

Evacuation measures (related to prediction), good emergency services and planning, earthquake drills.

Reinforced masonry, reinforced concrete/steel frames. Extra strengthening given to bridges.

Engineered building design - flexible buildings on low slopes. Smart buildings” with counter weight, rubber dampers on foundations etc. Thought given to flexible gas pipe, hoardings and glass in high-rise buildings.

Hazard Maps – prevention of building on land liable to subsidence, liquefaction, flow.

(Max 15 marks, no case study max 12)

Total 25 marks

Q.4 *(a)* *Describe the potential hazards associated with lava flows and explain how the risk to life and property often depends upon the composition of the magma.*

Expect:

Lava flows

Hot 800^{o}C-1000^{o}C, fluid (depending on composition and temp)
Can be fast flowing (50km/hr) or slow, travel far (50km) or not
Easy to avoid for people/not for property
Causes fire and loss of property
Can kill in rare cases (very fluid lava)
e.g. Nyiragongo (Congo), Etna, etc.

Types of magma - mafic/intermediate/silicic
Various magmas have different
compositions that affect viscosity (more silica rich - more viscous)
gas content that affects viscosity (higher gas - more viscous)
More viscous silicic magma – explosive as gas is not able to escape easily
e.g Pinatubo, Vesuvius, Iceland, Hawaii

(Max 10 marks, no case study max 7)

(b) *Using one or more case studies, explain how the risk to life and property associated with a major volcanic event largely depends upon the extent to which the eruption can be predicted or its effects minimised.*

Holistic approach

Minimising volcanic hazards and efficient/effective prediction reduces the risk and scale of the potential hazard

Prediction **may** include - monitoring ground deformation, gravity and thermal anomalies, gas emissions and seismic activity (harmonic tremors)
Effectiveness discussed and case studies given credit – Pinatubo

Minimising may involve - evacuation, hazard mapping, diversion/blocks, dropping/spraying with water, explosion of flow margin
Case studies credited – Iceland, Etna

Ultimately always risk of hazard if people choose to live near volcanoes

(Max 15 marks, no case study max 12)

Total 25 marks

Q.5 *(a)* *Using diagrams, describe how the stability of working faces, associated with the extraction of rock and minerals, may reflect the friction angle and presence of rock disconformities.*

Effect of strata dipping "into" and "out of" a rock face (daylighting) at angles < and > the stable slope friction angle (~35^{o}).
Friction angle changes with pore pressure and rock type (shale v sandstone)
Examples

Disconformities = Joints/faults/cleavage/bedding.
Increased weathering of surface, breaks rock up into discrete sections.
Density of joints/faults controls weathering rate. Joint/fault direction patterns.

(Max 10 marks, no diagram max 7)

(b) *Explain the methods that may be used to monitor potentially unstable slopes.*

Holistic

Ground levelling/surveying
Changes in height/position - Rate of change increase
Micro seismic monitoring
Micro seismic events as rock begins to slide - Increase in number/size/rate
Surface strain measurement
Changes in the width of surface cracks - Increase in size/rate
Electronic distance measurement
Laser beam measures distance between fixed points - Changes in distances
Tiltmeter
Records changes rate of inclination of slope face
Borehole distortion meter
Measure tilt/inclination of borehole - Greater distortion from vertical with strain changes
Aerial photographs/satellite imagery - Changes with time
Groundwater pressures – Pore pressure changes with time

Credit examples
Accept volcanic slope monitoring (Mt St Helens)
(Max 15 marks)

Total 25 marks

MARK BAND CRITERIA FOR AS 2013 ESSAYS.

Summary Description	Mark out of 25	Mark out of 15	Mark out of 10	Criteria
Excellent	21 - 25	13-15	9-10	Not the perfect answer but purposeful, demonstrating a secure grasp of knowledge and understanding and few significant omissions. Well-supported and illustrated with detailed examples selected from named geological situations. Ideas expressed fluently in logical form using appropriate geological terminology. Few errors in grammar, punctuation and spelling.
Good/Very good	16 - 20	10-12	7-8	Sound answers with relevant material providing evidence of good knowledge and understanding. May be limited in terms of supporting material and breadth of coverage but appropriate examples selected. Ideas expressed with clarity with only occasional errors in grammar, spelling and punctuation.
Modest/ Quite Good	11 - 15	7-9	5-6	A reasonably secure grasp of basics but some deficiencies in knowledge and understanding although use is made of geological terminology. Examples and illustrations may lack detail or may not relate to real geological situations. Reasonable use of language with adequate spelling and punctuation.
Weak/ Minimal	6 - 10	4-6	3-4	Answers show limited basic knowledge and understanding, lacking directness and organisation; tendency to rehash prepared material and answer by inference. Superficial use of examples. Deficiencies in use of language evident; weaknesses in spelling and punctuation apparent.
Very weak	1 - 5	1-3	1-2	Little evidence of knowledge and understanding with erroneous or repeated material evident. Candidate is unable to address the question. Largely irrelevant; possibly too brief. Language skills poor, with spelling, grammar and punctuation errors becoming obtrusive.

