GCE MARKING SCHEME

GEOLOGY
AS/Advanced

SUMMER 2012

INTRODUCTION

The marking schemes which follow were those used by WJEC for the Summer 2012 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.

GL1

Q.1 (a) (i) X = Cephalon (1) [2]
Y = Pygidium (1)

(ii) Limestone (1) [1]

(b) Description
Marine (1) [3]
Shallow (1)
High energy (1)
Warm/tropical (1)

Reasons
Brachiopods and/or trilobites were marine organisms (1)
Brachiopods live in shallow water (1)
Fragmented fossils indicates high energy (1)
Limestone/$CaCO_3$ indicates warm temperature (1)
Limestone/$CaCO_3$ indicates marine (1)

For 3 marks must have at least one description and one reason

(c) Credit can be awarded for recognition of factors indicating life or death assemblage

Not a life assemblage because: [3]
Explicit definition of a life or death assemblage
e.g. indicates they are preserved in life position/not transported etc.
have been transported from life position (1)

Stated evidence for movement:
e.g. fossils fragmented (1)
groups which did not live together found together (1)
Indicates they have been moved/ not in life position etc. (1)

Or

Yes a life assemblage because:
Explicit definition of a life assemblage
e.g indicates they are preserved in life position/not transported etc. (1)

Stated evidence for a lack of movement:
e.g. fossils not fragmented/complete/well preserved (1)
fossils not orientated (1)
Indicates that they have not been moved from life position (1)

(d) (i) Time zone 3 (1) [2]
This is the only time that both **A** and **C** exist (1)

(ii) Time zone 4 (1) **R** [3]

B is the derived fossil (1)
Correct explanation of how **B** is incorporated into time zone 4 (1)
e.g. **B** eroded out of earlier rock (time zone 1) or re-deposited later (time zone 4) (1)

D could not be older than time zone 4 (1)

14 marks

Q.2 (a) (i) E at point at which P- and S-waves originate on Fig 2a (1) [1]

(ii) S-waves cannot pass through liquid (1) [2]
Outer core liquid (1)
(S-waves cannot pass through liquid outer core = 2)

(b) (i) P S Surface (2) [2]

3 correct = 2 marks
1 (or 2) correct = 1 mark

(ii) They travel at different velocities or equivalent (1) [2]
They travel along different paths
e.g. body waves within the Earth, surface waves over the surface (1)
Reference to the different nature of wave transmission
e.g. P-waves compressive but S-waves shear (1)

(iii) Located within 0-103° of epicentre (1) [2]

All three (or P- and S-) are recorded/not in a shadow zone (1)

(c) (i) Travel time = 10 minutes or 600 s (1) [3]

Distance / time calculation i.e. 6600/ time (1)

11 km s^{-1} (1)

(ii) P-wave **R** (1) [3]

Credit correct reference to shadow zone pattern
e.g. they do occur beyond 103° /reappear at 142° (1)

Credit why not surface waves
e.g. surface waves do not have shadow zones (1)

Credit why not S-waves
e.g. S-waves would not show reappearance within the shadow zone (1)

Credit reference to these velocities/travel times are those of P-waves (1)

(iii) Surface (1) [2]
It is in the shadow zone (1)
Because surface not affected by shadow zones (1)
(or equivalent e.g. not reflected or refracted by the core because they do not pass through it)

17 marks

Q.3 (a) (i) 1 mark for each correct response [3]

Strike	• *N-S (or N or S) or 000-180° (or 000° or 180°)*
Angle of dip	• *63° (accept 50-75°)*
Direction of dip	• *East or 090°*

(ii) Dyke **R** (1) [3]
Discordant or equivalent **R** (1)
Sheet like body or equivalent (1)
Small-scale/minor/1.5 m wide (1)
(max 3)

(b) Not true because:
Yes, formed along a fault or yes, because beds are displaced (1) [3]
but reverse fault (1)
footwall moved down/hanging wall up/fault dips to upthrow side (1)

(c) (i) Younger on top of older (1) [3]
Unless rocks overturned (1)
Correct example using sedimentary rocks in Fig 3
e.g. conglomerate **younger** than sandstone/limestone **younger** than conglomerate or sandstone (1)

(ii) Fragments are older than the rock [2]
they are contained in, or equivalent (1)
Mafic fragments in conglomerate **R** (1)
are older than conglomerate (1)

(iii) Older **R** (1) [3]
Igneous body A^2 is same age/offshoot of A^1 (1)
Igneous body A^1 cuts through conglomerate (1)
Conglomerate older than igneous bodies (1)

Conglomerate deposited before faulting but A^1 and A^2 after faulting (2)

17 marks

Q.4	(a)	(i)	Mineral vein or <u>hydrothermal</u> vein (1)	[1]
		(ii)	Quartz (1) Fluorite (1)	[2]
	(b)	(i)	Unconsolidated sediment/sediment/sand/mud **R** deposited on top of mud (1) Denser sand slumped into mud (1) Mud squeezes up into sand (1) De-watering (1) (max 2)	[2]
		(ii)	Anticline has older beds in core/middle (1) Load cast down/flame structures up (1) Beds right way up (or recognition of this) (1) “Slate” therefore older than “metaquartzite” (1) Not an overturned syncline (1) (max 3)	[3]
	(c)	Description Regional metamorphism (1) Temperature and directed pressure (1) Low grade or equivalent or low temperature-high pressure (1) Reasons Slate is regional metamorphic rock (1) Closely spaced planes/cleavage planes/foliation/alignment indicate directed pressure **R** (1) Slate is a low grade metamorphic rock r (1)		[4]

12 marks

WJEC
May 2012

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 this 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.
- ® is a reserved mark which must be given for full marks.

- **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 equals one mark.**
- **Write the total in the margin close to the brackets at the end of each part-question.**
- **Do not exceed the total for each part-question and do not re-distribute marks between sections.**
- **Write the question total in a circle in the margin 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

Note: there is a new e-mail address this year gl2a@wjec.co.uk

Craig Wall
Principal Moderator

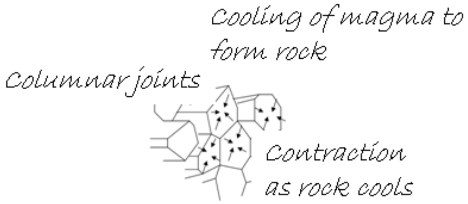
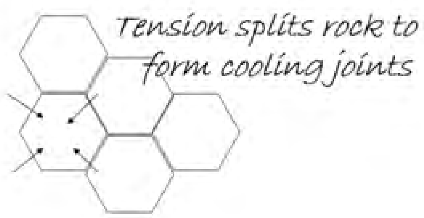
GCE AS Geology

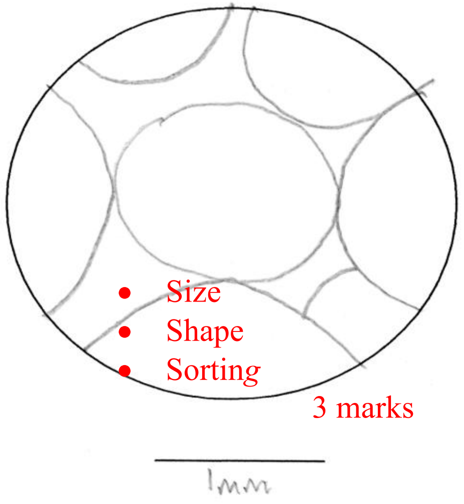
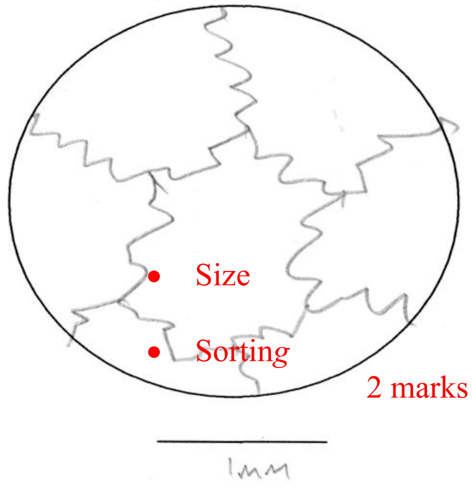
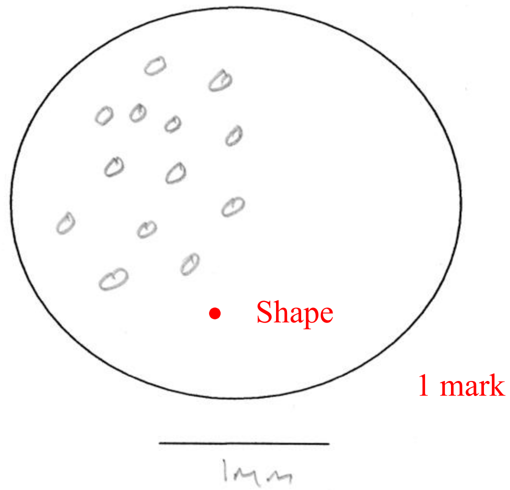
GL2a (1212/01) Specimens 2012

