Earth Systems 3209 Grading Standards
June 2006

Pre-Marking Appraisal

The examination was considered fair and had sufficient coverage of each unit of study and each level of cognitive learning. The following decisions were made by the marking board:

Item #1: Both B and D were accepted as answers for this item. The term "observed regularity" is not referenced in the student text or curriculum guide and as a result, arguments can be made to support both answers.

Item #23: Both B and C were accepted as answers for this item. Arguments can be made to support both answers by referencing page 21 (Table 3.7), and page 67 of the student text book.

Item #61(b): This item was dropped from the exam. The curriculum guide does not explicitly state that varves must be the method chosen to determine age by direct observation.

Post Marking Report

a) Marking Standard and Consistency

Marker reliability was checked by obtaining a random sample of 50 papers. On the first marking day, these 50 papers were marked and the value for each question was recorded on a separate sheet of paper. The 50 papers were put back into the original stack of papers to be corrected over the next week. Throughout the marking period, these reliability papers were corrected by the markers, the two values were compared and if there were discrepancies in the marks, the chief marker would discuss and review the scoring with the individual marker.

b) Summary

Overall performance in the Earth Systems 3209 examination decreased from June 2005 to June 2006. The provincial performance was similar to the performances prior to 2005. As in past years, however, performance was lower for items that assessed outcomes from the core labs. Core labs enrich and enhance material in each unit of the course. It is essential that teachers complete all core labs to ensure that students are prepared for the examination. On provincial examinations, core lab outcomes are often assessed at higher levels of learning. Teachers, therefore, should assess these areas of the course in a similar manner throughout the year.

Teachers should also encourage students to read questions carefully and critically. Very often on the provincial examination, errors occur because students fail to read the whole question. If they read the complete question or read it several times, they are less likely to misinterpret the item and are more likely to perform better.

c) Commentary on Responses

Part II - Constructed Response - Total Value: 40%

2% 61.(a) An organism contained 28 kg of carbon-14. If the half life of carbon-14 is 5730 years, what mass of carbon-14 remains in a fossil of this organism that is approximately 22 920 years old? Show all workings.

Answer:
Determine the number of half-lives. **1 mark**

"N" = $\frac{\text{age of rock sample}}{\text{\# of years per half-life}} = \frac{22920 \text{ years}}{5730 \text{ years}} =$ 4 half lives

OR:

Add the half-life to itself until you get the age of the sample;
5730 years + 5730 years + 5730 years = 5730 years = 2139 million years.
Thus, the sample went through 4 half-lives.

Calculate the mass of carbon-14 remaining. **1 mark**

28 g ➜ 14 g ➜ 7.0 g ➜ 3.5 g ➜ 1.75 g

OR:

256 g × ½ × ½ × ½ × ½ = 1.75 kg

Answer is **1.75 kg**

Common Errors
Students:

- incorrectly calculated the amount of parent material remaining.
- incorrectly calculated the number of half-lives (stopped at three).
- found the corresponding mass equivalent to three half-lives.
- presented answer as a percent (6.25%) remaining rather than the mass remaining.

2% 61.(b) This item was dropped.

2% 62.(a) If volcanic activity had never taken place on Earth, explain what effect this would have had in relation to the origin of the atmosphere and hydrosphere.

Answer:
Scientists believe that the atmosphere and hydrosphere originated from gases released through volcanic activity billions of years ago as described by the nebular theory. As a result, if volcanic activity had never taken place on Earth, then neither the atmosphere or hydrosphere would have been formed and/or created.

Stating no atmosphere would have been created. **1 mark**

Stating no hydrosphere would have been created. **1 mark**

Common Errors
Students:

- described how both the atmosphere and hydrosphere formed.
- stated that the atmosphere and hydrosphere would not change if volcanism did not occur in the past.
- stated that the atmosphere and hydrosphere would be considerably cleaner as a result of no gases and dust being emitted from volcanoes.
- stated that life on Earth would not exist if volcanic activity never took place on Earth.

2% 62.(b) When a hole was drilled into a thick layer of sandstone a large amount of water was found to flow. Explain what can be concluded about the porosity and permeability of the sandstone.

Answer:
Since a large amount of water was found to flow from the thick layer of sandstone, it can be inferred that the porosity and permeability of the sandstone layer is significantly high. The large amount of water suggests that the amount of pore space (porosity) in the rock is high. The ability of the water to flow suggests that the pores are connected and has a high degree of permeability.

