GCE MARKING SCHEME

GEOLOGY
AS/Advanced

SUMMER 2014

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INTRODUCTION

The marking schemes which follow were those used by WJEC for the 2014 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.

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GCE GEOLOGY GL1

SUMMER 2014 MARK SCHEME

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

(ii) Sandstone (1)
On top – superposition / included fragments of shale in sandstone (1)
[2]

(b) (i) Only one baked margin – underneath / no baked margin above (1)
Weathered/rubbly upper surface (1)
Upper and lower surfaces not parallel/planar/regular (1)
Credit could be a sill (as concordant) but top has been eroded (1)
any 2 [2]

(ii) Similarity – both mafic / basic / crystalline / both contain augite or feldspar or olivine / basalt weathered to clay (1)
Difference – Dolerite is coarser/Rock **A** is finer (accept use of numbers/crystal sizes) (1) [2]

(c) (i) 6 metres [1]

(ii) Normal fault (1)
Hanging wall downthrown/Footwall upthrown (1)
Tensional/extensional forces (1)
Credit extension/tension in second part if fault stated as reverse
Dips towards downthrown side (1)
No repetition of strata of strata in a borehole (1)
any 2 [2]

(d) (i) Contact metamorphic – anywhere in the baked margins of Rock **A** or the Dolerite (1)
Regional metamorphic – anywhere in the Schist (1)
Angular Unconformity – anywhere along the Schist/Limestone boundary (1)
1 or 2 correct for 1 mark; all 3 correct for 2 marks [2]

(ii) Garnet [1]

(iii) Crystalline (1) porphyroblastic (1)
Reference to crystal sizes/groundmass (1)
Foliated/Schistose/aligned (1R) – Reserved mark
Regional metamorphism / heat and pressure (1R)
Recrystallized under directed stress (1)
[4]

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Q.2 *(a)* (i) Very slow increase/low numbers from start of Ordovician to mid-Carboniferous (1)
Quite rapid/faster increase from mid-Carboniferous to end of Cretaceous (1)
Reference to peak diversity (1) Declining from K/T boundary through the Tertiary (1) [3]

(ii) Tertiary [1]

(b) (i)

C (1)
D (1)
C (1)

[3]

(ii) Brachiopods [1]

(c) (i) Length 25 ± 1mm, Width 30 ± 1mm (1)
Correct plot on graph (1) [2]

(ii) No mark for saying life or death assemblage

Difficult to tell/could be either/insufficient information (1)
Can't tell if shells are complete/broken (1)
Can't tell if shells are current aligned (1)

Life – shells appear complete if one on 2d is typical (1)
positive correlation on graph (1)
Life – graph shows a continuous straight line (1) – could indicate bivalves of different ages (1)
Life – absence of juveniles(1) – too lightweight/flimsy delicate to be preserved in this environment (1)

Death – absence of small shells – juveniles not represented (1)
Death – gaps in 'continuous line' = not life (1)
Death – shells may not be complete – just broken fragments – poorly sorted/rapid deposition (1)
any 4
max 3 if death assemblage stated
holistic

[4]

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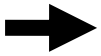
Q.3 *(a)* (i) Eurasian plate  (1)

Pacific Plate  (1) [2]

(ii) Convergent [1]

(b) (i) Increase in depth from east to west (1) two lines (1)
Slope at an angle to the west (1) linear/inclined (1)
Mainly occur shallower than 150 or 200 km depth (1)
Cluster of shallow focus <25 km depth beneath Japan (1)
/ under volcanic region (1)
Stop/decrease significantly at 200 or 250 km depth (1)
3 different clusters (1) between volcanic region and trench (1)
More dispersed cluster below trench up to 120 km deep (1)
any 3 [3]

(ii) Subduction (1) Benioff Zone (1)
Friction between plates (1) Release of pressure (1)
Rising magma towards the surface below Japan (1)
Rising magma causes micro-fractures to open = quakes (stoping) (1)
Movement along faults due to compressive forces (1)
max 3 for one idea developed [4]

(c) (i) Partial melting (1R) of basalt / mantle wedge / oceanic lithosphere (1)
Credit release of water from upper part of subducted slab (1) [2]

(ii) Andesitic has higher silica/quartz content/more viscous or sticky (1)
Gases unable to escape/pressure builds then released explosively (1)
[2]

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Q.4 *(a)* (i) Two bars plotted accurately for 1 mark
All three bars plotted accurately for 2 marks
max 1 mark if more than three bars plotted [2]

(ii) Coarse grained = Sediment F (1)

Poorly sorted = Sediment F (1)

Furthest downstream = Sediment H (1) [3]

(iii) Energy conditions too high to allow deposition (1)
reference to small sizes (1)
Transported further downstream in suspension (1) [2]

(iv) Decrease in size/smaller (1)
More rounded/less angular (1)
More spherical/less angular (1)
Abrasion or attrition or description of process (1R)
[3]

(b) (i) Cross bedding/dune bedding/current bedding [1]

(ii) Scale – rivers only have small scale cross bedding centimetres rather metres as in 4*(b)* (1)
Large ripples/dunes (1) suggest Aeolian transport in deserts/wind (1)
Red haematite cement suggests terrestrial environment – oxidation (1)
Well sorted/uniform grain size (1) – wind can only transport small grain sizes (1)
Very well rounded/spherical grains (1) – very long distance of transport (1)
Sediment has undergone extensive abrasion/attrition (1)
Comprises only quartz grains (1) – mineralogically mature (1)
Texturally mature (1)
max 3 if no explanation [4]

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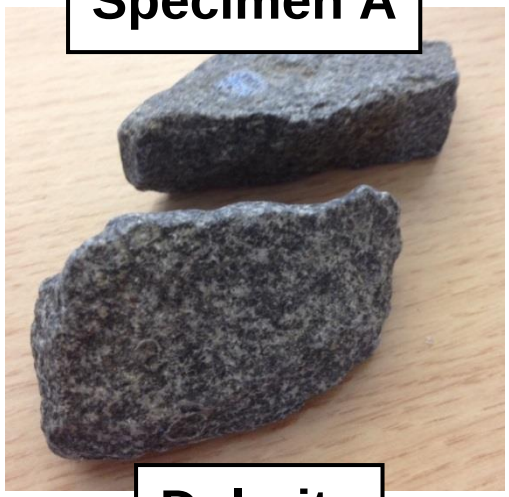
GCE AS Geology

GL2a (1212/01) Specimens 2014

Specimen A

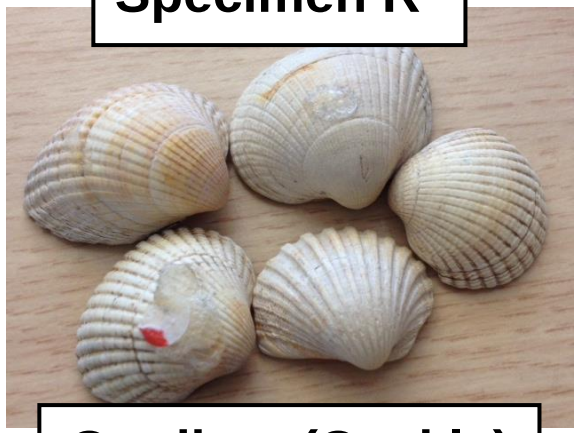


Dolerite

Specimen

Arkose Sandstone

Specimen R



Cardium (Cockle)