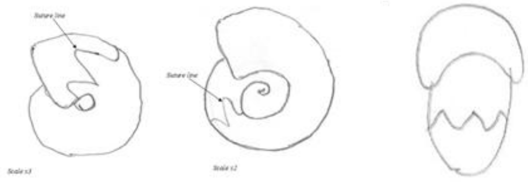
Specimen B	Specimen C	Specimen D
		
dolerite	sandstone	goniatite

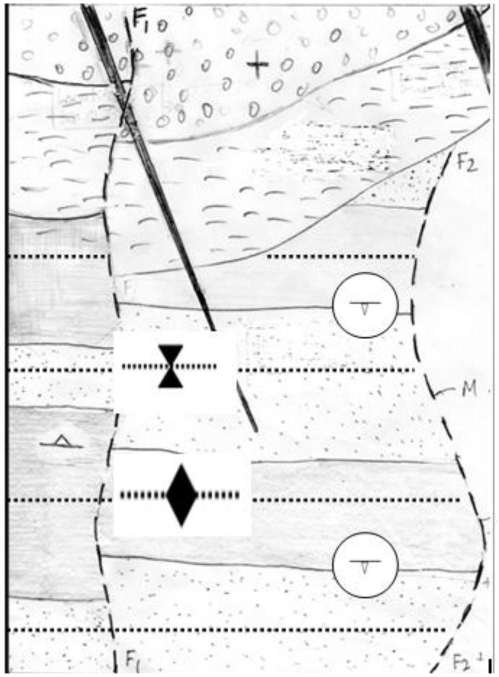
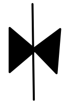
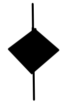
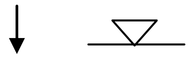
Q	Marks	Expected Answer	Acceptable Answer	Do Not Accept
1(a)(i)	1	• *Metamorphic aureole*	• *Large-scale intrusion* • *Discordant intrusion*	**Evidence not shown on Map 1 e.g. textural, xenoliths, off-shoots/veins**
(ii)	1	• *Coarse crystals*	• *Xenoliths* • *Off-shoots/veins* • *Chilled margin* If these are not credited in part (a)(i) • *Metamorphic aureole* • *Large-scale intrusion* • *Discordant intrusion*	If these are credited in part (a)(i) • *Metamorphic aureole* • *Large-scale intrusion* • *Discordant intrusion*
(b)(i)	1	• *Plagioclase (feldspar)*		• *Orthoclase feldspar/feldspar*
(ii)	1	**The explanation is only marked if the evaluation is correct.** Evaluation • *False* Explanation • The two cleavages are 60/120	Explanation • The two cleavages are not 90/90	**The explanation of the evidence if the evaluation is incorrect.**
(c)(i)	1	• *15 mm*	• *10 – 20 mm*	
(ii)	1	**The explanation is only marked if the evaluation is correct.** Evaluation • *False* Explanation • *Rock Unit A, granite and peridotite are all coarse grained plutonic rocks (so it is impossible to separate them on crystal size alone)*	• *Granite and/or peridotite are coarse grained*	**The explanation of the evidence if the evaluation is incorrect.** **Must mention granite and/or peridotite; no credit if only Rock Unit A is discussed**
(d)(i)	1	**Must give two values which total 100%** • ***Mineral S*** *80-60%* • ***Mineral T*** *20-40%*		**If the two values do not total 100% or outside these acceptable ranges**

Q	Marks	Expected Answer	Acceptable Answer	Do Not Accept
(ii)	✓ 1	**The explanation is only marked if the evaluation is correct.** Evaluation • *True* Explanation *(Rock Unit A is not granite)* • *because it doesn't contain (at least 10%) quartz*	**The explanation is only marked if the evaluation is correct.** Evaluation • *True* Explanation • *(Rock Unit A is not granite) because it contains too much (more than 30%) Fe-Mg/mafic mineral* *or* • *(Rock Unit A is not granite) because it is not silicic*	**The explanation of the evidence if the evaluation is incorrect.** Evaluation • *False* Explanation *(Rock Unit A is granite)* • *because it contains quartz* *or* • *because it contains a low % Fe-Mg*
	✓ 1	**The explanation is only marked if the evaluation is correct.** Evaluation • *True* Explanation *(Rock Unit A is not peridotite)* • *because it doesn't contain enough (at least 90%)* ***Fe-Mg/mafic/dark mineral***	**The explanation is only marked if the evaluation is correct.** Evaluation • *True* Explanation *(Rock Unit A is not peridotite)* • *because it doesn't contain enough augite/olivine* *or* • *because it is not ultramafic* *or* • *because it contains hornblende/Mineral T (and not augite/olivine)*	**The explanation of the evidence if the evaluation is incorrect.** Evaluation • *True* Explanation *(Rock Unit A is not peridotite)* • *because it doesn't contain any quartz* *or* • *because it contains feldspar*
(e)(i)	✓ ✓® ✓® 3	Name • *Dolerite* Evidence • *(Texture) medium crystal size (1-5 mm)* Evidence • *(Composition) medium/dark colour*	Evidence • *(Composition) it is mafic* *or* • *"Feels heavy"/Hefting*	Evidence • *(Texture) "crystalline"*

Q	Marks	Expected Answer	Acceptable Answer	Do Not Accept
(ii)	✓ ✓ ® ✓ 3	Name • *Columnar joints* Formation • *Cooling (of magma to form solid, but hot, rock)* *and* • *Contraction (causes joints to develop under tension/arrows point inwards)* *or* • *Joints form at right angles to edge of intrusion (horizontal columns in a vertical dyke)*  • name • cooling of magma • contraction 3 marks	Name • *Cooling (joints) – but only if "cooling" is not credited in the formation section.*  • name • contraction 2 marks	Name • *Joint* *or* • *Cooling (joints) – if "cooling" is credited in the formation section.* Formation • *Contraction (causes joints to develop under extension/arrows point outwards)*
(iii)	✓ ✓ ✓ 3	• *It is younger than the country rock* • *It is a dyke* • *It is formed where there is crustal tension*		**If more boxes are ticked, deduct 1 mark for each box which is wrongly chosen to a minimum of 0.**
	Total 18			

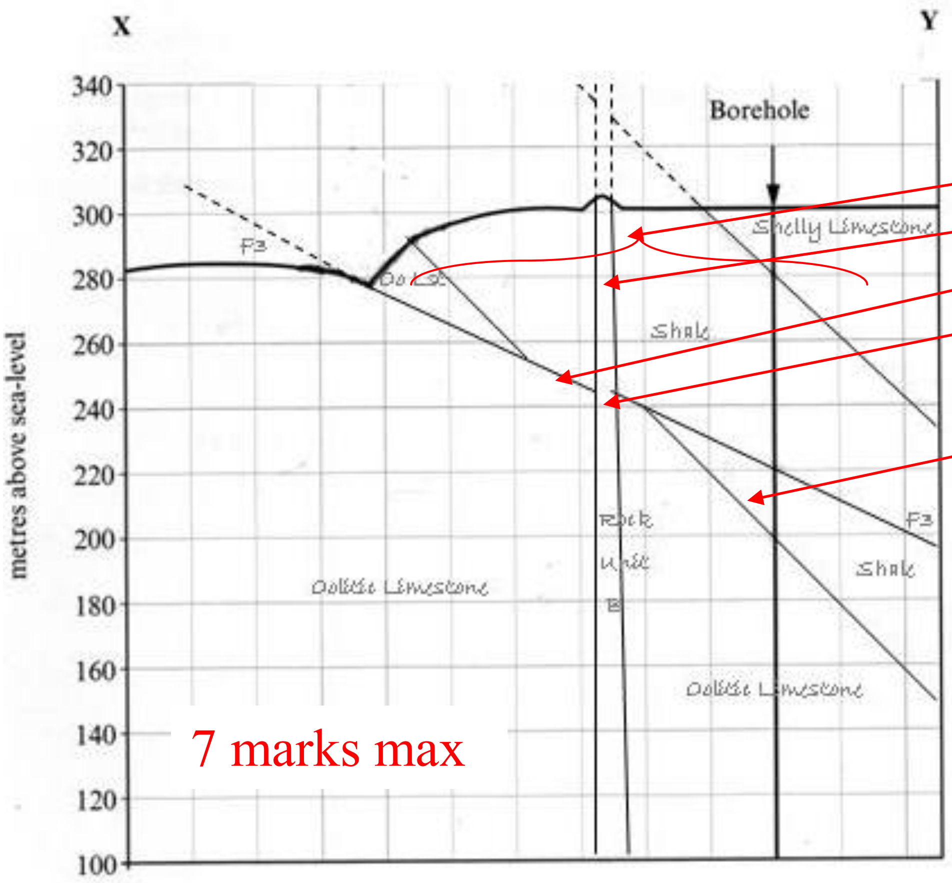
Q	Marks	Expected Answer	Acceptable Answer	Do Not Accept
2(a)	3	Drawing to show • Size: *1mm average, drawn to scale* • Shape: *Rounded grains, mostly in contact* • Sorting*: Good, no matrix*	**You may have to adjust depending on your centre's specimens.** • *Size: 0.25 – 2mm* • *Shape: there may be some angular feldspar in some specimens.*	
				