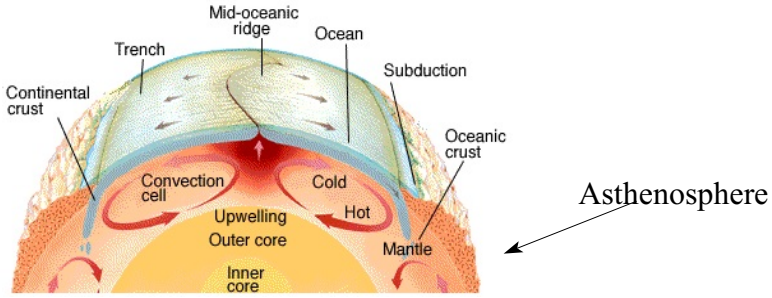
High porosity due to the amount of pore space. **1 mark**

High permeability due to the ability of the water to flow. **1 mark**

Common Errors
Students:

- stated that the porosity and permeability of the sandstone layer was low.
- stated that the porosity was high and the permeability was low and vice versa.

3% 63.(a) With the aid of a diagram, describe how our knowledge of the asthenosphere and convection currents allow us to explain plate motion.



Answer:
The asthenosphere is a layer in the upper mantle that is partially molten and is weak and plastic-like. Unequal distribution of heat in the mantle results in the flowing of the asthenosphere in a convective manner. The movement of convection currents in the asthenosphere is the force responsible for moving solid and rigid lithospheric plates located directly above the asthenosphere.

Labelled diagram. **1 mark**

Knowledge of asthenosphere causing convection. **1 mark**

Knowledge of convection driving plate motion. **1 mark**

Common Error
Students did not demonstrate a knowledge of the properties of the asthenosphere.

3% 63.(b) Describe the conditions that give rise to the formation of andesite at oceanic-continental plate boundaries.

Answer:
At oceanic-continental plate boundaries, basaltic oceanic crust (mafic) subducts beneath granitic continental crust (felsic). The melting of the basaltic rock and the granitic rock mixes to create an andesitic composition (intermediate) magma. This newly generated magma erupts to the surface and cools quickly. As a result a fine-grained intermediate rock called andesite is formed, usually in mountainous environments.

Basaltic or mafic composition, ocean crust **1 mark**

Granitic or felsic composition, continental crust **1 mark**

Mixing of (granitic, felsic, continental crust) and (basaltic, mafic, ocean crust) to produce intermediate **1 mark**

Marks were also awarded if students mentioned the following points;

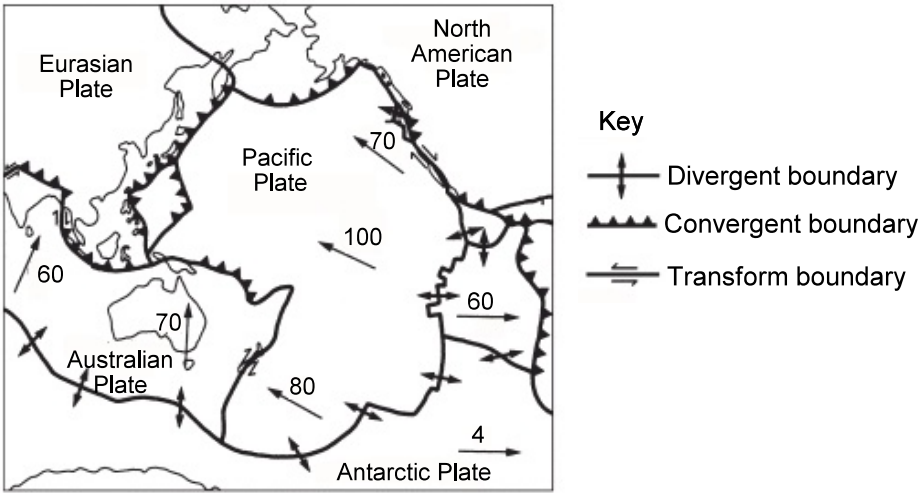
Relating subduction to melting **0.5 marks**

Associating andesite with extrusive volcanism **0.5 marks**

Common Errors
Students:

- mentioned subduction and melting but did not discuss how the intermediate (andesitic) magma composition was formed.
- indicated that andesite was a volcanic/extrusive rock that crystallized quickly at Earth's surface.