Incorporated into this mark scheme is the assessment of candidates on their ability to organise & present information, ideas, descriptions & argument clearly & logically, taking into account their use of spelling, punctuation & grammar.

GCE Geology – GL4

Summer 2013

SECTION A

Q.1 (a) (i) Wide range of sizes / poorly sorted / coarse and fine (1)
Use of numbers (e.g. 0.25-8 mm)(1)
Modal group / 40% is 2-4 mm (1)
(max 2 marks) **[2]**

(ii) A = less mature
less attrition (accept erosion/abrasion)
shorter distance of transport than B
or
B = vice versa
Must be clear which is A/B
(max 2 marks) **[2]**

(b) A = rich in quartz **and** feldspar /micas/ hornblende (more than just quartz) (1)
B = rich in quartz (1) (and mica,accept feldspar remaining if explained) – not clay
(max 2 marks)

Reasons – erosion from granite parent
(holistic) B - mineralogically more mature compared to A
B - more (chemical) weathering (hydrolysis /oxidation) / broken down through transport
B - feldspar has cleavages – more easily broken down
B - quartz and muscovite chemically more stable / resistant to weathering/erosion
quartz & mica – more stable (lower on Bowen's reaction series)
(max 2 marks) **[4]**

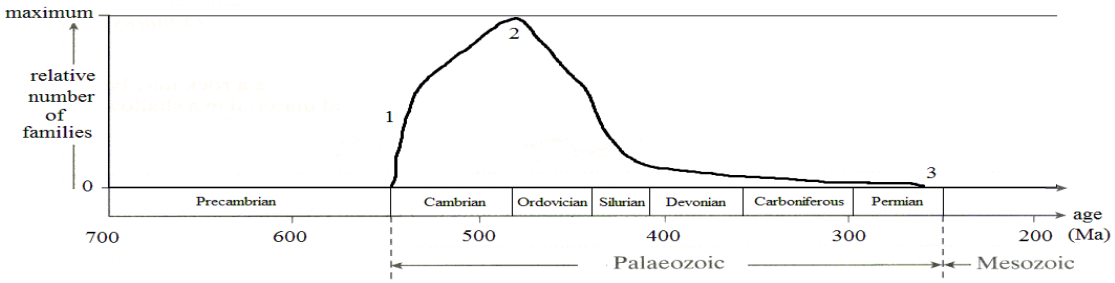
(c) (i) Partly (25% or 5g) composed of (1)
Limestone /$CaCO_3$/shelly material (1)
Quartz non-reactive with acid (1)
(max 2 marks) **[2]**

(ii) Weathering/marine erosion of **limestone**/sandstone/shale to **west** (1)
Transport of sediment by sea along the coast/from west to east (1)
Longshore drift (1)
Accept - beach shells from marine animals (1) washed up/broken (1)
(max 2 marks) **[2]**

(d) **Holistic** – 3 **evaluative** statements
Consistent with a braided stream environment at A (Fig 1a)
High energy – large, rounded pebbles in Fig 1d
Lower energy sand lenses shown in Fig 1b
Suggests variation in energy with time – river e.g. flash flood
Channels/sand bars of limited lateral extent – migrating channels
Sudden drop in gradient – braiding
Both have range of grain sizes (coarse and fine/poorly sorted)
Other relevant
Accept – sediment A does not show the same range of sediment size.
(max 3 marks) **[3]**

Total 15 marks

Q.2 (a)



Sudden appearance in Cambrian (1) – do not credit start in Precambrian
Peak in early Ordovician (1)
Extinction in Permian (1) – not Carboniferous/Permian boundary [3]

(b) (i) Olenellus = C (1)
Paradoxides = D (1) [2]

(ii) No eyes (1)
Frilled margin (1)
Longer genal spines (1)
Small thorax / fewest number of thoracic segments / only 5/6 thoracic segments (1)
Pleural segments not spinose (1)
Other sensible
(max 2 marks) [2]

(c) A – Burrower/mud grubber (benthonic/bottom dweller) (1)
No eyes – dark conditions/under mud (1)
Margin – shovel (1)
Margin – pores for filter feeding (1)
Genal spines – support in soft mud/feeding (1) – not for defence

OR

B - Swimmer (nektonic/pelagic) (1)
Large eyes / location of eyes on side of cephalon – to see beneath / 360° (1)
Streamline shape – ease through water (1)
Inflated/smooth glabella – float/buoyancy (1)
Many thoracic segments so more legs for propulsion (1)
Spine for defence (1) [3]