(b)	2	Name • *Quartz* Test/observation • *Vitreous lustre* • *Colourless (beneath red stain)* • *No cleavage* • *Frosted grains (indicate fracture)*	Name • *Haematite or feldspar – 0 marks* Test/observation (if one of above mineral named) • *Colour – 1 mark*	Test/observation (if quartz is correctly named) • *Hardness test/ Acid test*
(c)	2	Process • *Contact Metamorphism* Explanation • *Heat (from Rock Unit B/intrusion)*	Explanation • *Proximity to heat source (intrusion)/high temp and low pressure* • *Contact met (if not credited as process)*	Process • *RegionalMet/ Metamorphism* Explanation • *Any reference to high pressure/heat and high*
	Total 7			

Q	Marks	Expected Answer	Acceptable Answer	Do Not Accept
3(a)	4	**The detail depends upon which of the two specimens were sent from the board, but the following applies to either.** **A side view is expected (as on Photograph 4)** Scale • *Use of e.g. x1, x2* • *Use of a scale bar* • *Use of dimensions (labelled arrows)* *10 mm* Shape • *Width and height in proportion* • *Correct number/overlap of whorls* Suture line • *Drawn and labelled*	**If any other view is drawn, scale, proportion and suture line can be credited to max 3**  4 marks 4 marks 1 mark (no label/scale) Aperture can be at the side/bottom, etc.	
(b)	1	**Both must be correct for the mark** Specimen D • *Number 4* Photograph 4 • *Number 3*		**Only one correct 0 mark**
(c)	2	Name of Specimen D • *Goniatite* Era • *Late/Upper Palaeozoic*	Name of Specimen D • *Ammonoid* Era • *Palaeozoic*	Name of Specimen D • *Ammonite/cephalopod* Era • *Period names*
	Total 7			

Q	Marks	Expected Answer	Acceptable Answer	Do Not Accept
4(a) (i) (ii)	dips ✓ ✓ 2 axes ✓ ✓ 2		**Labels or alternative symbols** •  • *Syncline/synform or*  • *Anticline/antiform or*  • 	
(iii)	✓ 1	Wavelength • *250 m*		
(b)	✓ ✓ ✓ 3	Estimated dip Fault F1 • *70-80* Hanging wall Fault F2 has moved • *Upwards* Type of Fault F1 • *Reverse*	Estimated dip Fault F1 • *>20 but <90*	Type of Fault F1 *Thrust*
	Total 8			

Q	Marks	Expected Answer	Acceptable Answer	Do Not Accept
5(a)	see below max 7	*Candidates are asked to draw, but if they use the borehole data correctly, this is essentially a construction. The mark scheme allows for some variations (i.e. "sketching") in dips/positions of beds if borehole isn't used.*	• *Any dip <89º to Y (east) for unit/fault if borehole not used* • *dyke >80º* • *Arrows on Fault F3 (reversed mvt)if footwall hasn't oolitic lst/shale junction drawn* *(pages 10 & 11 give acceptable variations)*	• *Any dip <89º to X (west) for any sedimentary unit/fault* • *vertical dip for any sedimentary unit/fault* • *dyke <80º*

Expected answer:



Hanging wall of fault

- Draw all 3 beds dipping east ✓
- Draw vertical dyke ✓
- Draw F3 dipping east from its surface outcrop ✓
- Fault cross-cut by dyke ✓

Footwall of fault

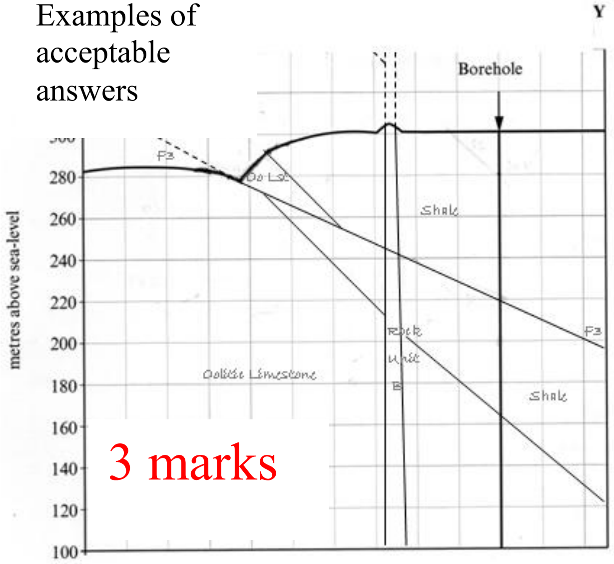
- Oolitic lst /shale dipping east (showing fault displacement) ✓
  or
- arrows showing reversed movement on F3

Use of borehole

- Shale/shelly lst boundary at 280m above sea-level
- Fault F3 at 220m above sea-level
- Shale/oolitic limestone boundary at 200m above sea-level

all 3 correct ✓✓
(*any 1 or 2 correct* ✓)

Examples of acceptable answers



Hanging wall of fault

- Draw all 3 beds dipping east
- Draw vertical dyke ✓
- Draw F3 dipping east from its surface outcrop ✓
- Fault cross-cut by dyke

Footwall of fault

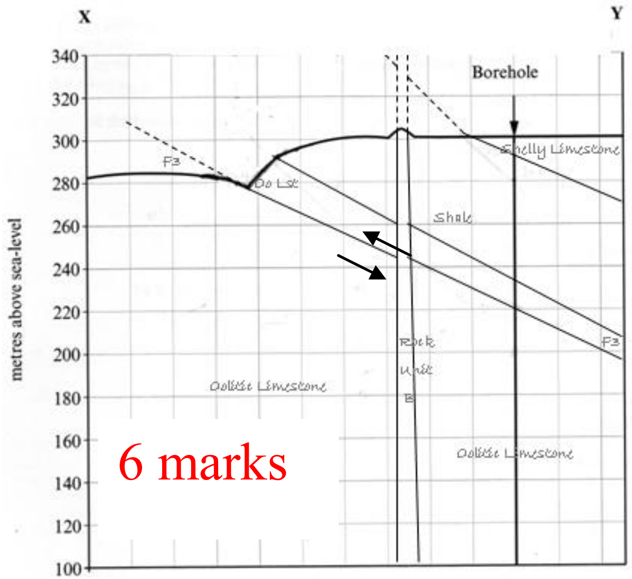
- Oolitic lst /shale dipping east (showing fault displacement) or
- arrows showing reversed movement on F3

Use of borehole

- Shale/shelly lst boundary at 280m above sea-level
- Fault F3 at 220m above sea-level
- Shale/oolitic limestone boundary at 200m above sea-level

all 3 correct

(any 1 or 2 correct ✓)



Hanging wall of fault

- Draw all 3 beds dipping east ✓
- Draw vertical dyke ✓
- Draw F3 dipping east from its surface outcrop ✓
- Fault cross-cut by dyke ✓

Footwall of fault

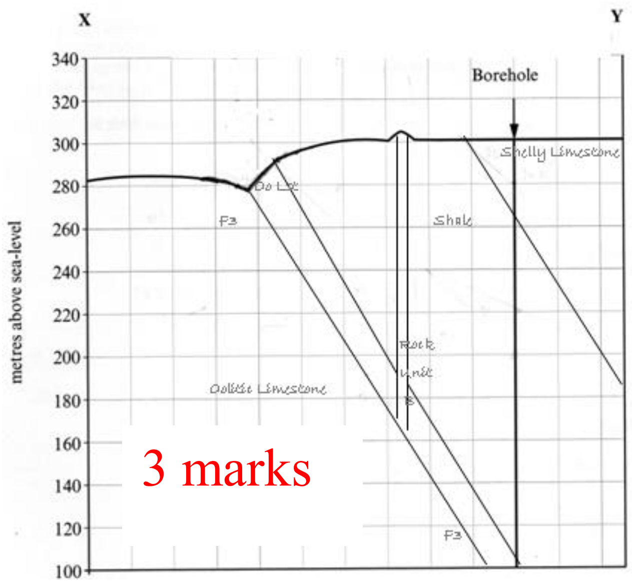
- Oolitic lst /shale dipping east (showing fault displacement) or
- arrows showing reversed movement on F3 ✓