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Q1	Marks	Expected Answer	Acceptable Answer	Do Not Accept
(a)	3	• Medium grained • Equigranular • It is dominated by crystals		• If more than 3 boxes are ticked, deduct 1 mark for each box which is wrongly chosen to a minimum of 0
(b)	1 1 1	• Evaluation True (no credit) but only continue marking evidence if evaluation is true Evidence = discordant or equivalent • Evaluation False (no credit) but only continue marking if evaluation is false Evidence = A cross cuts B /intrudes B or equivalent • Evaluation False (no credit) but only continue marking if evaluation is false Evidence = A is mafic/dolerite or B is silicic/granite	• Straight line/linear/tabular • A is dark colour or B is light colour • A is mafic/dolerite/dark colour/contains olivine or augite • A has no quartz	• A is younger than B • A overlies B • Any reference to texture • A is not granite • Reference to Plagioclase feldspar or feldspar • Do not credit a list of minerals in A if more than one is incorrect
(c)	1	• Dolerite		
	Total 7			

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Q2	Marks	Expected Answer	Acceptable Answer	Do Not Accept
(a)	1 1	• Evaluation True (no credit) but only continue marking evidence if evaluation is true Evidence = (All) bed**s** displaced horizontally or laterally **in same direction**/left/sinistral/to west across the fault or fold/APT displaced horizontally/laterally or F2 displaced horizontally/laterally • Evaluation False (no credit) but only continue marking if evaluation is false Evidence = F1 is straight so vertical or F2 is not straight or is sinuous so dipping less than 90°		• Reference to dextral or right • Reference to horizontal displacement of one identified bed only (which could occur with dip slip) • Just the term “Displacement” without idea of horizontal or lateral or left or sinistral or to west • F1 is vertical or F2 dipping less than 90° without statement of evidence from the map
(b)	1 1 1	• Younger • East • Normal		• If more than 1box is ticked on each line, do not award a mark for that line. • Any alternative to those answers in the “Expected Answer Column” ie no credit for reverse fault under any circumstances
	Total 5			

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Q3	Marks	Expected Answer	Acceptable Answer	Do Not Accept
(a)(i)	1 **G** 1 **Si** 1 **Sh** 1 **So**	• Grains touching other grains • Grains correct size using scale provided • Grains sub angular –sub rounded • Grains with relevant sorting i.e. a variety of sizes	• Minimum of 1 contact between grains Grain size mainly **0.5mm to 5 mm**. Some may have the odd larger individual grain	• Entirely "floating" grains with no contacts • Crystalline (all contacts shared with other crystals/grains) • Well rounded grains • All grains same size
(a)(ii)	1 1	• One of no cleavage vitreous lustre colourless • Quartz	• Does not scratch with steel pin • Scratches a streak plate • Conchoidal fracture	• Does not react with acid
(b)	1	• Column on far Left		• No mark if tick in more than 1 box
(c)(i)	1	• Crystalline/interlocking crystals/made of crystals	• No pore space/porosity	• Size of crystals • Impermeable
(c)(ii)	1 1	• Metaquartzite • Derived from (C which is)sandstone/quartz rich/orthoquartzite/arkose or "It Is quartz rich/made of quartz/contains quartz"	• Quartzite • (accept marble only if calcite in a(ii)) • Accept derived from (C which is) limestone/calcite rich if calcite in a(ii) or "It is made of calcite" if calcite in a(ii)	• Orthoquartzite
(c)(iii)	 1 1 1 1 1	Credit up to **3** points only • Contact/thermal metamorphism • Heat • From Granite/ B/pluton • Any ref to metamorphic aureole • Recrystallisation or equivalent	• Baked margin	• Any reference to just "metamorphism" or Regional metamorphism • Heat and pressure
	Total 13			

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Q4	Marks	Expected Answer	Acceptable Answer	Do Not Accept
(a)(i)	1	• U at edge of either rock units G or H	• Southern edge of unit F	• If more than one arrow labelled U and one is incorrect, score 0 marks
(a)(ii)	1 1	• Difference in dip angle either side of unconformity • Unconformity rests on more than one rock unit (other rock units)/discordant/cuts across beds/cuts across folds or Cuts across intrusion of B/pluton or Cuts across dyke/A or Cuts across edge of metamorphic aureole	• Rocks above not folded or equivalent but only if unconformity at base of G selected in a(i) • Unconformity covers underlying rocks/unconformity is sinuous unlike other beds • Beds not metamorphosed above the unconformity	• Ref to superposition ie “younger beds are on top of older” etc
(b)	1	• Synform APT trending N-S anywhere within the wider outcrop of rock unit D to east of F2, south of F1 (must have symbol on it if more than one APT drawn)	• The APT if it runs down the line marking the edge of rock unit D NB The APT does not need to cross the fault F1 but accept it if it does	• An APT if it is drawn **only** to the north of F1
(c)(i)	1 1	• Beds are right way up • because upward fining or equivalent e.g coarse on bottom	• Way up is correct/normal/unturned • because graded bedding right way up	• Any reason if the answer suggests they are overturned • “Upwards” • Explanation of coarse grains depositied first etc, since this is still the case if beds overturned
(c)(ii)	1 1 1	• Symmetrical • Anticline- if beds stated as right way up in (c)(i) Or Syncline- if beds stated as inverted in (c)(i) • Antiform		• If more than 3 boxes are ticked, deduct 1 mark for each box which is wrongly chosen to a minimum of 0
(c)(iii)	1	• South		• More than one box ticked = 0 marks
	Total 10			

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Q5	Marks	Expected Answer	Acceptable Answer	Do Not Accept
(a)	1 **Sc** 1 **Sh** 1 **D** 1 **T**	• Drawn to correct scale to represent 1.5cm – 4cm wide, 1.5cm to 3.5 cm high but depends on the actual specimen dimensions • Correct ratio of width to height (i.e. it looks correct shape rather than too tall or too elongate) • Suitable amount of detail shown ie crenulated margin or pallial line or muscle scars or teeth and sockets reasonably accurately drawn • Teeth and sockets labelled correctly	• Credit the scale mark for an **external view** • Credit the ratio of width to height ie shape for an **external view**	• The shape mark should not be credited if the drawing is "higher" (umbo to margin) than it is "wide" • No credit for detail if an external view • No credit for teeth and sockets if an external view
(b)	1	Death assemblage because: • Shells are disarticulated/separated/ broken or equivalent	• Shells are piled up on each other • Shells are not in life position or equivalent • Shells all facing same way (convex upwards	• Any reasons if the answer is given as "life assemblage"
	Total 5			

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Q6	Marks	Expected Answer	Acceptable Answer	Do Not Accept
(a)	12 See annotated cross section answer	*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 (80°-60°) and (40°-20°)	• Any dip > 5° on unconformity at base of G • Any dip <5° or > 20° on unconformity at base of H • Vertical APT of folds or APTs that do not approximately bisect fold limbs • Base of unit C dipping towards X in west of section, if it is drawn from the same point as the outcrop of the unconformity (base of unit H)
(b)	1 1 1 1	Folding **between** G and H Folding **between** B and D F1 younger than F2 (wherever they are located in the sequence) F1 **and** F2 **between** D and B		• Folding arrows which point into boxes G or H • Folding arrows which point into boxes B or D • Fault arrows which point into boxes B or D • Fault arrows which do not specify F1 or F 2 i.e. if just labelled F or fault then this is not acceptable
	Total 16			