(d) (i) Holistic
mineralised skeletons only evolved at the Cambrian
fossil record is biased
previously they were soft bodied / lacking hard parts
did not survive preservation before Cambrian(max 2) **[2]**

(ii) Arrow (E) at ~565Ma (635-542 Ma) **[1]**

(iii) Snowball Earth finishes (1)
New opportunities for evolutionary development (1)

e.g. environment changed / warmed, more favourable for life;
nutrients in the sea, organisms expand into niches;
volcanoes give out CO_2, could be used in creating hard parts / $CaCO_3$

Or alternative theory
(max 2 marks) **[2]**

Total 15 marks

Q.3 (a) (i) Lower below boundary/decreases above boundary/increases and reaches maximum (1)
Dramatic increase at KT boundary
Use of numbers (1)
(max 2 marks) **[2]**

(ii) Excellent / very good / strong (1)
Positive correlation / both peak at KT boundary / as iridium increases so does soot (or vice versa) (1)
Use of numbers (1)
Tertiary less good correlation, iridium decreases but soot fluctuates (1)
(max 2 marks) **[2]**

(iii) Asteroid / impact (related to iridium) (1)
Heat from impact caused wildfires creating **soot** (**1R**)
which correlates with impact debris/iridium falling from suspension (1)
(max 2 marks – **R** plus 1) **[2]**

(b) (i) Spherical – condense in a droplet (around initial nucleus)
drop through atmosphere
rotating as they fall
(max 1 mark)

Glassy - <u>rapid cooling</u> of melt (1) **[2]**

(ii) Holistic – evidence explained

Additional spherule layers (1) – further impacts (long geological time) of earlier
Chicxulub (1)
Micro-tektites/spherules show erosion (1) takes a long time (1)
Limestone deposited between spherule layers (1)
take a long time to be deposited (1)
Sandstone burrowed - long time in deposition to form (1)
Chicxulub layer is over 8m (1) down/below/underneath so long time between (1)
Other sensible credited
(2 plus 2 = max 4 marks) **[4]**

(c) One of:
Volcanic activity – Deccan (1) flood basalt (1) /
environmental impact/change e.g. SO2, ash blocks out sun (1)
Changes in sea-level – loss of habitat – greater competition
Rapid climate change – unable to adapt/loss of food/methane hydrate release
Other appropriate and explained
(max 3 marks) **[3]**

Total 15 marks

Q.4 (a) (i) Outcrop – must include xenoliths **[1]**

(ii) Dyke continued to Quarry A (1)
Cross-cutting pluton (1) **[2]**

(b) (i) Direction of σ max – N-S (1**R**) do not accept only 'north' or 'south'
Evidence
E-W orientation of slaty cleavage / slate dips / faces south (1)
aligned at 90 degrees to stress (1)
axial planar cleavage seen at 90° to the relict bedding (folds / axial planes) (1)
(max 3 marks – **R** plus 2) **[3]**

(ii) Forcible intrusion of granite (1)
locally (radial) distortion of the cleavage (1) **[2]**

(c) Holistic
C recrystallised following the (original) regional metamorphism / contact metamorphism (high temperature / low pressure) (1)
C shows random growth of <u>new mineral</u> – spotted rock/hornfels/chiastolite
That cut across the original foliation
It is in the metamorphic aureole of the pluton/close to the pluton
(max 3 marks) **[3]**

(d) (i) Na-rich on rim rising to Ca-rich in core **[1]**

(ii) Holistic
Ca-rich first to crystallise
Solid solution series
Temp drops too fast for equilibrium to be maintained
Crystals unable to completely react back with melt/equilibrium
<u>Before</u> more Na-rich crystals <u>form</u> around older crystals
Process continues until crystallisation complete
(max 3 marks) **[3]**