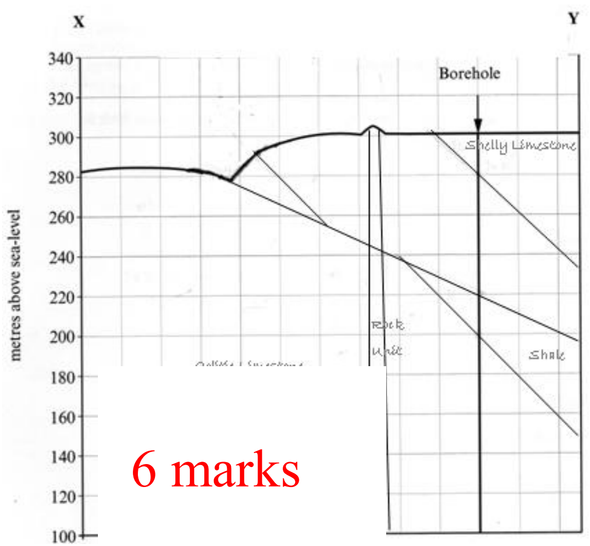
Use of borehole

- Shale/shelly lst boundary at 280m above sea-level
- Fault F3 at 220m above sea-level
- Shale/oolitic limestone boundary at 200m above sea-level

all 3 correct

(any 1 or 2 correct ✓)





Hanging wall of fault

- Draw all 3 beds dipping east ✓
- Draw vertical dyke ✓
- Draw F3 dipping east from its surface outcrop ✓
- Fault cross-cut by dyke

Footwall of fault

- Oolitic lst /shale dipping east (showing fault displacement)
  or
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- Shale/shelly lst boundary at 280m above sea-level
- Fault F3 at 220m above sea-level
- Shale/oolitic limestone boundary at 200m above sea-level

all 3 correct
(any 1 or 2 correct)

Hanging wall of fault

- Draw all 3 beds dipping east ✓
- Draw vertical dyke ✓
- Draw F3 dipping east from its surface outcrop ✓
- Fault cross-cut by dyke

Footwall of fault

- Oolitic lst /shale dipping east (showing fault displacement) ✓
  or
- arrows showing reversed movement on F3

Use of borehole

- Shale/shelly lst boundary at 280m above sea-level
- Fault F3 at 220m above sea-level
- Shale/oolitic limestone boundary at 200m above sea-level

all 3 correct ✓✓
(any 1 or 2 correct)

Q	Marks	Expected Answer	Acceptable Answer	Do Not Accept
5b	see below max 7	*The mark scheme allows for some variations*	*(pages 13 & 14 give acceptable variations)*	
	Total 14			

YOUNGEST

← **Fault F1**

← *intrusion of Rock Unit B* ✓

D

G

- D/G relative age correct ✓
- D or G younger than folding and uncon and F2 ✓

← *Unconformity*

← *Fault F2*

← Folding

- Uncon/fault relative age correct ✓
- Uncon/fault younger than folding ✓

C

E

- C/E relative age correct ✓
- C or E older than folding and uncon and F2 ✓

← Intrusion of **Rock Unit A**

7 marks max

OLDEST

F

Examples of acceptable answers

YOUNGEST

Fault F1

Intrusion of Rock Unit B ✓

G

- D/G relative age correct
- D or G younger than folding and uncon and F2 ✓

D

Fault F2

Folding

Unconformity

- Uncon/fault relative age correct
- Uncon/fault younger than folding

C

- C/E relative age correct ✓
- C or E older than folding and uncon and F2 ✓

E

4 marks

Intrusion of Rock Unit A

OLDEST

F

YOUNGEST

Intrusion of Rock Unit B

Fault F1

Fault F2

Unconformity

- Uncon/fault relative age correct
- Uncon/fault younger than folding ✓

D

G

- D/G relative age correct ✓
- D or G younger than folding and uncon and F2

Folding

E

- C/E relative age correct
- C or E older than folding and uncon and F2 ✓

C

Intrusion of Rock Unit A

3 marks

OLDEST

F

YOUNGEST

← *Intrusion of Rock Unit B*

← **Fault F1**

C

- C/E relative age correct ✓
- C or E older than folding and uncon and F2

E

← Folding

← *Unconformity*

← *Fault F2*

- Uncon/fault relative age correct ✓
- Uncon/fault younger than folding

G

- D/G relative age correct
- D or G younger than folding and uncon and F2

D

← Intrusion of **Rock Unit A**

2 marks

OLDEST

F

YOUNGEST

← **Fault F1**

← *Intrusion of Rock Unit B* ✓

E

- D/G relative age correct
- D or G younger than folding and uncon and F2 ✓

D

← *Fault F2*

← Folding

- Uncon/fault relative age correct
- Uncon/fault younger than folding

C

- C/E relative age correct
- C or E older than folding and uncon and F2

G

← *unconformity*

← Intrusion of **Rock Unit A**

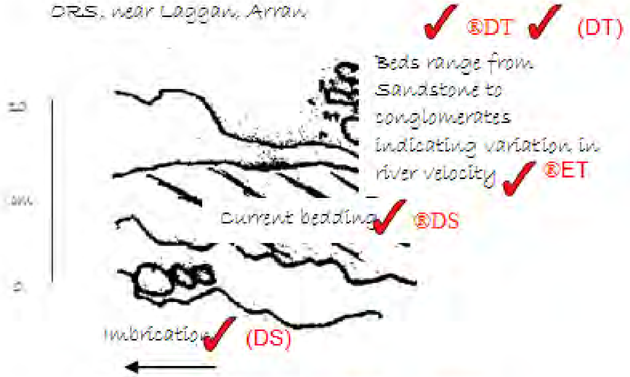
2 marks

OLDEST

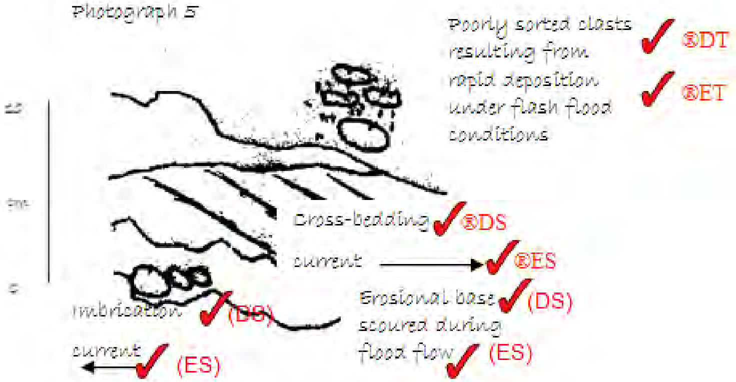
F

Q	Marks	Expected Answer	Acceptable Answer	Do Not Accept
6	✓ ®DS ✓ ®DT ✓ ®ES ✓ ®ET plus any other 2	**A wide range of responses is expected, but full credit may only be given to answers which relate to one, or more, of the following:** **Fieldwork observations of one rock outcrop/locality:** • *written description* • *annotated sketch* **Fieldwork observations of a modern fluvial environment:** • *written description* • *annotated sketch* **Photograph 5:** • *written description* • *annotated sketch* **Full marks can only be given to answers which address the description and evidence of a minimum of one structure and one texture i.e. contain all 4 reserved marks** **Marks to be awarded for:** • *describing (text and/or annotated sketch) structure and texture* (max 4) Structure - cross-beds, mud cracks, asymmetrical ripples Texture - size, shape and sorting of clasts • *how these provide evidence of "fluvial"* (max 4)	**Limited credit may be given to answers which fail to relate to fieldwork or Photograph 5.** Only award the reserved marks (DS), (DT), (ES) or (ET) to max 4 **Limited credit may be given to answers which fail to address description and evidence of structure and texture.** For each of (DS), (DT), (ES) or (ET) reserved marks not awarded, deduct 1 from question total to max 3-5 Structure - channels, erosional bases imbrication, flames Texture - fining-up sequences/ "grading" of bedding	**Modern organic remains or Fossils** **Pro-Delta or delta front environments** **A fieldwork locality name, or reference to Photograph 5, as evidence for (DS) or (DT) marks without any written description/ annotated sketch** **Not flute casts**
	Total 6			

fieldwork reference ok; structures not labelled 3 marks



fieldwork reference ok; no ®ES 5 marks



photograph ref ok 6 marks max

no fieldwork reference

insufficient (visual) proof of photograph

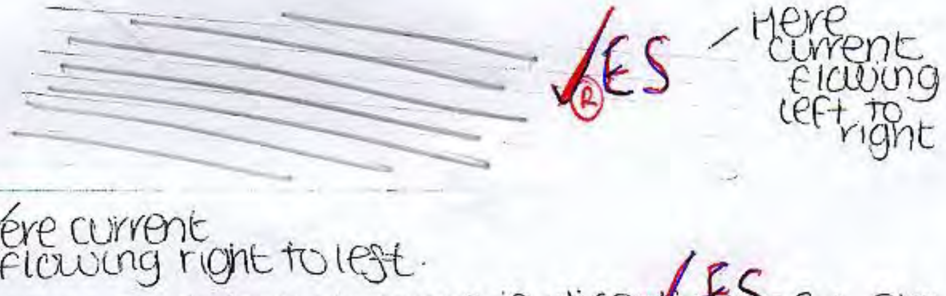
Can only award reserved marks 2 marks

Structures and textures such as graded bedding and rock shapes and sorting, can provide evidence for a fluvial environment. (R) DT ✓ ✓ ET

Rocks would be more rounded (R) If they were in a high energy fluvial environments.