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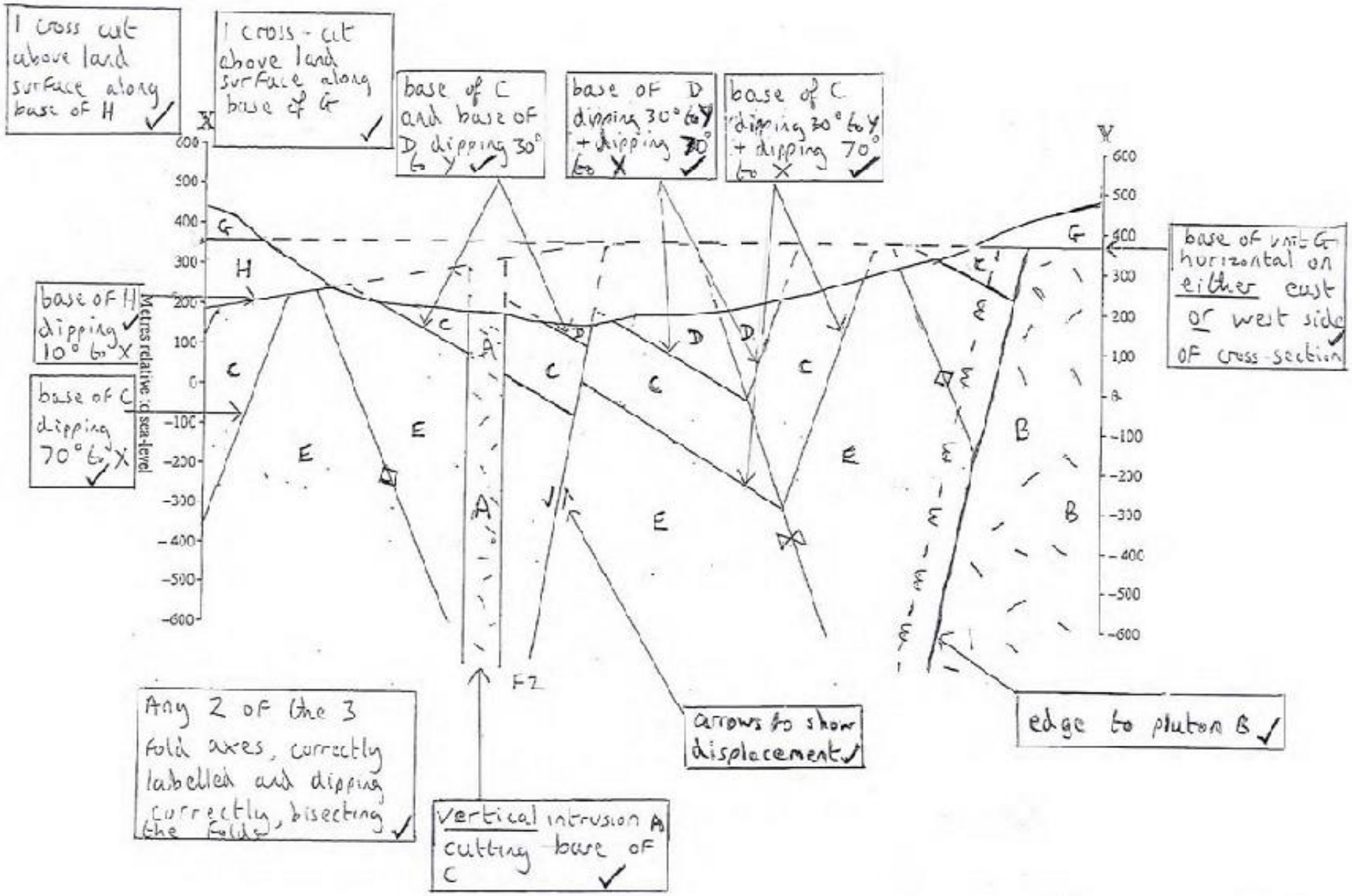

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Q7	Marks	Expected Answer	Acceptable Answer	Do Not Accept
	1 **N** 1 **C** 2 **O**	• Relevant named sedimentary structure e.g ripple marks, symmetrical ripple marks, asymmetrical ripple marks, flute casts, current bedding • Statements of **how** it shows current direction **1 mark** for **statement as to how it shows current direction** which could be written text or annotation - an arrow correctly showing current direction **or** written version of the arrow "flute cast gets wider in the direction of current flow" or steeper face of ripple mark points in current direction • Explanation of the origin of the structure **up to 2 marks** for **2 points** which could be written text or annotation e.g. current of water hollows out sediment (1), new layer of sediment fills in the hollow creating a flute cast on base of upper bed (1) e.g. current blows sand grains up to top of a sand dune (1) and they then avalanche down front face preserved as a current bed (1)	Imbricate structures	• A fieldwork locality name • A sedimentary structure that cannot be used to indicate a current direction. This scores 0 marks. e.g. load and flame, graded bedding, desiccation cracks.
	Total 4			

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GCE GEOLOGY GL3

SUMMER 2014 MARK SCHEME

Q.1 (a) (i) Subduction (1)
Convergent plate boundary / Cocos plate beneath NA plate (1)
More dense ocean lithosphere thrust below less dense continental lithosphere (1)
Friction/release of energy (1)
(max 2 marks) [2]

(ii) Seismic gap in time and space stated or implied (1R) – Reserved mark
Explained – stress build up with time/faults not moved recently (1)
(max 2 marks) [2]

(b) (i) Thicker the more damage (1)
Directly proportional (1)
Use of comparative numbers (1)
(max 2 marks) [2]

(ii) Ground amplified ground shaking (1)
Foundations do not reach deeper rock (1)
Clay soft/low rigidity/strength (1)
Liquefaction credited (1)
(max 2 marks) [2]

(c) (i) 6 storeys - 22 storeys [2]
(Where wrong because figure other than 25% used – credit 1 mark if BOTH are accurate for the percentage used e.g. 7-22 for 30%)

(ii) Holistic
Only buildings between 6-22 have a natural frequency of vibration which is closest to that of the earthquake vibrations reinforced/prolonged resonance – greater amplification.
Other sensible e.g. credit reference to foundation depth
Lower centre of gravity on smaller buildings
Larger building more flexible/earthquake proof
(max 2 marks) [2]

Total 12 marks

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Q.2 (a) (i) A – Water table reaches surface (1)
Interface between, permeable, impermeable rock at surface (1)
(max 1 mark)
B – Reference to Fault zone – weakness/fractured rock (1)
Water forced to the surface (hydrostatic/artesian pressure etc) (1R)
(max 2 marks) [3]

(ii) Holistic
Reduction in local artesian pressure
Cone of exhaustion/depression of water table
Where recharge is locally exceeded
Springs and flowing borehole may dry up / less water available / water table drops (max 1)
As potentiometric surface lowered below topographic surface
Saltwater incursion
(max 3 marks) [3]

(b) (i)

Sedimentary characteristic	Effect on porosity
Packing in model **A** compared to Packing in model **B**	• *Closer/tighter/closed packing in model* **A** *reduces the porosity (vice versa for* **B***)* ***1 mark***
Grain size in model **B** compared to Grain size in model **C**	• *No change in porosity with change in grain size, porosity the same in both models* **1 mark**

[2]

(ii) Sorting – better sorting – higher porosity because smaller grains fit into pores
Or
Angularity of grains – angular grains – lower porosity because grains fit into pores easier
Or
Cementation – More cementation – lower porsity because cement infils pores)
(max 2 marks) [2]