2% 63.(c) Describe two resulting characteristics of the Australian Plate - Antarctic Plate boundary if the direction of movement was reversed.



Answer:
If the direction of movement was reversed, then a convergent boundary (two plates colliding) would form between the Australian and Antarctic plates. Some of the characteristics associated with a convergent boundary include:

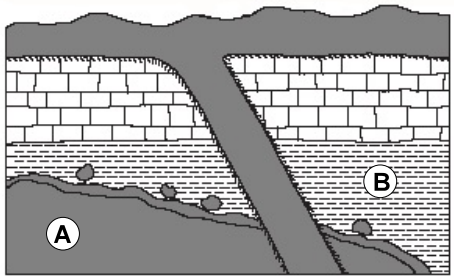
- convergent boundary
- deep-ocean Trench
- subduction zones
- volcanic island arcs
- accretionary wedge
- earthquakes
- mountain building (folded mountains)
- compressional forces

1 mark each was awarded for **any two** of the points outlined above. **2 marks**

Common Errors
Students:

- listed two or more characteristics without describing them well or relating them to convergent boundaries.
- described characteristics of a divergent boundary which is indicated by arrows in the diagram.

2% 63.(d) Describe two features from the cross-section below which show that the contact between rock unit A and B is an erosion surface.



Answer:
The boundary between rock units A and B can be concluded to be an erosional surface by describing any two of the following features:

- Inclusions of Rock unit "A" contained within rock unit "B".
- Absence of contact metamorphism at the base of the shale layer.
- Layer at the top of rock unit "A" may represent exfoliation.
- Surface of rock unit "A" is irregular.

1 mark each was awarded for **any two** of the points outlined **2 marks**

Common Errors
Students:

- stated inclusions as one of the features, but did not identify any other feature.
- outlined the sequence by which the rock units formed.
- included the granite intrusion and contact metamorphism as a feature to suggest erosion.
- used angular unconformity to describe the erosional surface.
- did not indicate the lack of contact metamorphism as one of the features to indicate erosion.

2% 63.(e) Give two reasons why swamps provide a suitable environment for coal formation.

Answer:
Swamps are suitable environments for coal formation because they provide an environment that is rich in organic material and is also oxygen deficient. These factors combined with moisture/temperature and compaction characteristics associated with buried swamps, provide a suitable environment for coal formation.

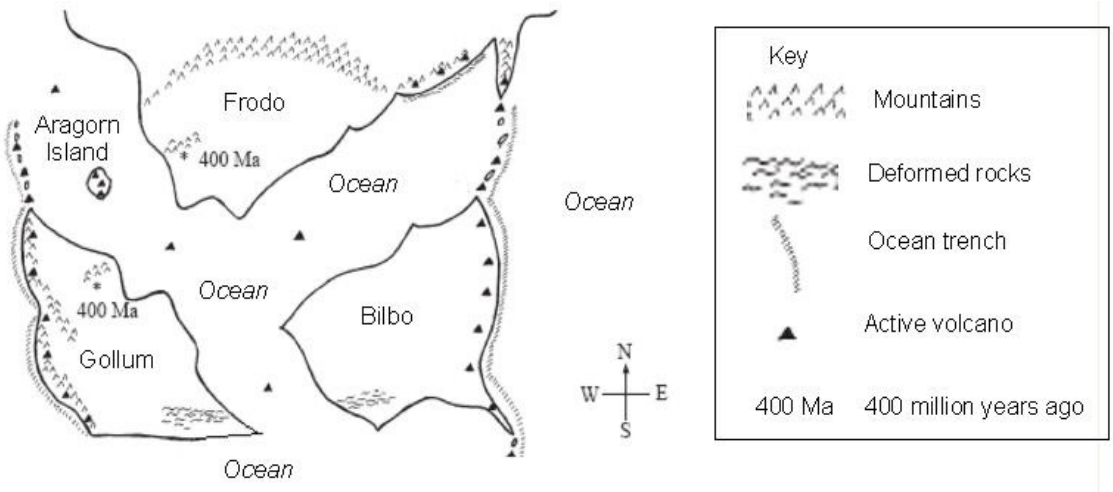
1 mark each was awarded for **any two** of the following: **2 marks**

- low oxygen environment (anerobic)
- abundant organic material
- lack of bacteria

Common Errors
Students:

- described the four stages in the formation of coal.
- did not state that coal formation requires an oxygen-poor (anaerobic) environment.