Total 15 marks

SECTION B

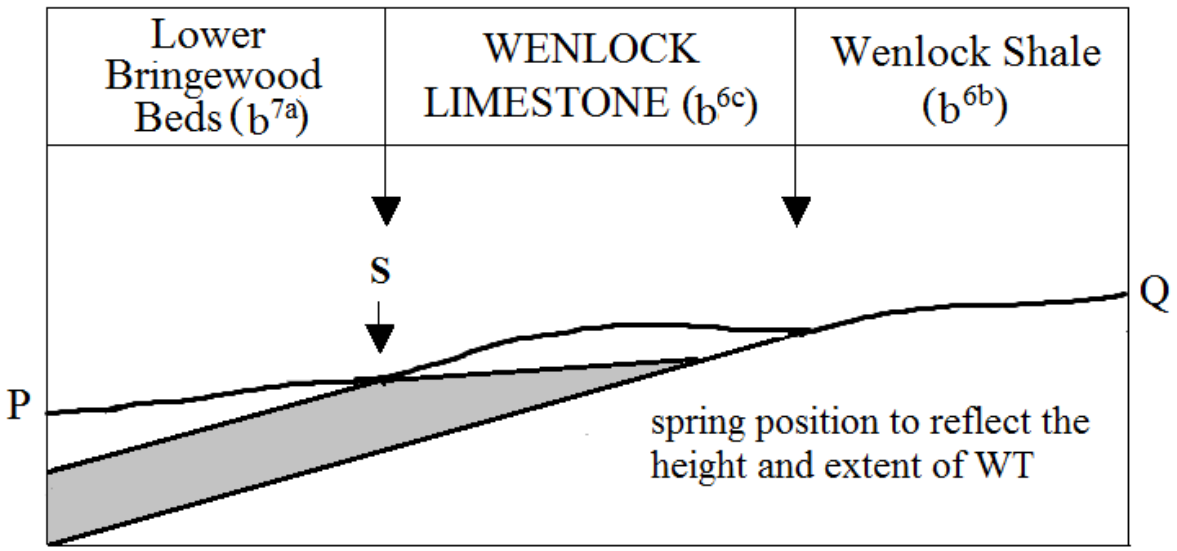
Q.5 (a) Describe
Linear (1)
Irregular (1)
Confined to river valleys (1)
Wider 500 m strip on east of map running N–S (1)
(max 2 marks) **[2]**

(b) V in direction of dip to west (1)
In a valley (1)
(max 2 marks) **[2]**

(c) (i) 2 bedding planes dipping to west (towards **P**) **[1]**

(ii) 1. Spring (as below) or at water table boundary – Wenlock Limestone only (1)

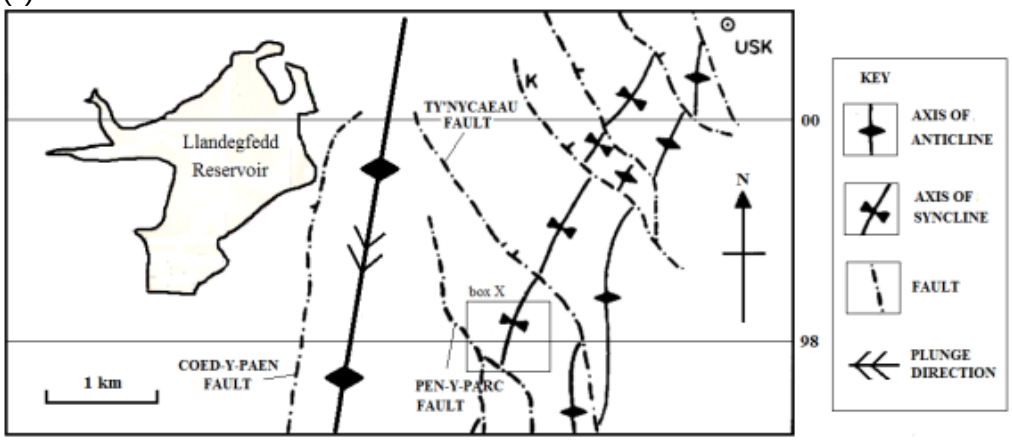
2. Water table (associated with Wenlock Limestone only) (1) **[2]**



Total 7 marks

Q.6 (a) (i) 1. Synform – Beds dip towards each other (1)
2. Syncline – Youngest rock in centre (1)
3. Plunge – V shape/close to NNE/opposite direction to plunge
Or opens in direction of plunge (SSW) (1)
(max 3 marks) **[3]**

(ii)



Axial plane trace (1)
Plunge SSW (1) **[2]**

(b) (i) Evidence - tick (1)
younger rock e.g. Downton Castle on downthrow side / east /
Upper Bringewood and Wenlock at same level (1) **[2]**

(ii) 8.2 cm x 42 (1)
= 345 m (accept 335–355 m) (1) **[2]**

(iii) The anticline axial plane trace offset (significantly) **[1]**

(iv) Yes, slickenside will give the orientation of the fault movement (1)
only rough or smooth will give direction (1)
But usually only the LAST movement (1)
may have been destroyed by dip-slip movement (1)
(max 2 marks) **[2]**

(c) Must give <u>evidence</u>
1. Yes - Both are normal faults because <u>tension/hanging walls downthrown</u> (1)

2. No - Ty'nycaeau is <u>bigger</u> than Coed-y-paen (1)

3. No - Folds are compressional (σ max horizontal) (1)
Faults are tensional (σ min horizontal) (1)
Faults cut the axis of folds thus later (1)
Faults reactivated (1)
(max 2 marks) **[4]**

Total 16 marks

Q.7 (a) Height = 200 cm (accept 150–250 cm) (1)
Direction = E (1) **[2]**

(b) Any two features for (1) each

Dip 10°
Massive (limestone)
Irregular bedding planes
Joints / fractures
Erosion surface
More weathered/less weathered
Other sensible e.g. biological weathering
No credit for 'rusty colour', unconformity, cleavage planes

