Earth Systems 3209 Grading Standards
June 2004

Pre-Marking Appraisal

All markers were in agreement that the exam length was appropriate and students should have no problem completing the exam in the scheduled time. Markers also felt that the level of difficulty and the quality of questions were fair.

The multiple choice questions were considered fair, well written, and clear in terms of what was being asked. It was agreed that for item # 48 all choices (A through D) be accepted. Although the most profound changes in life forms occurred with the reptiles, many other groups of organisms also experienced changes (extinctions).

The constructed response questions were also considered fair. Some concern was expressed by the markers regarding #53 (b). The difference between arrival times between P- and S- waves could be found by measuring 5 minutes on the vertical scale of the graph and finding the corresponding difference between P- wave and S- wave lines on the travel time graph. Markers also suggested that the distance represented by the 5 minutes above the seismogram which represents difference between P- and S- waves could also be used to find the answer to this problem. Either approach to answering this question was accepted. Also, the stem of #53 (c) had a 2% value assigned however there was no answer required. This 2% was reassigned to Question 54 (d), making it worth 4%.

Post Marking Report:

Marking Standard and Consistency

Marker reliability was checked by obtaining a random sample of 50 papers that went through the marker panel and marks were assigned to each question on a separate sheet of paper. The 50 exams were put back into the original stack of exams and corrected again when they appeared. The two values were compared and if there were discrepancies, the chief marker would review the scoring with the individual marker.

Throughout the marking process there was statistical analysis run on item data to enhance reliability and consistency of marking.

Commentary on Responses:

Although the questions were considered very fair there were questions that a significant percentage of students omitted

Summary:

It was apparent that many students performed poorly on those questions which tested outcomes at the higher cognitive level. It is imperative that students experience these types of questions throughout the year long evaluation process. It was also apparent that students who scored well in part II most often wrote their responses in a clear and concise manner. This approach to answering constructed response questions should be reinforced with students.

PART II
Total Value: 50%

Constructive Response/Common Errors

Item 51(a) *With reference to specific examples of radioactive dating and superposition, describe the difference between absolute and relative time.* ***3%***

Correct Answer:

Absolute time refers to an exact age of a material. Radioactive dating is one of the ways that a geologist may determine the exact age of the material. Whereas, relative time allows a geologist to determine the age of a material in relation or compared to another material. For example, a geologist may use the law of superposition to find that one material is older than another by seeing it is deeper in an undisturbed geologic sequence.

Commentary on Response:

This question was .

Common Errors:

- Students identified relative time as approximate time and failed to make the connection of a comparison or sequencing of events.
- Students used examples other than radioactive dating and superposition.

Item 51 (b) *A sample of carbon-14 has a half-life of 5730 years. If the parent isotope was 512 g, how many grams of parent isotope will remain after 34 380 years? Show all calculations.* ***2%***

Correct Answer:

$$\frac{34380 \text{ years}}{5730 \text{ years/half-life}} = 6 \text{ half-lifes}$$

512 g ➞ 256 g ➞ 128 g ➞ 64 g ➞ 32 g ➞ 16 g ➞ 8g

Commentary on Response:

Some students used the radioactive formula to find the final mass of the parent isotope.

$$N_f = N_0 (½)^{n/h} = (512\ g) (½)^{34380/5730} = (512\ g) (½)^6$$
$$= (512\ g) (1/64)$$
$$= 8\ grams$$

Students who used the formula and arrived at the wrong answer may not have received part marks because the calculation for the number of half-lifes may not have been evident. Some students, after finding the number of half lives, calculated the corresponding percentage (1.56%) and multiplied it by the original mass (512 grams) to get the mass remaining after 6 half lives, which is 7.99 grams or 8 grams.

Common Errors:

- Students associated the 512 grams with the first half-life, instead of the original amount at zero half-lives.

Item 51 (c) *Describe the processes that changed the original form of Earth's interior, 4.6 billion years ago, to its present form.* ***2%***

Correct Answer:

During the 4.6 billion years the interior of Earth has changed dramatically. At its initial formation Earth was a solid sphere which resulted from accretion of nebula. Radioactivity and collision of particles caused Earth's interior to heat up and melt. The process of segregation then began as gravity caused denser materials to move towards Earth's center forming the core and lesser dense materials to move toward the surface forming the crust. This density differentiation is still happening today and as a result Earth appears to have a layered interior.