4% 63.(f) The map below shows the surface of a fictional planet which is very similar to Earth.



The planet has three large continents: Frodo, Gollum, and Bilbo, that are separated by oceans. There are very high mountain ranges, seismic activity, and active volcanoes.

(i) What two pieces of evidence support the theory that Gollum and Frodo were once joined?

Answer:
The evidence from the diagram to suggest that Gollum and Frodo were once joined includes:

- Puzzle like fit of continental coastlines.
- Mountains are continuous across the continents once they are aligned.
- Mountain ranges or continents are of the same age (400Ma).
- Volcanic activity exists between continents suggesting rifting and divergence.

1 mark each was awarded for **any two** of the above. **2 marks**

Common Errors
Students:

- stated only one piece of evidence.
- stated evidence that Gollum was joined with Bilbo.

(ii) Assuming that the planet has a similar rock chemistry to Earth, describe the composition of the lava and the eruptive style of the volcanoes on Aragorn Island.

Answer:
Aragorn Island is a volcanic island located between the continents of Gollum and Frodo. This volcanic island is a shield volcano commonly found associated with oceanic ridges. If rock chemistry in the area is similar to that on Earth, one would expect the composition of the lava to be basaltic (mafic). The lava would have a low silica content, low gas content, and a high iron and magnesium content. Due to the composition of the lava, one would expect the eruptive style to be quiet and fluid where the lava flows with ease. The lava can also be described as non-viscous with a low explosive nature.

Stating composition, mafic, basaltic, low silica content, low dissolved gases. **1 mark**

Stating eruptive style, including one of; fluid lava, low viscosity, quiet eruption, or non-explosive. **1 mark**

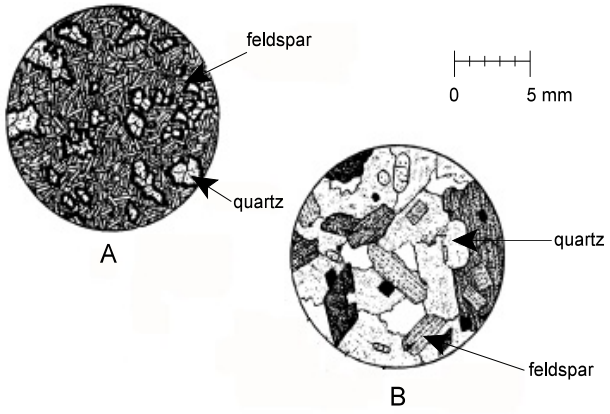
Note: **½ mark** was awarded for stating the volcano was a shield volcano.

Commentary on Response
Many students did not attempt this item.

Common Errors
Students:

- did not describe the composition of the lava and the eruptive style of the lava, rather they described the type of volcanic cone (shield volcano).
- stated that Aragorn Island was the result of hot-spots or intraplate volcanism.
- described the volcano type and the formation of these volcanoes.

5% 63.(g) The diagram below represents crystals of two igneous rocks.



(i) Name one texture represented in A. _____

Answer:
The texture represented in A may be considered; fine grained, aphanitic, porphyritic, or porphry. **1 mark for any one of these**

Common Errors
Students:
- stated that the texture of A was glassy.
- stated that the texture of A was coarse.

(ii) Why is the texture in A different from that of B?

Answer:
Textures seen in A and B differ mainly because the samples cooled at different rates. Sample A has a fine (aphanitic) texture which suggests that the sample cooled fast or quickly at or near Earth's surface not allowing for large crystal growth. The larger phenocryst, seen in sample A, may also suggest a porphyritic texture which involves a slower cooling phase beneath Earth's surface forming the larger quartz crystals followed by a rapid cooling phase at or near Earth's surface forming the finer feldspar crystals. Sample B has a coarse (phaneritic) texture which suggests that the sample cooled slowly beneath Earth's surface allowing larger crystal growth.

Relating fine texture to fast or rapid cooling rate. **1 mark**
Relating coarse texture to slow cooling rate. **1 mark**

Common Errors
Students:
- described the environment where they thought the texture formed.
- described the fine and coarse textures.

(iii) In what tectonic setting did A and B form?