[2]

(c) Holistic

Suitable:	Limestone is jointed = permeable
	Underlain and overlain by impermeable siltstones and mudstones = water (artesian) trapped
	Synformal structure between faults – basin to trap water
	Outcrop on surface
	Not much faulting – stable
Less suitable:	Limestone relatively thin – 10 m
	Limited surface outcrop
	Antiformal structures - water will flow away down dip
	Faulting in area
	(max 3 marks) **[3]**

Total 7 marks

Q.8 (a) 1. Dip (limited factor) (1)
Angle too shallow/gentle/10° or less – below stable friction angle (1)
Direction – against the dip to SW into the hill (– not significant) (1)
Credit lubrication / pore water pressure
(max 2 marks)

2. Fluvial conditions (possible factor) (1)
River <u>undercutting</u> the toe of slide (1)
Change to hydrological system (limestone filling up with water, lubricating/reducing friction) (1)
(max 2 marks)

3. Faulting (possible factor)
<u>Reactivation</u>/movement/activated/dynamic movement- weakness – water channel
(max 1 mark) **[5]**

(b) (i) Holistic
<u>Siltstones and mudstones</u> (b^{7a} Lower Bringewood beds) base (1)
<u>Impermeable</u> – less leakage (1)
River valley bottom – catchment (1)
Spring line evidence (1)
Stable, no faults cut the site (1)
(max 2 marks) **[2]**

(ii) Following explained
Landslide – further slip / unstable ground (1)
Permeable limestones (b^{6c} Wenlock Limestone) – leakage (1)
Faulting – reactivation/ leakage (1)
Other sensible e.g. weight of dam on rocks (1)
(max 3 marks) **[3]**

Total 10 marks

GCE GEOLOGY

SUMMER 2013 MARK SCHEME

Theme 1 – Quaternary Geology

Q.1 (a) (i) Scotland granite fragments (1)
calcareous mud and marine shell fragments from sea bed (1) **[2]**

(ii) e.g. glacial striations (1)
scratches on bedrock made as a result of erosion by fragments held in the ice (1) trending NE-SW (1)
allow other evidence 2 max **[2]**

(b) (i) alignment - flow/solifluction flow (1)
local debris not transported far (1)
ice wedge casts, origin (2) **[2]**

(ii) poorly sorted - dumped by ice (1)
angular - little attrition during transport by ice (1)
matrix of rock flour ground by ice (1)
no bedding - dumped by ice (1) 3 max **[3]**

(c) (i) raised beach/wave-cut platform above sea level
accept conglomerate above sea level **[1]**

(ii) drowned river/ria and /or submerged forest
explained **[2]**

(d)

interglacial/temperate	raised beach/conglomerate and platform
periglacial cooling climate	lower head
ice advance/glaciation	till
periglacial warming climate	upper head
interglacial/temperate	ria/submerged forest

5 correct (3) 3/4 correct (2) 1/2 correct (1)
[3]

Total 15 marks

Q.2 *(a)* *Draw a sketch section across a modern carbonate reef system. Describe the variation in grain type, grain size and texture of limestones that may be found in this environment.*

(b) *Evaluate the extent to which biological, physical and chemical processes contribute to the formation of the types of limestone shown in the sketch section.*

(a) **Description**
grain type – peloids, ooliths, bioclasts, microfossils, macrofossils, reef fragments, calcite mud
grain size – coarse to fine
textures – oolitic, bioclastic, pelitic, micrite, sparite, coarse fragments

OR

description of rock types such as oosparite, biosparite, micritic mudstone, breccias (reef debris)

(b) **Evaluate** role of processes such as currents (oolitic), biological (reef), storm waves (reef debris), chemical (precipitation of calcite mud)

Total 25 marks

Q.3 *(a)* *Describe how an analysis of*
(i) *pollen diagrams and*
(ii) *the vertebrate record*
can provide evidence for climatic fluctuations in Britain during the Quaternary.

(b) *Evaluate the use of radiocarbon dating (^{14}C) of organic material from the Quaternary.*

(a) **Description**

(i) **pollen** – dispersal of pollen from living vegetation, death assemblage in lake sediments not same as original vegetation proportions due to differing amounts from each plant/types of pollination
ease of preservation
analysis of sediment, reconstruction of assemblage may be biased to certain species,
interpretation based on modern floral distributions related to climatic zones
use of herbs/grasses, lack of tree pollen (tundra) coniferous forest, deciduous forest in determining climate

(ii) **vertebrates** – disarticulated skeletons, incomplete terrestrial record, lack of abundance, special preservation
uniformitarianism, similar modern species, similar adaptations, adapted to climate (temperature)
or distribution of food source

http://www.chobham.info/images/Glacial_Animals.gif

(b) **Evaluate**
only date organic material; half-life of 5,730 years so can only date recent events (100,000 y?)
cannot be used for most of the Quaternary
problems with contamination e.g. pollen
can be useful for marine record but terrestrial record of fossils incomplete and discontinuous