Commentary on Response:

This question was poorly done.

Common Errors:

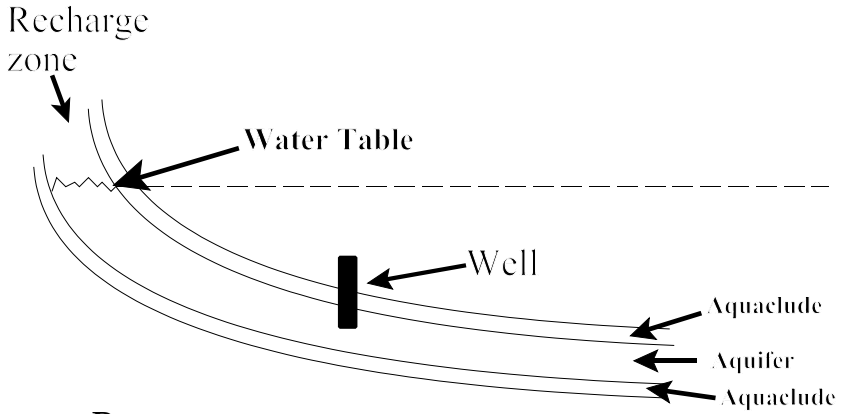
- Students assumed that Earth was molten at first and made no mention of heating of Earth's interior from radioactivity, and collision of particles.
- Students referenced the Rigid Earth theory of the formation of Earth.

Item 51(d) *Using a labelled diagram, describe the geologic conditions necessary for an artesian well to form.* ***3%***

Correct Answer:

For an artesian well to form, a confined aquifer must be positioned between two aquicludes. This aquifer must be inclined and exposed at the surface so it can be recharged with water. Gravitational pressure then causes the water to move through the aquifer.

The diagram should be similar to the following:



Commentary on Response:

This question was done moderately-well.

Common Errors:

- Students reversed the terms, aquiclude and aquifer.
- Students did not label diagrams.

Item 52(a) *What are two reasons why $CO_2(g)$ levels increase during springtime?* ***2%***

Correct Answer:

CO_2 levels reach their peak at spring time for a number of reasons. Firstly, during the winter, plants experience low levels of photosynthesis and remove less CO_2 from the atmosphere, which results in an increase in CO_2 levels. Secondly, during the winter time the consumption of fossil fuels increase which in turn releases CO_2 into the atmosphere, which also results in an increase in CO_2 levels. This trend of an increase in CO_2 levels during winter causes the peak at spring time.

Commentary on Response:

This question was done moderately-well.

Common Errors:

- Students suggested that plants produce CO_2.

Item 52(b) *Compare the reliability of using the physical properties of streak and colour when identifying minerals.* ***2%***

Correct Answer:

Streak is more reliable than colour because streak gives the true colour of a mineral in powdered form while the colour of a mineral may vary. The streak of any one mineral, regardless of its apparent colour will always be the same, whereas, any one mineral may vary in colour because of impurities contained within the mineral.

Commentary on Response:

Credit was also given if students alluded to different minerals having the same colour or if a mineral's colour changed because of oxidation or alteration of some kind.

Common Errors:

- Students mentioned that streak was used to find hardness of a mineral. Maybe the use of a streak plate could give some indication of a minerals hardness.
- Students suggested that neither streak nor colour is a reliable property to identify minerals.

Item 52(c) *Use an example to explain why two minerals with the same compositions can have different hardness and cleavage.* ***3%***

Correct Answer:

One example of two minerals with the same composition is graphite and diamond, both are composed of carbon. The physical properties, hardness and cleavage, are very different for the two forms of carbon mainly because:

(i) the arrangement of the carbon atoms: Diamond has its carbon atoms arranged in a tetrahedral network and graphite has its carbon atoms arranged in hexagonal sheets.

(ii) the strength of bonding between the atoms: Diamond has its carbon atoms bonded strongly in all directions while graphite has its carbon atoms bonded relatively strong within the hexagonal sheets with weak bonding between the sheets.

Commentary on Response:

This question was poorly done. Many students did not attempt this question.

Common Errors:

- Students compared two rocks instead of minerals.
- Students compared different silicates, sheet silicates with chain silicates.
- Students compared diamond and coal.
- Students provided definitions for cleavage and hardness and did not answer the question.
- Students failed to mention arrangement of atoms and/or strength of bonding in the answer.