(c) Holistic
Pore pressure reduced,
grains repack,
reducing porosity,
reducing volume
(max 3 marks) [3]

Total 13 marks

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Q.3 (a) *Describe the **factors** that affect the risk of damage to property or loss of life in coastal areas prone to tsunamis.*

Primary hazard – size of the tsunamis
Secondary effects (slope/shape of the coastline, etc)
Population size/density/coastal development
Building type/density/design – building codes
Economic influences (MEDC v LEDC)
Social influences – apathy, indifference etc.
Levels of hazard planning/hazard prediction/protection
Use of case studies as examples credited
Max of 7 if not described "FACTORS that affect RISK" and referred to nature of tsunamis themselves
(max 10 marks)

(b) *Explain how **two** of the following might be effectively used to minimise the risk from the destructive effects of natural geological hazards.*

(i) *Controlled stress release along faults*

Stress release on faults. Theoretical. Release of "locked" areas of fault by injecting fluids along fault to produce smaller controlled earthquakes. Denver – waste fluids injected into deep wells in fractured rock triggered minor earthquakes until pumping stopped. Water lubricates fault zone – pore pressure increased.
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 or effective yet.
(max 7 marks plus 1)

(ii) *Slope monitoring techniques*

Mechanics of mapping, ground levelling and surveying – changes in height/position/rate
Rock noise monitoring – microseismic events as rock begins to slide
EDM – laser beam measures distance between fixed points
Air photo-satellite imagery – using satellite imagery
Surface creep/strain measurement – changes in the width of surface cracks
Piezometer – groundwater pressure measurement
Tiltmeter – tiltmeter records changes in inclination of wall/face
Borehole distortion – measure tilt/inclination of borehole
Instruments used
Accept volcanic slope monitoring (Mt St Helens)
All give warning of potential failure and rate of failure – effective but sometimes failure is without warning
(max 7 marks plus 1)

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(iii) *Indicators of magma movement*

Ground deformation

As stress increases with filling of magma chamber, strain causes deformation of volcanic cone leading to increasing slope angles and increased distances across the vent/height of vent.
Changes in slope angle measured by Tiltmeters. Description of their mechanism.
Changes in distance - EDM (electronic distance measurements) from known fixed points. Lazar reflections etc.

Gravity and thermal anomalies

Gravity - Explanation of the method. High and low changes indicate changes of mass beneath volcano which equates to rising magma.
Thermal anomalies - measured by satellite imagery. Hot rocks identified from space.
Thermal anomalies - measured in lake temperature changes.
Problems with this method (water heats slowly/influx of colder groundwater/rain masks effect of temp rise etc)

Gas emissions

Changes in gas emissions - SO_2 etc. Degassing of vent during pressure release as magma moves to surface.
Decrease in gas - vent blocked = explosion. (COSPEC)
Example(s) essential credited. Holistic.

Seismic activity

Increase in activity. Large number of foci. Confined pattern/fingerprint.
Harmonic tremors of long duration and low amplitude.

All above indicate the movement of magma and possibility of an eruption – though nothing guaranteed . Some volcanoes erupt without warning or laterally.
Credit for examples
(max 7 marks plus 1)

Holistic (max 7 × 2 + 1 marks)

Total 25 marks

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Q.4 (a) *Using one or more diagrams, describe how the excavation of a roadway cutting or tunnel in an area of dipping sandstones and shale might lead to slope instability or tunnel collapse.*

Where competent sandstone is subjected to high density of joints - permeable
Significance of shale - incompetent - lubrication when wet/pore pressure.
Dip of strata (and joint patterns that daylight) towards cutting at angles >35°
Rock fall from sandstone beds along vertical fractures - with poor support.
Shale may expand due to removal of overburden during excavation.
Vibrations from excavation - trigger mass movement.
Diagrams to show strata dipping essential
(max 10 marks - 7 without diagrams & 7 without reference to lithological factors) [10]

(b) *Explain how slopes prone to mass movement might be stabilised.*

Reprofile to below the stable angle (approx. 35° depending on other factors)
Steps - allows for steeper stable slope angle.
Drainage control – drains, pipes etc to remove surface water to improve cohesion.
Planting trees – reduces interception, removes water and roots bind the soil.
Engineering structures – gabions, retaining walls, shotcrete, rock bolts, grouting, netting etc
Prevention of instability caused by human activity – undercutting/deforestation
Other sensible specifically related to case studies
Credit for examples
(max 15 marks) [15]

Total 25 mark

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Q.5 (a) *Describe how the different hazards associated with volcanoes **and** earthquakes might give rise to similar types of risk.*

Similarities (Holistic)

Hazard

- Both linked to specific zones around the globe
- Seismic activity is also associated with volcanic activity – underground magma movement
- Volcanic and seismic events - often fast and violent
- Both may cause fast mass movements of material (pyroclastic flows v landslides)
- Both cause tsunami
- Both produce piles of unstable, loose debris (ash etc and collapse buildings/unstable rock waste)
- Hazard in both depends upon frequency, intensity (VEI and Richter scales)
- Hazard in both depends upon degree and quality of economic development (local building standards, population density etc) which affect risk
  (max 7 if list of hazards for both which are not comparable)

Credit for examples
(max 10 marks) [10]

(b) *Explain the geological factors that might be investigated when developing a hazard map for an active island volcano.*

Holistic

Nature of the magma (silcic/mafic) relates to
the type of eruption (explosive/effusive) which affects the risk from different volcanic hazards – (pyroclastic flows, lava flows, ash fall, lahars, lateral blast, volcanic gases) Tsunamis.
Nature of the slopes – prone to landslides during earthquakes
Type and extent of previous eruptive events – deposits/historical records
Topography – pathways for lahars/lava/pyroclastic flows.
Location of the population – no people/infrastructure – no hazard
Level of preparedness/development (LEDC v MEDC)
Degree of monitoring
Climate and weather conditions
(max 9 if only refer to *NON GEOLOGICAL* factors *in italics*)

(max 15 marks) [15]

Total 25 marks

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MARK BAND CRITERIA FOR AS ESSAYS

Summary Description	Mark out of 25	Mark out of 15	Mark out of 10	Mark out of 7/8	Criteria
Excellent	21-25	13-15	9-10	7-8	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	5-6	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	4	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	2-3	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	1	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.

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GCE GEOLOGY GL4

SUMMER 2014 MARK SCHEME

SECTION A

Question 1

(a) (i) Adductors – close (1)
Diductors – open (1)
Reference to hinge as a pivot (and/or cardinal process) (1)
Credit 1 mark for reference to adductors/diductors if wrong way round
(max 2 marks) [2]

(ii) Morphology reference (R) – Reserved mark
Spines or convex/concave pedicle/brachial valves
Related to mode (1)
Sessile/fixed/non-locomotive, epifaunal/benthonic etc
Spines anchor in sediments
(max 2 marks) [2]

(b) (i) Coral [1]

(ii) 30° (accept 25-35) [1]

(iii) Holistic
- Slope – ref to infill sediment/minerals – horizontal v dip (geopetal) (R)
- High energy – debris/broken spines/clast size/strength of coral
- Coral reef – coral present and/or marine brachiopod/debris/death assemblage (Productid not in life position)

(max 3 marks) [3]

(c) (i) Any two correct statements (1 + 1)
Found in all climatic zones
More in Northern Hemisphere
Abundant in Temperate latitudes/fewest in Polar
Use of numbers related to genera
(max 2 marks) [2]