Total 25 marks

Q.4 *(a)* *Using illustrated examples, explain the relationship between geology and topography in **three** of the following:*

- *dipping strata*
- *folds*
- *faults*
- *joints*
- *igneous bodies*

(b) *Evaluate the view that Quaternary landforms are only partly controlled by geological structure and lithology.*

(a) **Description** of **three** examples
Case studies might include:
Wenlock Edge (dipping strata), Pennines / Weald (folds),
Great Glen / Craven fault (faults), Arthur's Seat / Skye (igneous),
Giant's Causeway (igneous / joints)
Look for quality diagrams, labelling, authentic examples and relationship to geology

(b) **Evaluate** influence of glacial/periglacial deposits and glacial erosion on landforms which mask/add to underlying geology

Total 25 marks

Theme 2 – Geology of Natural Resources

Q.1 (a) (i) >100m wide at top, 20-30m wide at bottom (1)
elongated (1) vertical/very steeply dipping (1) thin (1) tapering down (1)
[(1) for size + (1) for description of shape]
2 max **[2]**

(ii) massive sulphide (1) + (hydrothermal) veins (1)
in association with volcanic rock (1) parallel to boundaries of lava (1)
at a destructive plate margin (1) black smokers (1)
3 max **[3]**

(b) (i) covered by glacial till (1) no exposure at surface (1)
till impermeable so no geochemical trace (1)
other acceptable reason (1) 2 max **[2]**

(ii) **gravity** survey (1) gravimeter (1) measures changes in density (1)
ore mineral denser than surrounding rocks (1) done on land or in the air (1)
magnetic survey (1) measures changes in magnetic field (1)
ore minerals mostly have some iron content (1) done on land or in the air (1)
seismic survey (1) explosions/vibrations (1)
reflect seismic waves off ore body (1)
denser than surrounding rocks (1) record 2-way travel time (1)
electrical survey (1) current passed through the ground (1)
measure conductivity / resistivity of rocks (1) less effective because of impermeable cover (1)
only credit 1 technique 4 max **[4]**

(c) (i) waste tips at surface (1) acid mine drainage (1)
heavy metal contamination (1) visual impact of mine (1)
interference with groundwater flow (1)
stability of rock faces (1) noise/vibration from blasting (1) – any one
[1]

(ii) answer depends on problem chosen e.g. restricted blasting, bunding, settling tanks, treatment of water, backfill, vegetation,
liners / geomembranes
holistic mark **[3]**

Total 15 marks

Q.2 *Evaluate the statement:*
"Sedimentary processes and associations can produce metalliferous ores and non-metallic minerals of economic importance."

Metalliferous ores: reference to placer deposits (e.g. gold),
residual deposits (e.g. bauxite) and precipitated deposits (e.g. lithium),
weathering (e.g. Malachite & Azurite)
Processes concentrating metals into economically viable deposits

Non-metalliferous minerals (deposits): reference to china clay, limestone, diamond sands, bulk sand and gravel etc. [could refer to coal]

Credit examples given and discussion of processes
Breadth v depth
Must **evaluate** the role sedimentary processes play for full marks

Total 25 marks

Q.3 *(a)* *Describe how coal-forming environments can produce coal of different ranks.*

(b) *Evaluate the use of depleted oil and gas reservoirs as possible CO_2 repositories (carbon sequestration).*

(a) Description of coal-forming swamps/deltas
Supply of organic material exceeds rate of decay
Rapid burial of organic material/removal from aerobic conditions
Subsidence of sequence of rocks
Temperature and duration of burial
Expulsion of volatiles/increase in % of carbon
Progression from peat-lignite-bituminous coal-anthractite

Credit diagrams and examples

(b) Possible solution to climate change
Carbon capture and storage, CO_2 is removed from flue gases, such as in power stations and oil refineries, before being stored in underground reservoirs. Can reduce emissions by 80-90%.
Hydrocarbon traps provide a location to permanently store carbon dioxide in the rocks.
Energy cost - uses 10-40 % of the energy produced by a power station.
Wide adoption of CCS may negate efficiency gains of the last 50 years.
No effect on emissions from transport & extraction of fuel
Expensive solution to problem
Must **evaluate** for full marks

Total 25 marks

Q.4. *Evaluate the role of geological factors in controlling the formation, migration and accumulation of oil and natural gas.*

Planktonic life in surface waters of oceans (oil & gas)
Land plants (gas)
Source rock – clay/shale with high organic content
Depth: temperature and duration of burial
Porosity and permeability of rock
Pathways of migration: faults, joints, bedding surfaces, pore spaces
Reservoir rock
Cap rock: impermeable clay/shale
Structures to create traps: anticline, fault, unconformity, salt domes