Item 52(d) *What two pieces of information about glaciers can be determined rom eskers and terminal moraines?* ***2%***

Correct Answer:

Eskers and terminal moraines can provide various information about glaciers and marks were given for mentioning any two of the following:

(i) direction,
(ii) termination of glacier,
(iii) type of rock glacier passed over,
(iv) streams flowed beneath glacier,
(v) type of glacial sediment (till versus drift),
(vi) relative size of glacier.

Other answers were accepted if deemed appropriate.

Commentary on Response:

This question was done moderately-well.

Common Errors:

- Students provided just definitions and suggested nothing of what these features indicate.
- Students suggested that the thickness and rate of melting of the glacier can be determined from eskers and terminal moraines.

Item 53(a) *Rhyolite and granite have very similar chemical composition, yet they look quite different. Explain why. 2%*

Correct Answer:

Rhyolite and granite may originate from a single magma source and thus have the same chemical (mineral) composition. The environment, volcanic versus plutonic, in which the molten rock solidifies is the reason why the two rocks look different.
Rhyolite, is a fine grained felsic igneous rock which forms in a volcanic environment, on or near Earth's surface. This environment allows the lava to cool quickly which results in a fine textured igneous rock.

Granite, is a course grained felsic igneous rock which forms in a plutonic environment, deep beneath Earth's surface. This environment allows the magma to cool slowly which results in a course textured igneous rock.

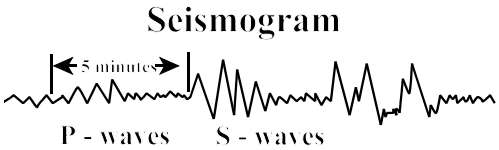
Commentary on Response:

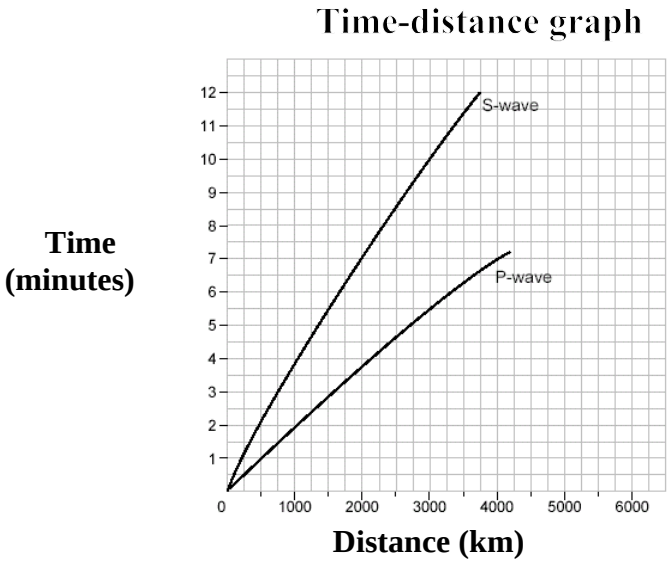
This question was poorly done. Many students scored zero and/or did not attempt this question.

Common Errors:

- Students referred to granite and rhyolite as metamorphic rocks.
- Students confused granite with rhyolite by providing an explanation for granite which was correct for rhyolite, and visa versa. (e.g., referring to granite as volcanic and rhyolite as plutonic).
- Students provided correct information to differentiate between granite and rhyolite, but did not state which explanation referenced granite and rhyolite. In many cases, granite and rhyolite were not mentioned in the answer.

Item 53(b) *At a seismic station, the P - and S - waves of an earthquake were recorded on a seismogram shown below. Using the travel time graph given, how far away was the earthquake from the seismic station? Explain how you arrived at this answer.* ***2%***





Correct Answer:

Using the travel - time graph, it can be determined that the difference in arrival times between the P- and S-waves was 3500 kilometers. This can be found by measuring 5 minutes on the time scale (vertical axis) and then finding the vertical distance between the P-wave and the S-wave arrival lines that is equal to 5 minutes (10 blocks) between the two lines on the graph. The corresponding distance can then be read off the x-axis below, in this case the distance is 3500 km.