(ii) Temperature (R)
Qualified as below (1)
None of the others would give such a regular, worldwide pattern
Correlates with the climatic zone distribution
Depth and quality of seafloor are local effects
Salinity – brachiopods are usually only found in normal marine salinity
(max 2 marks) [2]

(d) Tropical – 30° N/S of equator (1)
Evidence from coral which are confined to this zone
(max 2 marks) [2]

Total 15 marks

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Question 2

(a)

Melt **P** 65% Anorthite (An_{65})	Temperature of melt (°C)	Composition of melt (% An)	Composition of crystals (% An)
Initial crystallisation	**1500**	65	**90**
Crystallisation at 1400°C	1400	**35**	75
Final crystallisation	**1350**		**65**

Max 5 marks [5]

(b) (i) Top – ~800m described (1)
~800m – bottom described (1)
Anorthite decrease to ~800m/increase to top/bottom (1)
Numbers – An_{69} at base – An_{30} at ~800m – An_{69} at top (1)
(max 2 marks) [2]

(ii) Holistic
Early crystals more An rich (1)
Do not have time to react back with melt (1)
Crystals get trapped (1)
Temp drops too fast for equilibrium to be maintained (1)
Cooling up from base (and sides) and down from the top (1)
~800m last crystallisation of remaining melt less An rich (1)
(Do not credit gravity settling)
(max 3 marks) [3]

(iii) Gneiss (1)
More silicic than basalt (1) [2]

(c) Holistic
Olivine and Augite crystallise first/at higher temperatures
Olivine and Augite more dense than Plagioclase
Gravity settling/differentiation from floor upwards, crystal fractionation
Repeated pulses of deposition (cumulates) – currents in magma? (R)
(max 3 marks) [3]

Total 15 marks

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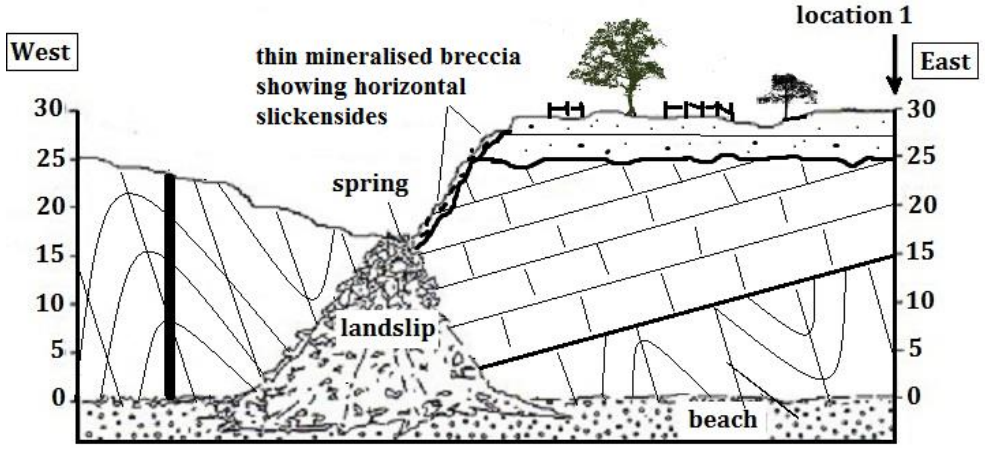
Question 3

(a)

Geology	Marks
Folded slates with an axial planar cleavage dipping 80°E	1 – folds drawn 1 – axial planar cleavage dipping at ~80°E (either on west or east)
Cut by a 2 metre thick vertical, basaltic dyke	1 – drawn vertical (thickness not important)
5m bedded sandstone, dipping 10°N	1 – marked in 5m thick (regardless of dip)
Irregular unconformity, dipping 10°N	1 – horizontal 1 – irregular
10m well-bedded limestone, dipping 15°W	1 – limestone – 10m thick
Unconformable junction, dipping 15°W	1 – dipping 15°W
15m folded slates with an axial planar cleavage dipping 80°E	1 – 15m marked in fold/cleavage dipping 80°E (credit here if not previously)



(max 8 marks) [8]

(b) (i) Inclined fault, dipping west – Yes (agreement needed/implied for 2 marks)

- Displacement of beds
- Fault scarp
- Spring
- Fault breccia
- Slickensides

(max 2 marks for stated EVIDENCE explained) [2]

(ii) Normal (tension) – No (disagreement needed for 3 marks)

- Reverse (R)
- Compression
- Hanging/upthrown or footwall/downthrown
- Metamorphic rocks older than sedimentary/upthrown
- Also accept NO / Slickensides/strike slip movement (max 2)

(max 3 marks for stated EVIDENCE explained) [3]

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(iii) Reactivation – Yes (agreement needed for 2 marks)

- Slickensides
- Last movement horizontal not vertical (R)
- Fault must have moved more than once in different directions

(max 2 marks for stated EVIDENCE explained) [2]

Total 15 marks

Alternative valid answer to (b) Max 7 marks

(i) Inclined fault – Could be a second fault – vertical or inclined east associated with

- *Displacement of beds*

(max 2 marks)

THUS (ii) Normal Fault – Yes

- *Youngest rock downthrown/hanging wall east*
- *Metamorphic rocks older than sedimentary/upthrown*
- *Tension*

(max 3 marks)

(iii) Reactivation – Yes (agreement needed for 2 marks)

- *Last movement horizontal not vertical*
- *Fault must have moved more than once in different directions*

(max 2 marks)

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Question 4

(a) X = jagged /toothed margin; Y = smooth/entire margin (1)
X = wider at base/elongated; Y = tapers to base, symmetry (1)
Width/length ratio (X 3:1; Y 2.5:1)
Credit actual sizes (X = 5 × 1.75cm; Y = 9.5 × 3.75cm) [2]

(b) (i) Very good (1)
Positive correlation (1)
Hotter the climate the more entire the leaf margin (1)
Use of numbers (1)
(max 2 marks) [2]

(ii) Y (R)
Highest mean annual temperature (1)
Largest proportion of smooth/entire leaf margin species (1)
(max 2 marks) [2]

(c) (i) Best fit line showing a negative correlation (1) [1]

(ii) Overall cooling in temperature with time (negative correlation) (1)
With several fluctuating warmer/cooler periods (1)
Use of numbers to describe (1)
(max 2 marks) [2]

(iii) Global cooling to form permanent icecaps
^{18}O is heavier than ^{16}O, more remains in ocean during evaporation
^{16}O locked in ice during glacial – ocean richer in ^{18}O
$^{18}O/^{16}O$ ratio is incorporated into the carbonate shells of foraminifera
(Holistic - max 3 marks) [3]

(d) Holistic
Continental preservation is poorer than in ocean - explained
Land plants macro-fossils – more fragile than ocean micro-fossils
Leaves more likely to decay than carbonates foraminifera shells
Fossil record biased
More continuous sedimentation in ocean - erosion on continents
Plant record subject to greater climate fluctuation
Figures show a greater range and detail of data from deep ocean
Inferred/absent data of continental leaf shape
Other factors – rock/soil type/rainfall
Other sensible e.g. uniformitarianism
(max 3 marks – max 2 if no reference to both) [3]

Total 15 marks

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SECTION B

Question 5

(a) (i) 15 (16 or 18) + 10 + 8 (1)
= 33/3 = 11 (11.3 or 12) (1)
(max 2 marks) [2]