All factors must occur in correct sequence for economic accumulations of hydrocarbons
Credit diagrams and examples
Must **evaluate** for access to full marks

Total 25 marks

Theme 3 – Geological Evolution of Great Britain

Q.1 (a) L: graptolite (1)
M: trilobite (1) **[2]**

(b) (i) any 2 from
irregular / folded / discontinuous (disjointed / chaotic etc) for (1) each
2 max **[2]**

(ii) current-bedded / undisturbed beds below (and above) /
no metamorphism **[1]**

(c) (i) (assemblage or) corals / brachiopods / trilobites (1)
one explained (1) **[2]**

(ii) flute casts ? / shales ? / (grading?) / no fossils (1)
explained (1) **[2]**

(iii) slump structures (1) explained (1) **[2]**

(d) corals and brachiopods / Law of Uniformitarianism = warm climate
no evidence of latitude change / require pattern or palaeomagnetism
sound conclusion **[4]**

Total 15 marks

Q.2. *Geological evidence suggests that Britain drifted northwards throughout the Carboniferous and Permo-Triassic.*
Describe and evaluate the evidence provided by
(i) *sedimentary rocks and fossils,*
(ii) *palaeomagnetism.*

Description – up to 19 marks

(i) Carboniferous equatorial carbonate platform
Bioclastic and oolitic limestones re Law of Uniformitarianism
Colonial corals / reefs
Brachiopods
Coal / seatearth / abundant vegetation / tropical forest / swamp
Cross-bedded deltaic sandstones
Abundant plant fossils - ferns, tree ferns
Insects / amphibians
Permian desert
Red sandstones / haematite / iron oxide staining / well sorted, rounded / aeolian dune bedding / evaporites / breccias / desiccation cracks
Rare fossils / tracks / trails / footprints
(ii) Palaeomagnetism, low angle inclination explained

Evaluation – 20+ marks
(i) Open to interpretation, overall trend plus Law of Uniformitarianism offers convincing evidence
(ii) Reliable data will give low angle magnetic inclination, decreasing to zero and then to a low angle again, possibly more convincing than (i)?
Assumes dipolar field
Assumes rocks undisturbed / tectonic / metamorphism
Inaccuracies in dating methods

Total 25 marks

Q.3 *(a) Describe the range of igneous bodies and their associated rock types found in the Tertiary Igneous Province.*

(b) Evaluate the importance of this range to an understanding of the plate tectonic setting in which it was produced.

(a) **Description – up to 19 marks**

Abundant igneous activity in NW Britain. Locations.
Range of bodies. Flood basalts. Plutons - granitic and gabbroic.
Dyke swarms.
Sills. Columnar jointing.
Range of rock types. Basaltic volcanic activity and associated gabbroic and granitic centres.

(b) **Evaluation – 20+ marks**

Mantle plume develops beneath northwest UK and Greenland.
Rifting and development of spreading centre, opening of North Atlantic.
Large volume of (flood) basalt associated with mantle plumes.
Hot spot trail to Iceland. Mid ocean ridge still active.
Evidence of tension (dykes etc.)
Later granitic intrusions due to melting of continental crust.

Total 25 marks

Q.4. *Describe and evaluate the use of igneous and metamorphic rocks and structures in interpreting the plate tectonic setting in which the Caledonian Orogeny developed.*

Description – up to 19 marks

Granite intrusions in Scotland and Lake District, less so in Wales.
Andesites, tuffs etc. in Lake District, Rhyolites etc. in Wales
High grade regional metamorphism in Scotland (gneiss, migmatites), lower grade in Lake District and Wales (slates)

Evaluation – 20+ marks

Granites suggest deep crustal melting
Metamorphism suggests heat/ pressure at depth in continental crust
Continent/continent convergence (NE-SW trend suggest plates converging from SE and NW)

Total 25 marks

Theme 4 – Geology of the Lithosphere

Q.1 (a) station 2: 30 s (accept 28-32) (1)
station 11: 77 s (accept 74-78) (1) **[2]**

(b) drawn correctly starting at source with i = r (accept multiple reflections) **[2]**

(c) velocity increases as P waves enter more rigid medium / mantle 6.5 to 8.1 kms^{-1}
refraction (occurs / away from the normal)
reverse occurs as P wave refracts to station (3 valid points) **[3]**

(d) (i) 260 ±10% **[1]**

(ii) use the candidate's answer to (d)(i)
correct use of velocities 8.1 and 6.5 (1)
correct substitution = √(1.4/14.6) or √0.11 (1)
answer should be = 260/2 x 0.33 = 43 (1) **[3]**

(e) holistic 3 marks for description / explanation

A – weathered and eroded / craton / expect "average" 30-35km / 40km above average
B – ocean basins / thin oceanic crust/ expect 5-10km
C – orogenic belt / collision / crustal thickening / above average
D – collision / subduction / thickening / above average / not to 40km
[4]