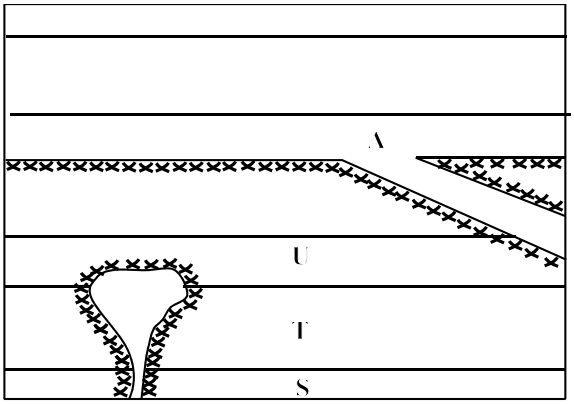
Commentary on Response:

Answers were accepted that ranged from 3250 km to 3750 km. Some students used the distance represented on the seismogram above and credit was given for the corresponding distance of the earthquake epicenter in this case which was accepted between 2250 km and 2500 km.

Common Errors:

- Students did not use the correct vertical scale, counting one block as one minute.
- Students recorded the distance from the end of the S-wave line and not the difference between the P-wave and S-wave lines.
- Students measured from the 5 minute mark across to the P-wave line and recorded the corresponding distance for this point, which read 2750km.
- Students failed to justify the correct distance.

Item 53 (c) *In the diagram below, A and B represent igneous rock units.*



Item 53 (c) (i) *State one igneous rock that could be represented by:* ***2%***

Rock unit "A"? _____

Rock unit "B"? _____

Correct Answer:

Rock unit "A"? Any volcanic igneous rock, such as basalt or rhyolite
Rock unit "B"? Any plutonic igneous rock, such as granite diorite

Commentary on Response:

This question was poorly done.

Common Errors:

- Students provided minerals as examples instead of rocks.
- Students stated sedimentary and metamorphic rocks as examples.
- Students stated a volcanic example for rock "B" (plutonic rock) and a plutonic rock for rock "A" (volcanic rock).

Item 53 (c) (ii) *Which igneous formation from the diagram would display smaller crystals? Explain.* ***2%***

Correct Answer:

Rock unit "A" would display the smaller crystals. This rock is representative of an extrusive lava flow that was exposed to the surface. Such exposure causes a rapid rate of cooling and did not allow time for crystals to form and grow. If students said rock unit "B" had finer crystals and supported their claim by stating the igneous unit is smaller or narrower and would thus cool faster, credit was also given.

Commentary on Response:

This question was done moderately well.

Common Errors:

- Students picked rock unit "B" instead of rock unit "A", but said it cooled faster.

Item 53 (c) (iii) *What does the symbol "* *" represent surrounding rock unit B?* ***1%***

Correct Answer:

The symbol surrounding rock unit "B" is representative of contact metamorphism. Other acceptable answers include burning, baking, alteration, etc....

Commentary on Response:

This question was done moderately well.

Common Errors:

- Students referred to the symbol as regional metamorphism.
- Students stated the symbol represents an intrusion, which is not correct. Rock unit "B" is an intrusion which causes contact metamorphism.

Item 53 (c) (iii) *Describe the effect rock unit B has on the layers S, T, and U.* ***1%***

Correct Answer:

The intrusion of rock unit "B" has caused contact metamorphism on rock units "S, T, and U." The heat given off as unit "B" cools causes the surrounding rock to become baked, burned, or changed.

Commentary on Response:

This question was done moderately well.

Common Errors:

- Students mentioned that rock unit "B" cross cuts rock units "S, T, and U." This is true but does not answer the question.
- Students associated rock unit "B" with an unconformity.

Item 53(d) *Describe the formation of ripple marks in a shallow water environment.* ***2%***

Correct Answer:

Ripple marks form in shallow water environments due to the effects of moving water. Water moving as currents typically is unidirectional and water moving as waves typically is bidirectional (back and forth). Water movement is the mechanism by which sediment particles are moved and deposited in the form of small ridges or ripples. Asymmetrical ripples are formed by unidirectional water movement and symmetrical ripples are formed by back and forth (bidirectional) water movement.