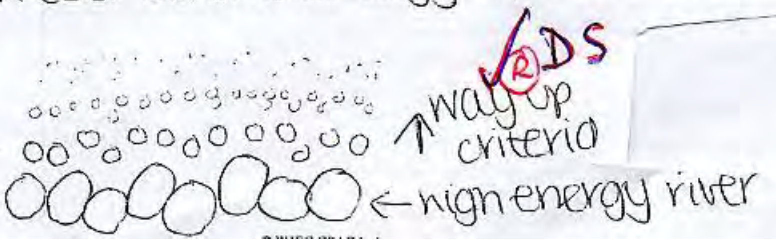
(High energy) rounded - OOOOO   OOOO - sub rounded.

Structures such as cross bedding, can determine ✓ DS the way in which the current was flowing



This shows us the change in direction ✓ ES of a flow (could be a meandering river).

other structures such as graded bedding can tell us the energy of the river



[Total 6 marks]

No reference to fieldwork or Photograph 5 so only the reserved marks (DS), (DT), (ES) or (ET) to max 4

4 marks

GL3

Question 1

(a) Centred on Pozzuoli (1) [1]

(b) (i)

[3]

Time period	Lowest reading (mm)	Highest reading (mm)	Maximum uplift (mm) between 1970 and 1995
January 1970 to January 1982	**800**	• 1600(±50) (1)	• 2200 (1)
January 1982 to January 1995	• 1300(±50) (1)	**3000**	

(ii) ~1700/1095 = ~1.55 mm day^{-1} (accept 1.5-1.6) [2]
(1) (1)

(c) (i) Rise from 1970-1972 followed by a decline to 1982 (1)
Rapid rise between 1983-1985 then a rapid decline (1)
Use of numbers (250/mth in 1972 v 1200/mth in 1984) (1)
Or qualitative description (1)
(max 2 marks) [2]

(ii) Very good correlation (1)
Uplift leads to earthquakes (1)
High activity – uplift (1)
Moderate activity (plateau) (1)
Low activity – sinking (1)
Quantitative
(max 2 marks) [2]

(d) Holistic
Rising magma/pressure (**R**) indicated by
Earthquakes
Land uplift } Linked to volcanic eruption (non-specific)
Shape of uplift - circular
Previous eruptions indicated
(max 3 marks) [3]

Total 13 marks

Question 2

(a) (i) Any two of:
Measures magnitude/energy released (1)
Logarithmic scale (no limit) (1)
10 times amplitude per point (1)
30 times energy per point (1)
(max 2 marks) [2]

(ii) Mark *F on the fault line and below Bam only (1) [1]

(iii) Three of the following explained:
- shallow – greater intensity
- Bam was epicentre – greater intensity
- adobe – weak buildings
- heavy roofs – too heavy to be supported
- early morning – people in bed/unprepared
- lake sediments - amplification/liquefaction
- built on unconsolidated sediments - unstable

(1 mark for each explanation of evidence) [3]

(b) (i) Two from the following:
- permeable
- porous
- coarse-grained
- uncemented
- sub-rounded
- moderately sorted [2]

(c) (i) Antiform/anticline/upfold/monocline (1) [1]

(ii) Holistic **NB**
R Folding produces a basin structure (syncline) for collection of water
Permeable rock above - aquifer
Impermeable rock (aquiclude) below
Perched water table, unconfined aquifer
(Any developed plus **R** for 3, max 3 marks) [3]

Total 12 marks

Question 3

Using one or more case studies;

(a) *describe the volcanic hazards associated with pyroclastic flows.*

Pyroclastic flow (Nuees ardentes) - Rapid flow of hot gas/debris
Rapid - 100kmhr^{-1}
Hot - 800°C
Silent, frictionless, turbid flow
Little warning
Moves over water as well as land
Examples: Pinatubo, Herculaneum, St. Pierre, Monserrat, etc
Caused over 70% of volcanic deaths this century
Credit diagrams
Fully accept Lahars (sometimes classified as a type of pyroclastic flow)
(no case study – max 8) [10]

(b) *explain the difference in the hazards typically associated with the eruption of*
(i) basaltic and
(ii) andesitic magmas

Different magmas have different characteristics that affect viscosity
Nature of hazard depends upon composition, viscosity and gas content

(i) Basaltic - mafic and non-viscous
- gas readily escapes – not explosive (red volcanoes)
- less ash – localised hazard
- fluid lava main hazard - fast moving (initially few kmhr^{-1})
- fire fountains
- flows further - more hazard to property on lower slopes
- hotter initially (1000°C)

Examples: Nyirongongo, Iceland, Hawaii, Nyos, Columbia, etc.

(ii) Andesitic – intermediate and viscous magma
- gas does not easily escape – explosive (grey volcanoes)
- bombs
- blast hazard
- much ash/bombs – worldwide effect
- pyroclastic flows
- lava slow moving (10's m hr^{-1} to few m day^{-1})
- associated with lahars
- tsunamis
- landsides

Examples: Pinatubo, Mt St Helens, Vesuvius, Krakatoa, etc. [15]
(no case studies – max 12)

Total 25 marks

Question 4

(a) *Account for the devastation sometimes caused by tsunamis in coastal areas.*

Tsunamis - “harbour waves”
Major sea waves caused by rapid movement of sea floor - submarine earthquakes or volcanic eruptions
Energy radiates out from epicentre - usually Pacific Ring, Hawaii (also collapse of volcanic cone - La Palma/Tenerife)
Velocities high - 700km hr^{-1} in open water, slow in shallow coastal areas
Effect of coastal shape on funnelling in bay/estuary
Large wavelength (150-250km)
Small amplitude in open ocean (0.5m) - increases up to 35m on slowing in shallow coastal water
Not easy to detect or predict (not all quakes produce large tsunamis)
99% of the deaths related to tsunamis in the Pacific occur within 100 km of the source - little time to warn
Credit examples - Prancer eastern Java - 1994, Philippines 1999
Chenga Island - Alaska - 1964, Krakatoa - 1883
SE Asia (Boxing Day 2004)
(max 10 marks, max 6 if no attempt to account) [10]

(b) *Describe how the problems associated with one of the following hazards might be overcome or reduced:*
Either 1. tsunamis
Or 2. earthquakes

EITHER 1. Tsunamis hazards
Prediction and warning
Pacific Early Warning System - based on Hawaii - 1 hour alert
Japanese system issues warning within 20 mins
Project THRUST (Tsunamis Hazard Reduction Utilising Systems Technology) - rapid warning via satellite - low cost
Based on magnitude of quake but not all produce tsunamis

Land-use planning and engineering solutions
Raised evacuation road - access for relief work
Wall or embankment - barrier to inland flooding, absorb energy of wave, above projected height of flood, channels for flood water
Buildings at right angles to coast on concrete piles - waves pass through piles/easily drains, least resistance to force of water, strength of orientation
Development free zones of parks or forests - trees dissipate wave (flexible-barrier), no development to destroy, provide run-up for waves to dissipate energy [15]

OR 2. Earthquakes
Prediction and warning
Prediction methods – seismic, groundwater levels, ground movement, radon gas, etc
Evacuation measures (related to prediction), good emergency services and planning
Earthquake drills

Land-use planning and engineering solutions
Building types: low level – less damage v high-rise more prone to resonance
Construction – unreinforced masonry, adobe (South America/Middle East), heavy tiles, no internal walls, poor standards of workmanship/design - can be abolished with thought
Reinforced masonry, reinforced concrete/steel frames
Strengthening given to bridges
Engineered building - 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
Credit actual examples/case studies
A holistic approach – breadth v depth [15]

Total 25 marks

Question 5

(a) *Describe the influence of geological structure (bedding, joints, faults and cleavage) on the stability of rock cuttings and tunnels.*

Unstable patterns of geological structures (e.g. bedding, jointing, faulting, cleavage)
Effect of dip of beds/cleavage
Slope faces daylight
Stable friction angles
Fracturing of fault planes
Density of joints/erosion/weathering of joints
Lubrication by water
Case studies [10]

(b) *With reference to one or more case studies, explain the geological hazards associated with mining activities.*

Radon/methane gas hazards/explosions etc
Overburden/waste disposal - mass movement of tips
Mining subsidence/ground failure/collapse/stability of rock faces
Flooding/groundwater pollution
Release of untreated mine water into river system
Case studies essential (max 12 with no case study) [15]

Total 25 marks

Geology AS

MARK BAND CRITERIA FOR AS 2012 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.