Total 15 marks

Q.2 *(a)* *Describe the range of tectonic structures caused by brittle deformation.*

(b) *Evaluate the role of tensional stresses in their formation in orogenic belts.*

(a) **Descriptions – up to 19 marks**
Faulting - normal, reverse and tear, credit labelled diagrams

(b) **Evaluation – 20+ marks**
Forces (principal stresses) produce folding (ductile) and/or faulting (brittle)
Orogenesis mainly compressional / thrusts
Tension produces normal faults / rifts, more common at CPM
Relationship between stress orientation and type of deformation,
stress / strain curves
Elastic limit, faulting before elastic limit, effect of temperature

Depth v breadth

Total 25 marks

Q.3 *(a)* *Describe the nature and origin of the layered structure of the oceanic lithosphere.*

(b) *Evaluate the contribution that ocean drilling has made to our understanding of the layered structure and composition of the oceanic lithosphere.*

(a) **Descriptions – up to 19 marks**
Layers 1, 2 and 3, credit labelled diagrams
MOR, sediment (oozes), pillow, dyke, plutonic form, sea floor spreading
Convection, thickening of sediments (+crust) away from ridge

(b) **Evaluation – 20+ marks**
Confined to upper layers, sediment and pillows easy by dredging, drilling very superficial
Modern technology beginning to make possible but as yet very limited and best “direct” evidence from ophiolites

Total 25 marks

Q.4 *(a)* *Describe the distribution of ages of rocks in continental areas.*

(b) *Evaluate the link between this age distribution and the J Tuzo Wilson cycle.*

(a) **Descriptions – up to 19 marks**

Example(s), older rock surrounded by or adjacent to younger rocks
Africa and North America provide examples, Britain older to NW and younger to the SE

(b) **Evaluation – 20+ marks**

Continents "grow" due to abduction at DPM, younger material is obducted onto older material
Destructive plate margins, essentially older material in the centre / progressively younger outwards (e.g. North America)
Obduction may not be from all sides and continents may be split due to plate tectonics (e.g. Britain.)
This may be explained by the J Tuzo Wilson Cycle re. break up of (super)continents in stages leading to formation of (super)continents

Total 25 marks

MARK BAND CRITERIA FOR A2 ESSAYS

Summary Description	Marks out of 25	Criteria
Outstanding	25-23	Not the perfect answer, but a candidate could not be expected to produce better work at this level in the time allowed.
Very good	22-20	Arguments are purposeful, well supported & show both balance and style. Irrefutable evidence of a thorough grasp of concepts & principles. A hint of flair apparent in work.
Good	19-17	The answer is direct & explicit; shows the ability to use knowledge & understanding & to discuss. May be limited in terms of supporting material & breadth of coverage.
Quite good	16-14	Shows a reasonably secure grasp of the basics, but answer may show some slight deficiencies in terms of either knowledge & understanding or directness & organisation.
Modest	13-11	Material is mainly relevant & sound, but points need more development (& support). Could be much more direct & explicit in approach.
Minimal	10-8	Work impoverished by limited knowledge & understanding; tendency to rehash prepared material & to answer by inference. Answer rather hit & miss.
Weak	7-5	Little evidence of knowledge or understanding; unable or unwilling to address the question; essentially random in approach.
Very weak	4-1	Largely irrelevant; too brief; abundant erroneous material.
Unacceptable	0	Wholly irrelevant or nothing written.

Incorporated into this mark scheme is the assessment of candidates on their ability to organise & present information, ideas, descriptions & argument clearly & logically, taking into account their use of spelling, punctuation & grammar.

QUICK GUIDE

Description		K / U	Discussion	Terminology
Outstanding	23-25	Not perfect BUT		Thorough
Very good	20-22	Thorough grasp	Well supported. Hint of flair + EVALUATION	Sound
Good	17-19	Direct/explicit	Limited support - breadth. Lacks detail - depth	Significant
Quite Good	14-16	Basics	Slight deficiencies. Limited scope relevance	Basic
Modest	11-13	Mainly relevant	Needs much more development	
Minimal	8-10	Limited/rehash	Hit and miss	Little
Weak	5-7	Little evidence	Question not addressed	
Very Weak	1-4	Irrelevant/erroneous	Too brief	
Unacceptable	0			

Thus key dividing lines are:

Outstanding - Across the board – no significant weaknesses

Very good - EVALUATION

Good - Good read - some omissions in content/detail/discussion

Quite Good - Essay title has been addressed but not a convincing argument

Modest - Bit difficult to follow. Do they really know?
Addressed the question but need much more discussion = mark scheme

Minimal/Weak/Very Weak - R*ehash at best - irrelevant material/no essay to mark/mark per point?*

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