Commentary on Response:

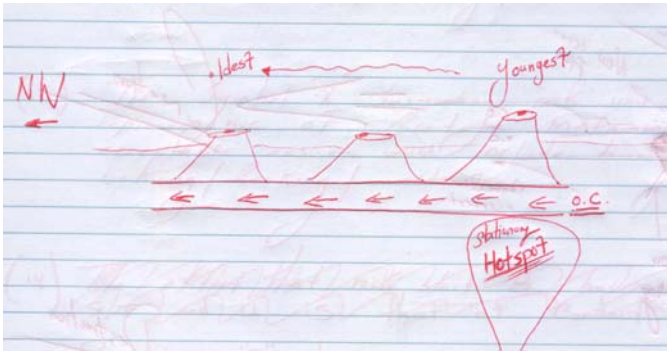
This question was poorly done.

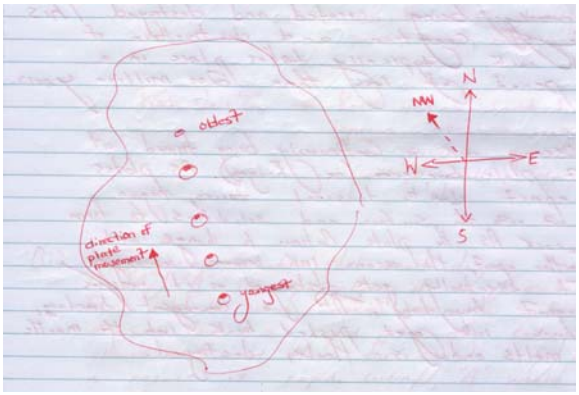
Common Errors:

- Students discussed the formation of ripple marks by wind.
- Students failed to mention the formation of tiny ridges (ripples) in the sediment.

Item 54 (a) *Using a labelled diagram, explain how the Hawaiian Islands support the theory of Plate Tectonics.* ***2%***

Correct Answer:





The Hawaiian Islands are formed as a result of intraplate volcanism where the pacific plate is moving over a stationary hot spot located in the upper mantle. The Northwest movement of the Pacific plate over the hot spot has left a chain of volcanic islands which progressively increase in age the farther you travel from the island of Hawaii presently positioned over the hotspot. Convection currents in the asthenosphere is responsible for moving the Pacific plate to form the chain of inactive volcanic island to the Northwest. This data supports the theory of plate tectonics.

Commentary on Response:

This question was done moderately well.

Common Errors:

- Students associated the formation of the Hawaiian Islands with plate divergence or plate convergence and not a hot spot (intraplate tectonics).
- Students suggested that the hot spot was moving beneath the Pacific plate.
- Students drew diagrams of divergent and/or convergent plate boundaries.

Item 54 (b) *If Earth is 4.6 billion years old, explain why the oldest oceanic rocks are less than 200 million years old?* ***2%***

Correct Answer::

The oldest oceanic rocks are less than 200 million years old because the ocean floor is continuously being created and destroyed. This recycling of the ocean floor typically takes place in a time period of less than 200 million years. New ocean floor is created at divergent plate boundaries (ridges) and gets older the farther you move away from these boundaries. The older ocean floor eventually gets destroyed as it subducts deep into convergent boundaries (trenches) where it melts and recycles back into the mantle.

Commentary on Response:

This question was poorly done.

Common Errors:

- Students described divergent boundaries and the creation of crust or convergent boundaries and the destruction of crust. Discussing one of the above alluded to half of the correct answer. Very few students mentioned the cycling or recycling of the ocean floor.
- Students discussed the rock cycle instead of the cycling of the ocean floor.
- Students mentioned volcanic outgassing as a source of formation of new ocean floor.

Item 54 (c) *Which type of volcano is formed at ocean-continent convergent boundaries? Describe the composition of lava associated with these volcanoes.* ***2%***

Correct Answer:

A composite or strato-volcano would form at ocean-continent convergent boundaries. The lavas associated with these volcanoes would range from granitic to andesitic in composition. These lavas would have a relatively high silica and dissolved gases content. This would make the lava very viscous (thick) and as a result explosive.