(ii) Diagram and annotation to show:
1. Dip direction (Compass direction at 90° to strike (SW)/water)
2. Strike orientation – Compass (NW-SE)
3. Angle – of dip using clinometer (~11°)
(max 3 marks) [3]

(iii) Gentle – reference to way beds cross the contours (1R)
SW - shape relates to a valley (1R)
with "V" in direction of dip (SW) (1)
(credit discussion of wide valley giving U rather than V shape)
(max 3 marks) [3]

(b) (i)

Fault characteristic	Fault F1	Fault F2
Dip of fault (degrees)	**75 (70-80)**	
Throw (m)	**10-12**	*10m*
Fault type	*Normal*	**Normal**

[3]

(ii) Drawn vertical only  [1]

(iii) Similarity – both components **= horizontal** (1)
Difference – different orientations
e.g. North Head ~NE-SW
South Head ~ N-S
(max 1) [2]

Total 14 marks

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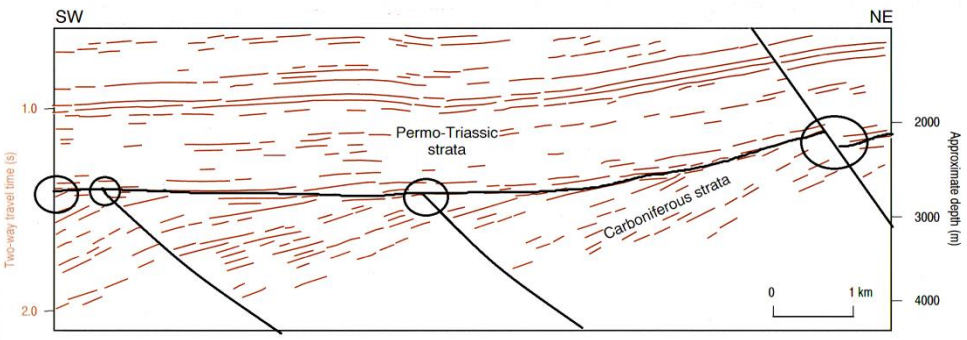
Question 6

(a) (i) Evidence of overstep identified in drawing (1)
Unconformity labelled (1)
Correct relative ages (younger/older) (1)
(max 3 marks) [3]

(ii) The thickness varies (0 – 40m) [1]
Wedge shaped

(b) (i)



1. Unconformity marked to fault (1)
Unconformity downthrown (1)

2. 2 faults inclined (2)
Truncated by unconformity (wherever drawn) (1)
(max 4 marks) [4]

(ii) 2 × 2.15 = 4.3km (1)
4.3/2 (division by 2) = 2.15 km (1) [2]

Total 10 marks

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Question 7

Holistic
Agreement with statement
Found mainly in the Carboniferous Great Scar Limestone group (limestone and sandstone)
Carboniferous limestone is permeable – access for fluids
Less so in the Permo-Triassic rocks and Carboniferous rocks
Not in the Skiddaw Group and mudstones
Absent from impermeable – limited access for fluids
Closely associated with faults – pathway for mineralising fluids
(max 4 marks) [4]

Total 4 marks

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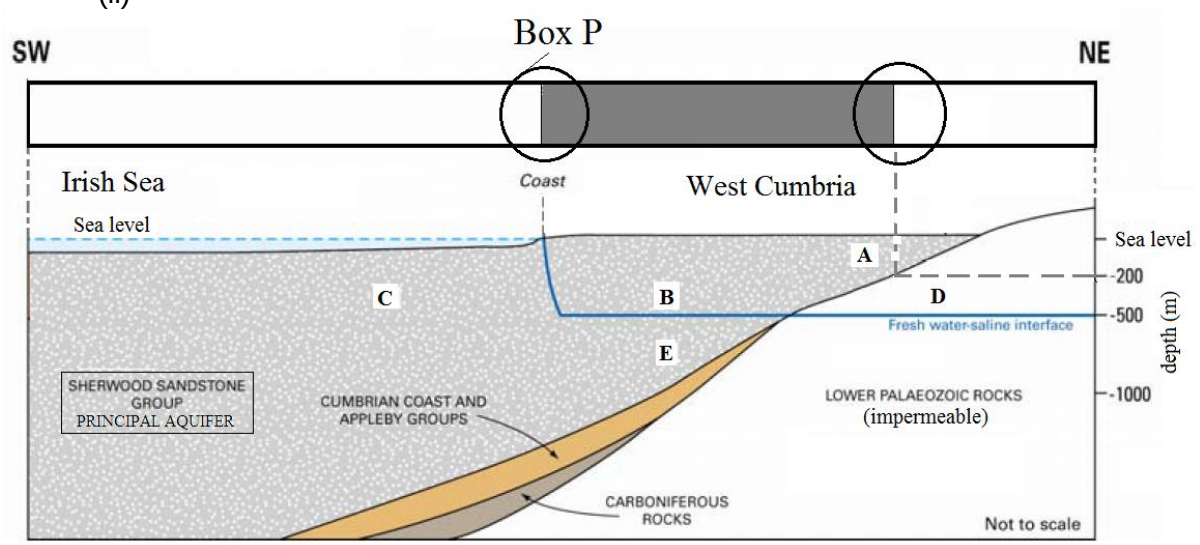
Question 8

(a) (i) B (1)

B = above the fresh water interface AND below 200m (1)
or explanation as to why the others are not viable
(Credit D as 1 mark only IF argued below 200m and above saline boundary)
(max 2 marks) [2]

(ii)



Extent shown (1 mark for each correct extreme)
(max 2 marks) [2]

(b) Holistic
Answer related to:
Reserves of: Coal – fossil fuel
Gas/fracking – fossil fuel (alternative)
Iron Ore – mineral reserve
Limestone – bulk mineral reserve
Evaporite, veins/lead
Freshwater – aquifer
(any 3 or more)
Only Lower Palaeozoic (Skiddaw Group) not excluded
(max 4 marks) [4]

(c) Holistic
Answers related to:
Porosity/permeability
Subsidence - sinkholes
Faults and joint patterns
Flow rates
Earthquakes
Sea level change
Erosion rates related to TIME
(max 4 marks) [4]

Total 12 marks

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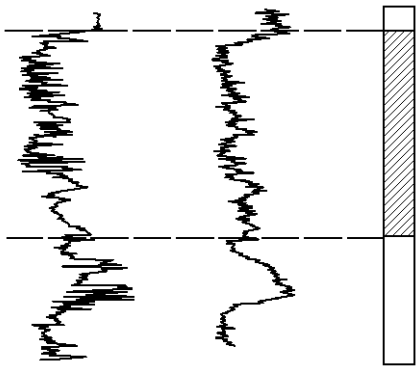
GCE GEOLOGY GL5

SUMMER 2014 MARK SCHEME

Theme 1 – Quaternary Geology

Section A

1. (a) (i) correct position of start (1) correct position of end (1)
(between peaks and troughs)



[2]

(ii) the lower/higher the ratio the lower/higher the temperature [1]

(b) (i) **Zone 1**
vegetation: mainly oak (1) deciduous broad leaved woodland (1)
rare juniper/birch/pine (1)
climate: temperate/warm (1)

Zone 3
vegetation: dominantly pine (1) and grasses (1)
decreasing oak and elm (1) increase in juniper (1)
evergreen coniferous woodland (1)
climate: cold (1)

2 × 3 marks [6]

(ii) interglacial to glacial/colder/cooling [1]