Question 1

(a) (i)

Classification	
Class	Reptile
Order	Saurischian (1)
Genus	Dromaeosaurus (both)
Species	albertensis = (1)

(max 2 marks) [2]

(ii)

Size	
Footprint length	18**cm** (0.18**m**) (1) range 17 -19 cm
Hip height = approximately 4 times footprint length	72 **cm** (0.72**m**) (1) range 68 – 76 cm follow through from above
Body length = approximately 10 times footprint length	1.8 m

(max 2 marks) [2]

(b) (i) A - Large forward eyes = 3D focus for estimating distance when running down prey
B - Sharp teeth for tearing flesh – large skull gives large bite for killing
C - Sharp claw – clinging onto prey and puncturing a main organ/artery, ripping open prey
D - Walking on tiptoe – increased the length of leg and enabled a longer stride and faster speed
(max 2 x 2 marks) [4]

(ii) Explanation – tail flexible at base (1) with rods which strengthen the tail (1)

Advantage – reduces the drag of a long tail (1) which prevents the animal making sharp turns when chasing its prey (1), balance (1)
Other sensible e.g. signal to pack in long grass (1)
(max 3 marks) [3]

(c) (i) Holistic :- Two Dromaeosaurus tracks (pack), converging to one spot (prey), mixed up ground (fight), one large set of prints with bigger stride (larger dinosaur with higher hip height), large and
one small track show animals moving faster towards where they meet (running away/towards each other)
(max 3 marks) [3]

(ii) Holistic :- All three dinosaurs may be moving towards a waterhole to drink
Three dinosaurs may be scavengers on a dead animal
No evidence that tracks were formed at the same time
Alternative valid suggestions
(max 2 marks) [2]

Total 16 mark

Question 2

(a) (i) South of island arc (1)
extending ~2000km (must be curved) (1) [2]

(ii) Andesitic / Silicic / Intermediate (1)
Convergent plate boundary / Subduction (1)
Melting / Partial melting of ocean (mafic) crust (1)
Magma mixing / magma differentiation (1)
(max 3 marks) [3]

(b) (i) ~27.5 Ma (accept range 26 – 29) (1) [1]

(ii) ~2400 km/27.5 Ma (1)
8.73 cm yr^{-1} (accept 8.2 – 9.2) (1)

or

~3500 km/40 Ma (1)
8.75 cm yr^{-1} (accept 8.6 – 8.9) (1) [2]

(iii) Linear chains (1)
Age distribution increase to NW (1)
Volcanoes extinct further from the volcanic centre (1)
Basaltic magma associated with plume (1)
Pacific plate is moving in the same orientation as chain (1)
Positive correlation (age distribution) (1)
Hawaii intraplate location = plume (1)
(max 3 marks) [3]

(c) Holistic
Change in orientation of the two chains at ~42 Ma
The Emperor Seamount rate is different (slower) than Hawaiian
Emperor data is mainly above the best fit line for Hawaiian (steeper gradient)
Kink/bend in graph
(max 3 marks) [3]

(d) Holistic
Decompression (1) melting (1) of lithosphere beneath
Partial melting of Mantle Peridotite
Crust progressively unzips with time
Towards the SE
(max 3 marks) [2]

Total 16 marks

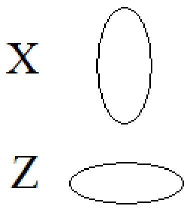
Question 3

(a) (i) E-W (1) [1]

(ii) Vertical in section (in upper shale) (1)
Following axial plane trace on surface (1) [2]

(b) (i) Moderately sorted (1)
Spherical (1)
Grain supported (1)
Concentric rings (1)
Fine ashy matrix (1)
Size – small, airborne (1) (max 3 marks) [3]

(ii) Drawn (1)



X = compression (1)
Z = tension (1)

[3]

(c) Overturned — Yes (1)
any <u>named</u> sedimentary structures upside down (1)
or explanation as to why any of the three shows way up (1)

Symmetrical — Can't tell – full limb length not seen (1)

Syncline — No - Anti<u>cline</u> (it is a syn<u>form</u>) (1)
Oldest beds in the fold core (1)

(max 5 marks) [5]

Total 14 marks

Question 4

(a) (i) Falls rapidly at 660 Ma (from +12 to -50) (1)
Rises steadily until 635 Ma (to -10) (1)
Rises rapidly at 635 Ma (to +40) (1)
Then drops to previous temp (+12) (1)
(max 3 marks) [3]

(ii) 635 = R [1]

(b) (i) Magnetic inclination indicates horizontal magnetic field
Suggests sedimentation at the Equator
Ice at Equator
(max 2 marks) [2]

(ii) Dropstones coarse-grained = not deposited in a low energy environment
Marine sediments fine-grained = low energy
<u>Glaciation/Glacial</u> debris (1) falls/dropped from melting ice/icebergs (1)
(max 2 marks) [2]

(c) Volcanic eruption
Under Snowball ice, increase in greenhouse gases
(greenhouse gas/CO_2 release)
Rapid melting of the ice with runaway global warming

Rock weathering
Greenhouse gas/CO_2 released - washed from atmosphere when hydrological cycle restarts as acid rain
Rapid <u>chemical</u> weathering of <u>silicate</u> rocks and deposition of carbonates <u>washed into sea</u>

Methane Hydrate
(Ice that burns) – methane gas <u>locked in</u> frozen sediment/ice
Rapid <u>thawing</u> - methane <u>released</u> to atmosphere
Adds to runaway <u>global warming</u> (most powerful greenhouse gas)

Holistic (2 + 2 + 2 = 6 marks) [6]

Total 14 marks

Question 5

5. (a)

498649	• Infilled/backfilled ground (1)
494644	• Solution hollow/swallow hollow (1)

[2]

(b) Quality of drawing of photo (2)
Scale (bar/hammer etc) (1)
(Dolomitic) conglomerate (pebbles/coarse grains etc.) identified (MMMF) (1)
Unconformity labelled (1)
Unconformity explained (cross cutting/time gap/erosion etc.) (1**R**)
(max 5 marks) [5]

(c) (i) Irregular (1)
Surrounds the Carboniferous Limestone CDL (1)
Unconformable/cross cutting (1)
Associated/infilling current valleys (1)
Ribbon-like /tongues/lobes (1)
Other sensible
(max 2 marks) [2]

(ii) Evidence (must explain)
coarse-grained – high energy
poorly sorted/angular grains – rapid deposition/short transport
matrix supported – rapid deposition
breccias/conglomerate – river (flash flood) deposit
(1) for any textural term
(1) for depositional characteristic/transport explanation
(max 2 marks) [2]

Total 11 marks

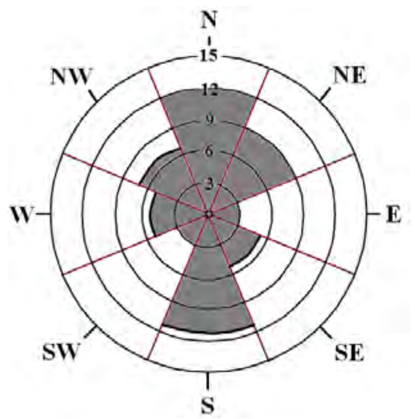
Question 6

(a) (i)

Direction	N	NE	E
Tally	~~IIII~~ ~~IIII~~ II	~~IIII~~ IIII	III
Total number of dip arrows	• 12 or 13	• 9 or 8	• 3

(1) for tally, (1) for totals [2]

(ii)



(1) per correct sector – follow through from part (i)
(max 2 marks if all correct) [2]

(b) (i) One 'yes' e.g. dome or plunge to E–W (1)
<u>Oval</u>/circular outcrop pattern (1)
Dome – <u>dip arrows</u> are orientated in all directions/outwards from centre (1)
Plunging – outcrop Vs/closes to W and E (1)
Fold <u>wider</u> W–E along axis thus elongated (1)
Oldest beds in middle (1)
Limited data in E (1)
(max 4 marks) [4]

(ii) Does not distinguish between anticlines/synclines(1)
Does not give dip amount or variation (1)
Depends upon the availability of dip arrow observations available thus bias (1)
Other (size of grouping, symmetry, data that falls on the line, etc.)
(max 2 marks) [2]

(c) (i)

Fault Characteristic	
Average dip angle	~25 degrees (accept >20 to 30)
Strike direction	roughly E–W
Throw	~ 300m (accept 250-350)
Downthrow side	south
Hanging wall side	north (accept NE)
Type of fault	Thrust/reverse fault (low angle)

[4]

(ii) Yes (1)
σ max is N–S for both (1)
W–E trend of axial plane (1)
Folding indicates crustal shortening/compression N–S (1)
Reverse/thrust faults indicating crustal shortening N-S (1)
(max 3 marks) [3]

Total 17 marks

Question 7

(a) Limestone – jointed/permeable
Limestone – $CaCO_3$
Rain and ground water is acidic
Limestone is dissolved by acid/chemical weathering
Provides a pathway for water to further erode
(max 3 marks) [3]

(b) No drift (1)
Aquifer near the surface (1)
Near fault/fractured rock (1)
Beds dipping towards borehole (natural drainage) (1)
Other sensible
(max 2 marks) [2]

(c) Holistic
Surface subsidence associated with solution
Rock strength reduced – surface deposits only thin
Subsidence associated with lead mining/landfill
Removal of potential mineral (Pb) waste pollution from mines
Pollution of water courses by surface runoff and aviation fuel leakage
Landfill waste removal and gases problems
Faults – fault reactivation/water pathways
Tarmac extension – impermeable – less water percolation to aquifer
Other sensible
(max 7 marks) [7]

See general marking criteria below

Total 12 marks

General marking criteria for 7(c)

Excellent	6-7	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	4-5	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	2-3	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	1	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	0	Little evidence of knowledge and understanding with erroneous or repeated material evident. Candidate is unable to address the question. Irrelevant; too brief/absent. Language skills poor, with spelling, grammar and punctuation errors obtrusive.