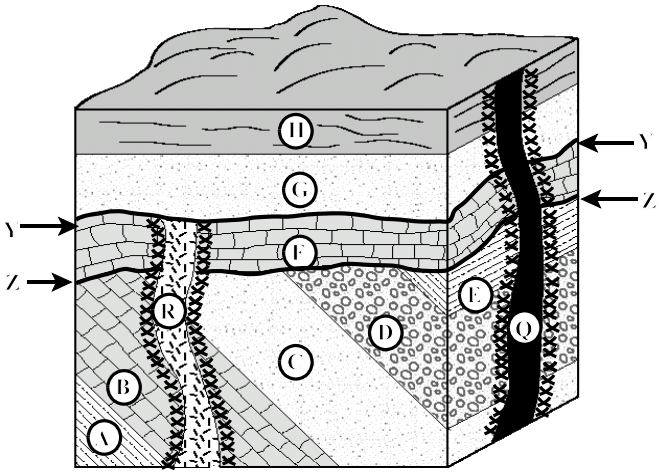
Commentary on Response:

This question was poorly done.

Common Errors:

- Students said that shield volcanoes are found at continent-ocean boundaries.
- Students described basaltic composition and not andesitic or granitic composition.

Item 54 (d) *Arrange the letters from the diagram below in the order they occur, beginning with the oldest event and ending with the youngest event.* ***4%***



Oldest Youngest

__ __ __ __ __ __ __ __ __ __ __

Correct Answer:

Oldest Youngest

A B C D E Z F R Y G H Q

Commentary on Response:

This question was well done .

Common Errors:

- Students labelled the letters in the reverse order.
- Students reversed letter "Y" and letter "R", which suggest the unconformity, "Y" occurred before the intrusion of "R".

Item 54 (e) *Complete the following chart.* ***2%***

Resource	How Formed	Use in Society
bauxite	secondary enrichment	aluminum foil
halite		
gold		

Correct Answer:

Resource	How Formed	Use in Society
bauxite	secondary enrichment	aluminum foil
halite	*evaporation, evaporite, or chemical sediment*	*road salt, or table salt*
gold	*hydrothermal, placer, or disseminated*	*jewelry, electronics, dental, etc...*

Commentary on Response:

This question was poorly done.

Common Errors:

- Students left the column out with reference to how the mineral resource formed. Other answers in this column included primary enrichment and secondary enrichment.
- Students suggested that halite was used for building material, wiring, and light bulbs.

Item 55 (a) *Use the Law of Uniformitarianism to explain why oil may be considered a renewable resource.* ***2%***

Correct Answer:

Since the Law of Uniformitarianism suggests that the present is the key to the past, processes occurring today and in the past will continue to occur in the future. From this perspective, the processes that created oil deposits in the past are likely to create oil deposits in the future. Even though this process will take considerable time, it is still occurring and, as such, oil may be considered renewable.

Commentary on Response:

This question was done moderately - well.

Common Errors:

- Students referenced the recycling of oil by society and not by natural processes.
- Students talked about the recycling of oil and made no reference to uniformitarianism.

Item 55 (b) *Describe two possible reasons why jellyfish are poorly represented*
2% *in the fossil record even though they were relatively abundant during the Paleozoic Era.*

Correct Answer:

Jellyfish are poorly represented in the fossil record because they lacked the hard body parts necessary for fossilization. As well, they tend to float, making them prone to predation and making it difficult for them to sink for rapid burial. Soft bodied organisms tend to decompose quickly making it difficult to become fossilized.

Commentary on Response:

This question was well done .

Common Errors:

- Students stated only one reason to suggest why jellyfish are poorly represented in the fossil record.

Item 55 (c) *Explain how the fossil record demonstrates the progressive*
3% *changing of life forms. Use specific examples that reference geologic time.*

Correct Answer:

The fossil record demonstrates the progression of life by showing how organisms appeared to develop from simpler single cell life forms to complex multicellular organisms. The Precambrian fossils represent simpler life forms, while the Paleozoic, Mesozoic, and Cenozoic show the development of life to more complex forms.

Life during Paleozoic time showed evolution trends such as, invertebrates to vertebrates (e.g., fish to amphibians and to early reptiles). Plant life also developed during this time moving from a water environment to a terrestrial environment. Life during the Mesozoic evolved to include birds and early mammals. Finally, life throughout the Cenozoic marked the development and dominance of mammals. Each change in life form represents an increase in the complexity of life throughout geologic time.

Commentary on Response:

This question was poorly done.

Common Errors:

- Students did not connect the advancements of life forms with geologic time.