Answer:
Associating texture A with divergent boundary, volcanic activity at convergent boundaries, stating extrusive (volcanic) environment, or describing environment for porphyritic texture to form. **1 mark**

Associating texture B with plutonism within convergent boundaries, intrusions within continental plates, intrusive (plutonic) environment. **1 mark**

Common Error
Students related texture to the rate of cooling.

2% 63.(h) Why is anthracite often found in association with slate rather than shale or sandstone?

Answer:
Anthracite is the highest grade of coal and is associated with slate because both rocks have been exposed to similar conditions and are metamorphic in origin. Anthracite is not commonly associated with shale and sandstone because shale and sandstone are sedimentary in origin.

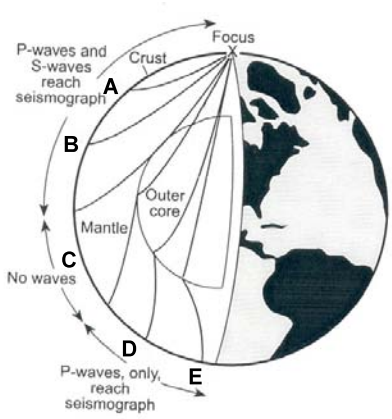
Recognize anthracite and slate form in a metamorphic environment.**1 mark**

Recognize that shale and sandstone form in a sedimentary environment.**1 mark**

Commentary on Response
Many students did not attempt this item.

Common Errors
Students:
- did not connect slate and anthracite to metamorphic processes.
- did not compare anthracite to sedimentary rocks.
- assumed shale was a metamorphic rock and described the continuum of shale metamorphosing to form slate and eventually to gneiss.

3% 63.(i) In the diagram below, both P-waves and S-waves were received at seismic stations A and B, only P-waves were received at seismic stations D and E, and no waves were received at seismic station C. Explain why this occurred.



Answer:

Seismic waves arrive at different locations around Earth because of the differing properties of P and S-waves. Seismic stations A and B receive both P and S-waves because they pass through the solid crust and mantle and do not pass through any portion of the outer core. Seismic stations D and E receive only P-waves because as the seismic waves pass through the liquid outer core, the S-wave is eliminated since the S-wave cannot shear liquids. Seismic station C will not receive any seismic waves because it is located in a P and S-wave shadow zone. No waves are received at this location because S-waves are eliminated and P-waves get refracted as they move through the liquid outer core.

Stating that P and S-waves travel through the solid Earth and will arrive at Stations A and B. **1 mark**

Stating that no seismic waves arrive at station C because P-waves get refracted (they bend) and S-waves are terminated due to the properties of the outer core. **1 mark**

Stating that only P-waves can pass through the outer and inner cores and arive at stations D and E. **1 mark**

Common Errors

Students:

- did not state that density differences were responsible for the refraction of seismic waves which resulted in shadow zones.
- did not state that stations A and B received both P and S-waves.
- did not explain why no waves were received at station C.

2% 64.(a) What is one similarity and one difference between rocks produced at convergent and transform plate boundaries?

Answer:
A similarity of convergent and transform plate boundaries is that metamorphic rocks can be formed at both, while a difference between convergent and transform boundaries is that no igneous rocks are formed at transform boundaries.

One similarity is that both convergent and transform boundaries contain metamorphic rocks. **1 mark**

One difference is that igneous rocks are formed at convergent boundaries but not at transform boundaries. **1 mark**

Commentary on Response
Many students did not attempt this item.

Common Errors
Students:
- stated similarities but did not state a difference in rock types.
- described processes at the two boundaries rather than rocks being produced at the boundaries.

2% 64.(b) Explain two ways volcanism affects natural systems on Earth.

Answer:
A wide variety of answers can be accepted, which include the following;

- Add gases to atmosphere, SO_2, CO_2, and H_2O.
- Outgassing changed atmospheric composition.
- Ash and dust affects global climates (global cooling).
- Volcanic eruptions block sunlight and thus interrupt the biosphere (photosynthesis).
- Adds new lithosphere.
- Adds nutrients to soils.

1 mark each was awarded for **any two** of the points above. **2 marks**

Common Error
Students only stated one way volcanism affects natural systems.

2% 64.(c) Explain two ways human activity has affected natural systems on Earth.

Answer:
Human activities affected natural systems in a variety of ways. The more popular responses include;

- Pollution of atmosphere or hydrosphere.
- Contributes to acid raid and reduces pH of water.
- Mining which depletes non-renewable resources.
- Industry depleting renewable resources.
- Depletion of ozone.
- Increase in greenhouse gases.
- Man-made structures affect natural systems.