(iii) rapid oscillation of isotope ratio/temperature on a smaller cycle [1]

(iv) must evaluate for 4 marks
- increase in CO_2 corresponds to interglacial (higher temperatures)
- decrease in CO_2 corresponds to glacial (lower temperatures)
- the greater the change in CO_2 the greater the change in temperature
- CO_2 could be the cause of climatic fluctuations
- but the correlation may be a coincidence or CO_2 changes might be caused by changes in temp
- volcanic activity / Milankovitch etc. [4]

15 marks

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Section B

2. *(a)* *Using a named modern sedimentary environment, describe the characteristics of that environment and link them to the processes which form them. You may refer to any of the following;*

- *lithologies*
- *sedimentary structures*
- *organic forms*
- *bed shapes and field relationships*

(b) *Evaluate how the link between product and process can be used to reconstruct earlier environments recorded in sedimentary rock sequences*

[25]

(a) Description

A named modern sedimentary environment e.g. continental slope turbidites
description of lithologies (greywacke) linked to process
sedimentary structures such as graded bedding, sole structures, flute casts linked to processes
interbedded fine grained muds containing planktonic remains but generally lacking in life
Fan shaped deposits at foot of continental slope, proximal and distal turbidites

(b) Evaluation

reconstruction of earlier turbidites by recognition of similar sedimentary sequences produced by same processes
reconstruction of Lower Palaeozoic
Turbidites chosen here but could use other examples e.g. carbonates or coastal lithologies (sands, muds, pebble beds, dunes), bed geometries (channel fill), sedimentary structures (ripples, cross bedding, mudcracks), organic forms (bivalves, trails, burrows)

25 marks

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3. *(a)* *Describe the evidence from Quaternary deposits for the following sedimentary environments in Britain:*

- *periglacial*
- *glacial*

(b) *Evaluate the reliability of any interpretation of ice sheet dimensions from this evidence.*

[25]

(a) Description

Periglacial deposits e.g. head (composition / texture / structure / distribution)
Glacial deposits e.g. till (composition / texture / structure / distribution)

(b) Evaluation

Ice dimensions can be interpreted from terminal moraine and geographical distribution of glacial and periglacial sediments and landforms. Can be unreliable due to the repeated waning and growth of ice sheets masking earlier deposits.

25 marks

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4. *(a)* *With reference to examples, describe and explain how geological structure and lithology can control :*

- *river drainage patterns*
- *underground river courses*
- *groundwater flow*

(b) *'In some areas drainage is only partly controlled by geological structure and lithology.' Evaluate this statement.*

[25]

(a) Illustrated examples to demonstrate different river drainage patterns e.g.

Trellis Drainage Pattern

Trellis drainage patterns look similar to their namesake, the common garden trellis. Trellis drainage develops in folded topography. Short tributary streams enter the main channel at sharp angles as they run down sides of parallel ridges.

Radial Drainage Pattern

The radial drainage pattern develops around a central elevated point. This pattern is common to such conically shaped features as volcanoes. The tributary streams extend the headward reaches upslope toward the top of the volcano.

Dry valleys

Developed on many kinds of permeable rock, such as limestone, that does not regularly sustain surface water flow. Such valleys do not hold surface water because it sinks into the bedrock.
There are many examples of chalk dry valleys along the North and South Downs.
Usually created when melting water erodes limestone to the permafrost layer after the last ice age.
Subterranean river courses
Cave systems. Karst. Sinkholes.
Springs
Aquifer meeting the surface. Examples.

(b) Evaluation

Those streams that are discordant with the rocks over which they flow are either antecedent or superimposed. For instance, antecedent streams flowed across bedrock structures prior to uplift. Slow mountain building permitted stream erosion to keep pace with uplift. Other streams appear to be superimposed over the rock layers that they presently flow over
e.g. Lake District

25 marks

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Theme 2 – Geology of Natural Resources

Section A

1. (a) Lignite/Brown Coal [1]

(b) (i) Increase in % carbon (1) decrease in oxygen & hydrogen (1) quantified (1) [2]

(ii) Price increases with rank (1) non-linear (1) higher price of peat is an anomaly (1) [2]

(iii) Greater calorific value / heat / energy (1) cleaner (1) availability (1) different uses for peat account for anomaly (1) (+1) for development (gardening/fertiliser) [3]

(c) (i) Increase in rank towards centre of coalfield/core of syncline [1]

(ii) Increased temperature (1) increased pressure (1) deeper burial (1) core of fold (1) (+1) for development [2]

(d) (i) *Deep Mine*: Waste tips at surface (1) acid mine drainage (1) visual impact of mine (1) interference with groundwater flow (1) subsidence (1)

Open Cast Mine: stability of rock faces (1) noise/vibration from blasting (1) settling of infill (1)

Credit other reasonable environmental problem identified [1]

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

15 marks

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Section B

2. *(a)* *Describe the origin of hydrocarbons (oil and natural gas).*

(b) *Evaluate the role of porosity and permeability in the distribution, migration and accumulation of hydrocarbons (oil and natural gas).*

Description
Planktonic life in surface waters of oceans (oil & gas). Land plants (gas).
Rapid burial. Anaerobic. Source rock – clay / shale with high organic content.
Depth, temperature and duration of burial. Windows for oil and gas.
Porosity (packing, sorting, shape, cementation).
Permeability (grain size, interconnected pores).
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.

Evaluation
All factors "essential." Must occur in correct sequence for economic accumulations of hydrocarbons.

25 marks

3. *Describe and evaluate the importance of igneous processes in the formation of metalliferous ores of economic importance.*

Metalliferous ores:

Magmatic segregation: separating minerals by their crystallisation temperature and density e.g. chromite and magnetite.
Magma immiscibility: Sulphide melts are immiscible with silicate melts and may separate and sink below the silicate-rich part of the intrusion or be injected into the rock surrounding it, e.g. sulphide ores containing copper, nickel or platinum.
Pegmatites: Pegmatites formed by the crystallisation of late stage aqueous magmas. Very coarse grained.
Hydrothermal veins: The movement of heated waters within the crust, often as a consequence of magma intrusion or tectonic activity. Sources of hydrothermal solutions include seawater and groundwater circulating through fractured rock.

Ores can be formed by sedimentary and metamorphic processes (e.g. placer deposits, residual ores etc). Examples.

25 marks

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4. *Evaluate the importance of geophysical techniques in prospecting for mineral and energy resources.*

Gravity Surveys, seismic surveys, magnetic surveys & electrical surveys

Can use them to search a wide area often remotely (gravity & magnetic).
Can find deposits that don't have a surface outcrop/deeply buried.
Can narrow areas for further investigation.
Very useful for finding metals (particularly gravity/magnetic) and petroleum (seismic survey).
Can be used to determine structure and extent of deposit.
Only finds deposits where there is a physical contrast with surrounding rocks.
Cannot be used to determine grade of mineral deposit – more detailed work such as mapping and drilling required.
Cannot prove the occurrence of oil or gas, only structures in which it may have accumulated. Well log data is important once a hole has been drilled.

Credit examples given.