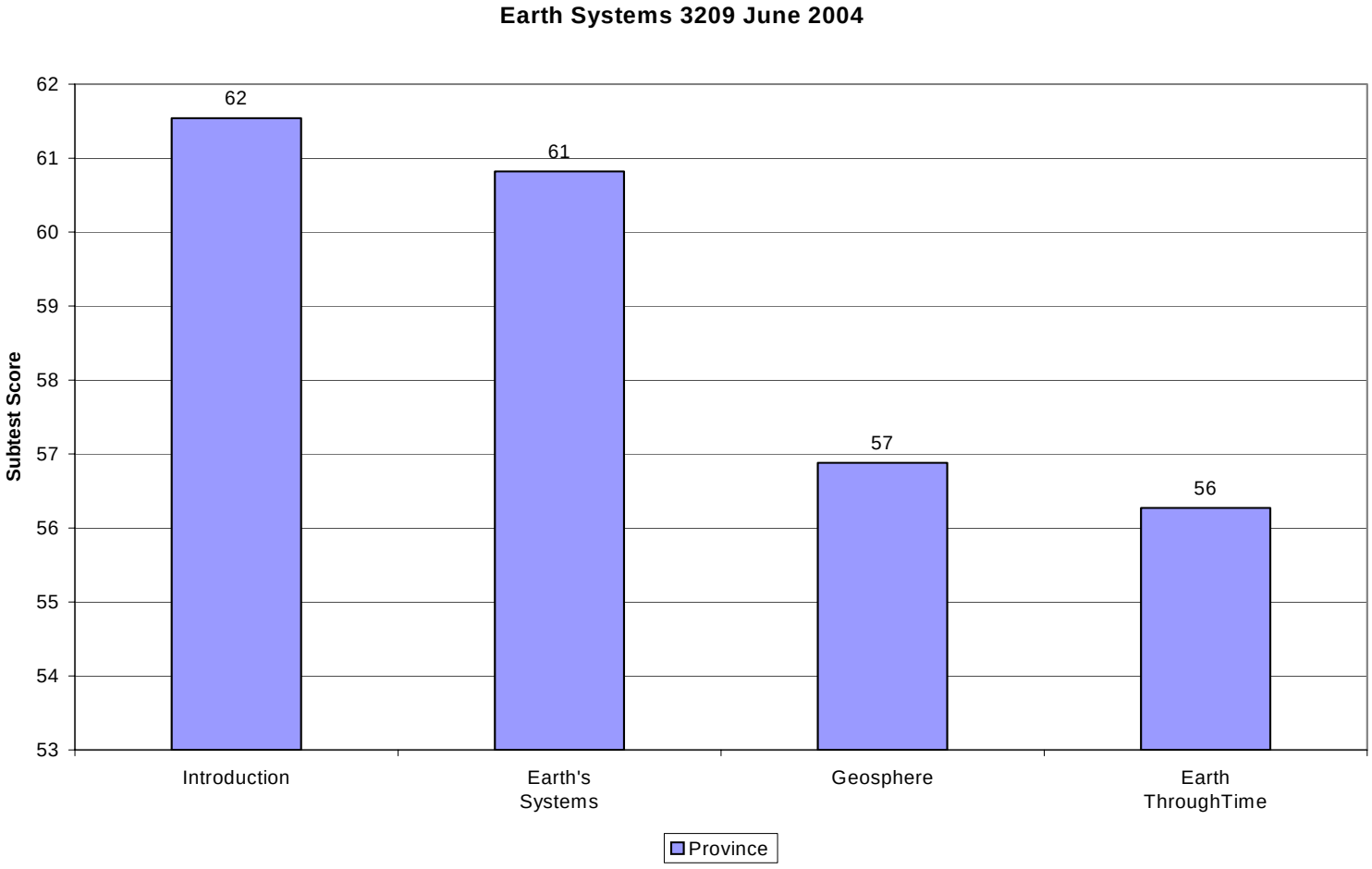
EARTH SYSTEMS 3209 ITEM ANALYSIS
SELECTED - RESPONSE (PART I)