Thematic Unit 1 – 1215/01

Quaternary Geology

Section A

1. (a) (i) Coarse clasts (1) fine matrix (1) poorly sorted (1) angular clasts (1)
both contain limestone (1)

(ii) **A** mixture of rock types / limestone in **B** (1)
A random / **B** aligned (1)

(iii) Holistic - evaluation required for 3 marks
form of terminal/recessional moraine (1) end of the glacier (1)
glacier snout stationary (1) prolonged period of deposition in one place (1)
mixture of rock types re movement of glacier (1)

(iv) Clasts are aligned (1) clasts are local to deposit (1)

(b) (i) **C** / marine fossils (1) rounded clasts (1) non-alignment (imbricate?) (1)
ripples (1) well sorted (1)

(ii) Sea level was higher before glaciation (1)
Eustatic change before isostatic change (1) Deposit from previous glacial period
(1)

Section B

2. *Evaluate the statement: "There is a strong relationship between geology and topography that results in a variety of relief forms."*

Credit to be given for examples of landforms illustrating ideas
Dipping Strata
Cuesta (Downs)
Folds
Hills from anticlines (Pennines)
Mountains from core of synclines (Snowdonia)
Fold mountain chains (Himalaya)
Faults
Rift valleys (Rhine, East Africa)
Faults as planes of weakness (Great Glen Fault)
Fault scarps (Wenlock Edge)
Thrust faults (Moine thrust)
Joints
Tors (Dartmoor)
Limestone Pavements (Yorkshire Dales)
Igneous Bodies
Plutons creating highland areas (Dartmoor, Mourne Mountains)
Volcanoes (Arthur's Seat, Deccan Plateau)
Resistant Rock
Monadnocks (Malvern Hills, Wrekin)
Coastal features

Credit given for other examples. Breadth vs depth
Discussion of other factors that might influence landscapes, such as glaciation

Must evaluate the relationship between geology and topography for full marks

3. *(a)* *Describe how the Hjulstrom Graph can be used to enable the reconstruction of earlier environments recorded in sedimentary rock sequences.*

(b) *Evaluate the use of sedimentary structures in interpreting the physical processes that lead to the formation of turbidites..*

(a) Hjuslstrom curve derived experimentally
Logarithmic scale to accommodate wide range of grain sizes and velocities
Relationship between flow velocity in a river and grain size
Shows range of velocity that will erode, transport and deposit grains
Allows geologists to apply uniformitarianism to reconstruct ancient river speeds from grain size of sediments

Credit examples

Limited to river transportation
Only considers unconsolidated sediment
Doesn’t consider varying shape or sphericity of grains

(b) **Erosion**
Erosive bases to Bouma sequences – high energy levels
Flute casts/Groove Casts/Prod marks – turbid flow, palaeocurrent direction

Deposition
Graded bedding – diminishing energy of flow
Lamination – high or low flow conditons
Ripple marks/cross bedding – energy and direction of flow

Post deposition
Load casts – dewatering

Credit link to Bouma Sequence
Evaluate link between process and product

4. *(a)* *Describe the evidence from ice cores for climatic fluctuations.*

(b) *Evaluate how fossils can be used to provide evidence for climatic fluctuations in Britian during the Quaternary period.*

(a) Continuous records can be obtained from drilling where ice has accumulated for a long time (Antarctica, Greenland)
Inclusions in the snow of each year remain in the ice, such as wind-blown dust, ash, bubbles of atmospheric gas and radioactive substances
Water molecules containing heavier isotopes have a lower vapour pressure - when the temperature falls, the heavier water molecules will condense faster than the lighter water molecules, the relative concentrations of the heavier isotopes in the snow indicate the temperature of condensation at the time, allowing for ice cores to be used in local temperature reconstructions.
Air bubbles trapped in the ice cores allow for measurement of the atmospheric concentrations of trace gases such as carbon dioxide, methane and nitrous oxide
Volcanic eruptions leave identifiable ash layers that can be dated
Dust in the core can be linked to increased desert area or wind speed

(b) **Pollen**
Well preserved, easily fossilised abundant material
Sampled from sediments of different types, particularly lake deposits
Relative abundance of pollen types used to reconstruct vegetation community
Fluctuating climate causes change in the vegetation community
Pollen therefore acts as proxy data for climate
Use of Pollen diagrams to present data
Doesn't allow for quantified climatic reconstruction
Only reconstructs a proxy for the climate
Vertebrates
Examples of Quaternary vertebrates – Wooly Mammoths, Hippopotamus, Hyena, Bison etc.
Application of uniformitarianism – relating modern mammals to fossils
Mammoths found preserved in glacial ice, heavy fur coats as an indicator of colder conditions
Use of individual species, rather than community, to reconstruct climate – mutual climatic range
Problems of fossilisation for large vertebrates
"Snapshot" of climatic conditions rather than continuous sequence
Other
Credit for other organisms used e.g. Beetles, Forams (for Oxygen isotopes)

Must evaluate for full marks
Breadth vs Depth

Thematic Unit 2 – 1215/02

Geology of Natural Resources

Section A

1.	(a)	(i)	Approximate dip angle Dip direction The minimum depth of extraction	20° (accept 18-22°) S 0.5 km	[3]
		(ii)	Poorly sorted (credit reference to range of particle sizes less than $^{1}/_{16}$ to 2 cm) rudaceous/rounded/well rounded clasts/matrix supported		[2]
		(iii)	Meandering/braided river channel/fluvial/fluctuating energy conditions/high energy conglomerate		[2]
		(iv)	Variations in density, quartz low density/gold high density Small gold particles get trapped between larger quartz grains		[2]
	(b)	(i)	15/1000,000 x 100 = 0.0015%		[2]
		(ii)	Heat – 4km down geothermal gradient results in very high temperatures typically over 36 °C – solution is to install super-efficient cooling and ventilation system and spray rock surfaces with cold water Problem of water in excavations – need very powerful de-watering/pumping system Roof / wall collapse / rock bursts may be prevented by rock bolts and/or reinforced shotcrete plus backfilling old excavations with mine waste		

Section B

2. *Evaluate the use of **two** of the following techniques in the exploration for mineral and/or energy resources:*

Drilling and downhole logging;
Geophysical surveying;
Geochemical prospecting;
Geological mapping;
Satellite remote sensing.

Drilling and downhole logging

Borehole drilling to assess 3-dimensional shape and size of ore-body
Assessment of grade and tonnage of ore body – rock geochemistry
    chemical analysis – atomic absorption spectrometry (AA) /
    x-ray fluorescence spectrometry (XRF) /
    inductively coupled plasma mass spectography (ICPMS)
Assessment of results – decision to mine or not
Downhole logging measures physical, chemical and structural properties of penetrated geological formations using logging tools that are either lowered into the borehole on a wireline cable or placed just behind the drill bit as part of the drill pipe itself
The tools employ various acoustic, nuclear and electrical measurement techniques to acquire downhole logs of properties such as sonic velocity, density and electrical resistivity. The wireline cable provides real-time communication between the tools and the surface; logging-while-drilling tools typically record the logs in downhole memory devices, which are subsequently downloaded when the tool returns to the ship.