25 marks

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Theme 3 – Geological Evolution of Britain

Section A

1. (a) (i) medium to coarse grained (1) moderately well/poorly sorted (1)
sub-rounded (1) non-interlocking (1) [3]

(ii) Environment: shallow water / marine / fluvial
Reasons: current bedding / moderately well sorted sand etc [3]

(b) (i) (worm) burrows / roots / rootlets [1]

(ii) perpendicular to bedding / vertical / deflect bedding (1)
oval / circular cross-section (1)
quantitative (1) [2]

(c) (i) brecciation (1)
of limestone due to fault movement (1) (+ 1 for discussion)
low-angle / horizontal (1)
foliation of the rock above the contact (1)
metamorphic above sedimentary (1)
dip to E so strike N-S (1) [3]

(ii) Holistic
Strike unlikely for Alpine / location too far N / Alpine structures more evident towards SE / metamorphism / false evaluation [3]

15 marks

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2. *(a)* *With reference to examples from the British stratigraphical column, explain how sedimentary rocks and their contained fossils may be used to distinguish shallow water marine from deep water marine environments.*

(b) *Evaluate the reliability of the evidence.*

(a) Examples: Devonian; Carboniferous; Triassic etc. or field localities
Rocks : Clastic. Conglomerates, sandstones, shales.
Textures. Compositions. Structures (current bedding ripples etc)
Bed dimensions.
Plants and bivalves. Rare reptiles and insects.

(b) Evaluation: Cross-bedding. Fluvio-deltaic versus dune bedding.
Arkosic sandstone interpretations.
Black / grey shales and their interpretation.
Fossil preservation.
Non-marine bivalves.
Plants washed out to sea / derived?

25 marks

3. *(a)* *Describe the rocks and fossils of the Carboniferous which suggest that they were formed in*

- *tropical,*
- *shallow marine and*
- *terrestrial environments.*

(b) *Evaluate whether changes in climate through time are an accurate reflection of changes in latitude.*

(a) Tropical: limestones, corals, coals
Marine: limestones, corals, brachiopods, crinoids
Terrestrial: coals, seat earths, plant fossils, non-marine bivalves

(b) Climate changes with latitude but other factors to consider.
Continent distribution. Sea level. Solar activity. Ice cover. Volcanic activity etc.

25 marks

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4. *Describe and evaluate the evidence from a named orogenic belt that may be used to reconstruct the plate tectonic regime on which it developed.*

Choice of 3 orogenies

Caledonian:

NE–SW trend
Rock types
Metamorphic (high grade regional metamorphism in Scotland, lower grade in Lake District and Wales)
Sedimentary (shallow and deep water facies)
Igneous (ophiolites and plutonic)

Fossils (shallow and deep water / different species)

Structures
Thrusting along the NW margin of the fold belt to form the Moine Thrust
Early phases of deformation produced large scale folds and nappes
Formation of major faults in Scotland such as Highland Boundary Fault (normal/reverse fault), Great Glen fault (tear fault)
Related to closure of Iapetus Ocean

Variscan:

Variscan Effect mainly on Devonian and Carboniferous rocks approx 300 Ma
Large batholith in Cornwall with associated mineralisation
Whin sill
Tight, vertical even overturned folds with E–W trend
Underthrusting along the Lizard Thrust zone and intrusion of ophiolites
North of main belt deformation less intense
Trends in all directions e.g. Pennine Anticline
New movement on older Caledonian structures
Preservation of coalfields in synclinal basins
Problems of relating to plate tectonic setting

Alpine:

E–W trend, SE Britain no metamorphism or igneous rocks and (younger) fossils
Mesozoic and Cenozoic rocks folded and faulted
Weald, Hampshire and Isle of Wight, Jurassic Coast
Collision of African and Eurasian plates with closure of the Tethys Ocean
Britain 1000 km from collision zone

25 marks

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Theme 4 – Geology of the Lithosphere

Section A

1. (a) (i) 20.5-21.5% (1)

0.5-1.5% (1) [2]

(ii) corresponds to orogenic mountain belts; geographically restricted to plate boundaries; rapidly eroded; not in isostatic equilibrium [3]

(b) (i) (8850 × 2700) / (3300 – 2700) = 39800 m (39 to 40 km) [3]

(ii) (answer to (b)(i)) + 40 + 8.85 ≈ 90 km [2]

(c) (i) Metamorphism / temperature / pressure at base of crust to high density eclogite
Dense root to mountain detaches from crust
Sinks into less dense asthenosphere
Less dense asthenosphere rises to fill place of detached root
Quantitative [3]

(ii) Weight removed from (bottom of) crust
Density of remaining crust dramatically reduced
Remaining crust now "floating" on asthenosphere
(Rapid) isostatic adjustment
Crust more buoyant
Quantitative [2]

15 marks

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Section B

2. *Describe and evaluate the factors that influence the composition of the magmas formed at*
   - *constructive plate boundaries and*
   - *destructive (island arc and cordilleran) plate boundaries.*

Description: Primary magma formation at CPM due to decompressional partial melting; of rising mantle 'peridotite'; convection; to form mafic magma; correct minerals or silica contents; solidus-geotherm graphs.
At DPM dehydrational partial melting; role of water at subduction zone; island arc (ocean-ocean) magmatism-partial melting of mafic oceanic crust to form Intermediate magma; cordilleran (ocean-continent) magmatism-partial melting of mafic oceanic crust to form intermediate magma; partial melting of base of continental crust to form silicic magma; correct minerals or silica contents; solidus-geotherm graphs.

Evaluation: Dominance of primary magmas; however role of differentiation and contamination for localised secondary magmas; differentiation: references to Bowen's reaction series; removal of more mafic components; lavas enriched in silicic components; evolved lavas more Si, Na rich; more likely in areas of thicker continental crust; dependence on cooling rate; need for distinct density contrasts for gravity settling. Contamination: xenoliths and assimilation; mineralogical/chemical contrast between magma type and country rock; dependence on thickness of crust and rate of cooling.

25 marks

3. *Describe and evaluate the role that seismology has played in determining the*
   - *structure and*
   - *composition of the lithosphere.*

Description: Structure: Identification of lithosphere / asthenosphere boundary; LVZ; P-S wave velocity curves; ray path modelling; refraction; identification of Moho; reflection data; oceanic crust layering.

Evaluation: Good for large scale structures; decrease in data quality with depth; better in areas with 'simple' geology i.e. oceanic v continental layering.
Composition: Limited direct information. Can yield information on density, rigidity, incompressibility etc. Indirect data needs to be compared with surface mapping; ocean drilling; boreholes; ophiolites; experimental petrology.

25 marks

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4. *(a) Describe and explain the pattern of surface heat flow across*
- *an active spreading centre and*
- *an active ocean-continent subduction zone.*

(b) Evaluate the role that temperature has on the type of deformation a rock experiences.

(a) Description
Active spreading centre. High heat flow over ridge; non-linear decrease to abyssal plain; sketch graph; thinned lithosphere; convection; closely spaced isotherms; isotherms become more widely spaced beneath abyssal plain; heat loss by conduction as lithosphere thickens

Ocean-continent subduction zone. Low heat flow over trench; oldest part of ocean lithosphere; conduction; widely spaced isotherms; depressed & 'inverted' isotherms; high heat flow over cordillera; volcanism/magmatism; 'high' concentrations of radiogenic isotopes; slight elevation of isotherms over volcanic arc; sketch graph & sketch cross-section

(b) Evaluation
Temperature effect on type of deformation: 'cold' = brittle = faults; 'hot' = ductile = folds; discussion of strain & stress-strain plots
Other factors. Confining pressure and rate of deformation; lithology competent v incompetent; type of stress.

25 marks

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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.

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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 - Rehash at best - irrelevant material/no essay to mark/mark per point?

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