Item	Answer	Cognitive Level	Responses				
			Multiple Answers or No Response	A	B	C	D
			%	%	%	%	%
1	D	1	0	5.1	24.2	4.8	65.9
2	C	1	0.2	18.8	3.4	75.4	2.2
3	C	2	1.1	3.8	14.2	67.9	13
4	B	1	0.1	23.2	38.7	33.4	4.6
5	A	1	0	86.2	1	2.3	10.5
6	D	1	0	19.7	0.5	0.8	79.1
7	A	1	0.2	64.5	8.8	13.3	13.2
8	A	1	0.3	65	20	5.1	9.6
9	B	1	0	4.2	71.6	21.7	2.5
10	B	1	0.1	6.1	54.6	31.2	8
11	B	1	0.2	10.4	54.8	16.4	18.2
12	D	1	0.5	6.7	20.3	10.6	80
13	A	1	0.3	60	1.8	33.2	4.7
14	C	2	0.2	17.2	11.3	57	14.3
15	B	1	0.1	23.1	20.1	36.9	19.8
16	D	1	0	7.5	7.4	10.7	74.4
17	A	2	0.1	87	2.5	1.9	8.4
18	C	1	0.2	6.5	29.4	54.4	9.6
19	B	1	0.2	24.7	61.4	8.2	5.5
20	C	1	0	14.1	5.5	75.8	4.7
21	B	1	0.1	10	53.9	16.4	19.5
22	D	3	0.2	1.4	4.8	2.5	91.1
23	D	2	0.1	13.5	25.8	16.2	44.4
24	B	1	0.1	12.9	71.2	11.1	4.7
25	A	1	0.2	76.5	13.8	3.1	6.5

Item	Answer	Cognitive Level	Responses				
			Multiple Answers or No Response	A	B	C	D
			%	%	%	%	%
26	D	1	0	0.6	10.1	0.5	88.9
27	D	1	0.3	32.3	6.6	5	55.7
28	B	1	0	8	73.3	9	9.8
29	C	1	0	11.9	3.4	83.2	1.5
30	C	1	0.1	4	3.2	85.8	6.9
31	D	1	0.1	17.9	1.7	20.3	60.1
32	C	1	0.1	7.5	7.5	69.4	15.5
33	B	1	0.1	30.7	62.6	1	5.6
34	B	2	0	9.1	56.8	8.3	25.8
35	B	1	0	1.5	95.3	1.4	1.8
36	B	3	0.1	28	34.9	21.4	15.6
37	C	1	0.1	15.6	20.5	58.4	5.5
38	A	1	0	69.6	3.8	4.7	22
39	C	1	0.1	35.2	9.7	50.2	4.9
40	A	1	0.2	45.5	18.4	23.4	12.4
41	A	2	0.2	66.6	8.2	20.3	4.8
42	B	1	0.1	26.3	39.2	26.4	8
43	D	1	0	17.6	14.7	7.6	60.1
44	C	1	0	25	5.5	59.7	9.8
45	A	2	0.2	37	18.8	15.5	28.6
46	A	2	0.1	80.9	0.7	11.9	6.4
47	A	1	0.1	70.2	14.8	10.7	4.1
48	A,B,C,D	1	0	9.1	14.9	4.9	71.1
49	C	1	0.1	4.4	4.3	75.9	15.2
50	B	1	0.1	18.2	23.5	35.4	22.8

EARTH SYSTEMS 3209 ITEM ANALYSIS
CONSTRUCTED - RESPONSE (PART II)

Item	Cognitive Level	Students Completing Item	Value	Average	Average % Per Item
51(a)	2	875	3	2.38	79.3
51(b)	2	875	2	1.11	55.5
51(c)	2	875	2	0.55	27.5
51(d)	2	875	3	1.68	56
52(a)	2	875	2	0.97	48.5
52(b)	2	875	2	1.57	78.5
52(c)	2	875	3	0.68	22.7
52(d)	2	875	2	1.15	57.5
53(a)	3	875	2	0.79	39.5
53(b)	2	875	2	0.83	41.5
53(c)(i)	2	875	2	0.68	34
53(c)(ii)	3	875	2	1.22	61
53(c)(iii)	2	875	1	0.61	61
53(c)(iv)	3	875	1	0.36	36
53(d)	2	875	2	0.81	40.5
54(a)	3	875	2	0.83	41.5
54(b)	2	875	2	0.7	35
54(c)	2	875	2	0.61	30.5
54(d)	3	875	4	3.21	80.3
54(e)	2	875	2	0.72	36
55(a)	2	875	2	1.24	62
55(b)	2	875	2	1.37	68.5
55(c)	2	875	3	0.79	26.3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Subtest Score
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