1 mark each was awarded for **any two** of the points above. **2 marks**

Common Error
Students only stated one way human activity affects natural systems.

TABLE 1
EARTH SYSTEMS 3209 ITEM ANALYSIS
SELECTED RESPONSE (PART I)

Item	Answer	Responses			
		A	B	C	D
		%	%	%	%
1	B & D	28.2	24	13.9	33.5
2	A	52.5	21.2	17	9.2
3	B	9.2	49.1	36.1	5.6
4	B	2.3	69.3	11.1	17.3
5	C	6.5	7.1	81.5	4.7
6	C	10.1	20.4	58.9	10.4
7	A	64.1	5.6	9.4	20.9
8	A	75.6	22.1	2.2	0.2
9	D	9.9	48.8	7.4	33.8
10	D	7.1	16.3	14.4	61.8
11	C	11.2	0.5	72.2	16.1
12	D	2.5	5.3	11.5	80.5
13	A	81.9	1.6	12.7	3.8
14	C	13.8	8.8	49.5	27.9
15	D	0.4	0.7	32.6	66.2
16	C	14.2	6.7	70.8	8.2
17	A	55.1	6.4	33.3	5.2
18	A	76.7	11.1	7.2	4.9
19	B	8.8	76.6	5.7	9
20	C	7.4	0.5	88.5	3.6
21	D	8.2	8.8	10.1	72.9
22	C	16.4	17.8	50.1	15.5
23	B & C	16.7	27	39.8	16
24	B	12.4	75.8	6.3	5.4
25	A	65.9	5.2	5.4	23.5

Item	Answer	Responses			
		A	B	C	D
		%	%	%	%
26	A	69.8	13.3	14.9	1.9
27	B	23.9	30.3	22.5	23.1
28	D	3.7	4.9	7.3	83.9
29	A	68.5	19.9	7.5	4.1
30	B	3.2	67.3	13.2	16.3
31	B	32.8	45.6	16.2	5.3
32	A	83	4.9	6.1	5.9
33	B	9.9	46.3	26.9	16.8
34	B	13.5	70.8	13.4	2.3
35	C	17.2	15.3	59.7	7.8
36	C	1.4	4	71.4	23
37	B	11.8	64.5	20.2	3.3
38	D	25.7	2.3	2.8	69.3
39	A	21.6	10	46.2	22.1
40	A	68.9	14.5	14.1	2.5
41	C	26.2	31.4	34.8	7.4
42	B	3.9	69.4	17	9.6
43	C	22.5	3.2	64	10.3
44	B	0.5	88.6	6.7	4.2
45	B	44.6	19.1	23.8	12.4
46	A	44.3	13.1	19.2	23.3
47	A	53.6	19.8	17.9	8.6
48	A	53.6	11.3	18.9	16.1
49	A	22.9	25.4	33.6	18.1
50	D	4.2	3.4	20.6	71.8
51	D	15.8	14.4	18.6	50.9

Item	Answer	Responses			
		A	B	C	D
		%	%	%	%
52	C	40.1	37.1	19.1	3.5
53	D	9.5	22.2	5.3	62.8
54	B	27.8	62.4	5.5	4.1
55	C	11.9	21.9	43.6	22.2
56	C	7.6	22.9	65.8	3.2
57	A	30.4	34.8	11	23.3
58	D	9.6	12.1	5.9	72.4
59	B	3.8	84.5	8.8	2.8
60	D	1.4	35.2	2.8	60.4

NOTE: Percentages may not add to 100% due to multiple answers or missing values.

TABLE 2
EARTH SYSTEMS 3209 ITEM ANALYSIS
CONSTRUCTED RESPONSE (PART II)

Item	Students Completing Item	Value	Average
61.(a)	958	2%	1.2
61.(b)	Dropped		
62.(a)	958	2%	0.9
62.(b)	958	2%	1.3
63.(a)	958	3%	1.4
63.(b)	958	3%	0.6
63.(c)	958	2%	1.2
63.(d)	958	2%	0.8
63.(e)	958	2%	1
63.(f)	958	4%	2.4
63.(g)	958	5%	2.6
63.(h)	958	2%	0.7
63.(i)	958	3%	1.8
64.(a)	958	2%	0.8
64.(b)	958	2%	1.7
64.(c)	958	2%	1.9