Geophysical surveying

Techniques (including labelled diagrams) e.g.
Seismic
Description – explosions / land / ship / reflection / record of 2-way time / graphical representation to identify structures / oil traps
Magnetic.
Description – magnetometer / land / plane / ship / graphical representation of magnetic readings / depends on changes in magnetic properties or distribution of rocks i.e. structures
Gravity.
Description – gravimeter / changes in gravity / changes in density of the underlying rocks / reflects the structure(s) / graphical representation
Advantages / disadvantages depend on technique chosen
Advantages e.g. cost / labour / area covered / accessibility / prospecting
Disadvantages e.g. cost / requires follow-up

Geochemical prospecting

Sampling stream, soil or vegetation to find particular trace element concentrations which might indicate the presence of an economic resource, concentrations vary with distance from the ore body, copper and lead
Advantages:
Sampling allows large catchment area to be investigated quickly
All elements have characteristic signatures which may show up in vegetation response and are easily recognised in soil and water samples
Very dependable and cost effective
Disadvantages:
Contamination can be a problem (earlier mining, processing, wind-blown, flooding)
Background rocks, variations in water pH and ore concentrations can give misleading results
Access may be difficult over wider areas

Geological mapping

Field work based – direct observation using trained geologists
Advantages:
High level of accuracy to pinpoint resources at the surface prior to exploitation
Can be very detailed – good to assess the problems of exploitation and viability of resource
Samples can be collected for accurate analysis
Disadvantages:
Labour intensive and time-consuming
Structural trends obscured on small scale
Accuracy depends upon sample points and interpretation
Possible problems of access in remote areas and lack of outcrops

Satellite remote sensing

Radiation is absorbed and reflected in different ways by different materials
Materials emit different types of radiation depending upon temperature and molecular structure
Emitted and reflected radiation can be monitored, analysed and displayed as a visual image
Suitable for major metalliferous deposits (e.g. copper, iron)
Advantages:
Provides a large-scale image relatively cheaply without need of fieldwork
Inaccessible areas studied easily
Large-scale structures show up which might be missed in the field
Satellites are generally in place – only need to buy image required
Disadvantages:
Used for only basic reconnaissance
Does not provide stereo images
Colours can be misleading

3. (a) *Describe the conditions necessary for the accumulation of large-scale coal deposits.*

(b) *Evaluate the ways in which the environmental impacts of quarrying and mining may be minimised.*

(a) Description of coal-forming swamps / deltas - credit examples
Rate of supply of organic material exceeds rate of decay
Rate of burial / subsidence / removal from oxidising conditions
Peat-lignite-bituminous-anthracite progression re heat and C-content

(b) Deep mining – combat subsidence
Open cast – combat noise / dust / transport, land restoration
Spoil heaps – aesthetic
Methane – monitor / remove
Effect on ground water – monitor
Legislation / planning controls

Emphasis should be on the effectiveness of techniques

4. *Describe and evaluate the importance of* ***two*** *of the following igneous processes in the formation of mineral and/or energy deposits:*

Magmatic segregation;
Pegmatite formation;
Hydrothermal activity.

Magmatic segregation

Reference to cumulates /segregation / mixing / density / melting (crystallisation) temperature
Layered intrusions / (mostly) mafic in origin
Credit relevant examples – iron ores / chromite

Pegmatite formation

Coarse-grained igneous rock / mostly granitic in origin / quartz, feldspar and mica
Also generally rare earth elements
Valuable rare minerals e.g. aquamarine, tourmaline, beryl, topaz, cassiterite, fluorite, apatite, tin and tungsten plus a host of other minerals
Slow crystallisation(?)
Dyke structures
Pegmatites are most famous for their large, high quality mineral specimens

Hydrothermal activity

Very hot waters derived directly from igneous intrusions / residual fluids formed during the late stages of crystallisation / heated groundwater during crystallisation of the intrusion
The hydrothermal fluids can react with and alter the rocks through which they pass or can deposit minerals from solution
Hydrothermal reactions include kaolinisation whilst hydrothermal vein and replacement mineral deposits include Cu, Pb, and Zn sulphides
Black smokers

Evaluation

All very important
Mainly minerals not energy / uranium
Important sources of gem and industrial minerals – examples

Thematic Unit 3 – 1215/03

Geological Evolution of Britain

Section A

1. (a) (i) 90-120° to 270-300° (1) (E–W or ESE–WNW)
(ii) correct position of arrows (1)
(iii) Variscan (1) because of the almost E–W trend (1) and Carboniferous age (1)
(iv) any 2 of:
trend of other folds (1)
trend of faults (1)
trend of igneous intrusions (1)
trend of geomorphological features (1)
trend of cleavage (1)
(max 2 marks – second mark can be credited for extra detail when reference to only one of above)

(b) (i) correct thickness **and** grain size (1)
(ii) cross-cutting (1) curved (1) erosive (1) channel (1) flash flood (1) unconformity (1) disconformity (1)
(max 2 marks)
(iii) Holistic – look for differences and explanation (sea level change) for full marks
Unit A – coarsening upwards / increasing energy / clastics / continental shelf / marine goniatites
Unit B – fine-grained consistently low energy / organic sediments / vegetation / seat earth / soil / non-marine bivalves
Explanation – A is high sea level / delta front; B is low sea level / delta top; sea level changes

[5]

Section B

2. *(a) Using one or more diagrams, describe* ***one*** *named major fault in the British area resulting from the* ***Caledonian*** *Orogeny.*
(b) Evaluate the extent to which large-scale geological features formed during the ***Caledonian*** *Orogeny can be used to reconstruct the plate tectonic regime at that time.*

(a) Description of named example with suitably annotated diagram

(b) Evaluation

Moine Thrust evidence of foreland outer zone of collision zone
Nappes suggest deformation of continental crust, ductile deformation in mountain chain
Faulting HBF brittle deformation
NE–SW trend suggest plates converging from SE and NW
Granites suggest deep crustal melting
Metamorphism suggests heat/ pressure at depth in continental crust
Andesites suggest ocean/continent collision
Accretionary wedge in Southern Uplands
Ophiolites obducted ocean crust
Subduction followed by continent/continent convergence

3. *(a)* *Explain how variation in magnetic inclination and apparent polar wandering curves can be used to determine palaeolatitude changes through time for the British area.*

(b) *Evaluate the reliability of the evidence and assumptions that are made in using these methods.*

(a) Magnetic inclination

Orientation of magnetic minerals in rocks aligned parallel to magnetic field at time of cooling - Curie point
Gives position of pole and angle of inclination which indicates latitude
Diagram of changes in magnetic inclination with latitude as UK drifts through latitude
Angle of inclination changes in rocks of different ages and analysis of rocks of different ages shows changes of latitude with time
Can be preserved in sediments aligned during deposition

Apparent polar wandering

Determination of position of magnetic pole at time of cooling (remnant magnetism)
Determined in rocks of different ages
Plotting positions of poles of different ages on a map and joining up points to produce an apparent polar wandering curve for a continent
Positions of pole relative to continent gives latitude of continent at a particular time and shows changes over time
Also shows time of continent collision and separation (diagram)

(b) Evaluation

Useful technique if backed up by study of sediments
Assumes magnetic field has always been dipolar and close to geographic north
Inaccuracies caused by problems with radiometric dating of rocks
Assumes rocks not overturned or magnetically disturbed since formation

4. *(a)* *Describe the evidence from sedimentary rocks which shows that;*

(i) *semi-arid and desert terrestrial and*

(ii) *hypersaline marine*

conditions existed in the British area during the Permo-Triassic.

(b) *Evaluate the extent to which climatic change demonstrated by sedimentary rocks can be used to interpret changes in palaeolatitude. Discuss any assumptions that are made.*

(a) Desert terrestrial

Red beds / desert sandstone (well sorted, well rounded) dune cross-bedding / breccias / arkoses / conglomerates – flash floods / saline lake deposits
Hypersaline marine

Mud cracks / evaporites (sequences)

(b) Evaluation

Climatic change interpreted as evidence for latitude change assuming that major climatic zones have been consistent throughout the Phanerozoic

Uniformitarianism for interpretation of sedimentary rocks

Evidence supported by palaeomagnetism

Thematic Unit 4 – 1215/04

Geology of the Lithosphere

Section A

1. (a) (i) P on ocean floor (1) Q bottom of mantle lithosphere (1)

(ii) Holistic – collision / scraping (scuffing) / density / obduction etc. (2)

(b) (i) approximately mid way between given isotherms (1)

(ii) Explanations – oceanic, lowers as cools (older) / depressed (at an angle) at the subduction = cold lithosphere entering warmer zone / domed in continental crust with the igneous activity

(c) D high T close to magma / low P away from collision zone
B collision zone (high P) / low T (low GTG)
C high T and P / depth and collision

(d) presence of (sea) water / lower pressure / lower melting point / (partial melting?)

Section B

2. *(a) Describe how seismology has made it possible to identify the lithosphere.*

(b) Evaluate the effectiveness of seismology in identifying the importance of the asthenosphere.

(a) **Description**
P-, S- and L-waves, only S- and L- of use
Properties of P- and S- waves re solid v “liquid"
Reflection v refraction
Layered lithosphere / Moho
Low velocity layer described and explained

(b) **Evaluation**
Seismology re solid / semi-liquid state of asthenosphere
Asthenosphere = possible movement / convection = mechanism for plate tectonics
Isostasy

3. *Describe how forces acting on continental lithosphere may cause brittle or ductile deformation. Evaluate the importance of the depth in the lithosphere on the types of deformation produced.*

Description
Forces (principal stresses) produce folding (ductile) and/or faulting (brittle)
Depth v breadth
Relationship between stress orientation and type of deformation
Stress / strain curves
Elastic v plastic / Elastic limit / Faulting before elastic limit / Folding beyond elastic limit
Effect of temperature

Evaluation
Depth = increase in temperature (geothermal gradient) and pressure
Change in state of rocks?
DPM v stable lithosphere (cratons etc.)

4. *Evaluate the contribution made by J.Tuzo Wilson to an understanding of plate tectonics.*

Description of cycle (= x phases) rifting / ocean growth / subduction

Evaluation
Provides an explanation for observable crustal tectonics and a unifying theory
Expanding Earth the proposed alternative

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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